2.0 PURPOSE AND NEED

Chapter 2 discusses the reasons why the National Nuclear Security Administration is proposing to construct and operate a Modern Pit Facility (MPF), as well as the goals to be achieved with MPF. This chapter also discusses relevant national security policies and their relationship to MPF.

2.1 INTRODUCTION AND NEED FOR A MODERN PIT FACILITY

As explained in Section 1.1, the U.S. Department of Energy's (DOE) National Nuclear Security Administration (NNSA) is responsible for the safety and reliability of the U.S. nuclear weapons stockpile, including production readiness required to maintain that stockpile. Plutonium pits are an essential component of nuclear weapons. Historically, plutonium pits for the nuclear weapons stockpile were manufactured at the DOE's Rocky Flats Plant in Colorado. At peak production, the Rocky Flats Plant produced a thousand or more pits per year (ppy). In 1989, due to environmental and safety concerns, pit production was shut down by the DOE at the Rocky Flats Plant, leaving the Nation without the capability to produce plutonium pits for the nuclear weapons stockpile. Today, the United States is the only nuclear weapons power without the capability to manufacture plutonium pits suitable for use in the nuclear weapons stockpile.[1]

Since approximately 1996, the NNSA has been establishing a small interim pit manufacturing capability at the Los Alamos National Laboratory (LANL). While this interim pit production capacity is expected to be completed in 2007, classified analyses indicate projected capacity requirements (number of pits to be produced over a period of time), and agility (ability to rapidly change from production of one pit type to another, ability to simultaneously produce multiple pit types, or the flexibility to produce pits of a new design in a timely manner) necessary for long-term support of the stockpile will require a long-term pit production capability. In particular, identification of a systemic problem associated with an existing pit type, class of pits, or aging phenomenon cannot be adequately responded to today, nor could it be with the small capability currently being established at LANL. Sections 2.1.1 and 2.1.2 discuss pit aging and assessment of the pit lifetime. Sections 2.1.3 and 2.1.4 provide a discussion of capacity and agility requirements that would be addressed by the proposed Modern Pit Facility (MPF).

2.1.1 Pit Aging as a Driver

Modern nuclear weapons have a primary which contains a central core, the "pit" (typically composed of plutonium-239). Many complex physical and chemical interactions occur during the split second that the primary operates.

However, as materials age, particularly those in nuclear weapons, they tend to change. Age-related changes that can affect a nuclear weapon's pit include changes in plutonium properties as

[1] The NNSA has demonstrated the capability to manufacture development pits at the LANL TA-55 Plutonium Facility.

impurities build up inside the material due to radioactive decay, and corrosion along interfaces, joints, and welds. The reliability of the U.S. nuclear weapons stockpile requires that pits will operate as designed.

Although the U.S. nuclear weapons stockpile is presently safe and reliable, these nuclear weapons are aging. The average age of the stockpile is currently about 19 years, and many weapons have exceeded their original design life. In the past, individual weapons in the stockpile were replaced by new-design or upgraded weapons before they approached the end of their design life. However, because the United States has not produced any new nuclear weapons since 1989, some weapons are remaining in the stockpile much longer than previously. This may create issues about the performance capability of stockpile weapons because of uncertainties in the effects of pit aging past the design life. Planning and design of a MPF is a prudent risk management approach to assure readiness to support the stockpile.

2.1.2 Assessment of the Pit Lifetime

The size and scope of a MPF is partly dependant on the age at which existing pits in the U.S. Stockpile must be replaced in order to ensure that each system can continue to meet the specified military characteristics. To date, only minor age-induced changes have been observed and there is no direct evidence that these affect pit performance, reliability, and safety. The response of each system to potential changes is specific to each particular design. The current estimate of the minimum age for replacement of pits is between 45 and 60 years. This is based on observations of pit and plutonium aging taken from pits up to 42 years old and conservative extrapolation of this data combined with system-specific design sensitivity analysis. Additional data and analysis coupled with further design sensitivity studies are needed to refine our estimates of minimum lifetimes for each system. It is possible these studies may show that certain systems exhibit lifetimes shorter than the stated 45 years or longer than 60. In the most conservative case that lifetimes are found to be less than 45 years of age, mitigation methods currently exist to extend these lifetimes to a 45-year minimum. The minimum lifetime assessment will be updated at the end of FY03 and again at the end of FY06 when more data and analyses are available. The age for replacement may vary from weapons system to weapons system depending on details of design and application.

The approach used to address the aging of pits starts with an identification of the key plutonium properties required to ensure safe and reliable weapon function. Knowledgeable design physicists and engineers—who use the information in computer simulations as part of the certification process—select the key properties. Next, materials scientists and chemists identify the aging mechanisms that could potentially alter these properties over time and develop models to help predict the changes. Finally, by combining data acquired through testing and evaluation, the material models for aging, and simulations of the system performance, an estimate of the pit life can be made. In addition, the program is also aimed at quantifying the margins and uncertainties associated with our understanding of aging in order to increase our confidence in the lifetime assessment.

Many of the important properties that affect performance have been measured on pits of varying age and/or on samples extracted from these pits. NNSA has had a surveillance program for several decades that includes destructive and nondestructive examinations. Over the past five years, this has been supplemented by examination of a large number of older pits of age up to 42 years. Over 1000 pits have been non-destructively examined, about 300 have been destructively examined and about 50 older pits have been subjected to special aging assessments. Each pit component has been assessed with the most focus placed on the plutonium.

The life limiting mechanisms of plutonium aging are understood to result from self-irradiation. Plutonium radioactively decays slowly to form uranium and helium, and in the process of this decomposition, can cause local disruption to the material structure. All but 10 percent of the damage is healed almost immediately and almost all of the remaining 10 percent forms stable defect structures called dislocations very soon thereafter. Of primary concern is the accumulation of helium within the material; how the helium build-up changes with time, and how it affects the plutonium properties—in particular the plutonium density. It is apparent from the evaluations conducted on samples from stockpile pits and follow-on modeling of the damage mechanisms that plutonium is aging very slowly. Pit designers are performing design sensitivity assessments to determine the extent to which performance may change with these properties. Nonetheless, at some age, the properties will change sufficiently so that replacement will be prudent.

While the pit aging assessment has so far been based on examination of old pits, the assessments to be completed at the end of FY06 include an evaluation of accelerated aging alloys. These alloys have been fabricated by substituting about 7.5 percent of the plutonium-239 with plutonium-238. This substitution accelerates the self-irradiation process because the decomposition of plutonium-238 into uranium and helium is faster than that of plutonium-239. If these alloys can be validated as sufficiently similar to plutonium alloys used in actual pits, then data from these alloys will be used in the updated lifetime assessment along with the data and analyses from old pits. In addition, new destructive and non-destructive examination tools have been developed and deployed in the NNSA surveillance program to better assure performance, safety, and reliability. The data from these examinations will also be used for the updated lifetime estimates.

During the public scoping period, some commentors questioned whether plutonium pits degrade over time. Many cited an article written by Raymond Jeanloz that appeared in *Physics Today* in December 2000, in which Professor Jeanloz concluded that, “Plutonium exhibits good crystalline order even after decades of aging.” Professor Jeanloz suggested this as evidence that phase stability was not a likely concern. Unfortunately, recent local-structure measurements by the weapons laboratories have demonstrated the immense complexity of local atomic arrangements in the crystalline plutonium lattice and increased delta-phase stability with aging cannot be assumed. Although measurements of naturally aged plutonium have shown macroscopic delta-phase stability over time, NNSA is examining the local structure picture carefully in the accelerated aging program to assure that the 45-60 year pit lifetime remains valid.

NNSA has made substantial progress in the past few years in achieving a fundamental understanding of age-related changes in plutonium. Further theoretical assessments, modeling, and experiments will allow for a more precise evaluation of the minimum age for pits from each system, and will allow for an assessment of the margins and uncertainties of this minimum age. NNSA is encouraged that measurements to date have not shown any significant degradation of pits. The changes observed have been quite small and the modeling has provided further confidence that the plutonium is aging at a slow pace—giving both LANL and Lawrence

Livermore National Laboratory (LLNL) investigators reasonable confidence in the minimum lifetime estimate of 45-60 years. However, further system-specific assessment is required. This range may be modified, including a finding that some systems have a lifetime shorter than 45 years and others a lifetime greater than 60 years, based on careful study of subtle changes in plutonium properties. In this event, mitigation methods are available to extend lifetimes in these systems to a 45-year minimum. Further experiments, modeling, and design sensitivity calculations on all weapon systems are required to gain greater confidence and reduce uncertainties in our estimates. A report entitled *Plutonium Aging: Implications for Pit Lifetimes*, prepared by LANL and LLNL, is included in Appendix G.

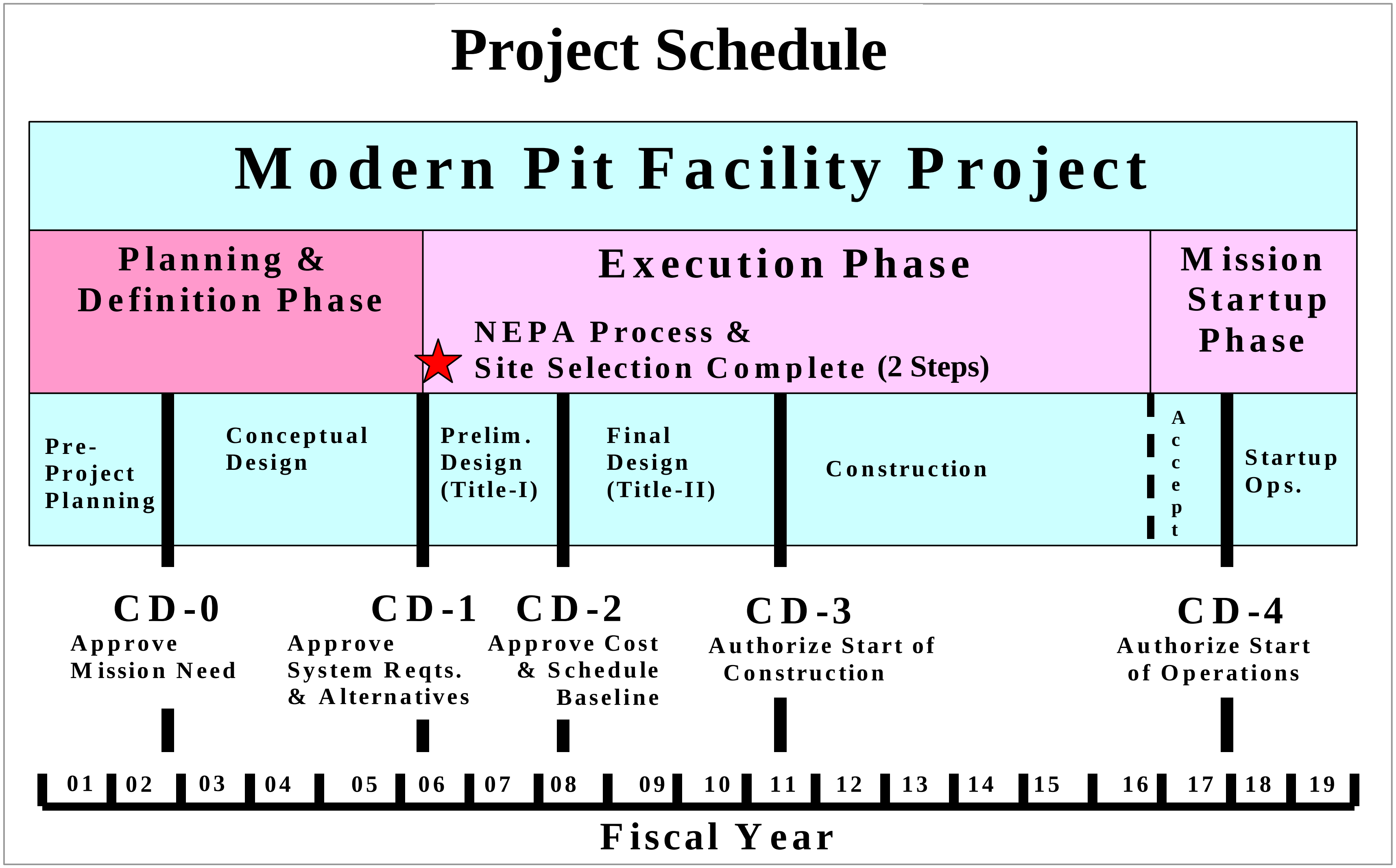
2.1.3 Capacity as a Driver

Most of the pits in the enduring stockpile were produced in the mid-to-late 1970s and 1980s, and no pits have been produced since 1989. In approximately 2020, some pits in the enduring stockpile will be approaching the 45-year pit lifetime. Given the fact that many types of pits in the enduring stockpile may reach their end-of-life (EOL) at about the same time (see Section 2.1.4 below), prudent risk management requires that NNSA initiate action now to ensure that appropriate pit production capacity is available when needed. As shown on Figure 2.1.3–1, it will take approximately 17 years to design and construct a MPF before full-scale production can begin. Consequently, in order for a MPF to be in production by approximately 2020, planning for such a facility must begin now.

It should also be noted that the size and composition of the enduring stockpile are also uncertain. In classified analyses, the NNSA has considered possible futures in which the stockpile size could be reduced to 1,000 total weapons or in which it could be as large as required to meet Nuclear Posture Review (NPR) requirements. Although the precise future capacity requirements are not known with certainty, enough clarity has been obtained through these ongoing classified studies (which are part of the classified appendix to this MPF EIS) that NNSA can identify a range of pit production capacity requirements that form the basis of initial MPF alternative evaluations during the conceptual design phase. The classified studies examined capacity requirements that would result from a wide range of enduring stockpile sizes and compositions, pit lifetimes, emergency production needs (referred to as “contingency” requirements), facility full-production start dates, and production operating practices, e.g., single versus multiple shifts.

Pit capacity requirements must also account for the need for additional pits, e.g., logistics spares and surveillance units. As a result of this requirement, the number of pits that must be available to support a specific weapon system will exceed the number of deployed strategic weapons and will vary by pit type.

Contingency production requirements are also an important driver for the need for a MPF. Contingency production, which is the ability to produce a substantial quantity of pits on short notice, is distinct from the capacity needed to replace pits destroyed for surveillance or other reasons (such as for production quality assurance or other experiments). The capacity of a MPF needs to support both scheduled stockpile pit replacement at EOL and any “unexpected” short-



Source: NNSA 2002.

Figure 2.1.3–1. Modern Pit Facility Project Schedule

term production. Such short-term "contingency" production may be required for reliability replacement (replacement of pits to address, for example, a design, production, or aging flaw identified in surveillance), or for unexpected stockpile augmentation (such as the production of new weapons, if required by national security needs).

In all cases, and in all combinations with other capacity drivers, the interim production capacity being established at LANL will be inadequate to maintain these projected stockpiles. The required production capacity is a function of pit lifetime, stockpile size, and start date of full-scale production. To account for these variables, this MPF EIS evaluates a pit production capacity between 125-450 ppy for full-scale production beginning in approximately 2020.

2.1.4 Agility as a Driver

A critical element of production readiness is the agility (the ability to change rapidly from the production of one pit type to another, or to simultaneously produce different pit types) of the production line. Pits in the current enduring stockpile were produced over a relatively short period of time and can therefore be expected to reach their respective EOLs at about the same time, as well. Thus, any strategy to replace the enduring stockpile pits before they reach their EOL must address both the production rate for a particular pit type (the capacity driver discussed in Section 2.1.1), and the ability to produce all necessary pit types in a relatively short period of time. For this reason, agility is an essential requirement for a MPF.

Contingency production also requires agility. If contingency production is ever needed, the response time will likely be driven by either a reliability problem that requires prompt response, or another type of emergency that must be addressed quickly. Thus, changeover from production of one pit type to another will have to be demonstrated for both replacements of pits at EOL (a process that will allow for planning and scheduled activities in advance of the need date), as well as for startup of contingency production with little notice (and therefore little planning time).

2.2 PURPOSES TO BE ACHIEVED BY A MODERN PIT FACILITY

If constructed and operated, a MPF would address a critical national security issue by providing sufficient capability to maintain, long-term, the nuclear deterrent that is a cornerstone of U.S. national security policy. A MPF would provide the necessary pit production capacity and agility that cannot be met by pit production capabilities at LANL.

As explained in Section 1.4, this EIS and *National Environmental Policy Act* (NEPA) process will support a Record of Decision (ROD) by the Secretary of Energy on: (1) whether to proceed with a MPF; and (2) if so, where to locate the MPF. A siting decision would enable NNSA to better focus detailed design activities and to improve the efficiency and cost-effectiveness of pre-construction activities. If the Secretary decides to proceed with a MPF, a tiered, project-specific EIS would be prepared after the MPF EIS ROD. That tiered EIS, which would utilize detailed design information to evaluate site-specific location alternatives in the vicinity of the host site picked in the MPF EIS ROD, would ultimately support a ROD for construction and operation of a MPF.

2.3 NATIONAL SECURITY POLICY CONSIDERATIONS

There are several principal national security policy overlays and related treaties that are potentially relevant to the proposal to construct and operate a MPF, such as: the NPR; the Nuclear Weapons Stockpile Memorandum (NWSM) and the corresponding Nuclear Weapons Stockpile Plan (NWSP); the Nuclear Nonproliferation Treaty (NPT), and the Comprehensive Test Ban Treaty. Each of these is discussed below.

2.3.1 Nuclear Posture Review

In 2001, Congress required the Department of Defense, in consultation with DOE, to conduct a comprehensive review of the nuclear posture of the United States for the next 5-10 years. The resulting classified report to Congress, entitled the *Nuclear Posture Review*, addresses the following elements:

- The role of nuclear forces in United States military strategy, planning, and programming
- The policy requirements and objectives for the United States to maintain a safe, reliable, and credible nuclear deterrence posture
- The relationship among the U.S. nuclear deterrence policy, targeting strategy, and arms control objectives
- The levels and composition of the nuclear delivery systems that will be required for implementing the U.S. national and military strategy, including any plans for replacing or modifying existing systems
- The nuclear weapons complex that will be required for implementing the U.S. national and military strategy, including any plans to modernize or modify the complex
- The active and inactive nuclear weapons stockpile that will be required for implementing the U.S. national and military strategy, including any plans for replacing or modifying warheads

With respect to the Proposed Action in this EIS, the NPR confirms that a MPF production facility will be required for large-scale replacement of existing plutonium components and any production of new designs. The NPR also recommends that the DOE/NNSA "accelerate preliminary design work on a modern pit manufacturing facility so that production capacity can be brought online when needed."

2.3.2 Nuclear Weapons Stockpile Memorandum and Nuclear Weapons Stockpile Plan

Although the NWSP and NWSM are classified documents, their effect in shaping the MPF EIS can be explained in an unclassified context. As explained in Chapter 1 (see Section 1.1.3), the NWSP specifies the types and quantities of nuclear weapons required, and sets limits on the size and nature of stockpile changes that can be made without additional approval by the President. The NWSM, which is jointly signed by the Secretaries of Defense and Energy, includes the

NWSP and a long-range planning assessment. As such, the NWSM is the basis for NNSA stockpile support planning. The NWSP and NWSM are highly dependent upon national security objectives determined by the President. In this regard, the United States has committed to reduce the number of operationally deployed strategic nuclear weapons to 1,700-2,200 in 2012.

2.3.3 Nuclear Nonproliferation Treaty

The NPT was ratified by the U.S. Senate in 1969 and officially entered into force as a Treaty of the United States in 1970. Today, the United States continues to view the NPT as the bedrock of the global effort to prevent the spread of nuclear weapons and to reduce nuclear weapons stockpiles. Article VI of the NPT obligates the parties "to pursue negotiations in good faith on effective measures relating to cessation of the nuclear arms race at an early date and to nuclear disarmament, and on a treaty on general and complete disarmament under strict and effective international control." The United States has taken this obligation seriously and has reduced its nuclear weapons stockpile. Some examples are the 1987 Treaty on Intermediate Range Nuclear Forces, which eliminated an entire class of nuclear weapon systems; and the 1991 Presidential Nuclear Initiative, which led to the withdrawal and destruction of thousands of U.S. nonstrategic nuclear weapons. U.S. and Russian cooperation throughout the 1990s has led to continued reductions in nuclear weapons and the withdrawal of hundreds of tons of fissile material from defense stockpiles. The 1991 Strategic Arms Reduction Treaty led to significant reductions in the number of deployed strategic nuclear warheads. In the future, the United States will require far fewer nuclear weapons. Accordingly, President Bush has decided that the United States will reduce its operationally deployed strategic nuclear weapons to a level between 1,700 and 2,200 over the next decade.

It must be noted that the NPT does not provide any time period for achieving the ultimate goal of nuclear disarmament nor does it preclude the maintenance of nuclear weapons until their disposition. For this MPF EIS, speculation on the terms and conditions of a "zero level" U.S. stockpile, as some have suggested during the scoping meetings, goes beyond the bounds of the reasonably foreseeable future consistent with the NPR. The Proposed Action in this EIS, which would enable NNSA to maintain the reliability of the enduring stockpile until the ultimate goals of the NPT are attained, is consistent with the NPT.

2.3.4 Comprehensive Test Ban Treaty

The Comprehensive Test Ban Treaty, which bans all nuclear explosions for civilian or military purposes, was signed by the United States on September 24, 1996, but has never been ratified by the U.S. Senate. Nonetheless, the United States has been observing a moratorium on nuclear testing since 1992, and the NPR strategy discussed in Section 2.3.1 reflects this policy. The Proposed Action in this EIS would be consistent with a continuing U.S. moratorium or a Comprehensive Test Ban Treaty.