



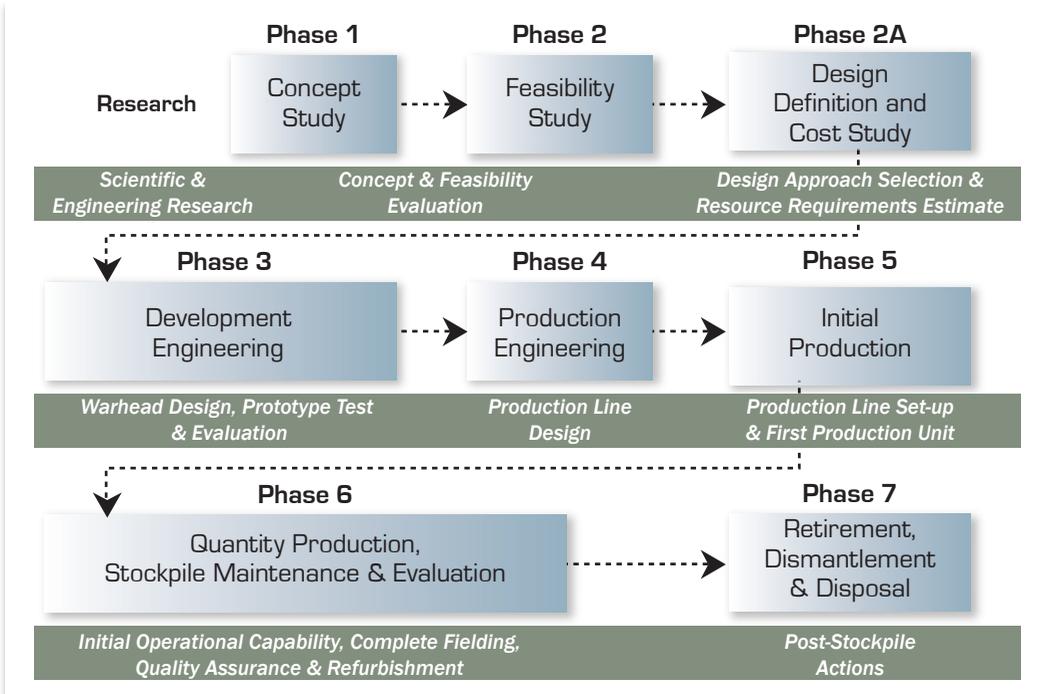
# Appendix **B**

## U.S. Nuclear Weapons Life-Cycle

### B.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 stockpile management, the DoD and the DOE, through the NNSA, have specific responsibilities related to nuclear weapons life-cycle activities. This chapter describes the most significant activities and decision points during 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 Between the AEC and the DoD for the Development, Production, and Standardization of Atomic Weapons*, commonly called the 1953 Agreement. U.S. nuclear weapons have not undergone the full life-cycle phase process since the completion of the W88 Phase 5 in 1991. The United States has not produced new nuclear weapons since 1991. **Figure B.1** depicts the traditional joint DoD-DOE/NNSA nuclear weapons life-cycle phases.

Figure B.1 Joint Nuclear Weapons Life-Cycle Phases



Historically, life-cycle phases 1 through 7 established activities associated with the acquisition of nuclear weapons into the stockpile through their eventual retirement. Since 1999, the phased life-cycle process has evolved to focus on key elements in weapon stockpile sustainment. Today, the 6.X Process provides the framework for nuclear weapon stockpile sustainment activities. The 6X Process is not intended to replace established Phase 6 activities such as routine maintenance, stockpile evaluation, enhanced surveillance, and annual assessment. Rather, stockpile sustainment encompasses the refurbishment of existing warheads and the reuse or replacement of nuclear and non-nuclear components in order to maintain the security, safety, reliability, and effectiveness of the nuclear weapons stockpile. The 6.X Process activities are for non-routine nuclear weapon alterations (Alts) at the system, sub-system, or component level; life extension programs (LEPs); and other warhead modernization activities. Stockpile sustainment activities conducted under the 6.X Process follow current policy to utilize warhead remanufacturing, component reuse, and component replacement, excluding limited life component exchange (LLCE) (e.g., tritium gas bottle replacement

which is managed under normal weapon maintenance programs). Nuclear weapon alterations are assessed on a case-by-case basis to determine applicability of the Phase 6.X Guideline. Depending on the specific stockpile sustainment activity some portions of the 6.X Process may be merged, deferred, modified, or omitted, as approved by the Nuclear Weapons Council (NWC). Additionally, the NWC may authorize the weapon Project Officers Group (POG) to coordinate Alts as routine weapon sustainment activities.

## B.2 Phase 6.X Process

Since 1992, the NWC has concentrated its efforts on research related to the maintenance and sustainment of the existing weapons in the legacy stockpile and oversight of the stockpile sustainment activities in the absence of underground nuclear testing. To manage and

facilitate the stockpile sustainment process, the NWC approved the *Procedural Guideline for the Phase 6.X Process* in April 2000. This guideline has been revised and the revision is in the NWC approval process. The revision takes into account the evolution of the stockpile since 2000 and draws on the experience from a

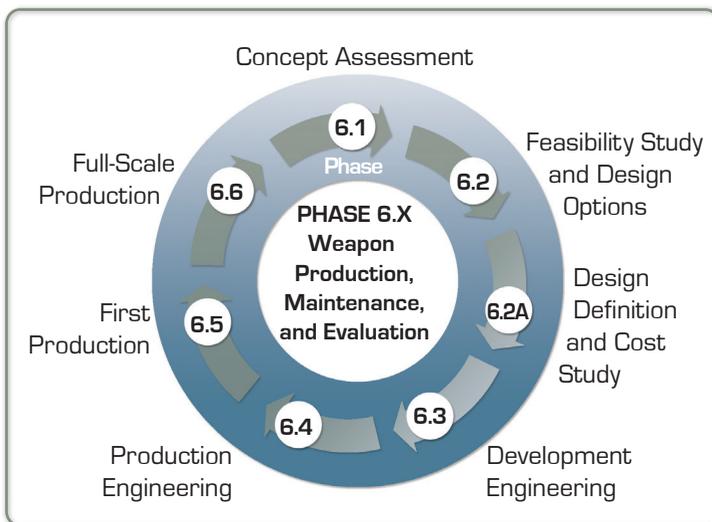


Figure B.2 Phase 6.X Process

number of LEPs, Alts, and modifications (Mods) conducted in this timeframe. **Figure B.2** is an illustration of the 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 6. There is no Phase 6.7, as any weapon slated for retirement, dismantlement, and disposition is covered by the Phase 7 Process. The phased life-cycle process was used to develop a complete warhead, whereas the 6.X Process is intended to develop and

field only those components that must be replaced as a part of the approved stockpile sustainment program for a legacy warhead-type. Each stockpile sustainment 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 approves proposed LEPs, Alts, and Mods. The NWC monitors progress throughout the 6.X Process to ensure the stockpile continues to be safe, secure, and reliable, while meeting DoD and DOE/NNSA requirements.

### B.2.1 Phase 6.1 – Concept Assessment

The DoD and the DOE/NNSA are continuously engaged in assessments of nuclear weapons or components as part of normal operations. These activities result in a continuous exchange of information and provide potential concepts for sustainment of systems or components. The DoD and the DOE/NNSA conduct Phase 6.1 studies independently, except when they influence design and operation of the other Department's components.

During Phase 6.1, concepts to meet DoD and DOE/NNSA needs are assessed. If the concept is assessed to be valid, the POG determines if a formal program study is warranted or whether the activity should be managed as a POG maintenance action outside the 6.X Process. A formal program study considers program execution; taking into consideration projected technologies, range of costs, and associated technological and program risks.

Prior to commencing a Phase 6.1 study, the POG provides written notification to the NWC Standing and Safety Committee (NWCSSC). This notification, at a minimum, includes an overview of the study's purpose, scope, objectives, and deliverables.

#### Key Tasks and Deliverables

At the completion of the Concept Assessment phase, the POG provides:

- summary of study results to the NWCSSC, including a discussion of all potential concepts and a range of costs and technological risks based on technical boundaries that were considered in the study;
- initial assessment of supply chain protection considerations;
- proposed potential changes to the military characteristics (MCs), stockpile-to-target sequence (STS), or other DOE/NNSA requirements drivers; and
- recommendation to proceed to Phase 6.2, to terminate Phase 6.1 without further action, or to address any issues through normal POG activities.

The POG briefs the NWCSSC on the status of the Phase 6.1 study as requested. Phase 6.1 is complete when the POG submits its reports and deliverables to the NWCSSC.

## B.2.2 Phase 6.2 – Feasibility Study and Design Options

Once the POG receives approval for entry into Phase 6.2, the POG is authorized to pursue a joint study to further refine potential concepts. During Phase 6.2, the POG develops design options and assesses the feasibility (e.g., cost, schedule, and technical maturity) of these options based on developed criteria to include tradeoffs and courses of action depending on MCs, STS, timelines, and budgetary and resource constraints to meet the needs for a particular nuclear weapon.

Prior to entering a Phase 6.2 study, the POG acquires written authorization for entry from the NWC or NWCSSC, as appropriate, based on the scope of the effort. In arriving at a decision to authorize entry into Phase 6.2, the NWC factors in the time available for completing activities when establishing the scope of a Phase 6.2 feasibility study of military performance requirements and design options.

### Key Tasks and Deliverables

The POG develops a joint, integrated Phase 6.2 study plan outlining the approach, scope, and schedule for the Phase 6.2 analysis activities as early as possible. At a minimum, the Phase 6.2 analysis considers the following programmatic areas during system design:

- range of design options, to include preliminary cost, technological risk, and schedule;
- ability to meet system requirements, to include notional surveillance and logistics components overbuilds;
- evaluation of options to enhance nuclear safety, security, and use control, to include supply chain protection considerations;
- technology readiness levels and associated risk analysis;
- research and development requirements and capabilities;
- qualification and certification requirements;
- production capabilities and capacities;
- research and development, production, life-cycle maintenance, and logistics scope;
- delivery system and platform integration, to include platform nuclear certification considerations;

- preliminary safety study, to include requirements to meet safety environments; and
- rationale for component reuse, remanufacture, or replacement.

The POG updates existing MCs or drafts new MCs to reflect DoD requirements. These updated or new MCs are validated within the DoD and analyzed by the DOE/NNSA to assess the ability to produce, qualify, and certify the design options. Additionally, the POG may evaluate and update existing STS and Interface Control Documents (ICDs). If updates are required, the POG coordinates any STS changes while approval of ICD updates are controlled between the DOE/NNSA and the appropriate Military Department.

The DOE/NNSA prepares a Major Impact Report (MIR), as necessary, reflecting any major impacts due to the down-selected option(s).<sup>1</sup> The POG includes the DOE/NNSA MIR as an appendix to the Phase 6.2 study report.

The Military Department may decide to conduct a preliminary Pre-Operational Safety Study to begin the process of identifying specific weapon system safety rules. During Phase 6.2 and continuing through to Phase 6.5, the Nuclear Weapon System Safety Group (NWSSG) examines system design features, hardware, procedures, and aspects of the concept of operation that affect safety to determine if DoD nuclear weapon system safety standards can be met. The NWSSG identifies safety-related concerns and deficiencies so corrections may be made in a timely and cost-efficient manner.

The POG briefs the NWCSSC on the status of the Phase 6.2 study at least every six months and delivers a final Phase 6.2 study report to the NWCSSC at the conclusion of the study.

The Phase 6.2 study report summarizes options considered and associated analyses. It documents criteria used to down-select from the options considered (e.g., the extent to which each concept meets DoD and DOE/NNSA requirements), as well as operational risk management plans to ensure U.S. operational commitments are not affected by the stockpile sustainment activity. Draft MC and STS documents are also included in the Phase 6.2 study report.

The POG down-selects design options to be analyzed for cost in Phase 6.2A. These options are presented to the NWC for approval prior to commencing Phase 6.2A.

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<sup>1</sup> Down-selected option(s) are those selected from a field of options to continue to the next phase.

### B.2.3 Phase 6.2A – Design Definition and Cost Study

Phase 6.2A continues upon successful completion of Phase 6.2 activities. During Phase 6.2A, the POG refines the down-select options by updating the down-select criteria developed in Phase 6.2, developing design and qualification plans, identifying production needs, and creating a preliminary life-cycle plan. The life-cycle plan includes costs to address system stockpile evaluation program requirements and rebuilds, maintenance and logistics, trainer procurement, and handling gear for the protected period. This phase culminates with the release of the Joint Integrated Project Plan (JIPP) from the POG and the Weapon Design and Cost Report (WDCR) from the DOE/NNSA.

#### Key Tasks and Deliverables

The POG creates the JIPP based on DoD and DOE/NNSA input to implement the proposed down-selected set of options. The JIPP serves as the baseline control document for the stockpile sustainment activity. It discusses, as applicable:

- scope (e.g., Mod, Alt, or LEP);
- design definition;
- project schedule (including joint DoD-DOE/NNSA milestones, planned management briefings and reviews, and certification schedules);
- cost analysis;
- configuration management;
- qualification and certification plans;
- supply chain protection program plan;
- Military Department test and evaluation plans;
- MCs, STS, and ICD changes;
- system memoranda of understanding between the DoD and the DOE/NNSA;
- stockpile evaluation planning;
- operational safety implications (integrated safety process);
- proposed changes to technical publications;
- trainers and weapon-type requirements;
- spares, handling gear, use control equipment, tools, gauges, and field testers;
- development testing and modeling support requirements;



*The lathe is used to machine high explosives parts for use in weapon life extension programs at Pantex*

- process development and product qualification;
- archiving and lessons learned;
- component and material characterization for disposition;
- product delivery (components and documents);
- risk management; and
- classification management review.

The DOE/NNSA develops the WDCR to reflect preliminary cost estimates for design, qualification, production, and life-cycle activities. The JIPP and WDCR are primary inputs to the Phase 6.2A study report.

The POG briefs the NWCSSC on the status of the Phase 6.2A study as requested. At the conclusion of the study, the POG delivers a final Phase 6.2A study report to the NWCSSC that serves as the basis for a Phase 6.3 entry request, if recommended. The report describes Phase 6.2A activities and includes a recommendation on the design option to carry forward into Phase 6.3, including the applicable Military Department costs. The JIPP and WDCR are included as appendices to the report.

The major deliverables for Phase 6.2A are draft MCs, draft STS, MIR, JIPP, WDCR, and the Phase 6.2A Report.

Upon completion of Phase 6.2A, the POG presents a summary of the Phase 6.2A study report to the NWCSSC. At a minimum, this summary includes the following program information:

- scope of stockpile sustainment activity;
- design definition, to include preliminary component reuse forecast;
- preliminary project schedule with major milestones;
- military requirements, to include any changes;
- supply chain protection program plan;
- qualification and certification plans, to include updated platform nuclear certification considerations;
- trainer and handling gear forecast;
- proposed Stockpile Evaluation Program (SEP) plan;
- platform requirements, to include any changes;

- risk management strategy;
- requirements management process;
- configuration management process; and
- cost analysis, to include trade-off decisions.

## B.2.4 Phase 6.3 – Development Engineering

During Phase 6.3, the DOE/NNSA, in coordination with the DoD, conducts experiments, tests, and analyses to develop and validate the selected design option. The national laboratories initiate process development activities and produce test hardware, as required.

The POG submits a recommendation to the NWC to proceed to Phase 6.3 with a down-select option. The recommendation for Phase 6.3 entry includes updated MCs and STS documents, as appropriate. Prior to executing Phase 6.3 activities, the POG acquires written authorization to proceed from the NWC.

### Key Tasks and Deliverables

Following its authorization to enter Phase 6.3, the NWC prepares a letter requesting Military Department and DOE/NNSA participation in Phase 6.3. The DOE/NNSA and the appropriate Military Department generate and approve interagency agreements, as required, to cover technical and financial responsibilities for product-specific or joint activities. The DoD and the DOE/NNSA forward acceptance letters to the NWC confirming their participation in Phase 6.3. These letters also include comments on the MCs and STS, as well as any exceptions or concerns regarding study execution or schedule.

As required, the NWSSG provides a preliminary Pre-Operational Safety Study briefing to the NWCSSC and appropriate Military Departments that includes draft weapon system safety rules.

The DOE/NNSA formally updates the WDCR and reissues it as the Baseline Cost Report (BCR). The DOE/NNSA provides the BCR to the NWCSSC to establish a program cost baseline. The DOE/NNSA, in coordination with the Defense Threat Reduction Agency (DTRA) and the Military Department, also prepares a product change proposal identifying stockpile sustainment activity scope, schedule, and specific DoD and DOE/NNSA roles and responsibilities.

The national laboratories prepare a draft addendum to the Final Weapon Development Report (FWDR) or create a new FWDR draft. This draft includes a status of the design,

as well as an initial discussion of design objectives, descriptions, proposed qualification activities, ancillary equipment requirements, and project schedules.

The Military Department convenes a Design Review and Acceptance Group (DRAAG) to review the draft FWDR. Once the review is complete, the Military Department informs the NWC of the preliminary DRAAG report findings and recommendations.

The POG updates the JIPP based on Military Department and DOE/NNSA input. The POG also updates the MC and STS documents, as appropriate, and ensures stakeholder requirements are fully considered.

The POG briefs the NWCSSC on the status of Phase 6.3 at least every six months.

The major deliverables for Phase 6.3 are BCR, draft addendum to the FWDR (or new FWDR draft), preliminary DRAAG report, updated JIPP, and approved MC and STS documents.

Once the national laboratories finalize the design definition and conduct the Baseline Design Review, the DOE/NNSA authorizes the laboratories and production plants to enter into Phase 6.4.

## B.2.5 Phase 6.4 – Production Engineering

During Phase 6.4, the DOE/NNSA refines the developmental design into a producible design and prepares the production agencies for production. During this phase, the acquisition of capital equipment is completed; tooling, gauges, use control, handling gear, and testers are 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. The DOE/NNSA updates production cost estimates based on preliminary experience gained in PPI and product qualification. Finally, the DoD and the DOE/NNSA define procedures to conduct stockpile sustainment including supply chain protection considerations and the necessary logistics supporting weapon movements.

### Key Tasks and Deliverables

During Phase 6.4, the DOE/NNSA performs a number of activities to transition to a producible design including:

- testing developmental prototypes, conducted with the Military Department to ensure operational validation, as appropriate;

- conducting PPI activities leading to a qualified process;
- publishing engineering authorizations to support product and process development; and
- updating production cost estimates.

The DoD and the DOE/NNSA also accomplish a number of joint activities including:

- provisioning for spare components;
- conducting a laboratory task group and joint task group review to validate proposed procedures;
- updating and finalizing technical publications through a manual files conference; and
- updating the SEP.

The POG briefs the NWCSSC on the status of Phase 6.4 at least every six months.

The POG provides an updated JIPP to the NWCSSC and the DOE/NNSA updates the BCR. Prior to entry into Phase 6.5, the POG provides written notification to the NWC that the DOE/NNSA is prepared to transition to Phase 6.5.

## B.2.6 Phase 6.5 – First Production

During Phase 6.5, the DOE/NNSA production agencies produce the first warheads. The POG determines if these warheads meet design and military requirements.

### Key Tasks and Deliverables

The DOE/NNSA makes a final weapon evaluation of the design and production processes. The national laboratories, in coordination with the DOE/NNSA, prepare the final draft addendum to the FWDR, and then submit the draft FWDR and addendum, and the draft MIR to the DRAAG for final review.

The Military Department convenes the DRAAG to review the final draft addendum to the FWDR. Once the review is complete, the Military Department informs the NWC of the final DRAAG report findings and recommendations. The DRAAG, in coordination with the Military Department, informs the DOE/NNSA whether the weapon meets MCs, STS, and other applicable requirements.

The national laboratories finalize and release the addendum to the FWDR upon receipt of DRAAG comments, findings, and recommendations and attach a nuclear system certification letter which serves as the formal recertification for the nuclear system and requalification for system deployment.

The national laboratories also finalize and transmit the Major Assembly Release (MAR) to the DOE/NNSA following evaluation of production activities and completion of DoD reviews; the DOE/NNSA formally issues the MAR. The first weapons are released to the DoD when the NWC accepts the final DRAAG report and the MAR is issued.

The first production unit (FPU) milestone occurs when the Military Department and/or the NWC accepts the design and the DOE/NNSA verifies the first produced weapon(s) meets the design. Phase 6.5 terminates with DoD acceptance actions, as conveyed in a letter from the Military Department and/or the NWC chairman to the NNSA Administrator.

The POG briefs the NWC on readiness to proceed to initial operating capability (IOC) and full deployment. The POG also coordinates specific weapon requirements for test or training purposes.

The Military Department conducts a final Pre-Operational Safety Study in such time that specific weapon system safety rules can be coordinated, approved, promulgated, and implemented at least 60 days before IOC or first weapon delivery. During this study, the NWSSG examines and finalizes system design features, hardware, procedures, and aspects of the concept of operation that affect safety. The NWSSG also validates the system meets DoD nuclear weapon system safety standards. The NWSSG recommends final weapon system safety rules to the appropriate Military Departments.

The POG briefs the NWCSSC on the status of Phase 6.5 at least every six months. The POG requests approval from the NWC to proceed into Phase 6.6.

## B.2.7 Phase 6.6 – Full-Scale Production

The DOE/NNSA must have written authorization from the NWC prior to beginning full-scale production and delivery of refurbished weapons for the stockpile.

### Key Tasks and Deliverables

The DOE/NNSA provides a briefing to the NWCSSC outlining the plans and schedule to complete full-scale production.

The POG prepares an End-of-Project Report that serves as the final JIPP and documents the details at each phase of the 6.X Process. This report also includes an analysis of lessons learned for the NWC to use when documenting the activities carried out in the 6.X Process.

The DOE/NNSA delivers and releases refurbished weapons into DoD custody on a schedule agreeable to both the DoD and the DOE/NNSA.

Phase 6.6 ends when all planned activities, certifications, and reports are complete.

### B.3 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 in quantity of a warhead-type in the Nuclear Weapons Stockpile Plan for any reason other than to support surveillance activities. However, the DOE/NNSA may be required to initiate Phase 7 activities to perform dismantlement and disposal activities for surveillance warheads that are destructively tested under surveillance activities. This phase initiates a process that continues until all warheads of a specific 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 DOE/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.