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# A Preliminary Analysis of the Reactor-Based Plutonium Disposition Alternative Deployment Schedules

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# A Preliminary Analysis of the Reactor-Based Plutonium Disposition Alternative Deployment Schedules

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## ABSTRACT

This paper discusses the preliminary analysis of the implementation schedules of the reactor-based plutonium disposition alternatives. These schedule analyses are a part of a larger process to examine the nine decision criteria used to determine the most appropriate method of disposing of U.S. surplus weapons plutonium. The preliminary analysis indicates that the mission durations for the reactor-based alternatives range from eleven years to eighteen years and the initial mission fuel assemblies containing surplus weapons-usable plutonium could be loaded into the reactors between nine and fourteen years after the Record of Decision.

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# Acronyms and Abbreviations

ABB-CE – Asea Brown Boveri – Combustion Engineering
AE – architect engineering
AECB – Atomic Energy Control Board of Canada
AECL – Atomic Energy of Canada, Ltd.
ARIES – Advanced Recovery and Integrated Extraction System
ASLB – Atomic Safety Licensing Board
BWR – boiling water reactor
CANDU – Canadian deuterium-uranium
CP – construction permit
DNFSB – Defense Nuclear Facility Safety Board
DOE – Department of Energy
EA – Environmental Assessment
ED – equipment delivery
ER – Environmental Report
ES&H – Environmental, Safety, and Health
FMDP – Fissile Materials Disposition Program
GoCo – government-owned, contractor-operated facilities
HLW – High Level Waste
HM – Heavy Metal
HWR – heavy water reactor
ITAAC – Inspections, Tests and Analyses of Acceptance Criteria
KD – key decision
kg – kilogram
LA – license amendment
LANL – Los Alamos National Laboratory
LEU – low-enriched uranium
LLNL – Lawrence Livermore National Laboratory
LUA – lead use assembly
LWR – light water reactor
M&O – management & operational
MD – Office of Fissile Materials Disposition
MOX – mixed-oxide, (uranium oxide and plutonium oxide, $UO_2$ and $PuO_2$)
MT – metric tonne
MTHM – metric tonne heavy metal
MWd – megawatt days
NAS – National Academy of Sciences
NEPA – National Environmental Policy Act
NRC – Nuclear Regulatory Commission
OL – operating license
ORNL – Oak Ridge National Laboratory
PEIS – Programmatic Environmental Impact Statement
Pu – plutonium
PuP – plutonium processing
PWR – pressurized water reactor
R&D – research and development
RASR – Reactor Alternatives Summary Report
RFP – Request for Proposal
ROD – Record of Decision
SAR – Safety Analysis Report
SER – Safety Evaluation Report
SNM – special nuclear material
TVA – Tennessee Valley Authority

# 1. Introduction

This paper presents a brief overview of the plutonium disposition mission and the initial decision process to determine the most appropriate method for disposing of surplus fissile materials. This disposition method will be selected using nine decision criteria which include cost, schedule, and other issues. In the main section of this paper, the preliminary analysis of one of these criteria, schedule, is presented for the reactor-based plutonium disposition method.

In the overview, a list of the possible plutonium disposition options is presented in four broad categories of disposition methods: placing the plutonium in long-term storage (the no action alternative); converting the plutonium into mixed-oxide (MOX) fuel and irradiating the fuel in reactors or accelerators; immobilizing the plutonium in glass, ceramic, or other material; and disposing of the plutonium directly with minimal pre-treatment, e.g., deep space launch. Many of the initial thirty-seven options within these broad categories were determined to be less suitable for various reasons, listed below, and were removed from the list of possible alternatives after completion of the initial screening process in late 1994 (1). Eleven disposition alternatives remained: one storage option, two direct disposal options, four immobilization options, and five reactor options.

The five categories of reactors in the remaining reactor-based options are: commercial existing light water reactors (LWR), partially-complete LWRs, new advanced or evolutionary LWRs, Canadian deuterium-uranium (CANDU) heavy-water moderated reactors, and foreign reactors in Europe. After the initial screening process was complete, it was determined that the use of European reactors for the plutonium disposition mission was not feasible and this alternative was not examined further.

Within the first four categories of reactors, nine unique variants have been defined in order to develop more complete analyses of the cost, schedule, and other measures for the decision criteria. These reactor-based variants are described in Chapter 2. The preliminary analysis of the implementation schedules for all nine these variants is presented in the six subsequent chapters of the paper. This work is a subset of the analyses described in the Fissile Materials Disposition Program (FMDP) *Reactor Alternatives Summary Report*, volumes 1-4 (RASR) (2)

The remaining storage, borehole, and immobilization options are discussed in their respective Alternatives Summary Reports (3), and all of the analyses for the eleven remaining options are summarized in the *Technical Summary Report for Surplus Weapons-Usable Plutonium Disposition* (4).

## 1.1 Plutonium Disposition Mission

The dismantlement of U.S. and Russian nuclear weapons and the clean-up of nuclear weapon production sites will lead to 50 metric tonnes (MT) of surplus plutonium (Pu) in the US and over 100 MT of surplus Pu in Russia. As the National Academy of Sciences (NAS) report on this subject declared, "The existence of this surplus material constitutes a clear and present danger to national and international security" (5). The Department of Energy (DOE) has created an Office of Fissile Materials Disposition (MD) with the mission to determine the most acceptable method for disposing of the surplus material. This decision is supported by the publication of a Record of Decision (ROD) and a Programmatic Environmental Impact Statement (PEIS).

The PEIS was announced on December 9, 1996 in *Storage and Disposition of Weapons-Usable Fissile Materials Final Environmental Impact Statement* (6). This PEIS describes the DOE's dual-track strategy for plutonium disposition which will continue to examine two disposition alternatives: immobilizing the plutonium in glass or ceramic and irradiating plutonium as mixed-oxide fuel in existing reactors. The Record of Decision was made public on January 14, 1997 in *Record of Decision for the Storage and Disposition of Weapons-Usable Fissile Materials Final Environmental Impact Statement* (7).

In the December 1996 press release announcing the availability of the PEIS, DOE described its activities for the next two years which will lead to the final decision concerning the disposition of the US surplus plutonium (8):

> Technical, institutional and cost uncertainties exist with both the immobilization and reactor options. Accordingly, the department, over the next two years, will complete the necessary tests, process development, technology demonstrations, site-specific environmental reviews and detailed cost proposals for both approaches. Final decisions to use either or both of these technologies depend on the results of this work as well as nonproliferation considerations and progress in efforts and negotiations with Russia and other nations. This approach gives the President the flexibility to begin plutonium disposition either multilaterally or bilaterally through negotiations or unilaterally as an example to Russia and other nations.

## 1.2 Plutonium Disposition Options and the Decision Process

The first step in the process to determine the most appropriate method for disposing of the surplus Pu was to determine the decision criteria which will be used to rank the various disposition methods. The nine decision criteria, listed in Table 1.1, are based on the policy goals of DOE/MD, the NAS report, and public comment.

As the same time, a list of all potential plutonium disposition options was developed. This list of thirty-seven distinct options, shown in Table 1.2, was developed by consolidating the methods discussed in several previous studies, including the NAS study (5), and suggestions from the public which were obtained from questionnaires and public meetings held across the country in 1994. This list of options was reduced to eleven alternatives after the initial phase of the screening process by disqualifying or eliminating twenty-six options (1). An option was

**Table 1.1: Screening criteria for surplus plutonium disposition**

| *Criteria* | *Description* |
|---|---|
| 1. Resistance to Theft and Diversion by Unauthorized Parties | Each step in the disposition process must be capable of providing for comprehensive protection and control of weapons-usable fissile materials. |
| 2. Resistance to Retrieval, Extraction, Reuse by Host Nation | The surplus material must be made highly resistant to potential reuse in weapons to reduce reliance on institutional control and demonstrate that the arms reductions will not easily be reversed. |
| 3. Technical Viability (Maturity) | There should be a high degree of confidence that an alternative will be technically successful. |
| 4. Environmental, Safety, and Health | High standards of public and worker health and safety, and environmental protection must be met, and significant additional ES&H burdens should not be created. |
| 5. Cost Effective | Disposition should be accomplished in a cost-effective manner. |
| 6. Timeliness (Implementation Schedule) | There is an urgent need to minimize the time period that surplus fissile materials remain in weapons-usable form. |
| 7. Fosters Progress and Cooperation with Russia and Other Countries | The alternative must establish appropriate standards for the disposition of surplus weapons-usable fissile material inventories, support negotiations for bilateral or multilateral reductions in these materials, and each step in the disposition process must allow international inspections. |
| 8. Public and Institutional Acceptance | An alternative should be able to muster a broad and sustainable consensus on the manner in which disposition is accomplished. The alternative must be consistent with U.S. policy. |
| 9. Additional Benefits | The ability to leverage government investments for disposition of surplus materials to contribute to other national or internationals initiatives should be considered. |

disqualified if it did not fulfill one or more of the decision criteria; *e.g.*, R4, irradiating MOX fuel in naval reactors was disqualified because of the lack of transparency, as no international inspections could occur on a naval vessel. Other options were eliminated because they did not fulfill some of the criteria as well as another option; *e.g.*, R5, irradiating MOX fuel in modular helium reactors was eliminated because the inventory of surplus plutonium would be irradiated faster using a more technically mature reactor technology.

The initial thirty-seven disposition options were defined very broadly without specifying the facilities or resources required to convert the surplus weapons-usable plutonium from its present forms into its final form. The next phase of the decision process involved refining the remaining eleven options by developing full alternative descriptions which include preliminary facility layouts and operational requirements. The process for defining the remaining reactor alternatives is discussed in Section 2.1.

As a part of the ROD announced on January 14, 1997, DOE declared that the department will immobilize at least 8 MT of the surplus material that is too expensive to purify for use in MOX. Thus at most 42 MT of surplus plutonium will be converted into MOX fuel for use in existing light water or CANDU reactors. As a result of this decision, additional schedule analyses will be completed using the new quantity of plutonium. These analyses will include trade-offs between the number and type of existing reactors to be used for the disposition mission and the quantity of surplus plutonium which will be converted into MOX and irradiated in the reactors. For the preliminary schedule analyses discussed in this paper, ROD was scheduled to occur on December 9, 1996 and the quantity of plutonium to be converted into MOX fuel was either 50 MT or 32.5 MT.

Table 1.2: Plutonium disposition options

| ID # | Disposition Option Name | Status after Initial Screening (reason for disqualification or elimination) |
|---|---|---|
| ***Storage Options*** | | |
| S1 | No Disposition Action (Continued Storage) | Baseline |
| S2 | Radiation Barrier Alloy (Storage) | Eliminated (Open-ended, ES&H) |
| ***Disposal Options*** | | |
| D1 | Direct Emplacement in HLW Repository | Disqualified (Retrievability, Timeliness) |
| D2 | Deep Borehole (Immobilized) | Reasonable |
| D3 | Deep Borehole (Direct Emplacement) | Reasonable |
| D4 | Discard to Waste Isolation Pilot Plant | Disqualified (Capacity) |
| D5 | Hydraulic Fracturing | Disqualified (Technical Viability) |
| D6 | Deep Well Injection | Disqualified (ES&H) |
| D7 | Injection into Continental Magma | Eliminated (Technical Viability, ES&H) |
| D8 | Melting in Crystalline Rock | Disqualified (Technical Viability, ES&H) |
| D9 | Disposal under Ice Caps | Disqualified (Technical Viability, ES&H) |
| D10 | Seabed (Placement on Ocean Floor) | Disqualified (ES&H, Treaty) |
| D11 | Sub-Seabed Emplacement | Eliminated (Technical Viability) |
| D12 | Ocean Dilution | Disqualified (ES&H, Treaty) |
| D13 | Deep Space Launch | Eliminated (Retrievability, ES&H) |
| ***Immobilization Options With Radionuclides Options*** | | |
| I1 | Underground Nuclear Detonation | Disqualified (ES&H, Licensing/Regulatory) |
| I2 | Borosilicate Glass Immobilization (existing facility) | Eliminated (ES&H, Cost) |
| I3 | Borosilicate Glass Immobilization (new facility) | Reasonable |
| I4 | Ceramic Immobilization | Reasonable |
| I5 | Electrometallurgical Treatment | Reasonable |
| I6 | Borosilicate Glass Oxidation/Dissolution System | Reasonable |
| ***Reactor and Accelerator Options*** | | |
| R1 | Euratom MOX Fabrication/Reactor Burning | Reasonable, later eliminated as unfeasible |
| R2 | Existing Light Water Reactors (LWRs) | Reasonable |
| R2A | Partially Completed LWRs | Reasonable |
| R3 | Evolutionary or Advanced LWRs | Reasonable |
| R4 | Naval Propulsion Reactors | Disqualified (Transparency) |
| R5 | Modular Helium Reactors | Eliminated (Technical Maturity) |
| R6 | CANDU Heavy Water Reactors (HWR) | Reasonable |
| R7 | Advanced Liquid Metal Reactors with Pyroprocessing | Eliminated (Technical Maturity) |
| R8 | Accelerator Conversion/Molten Salt | Eliminated (Technical Maturity) |
| R9 | Accelerator Conversion/Particle Bed | Eliminated (Technical Maturity) |
| R10 | Existing LWRs with Reprocessing | Disqualified (Theft/Diversion, Policy) |
| R11 | Advanced LWRs with Reprocessing | Disqualified (Theft/Diversion, Policy) |
| R12 | Accelerator-Driven Modular Helium Reactors | Eliminated (Technical Maturity) |
| R13 | Advanced Liquid Metal Reactors with Recycle | Disqualified (Technical Maturity, Policy) |
| R14 | Particle Bed Reactors | Eliminated (Technical Maturity) |
| R15 | Molten Salt Reactors | Eliminated (Technical Maturity) |

# 2. Reactor-Based Plutonium Disposition Alternatives

## 2.1 Generic Reactor-Based Alternative Definition

The generic reactor-based alternative involves converting the feed material, surplus weapons-usable plutonium in a number of different forms, into plutonium oxide, $PuO_2$; fabricating mixed-oxide fuel assemblies using the $PuO_2$ and uranium oxide, $UO_2$; irradiating the MOX fuel assemblies in a nuclear reactor; and, finally, placing the spent MOX fuel in a repository. A flow diagram of this process is shown in Figure 2.1.

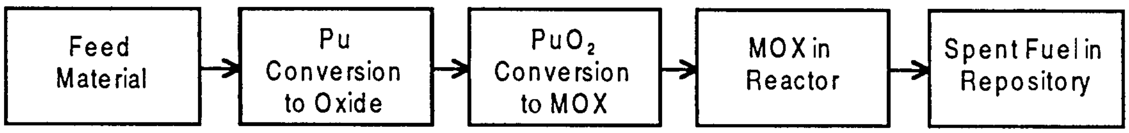


**Figure 2.1: Generic reactor-based disposition alternative**

Within each of the four remaining broad alternative reactor categories, existing light water reactors (LWR), partially-complete LWRs, advanced or evolutionary LWRs, and CANDU heavy water reactors (HWR), there are wide disparities in cost, schedule, technical maturity, and the other decision criteria measures. These disparities may be due, for example, to the type of evolutionary LWR used as there are differences in technical maturity between reactor types; to the number of reactors used in the alternative which affects the duration and cost of the mission; and to how many facilities will be used to process the plutonium into MOX, in one collocated facility or two separate facilities. These different deployment approaches for existing LWRs are categorized in Table 2.1. In order to develop a reasonable estimate of the decision criteria measures, more detailed descriptions of the reactor-based alternatives have been developed. For each reactor category, several variants were defined.

To begin the variant definition process, several major assumptions were made:

- All surplus plutonium forms will be processed, with either all 50 MT of the surplus plutonium being irradiated in a reactor or 32.5 MT of the Pu being irradiated in a reactor with the other 17.5 MT disposed of using one of the immobilization alternatives.
- All of the plutonium processing (PuP) will be done in government-owned, contractor-operated facilities (GoCo).
- All of the domestic MOX fuel will be fabricated in a building which is located on an existing federal site. The building may be either a new facility or a modified existing facility. The facility may be privately-owned or GoCo.
- All MOX fuel will be loaded into the reactors in less than twenty-five years after the initial mission fuel is loaded.

The reactor type and number used for each of the four options and their variants are as follows:

- For the existing LWR option, five pressurized water reactors (PWR) were selected to represent the base case because there are more operating PWRs than the other LWR type, boiling water reactors (BWR). For this alternative, the MOX fuel would be fabricated in a domestic, GoCo fuel fabrication facility located in an existing building on an existing federal site. Also, the MOX fuel is loaded with as much Pu as possible without having to include integral neutron absorbers. Three additional variants using existing PWRs were defined, one which uses a privately-owned MOX facility, the second variant uses some mission fuel which is fabricated in Europe to accelerate the mission start time, and a third variant which uses three PWRs and irradiates only 32.5 MT of the surplus Pu. A final existing LWR variant was defined using four BWRs and using full MOX cores which contain integral neutron absorbers. A full description of these variants may be found in the RASR, vol. 1 (2).

- For the CANDU option, the use of the CANDU HWRs at Bruce A on Lake Huron, in Ontario, Canada was assumed for two CANDU variants, one which irradiates all 50 MT and a second which only irradiates 32.5 MT of the surplus Pu. A full description of these variants may be found in the RASR, vol. 2 (2).
- Two partially-complete PWRs were selected as the representative reactors for the partially-complete reactor alternative. A full description of this alternative may be found in the RASR, vol. 3 (2).
- Two large evolutionary PWRs, ABB-CE System 80+, were selected to represent the evolutionary LWR alternative. Other possible reactor types include General Electric's Advanced BWR and Westinghouse's PDR-600, a plutonium-burning variant of the AP-600 reactor. A full description of this alternative may be found in the RASR, vol. 4 (2).

Each alternative definition includes all of the facilities discussed in the generic reactor alternative above. The nine reactor variants are shown in
Table 2.2.

## 2.2 Facility Descriptions

In order to develop the overall alternative decision measures for each alternative and variant, several individual facilities need to be defined more completely. The facility listings for each alternative and variant are shown in Table 2.3. As this paper only includes the implementation schedule analysis used as the performance measure for the timeliness decision criterion, brief descriptions of each facility and its throughput or fuel loading cycle are given below. Additional schedule specific assumptions for each facility are discussed in the schedule analysis sections. For complete facility descriptions including initial process descriptions, process flow diagrams, preliminary facility layouts, and other criteria analyses see the appropriate RASR volume (2).

**Table 2.1: Deployment approaches for existing LWRs**

| *Parameter* | *Range of Possible Choices* | *Comments* |
|---|---|---|
| Plutonium Processing Facility | • Siting – Greenfield, new facility at a DOE site, an existing facility at an existing site | All three options could also be done either in conjunction with (collocated facilities) or separate from a MOX fuel fabrication facility. |
| Mixed Oxide Fuel Fabrication Facility | • Ownership – Privately-owned domestic, Government-owned domestic, existing European facilities.<br>• Siting – Greenfield, new facility at a DOE site, an existing facility at an existing site | Except for the European cases, all options could also be done either in conjunction with or separate from a plutonium processing facility. For a PuP facility collocated with the MOX fuel fabrication activities, the facility would remain government-owned. |
| Type of Reactor | PWRs and BWRs | Even for a specific type of reactor, many core designs are available. Both types could operate with or without integral neutron absorbers. |
| Number of Reactors | 2-5 | Two reactors is the minimum number. The maximum number is limited by the number of reactors available. |
| Core Design Approaches | • Amount of MOX per core – full core with integral neutron absorbers, full core without integral neutron absorbers, partial MOX cores.<br>• Irradiation – 25,000 to 50,000 MWd/MTHM (megawatt days / metric tonnes heavy metal)<br>• Fuel Cycle length – 12, 18, and 24 months. | |

Table 2.2: Reactor-based alternatives and variants

| *ID* | *Category* | *Description* |
|---|---|---|
| 50SFL5 | Existing LWR Base Case | • Process 50 MT Pu<br>• Pu processing<br>  • Halide Processing at LANL.<br>  • Modified existing facility on an existing federal site which operates for 10 years.<br>• MOX Fuel Fabrication<br>  • Domestic, GoCo fuel fabrication facility located in an existing building on an existing federal site.<br>• Reactors<br>  • Five privately-owned domestic PWRs.<br>  • No integral neutron absorbers in the fuel.<br>• Spent fuel to federally-owned geological repository in western U.S. |
| 50SPL5 | Existing LWR Variant 1 | • Same as 50SFL5 except:<br>• Privately-owned MOX fuel fabrication facility located in a new building on an existing federal site. |
| 50QSL5 | Existing LWR Variant 2 | • Same as 50SFL5 except:<br>• Early $PuO_2$ available from Pu processing prototype operations<br>• Early MOX fuel fabrication in existing European fuel fabrication facilities. |
| 33SFL3 | Existing LWR Variant 3 | • Same as 50SFL5 except:<br>• Process 32.5 MT of Pu.<br>• Three privately-owned PWRs |
| 50COL4 | Existing LWR Variant 4 | • Same as 50SFL5 except:<br>• GoCo, collocated Pu processing and MOX fuel fabrication facility located in a new building on an existing federal site.<br>• Reactors<br>  • Four privately-owned domestic BWRs.<br>  • Maximum Pu cores with integral neutron absorbers. |
| 50SFP2 | Partially-complete LWR | • Same as 50SFL5 except:<br>• Reactors<br>  • Two GoCo, partially-complete PWRs which are completed and employed for the mission.<br>  • Maximum Pu cores with integral neutron absorbers. |
| 50SFE2 | Evolutionary LWR | • Same as 50SFL5 except:<br>• Reactors<br>  • Two new GoCo PWRs which are built on an existing federal site.<br>  • Maximum Pu cores with integral neutron absorbers. |
| 50SFC2-4 | CANDU Base Case | • Same as 50SFL5 except:<br>• Reactors<br>  • Two Bruce-A CANDU reactors, irradiating Reference MOX fuel for five years followed by<br>  • Four CANDU units irradiating CANFLEX fuel for the remainder of the mission.<br>• Spent fuel to Canadian geological repository. |
| 33SFC2 | CANDU Variant 1 | • Same as 50SFC2-4 except:<br>• Process 32.5 MT of Pu.<br>• Two Bruce-A CANDU reactors, irradiating Reference MOX fuel. |

Table 2.3: Facilities in the reactor-based alternatives and variants

| ID | Category | Facility Name (facility description heading) |
|---|---|---|
| 50SFL5 | Existing LWR Base Case | • GoCo Plutonium Processing Facility (2.2.1)<br>• GoCo MOX Fuel Fabrication Facility in an existing building (2.2.2)<br>• Five Commercial PWRs (2.2.2.2)<br>• High Level Waste Repository Facility (2.2.4.1) |
| 50SPL5 | Existing LWR Variant 1 | • GoCo Plutonium Processing Facility (2.2.1)<br>• Privately-owned MOX Fuel Fabrication Facility in a new building (2.2.2.1)<br>• Five Commercial PWRs (2.2.2.2)<br>• High Level Waste Repository Facility (2.2.4.1) |
| 50QSL5 | Existing LWR Variant 2 | • GoCo Plutonium Processing Facility, with early material available from the prototype processing line (2.2.1.1)<br>• Private European MOX Fuel Fabrication Facility (2.2.2.2)<br>• GoCo MOX Fuel Fabrication Facility in an existing building (2.2.2)<br>• Five Commercial PWRs (2.2.2.2)<br>• High Level Waste Repository Facility (2.2.4.1) |
| 33SFL3 | Existing LWR Variant 3 | • GoCo Plutonium Processing Facility (2.2.1)<br>• GoCo MOX Fuel Fabrication Facility in an existing building (2.2.2)<br>• Three Commercial PWRs (2.2.2.2)<br>• High Level Waste Repository Facility (2.2.4.1) |
| 50COL4 | Existing LWR Variant 4 | • GoCo, Collocated PuP and MOX Fuel Fabrication Facility (2.2.1.2)<br>• Four Commercial BWRs (2.2.3.2)<br>• High Level Waste Repository Facility (2.2.4.1) |
| 50SFC2-4<br>33SFC2 | CANDU Base Case and Variant 1 | • GoCo Plutonium Processing Facility (2.2.1)<br>• GoCo MOX Fuel Fabrication Facility in an existing building (2.2.1.2)<br>• Two and/or Four Bruce-A CANDU reactors (2.2.3.3)<br>• Canadian Geological Repository Facility (2.2.4.2) |
| 50SFP2 | Partially-complete LWR | • GoCo Plutonium Processing Facility (2.2.1)<br>• GoCo MOX Fuel Fabrication Facility in an existing building (2.2.1.2)<br>• Two GoCo PWRs (2.2.3.3)<br>• High Level Waste Repository Facility (2.2.4.1) |
| 50SFE2 | Evolutionary LWR | • GoCo Plutonium Processing Facility (2.2.1)<br>• GoCo MOX Fuel Fabrication Facility in an existing building (2.2.2)<br>• Two GoCo ABB-CE System 80+ Reactors (2.2.3.5)<br>• High Level Waste Repository Facility (2.2.4.1) |

### 2.2.1 Plutonium Processing Facilities

All plutonium will be processed in government-owned, contractor-operated (GoCo) facilities located on existing federal sites. All of the disposition options assume that any surplus plutonium which is in the form of a halide salt or oxide will be processed at Los Alamos National Laboratory (LANL). The rest of the surplus plutonium, in the form of pits, Pu metal and oxide, and a variety of scraps and residues, will be converted into $PuO_2$ through either stabilization and conversion or pit disassembly in a modified existing building. This plutonium processing (PuP) facility is assumed to operate for ten years at a nominal annual throughput of 5 MT.

The site selection process for this facility will begin after the ROD and will be completed with a site-specific Environmental Impact Statement (EIS). The implementation schedule for this facility is discussed in Section 4.1.1.

#### *2.2.1.1 Prototype Plutonium Processing*

For the early start option, 50QSL5, a small supply of $PuO_2$ is required for the European fuel fabrication facility before the full PuP facility is operational. This material will be available from the demonstration and prototype phases of the FMDP. The changes in the plutonium processing activities schedule with the addition of the prototype operation are discussed in Section 4.3.1.

#### *2.2.1.2 Collocated Plutonium Processing and MOX Fuel Fabrication Facility*

The collocated PuP and MOX fuel fabrication facility will be located in a new building on an existing federal site. This facility combines the PuP facility described above and the MOX fuel fabrication facility described below into one facility. This reduces some duplication of waste handling processes as well as reducing the shipping and receiving requirements. The implementation schedule for this facility is discussed in Section 4.5.1.

### 2.2.2 Mixed-Oxide Fuel Fabrication Facilities

The MOX fuel fabrication facility receives the $PuO_2$ and converts it into MOX fuel for the specified reactor at the rate required by the reactor loading schedule described below for each reactor type. The MOX fuel assembly production schedule and operation duration for each option are shown in Table 2.4. For all of the options, except for the CANDU and evolutionary reactor options, the initial assemblies produced will be used as lead use assemblies (LUAs) to confirm the performance of the fuel.

For most of the reactor-based disposition options, the MOX fuel will be fabricated in a GoCo facility located in a modified building on an existing federal site. The site selection process for this facility will begin after the ROD and will be completed with a site-specific EIS. The implementation schedule for this base case facility is discussed in Section 4.1.2.

#### *2.2.2.1 Private Mixed-Oxide Fuel Fabrication Facility*

The privately-owned MOX fuel fabrication facility will be located in a new building on an existing federal site. It is assumed that the change in ownership of the fuel fabrication facility does not have any major schedule impacts. Also, the change from modifying an existing building to building a new facility is assumed to not significantly affect the construction schedule. The minor changes in the implementation schedule for this facility are discussed in Section 4.2.1

**Table 2.4: MOX fuel assembly production schedule and fuel type**

| Alternative | annual assembly output | total # of mission assemblies | Pu (MT/yr.) | mission operation (years) | average throughput (MTHM/yr.) | fuel type | use of INA? † |
|---|---|---|---|---|---|---|---|
| 50SFL5, 50SPL5 | 280 | 2756 | 5 | 9.8* | 118 | PWR | no |
| 50QSL5 Europe | 85 | 375 | 1.5 | 4.5* | 35.8 | PWR | no |
| domestic | 280 | 2381 | 5 | 8.5* | 118 | PWR | no |
| 50COL4 | 570 | 9416 | 3.2 | 16.5* | 107 | BWR | yes |
| 33SFL3 | 175 | 1819 | 3.2 | 10.4* | 71.7 | PWR | no |
| 50SFC2-4 | 9200 | 45250 | 2.9 | 5 | 138 | CANDU | no |
| | 10450 | 75279 | 5 | 7.2 | 150 | CANFLEX | no |
| 33SFC2 | 9200 | 98485 | 2.9 | 11.5 | 138 | CANDU | no |
| 50SFP2 | 175 | 2692 | 3.2 | 15.4* | 69 | PWR | yes |
| 50SFE2 | 135 | 1807 | 3.8 | 14 | 53 | PWR | yes |

† INA – integral neutron absorbers

* For all of the reactor options except the CANDU and evolutionary LWR options, there is an additional six months of operation to produce the lead use assemblies.

#### 2.2.2.2 *European Mixed-Oxide Fuel Fabrication Facility*

The European fuel fabrication facility is an existing facility and it is assumed that no additional capacity will be required to supply the mixed-oxide fuel at the specified rate. Any modifications to the existing license at the European facility will be overseen by the appropriate European regulator. The production schedule and operation duration are shown in Table 2.4. An additional American facility may be required for lag storage of the outgoing $PuO_2$ and the incoming MOX fuel assemblies. The changes in the MOX fuel fabrication schedule are discussed in Section 4.3.2.

### 2.2.3 Reactor Facilities

All of the reactor facilities receive fresh MOX fuel from the fuel fabrication facility and irradiate the fuel until it reaches the end of its economic energy value. The spent MOX fuel is discharged from the reactor and placed in an on-site cooling pool for a minimum of ten years. For planning purposes, the reactors are assumed to operate at 80% capacity factor and the number of reactors have been selected to permit the loading of the entire inventory of surplus plutonium in less than twenty-five years.

#### 2.2.3.1 *Private Existing Light Water Reactor Facilities – Pressurized Water Reactors*

The base case and the first variant existing LWR alternatives, 50SFL5 and 50SPL5, assume the use of five, commercial, 3411 MWt (1150 MWe) PWRs. The plutonium disposition capacity and fuel cycle characteristics, shown in Table 2.5, are based upon a Westinghouse design for MOX cores which have as high a Pu-loading as possible without integral neutron absorbers. Each reactor begins MOX operation with a partial core loading of 84 MOX fuel assemblies. The five reactors are brought up sequentially in a 13.5 month period, 4.5 months apart, with the last two reactors loaded at the same time. The last reload of 68 MOX fuel assemblies and 16 low-enriched uranium (LEU) assemblies is loaded into the third reactor 9.75 years after the initial MOX load. These assemblies are discharged 4.5 years later. After the last reload of MOX fuel, the reactors sequentially reconvert to the use of LEU fuel assemblies. The PWR facilities schedule is discussed in Section 4.1.3.

For the "quick start" variant, 50QSL5, the initial MOX loads contain only 25 MOX fuel assemblies which have been fabricated in Europe. At the fourth reload of each reactor, the number of MOX fuel assemblies in the reload is increased to 84 and this fuel will have been fabricated in the domestic facility. The duration of MOX fuel loading for this alternative is 13.125 years, with the last MOX assemblies loaded into the fourth reactor. The quick start alternative schedule is discussed in Section 4.3.3.

For the 32.5 MT alternative, 33SFL3, three PWRs are loaded sequentially in a one year period, six months apart, and each reload contains 84 MOX fuel assemblies. The last MOX assemblies are loaded sixteen years after the first MOX load and into the third reactor. This alternative schedule is discussed in Section 4.4.3.

**Table 2.5: Existing PWR characteristics**

| | |
|---|---|
| *Plutonium capacity and rate for one reactor* | |
| Pu per assembly (kg) | 18.1 |
| % Pu in heavy metal | 4.3% |
| Pu dispositioned per year per reactor (MT) | 1 |
| Pu dispositioned per cycle/reload (MT) | 1.5 |
| *Fuel cycle characteristics* | |
| Total cycle length (days) | 548 |
| Effective full power days (EFPD) | 438 |
| Planned / unplanned outage (days) | 110 |
| Reload batch size (bundles) | 84 |
| Full core size (bundles) | 193 |
| Average discharge exposure (MWd/kg) | 45 |

### 2.2.3.2 *Private Existing Light Water Reactor Facilities – Boiling Water Reactors*

The last existing LWR variant, 50COL4, assumes the use of four, commercial, 3484 MWt (1165 MWe) BWRs. The plutonium disposition capacity and fuel cycle characteristics, shown in Table 2.6, are based upon the General Electric BWR-5 design for full MOX cores which include integral neutron absorbers in the fuel design. Each reactor begins MOX operation with a partial core loading of 176 MOX fuel assemblies and builds up to a full MOX core over a five year period. After the first reactor begins MOX operation, each additional reactor begins MOX operations one year after the start-up of MOX operations in the previous reactor. A three-month confirmatory period is included in the operating schedule for each reactor. The last reload of 88 MOX and 88 LEU fuel assemblies occurs 16.6 years after the initial MOX load and these assemblies are discharged 5.8 years later. After the last reload of MOX fuel, the reactors sequentially reconvert to the use of LEU fuel. The BWR facilities schedule is discussed in Section 4.5.2. It should also be noted that a MOX fuel assembly without integral neutron absorbers could be designed for the BWRs, this design change would shorten the expected licensing process duration and change the reactor loading schedule.

**Table 2.6: Existing BWR characteristics**

| | |
|---|---|
| *Plutonium capacity and rate for one reactor* | |
| Pu per assembly (kg) | 5.31 |
| % Pu in heavy metal | 3% |
| Pu dispositioned per year per reactor (MT) | 0.80 |
| Pu dispositioned per cycle/reload (MT) | 0.93 |
| *Fuel cycle characteristics* | |
| Total cycle length (days) | 425 |
| Effective full power days (EFPD) | 340 |
| Cumulative downtime per cycle (days) | 85 |
| Reload batch size (bundles) | 176 |
| Full core size (bundles) | 764 |
| Average discharge exposure (MWd/kg) | 33.7 |

### 2.2.3.3 *Canadian CANDU Heavy Water Reactor Facility – Bruce A Reactors*

The loading cycles defined for the CANDU HWR alternatives are based on the reactor characteristics for a 2832 MWt (769 MWe net) Bruce A heavy-water moderated CANDU reactor. The base case, 50SFC2-4, assumes two CANDU reactors will irradiate Reference MOX fuel for five years and then four CANDU reactors will irradiate a new hybrid fuel, known as CANFLEX, for the rest of the program for a total loading duration of 12.2 years to irradiate the full 50 MT of surplus weapons-usable plutonium. The variant case, 33SFC2, assumes that only two CANDU reactors will be used for the entire 32.5 MT disposition mission with no changeover to the new fuel design for a total loading duration of 11.6 years. Since CANDU reactors operate on a continuous refueling program, there are no planned shutdowns for refueling as in U.S. reactors. Periodic outages are planned for maintenance purposes, however, these downtimes are accounted for in the 80% capacity factor assumption. The plutonium loading capacity and fuel cycle characteristics for the CANDU reactors are shown in Table 2.7 and the modified characteristics for CANDU reactors using CANFLEX fuel are shown in Table 2.8. The CANDU HWR facility schedule is discussed in Section 5.1.3.

**Table 2.7: CANDU HWR characteristics with Reference MOX**

| | |
|---|---|
| *Plutonium capacity and rate for one reactor* | |
| Pu per MOX assembly (kg) | 0.23 |
| % Pu in heavy metal | 1.52% |
| Pu dispositioned per year (MT) | 1.06 |
| Pu dispositioned during program life (MT) | 25 |
| *Fuel cycle characteristics* | |
| Fuel residence (full power days) | 360 |
| Fuel residence time - 80% capacity | 450 |
| Full core size (bundles) | 6240 |
| Reload batch size (bundles/year) | 4600 |
| Average discharge exposure (MWd/kg) | 9.7 |

**Table 2.8: CANDU HWR characteristics with CANFLEX**

| | |
|---|---|
| *Plutonium capacity and rate for one reactor* | |
| Pu per CANFLEX assembly (kg) | 0.39 |
| % Pu in heavy metal | 2.7% |
| Pu dispositioned per year (MT) | 1.01 |
| Pu dispositioned during program life (MT) | 9.75 |
| *Fuel cycle characteristics* | |
| Reload batch size (bundles/year) | 2600 |
| Average discharge exposure (MWd/kg) | 17.1 |

*2.2.3.4 GoCo Partially-Complete Light Water Reactor Facilities – Pressurized Water Reactors*

The partially-complete LWR alternative, 50SFP2, assumes two PWR units will be completed and used for the mission. The plutonium loading capacity and fuel cycle characteristics, shown in Table 2.9, are based on the reactor characteristics of the 3817 MWt (1256 MWe), ABB-CE System 80 PWR. Each reactor will begin operation with a full core load of 241 MOX fuel assemblies with a 3.0% average Pu-loading. The second reactor begins MOX operations one year after the first reactor. There is a three-month confirmatory period included in the schedule for each reactor. The subsequent reloads of MOX fuel contain an average of 120.5 assemblies with a Pu-loading of 4.5%. The last reload of 40 MOX and 80 LEU fuel assemblies occurs 15.7 years after the initial MOX load and these assemblies are discharged 3.1 years later. After the last MOX fuel reload, the reactors will be converted to a full LEU core. The partially-complete PWR facility schedule is discussed in Section 6.3.

**Table 2.9: Partially-complete PWR characteristics**

| | |
|---|---|
| *Plutonium capacity and rate for one reactor* | |
| Pu per assembly [average for initial core (kg)] | 13.17 |
| Pu per assembly [average for equilibrium core (kg)] | 19.75 |
| % Pu in heavy metal, initial core | 3% |
| % Pu in heavy metal, equilibrium core | 4.5% |
| Pu dispositioned per year (MT) | 1.54 |
| Pu dispositioned per cycle/reload [average (MT)] | 2.38 |
| *Fuel cycle characteristics* | |
| Total cycle length (days) | 562.5 |
| Effective full power days (EFPD) | 450 |
| Fuel shuffling/refueling length (days) | 112.5 |
| Reload batch size (bundles) | 120.5 |
| Full core size (bundles) | 241 |
| Average discharge exposure (MWd/kg) | 32.5 |

#### *2.2.3.5 GoCo new Evolutionary Reactor Facility – ABB-CE System 80+ Reactors*

Alternative 50SFE2 assumes the use of two new, 3817 MWt (1256 MWe) ABB-CE System 80+ reactors. This reactor design is a MOX-burning variant of the commercial ABB-CE System 80+ reactor which uses conventional LEU fuel. The plutonium loading capacity and fuel cycle characteristics for these reactors are shown in Table 2.10. The second reactor begins MOX operations two years after the first reactor starts. The schedule includes a six-month confirmatory period for the first reactor. Each reactor begins MOX operation with a full core loading of 241 MOX fuel assemblies. This load resides in the core without refueling for a period of about four years, during which the fuel assemblies are relocated ("reshuffled") within the core three times at nominally equal intervals in order to achieve more uniform burnup. The last reload of MOX fuel occurs 13.3 years after the initial MOX load. Half of the fuel assemblies in this final reload are MOX and half are LEU, subsequent reloads are full core loads of LEU fuel. The System 80+ facility schedule is shown in Section 7.3.

**Table 2.10: ABB-CE System 80+ reactor characteristics**

| | |
|---|---|
| *Plutonium capacity and rate for one reactor* | |
| Pu per assembly (kg) | 27.7 |
| % Pu in heavy metal | 6.8% |
| Pu dispositioned per year (MT) | 1.8 |
| Pu dispositioned per cycle/reload (MT) | 6.7 |
| *Fuel cycle characteristics* | |
| Total cycle length (days) | 1370 |
| Effective full power days (EFPD) | 1096 |
| Fuel shuffling/refueling length (days) | 274 |
| Reload batch size (bundles) | 241 |
| Full core size (bundles) | 241 |
| Average discharge exposure (MWd/kg) | 42.4 |

### 2.2.4 Repository Facilities

All of the repository facilities receive spent MOX fuel from reactors and isolate the spent fuel permanently in a sub-surface facility. There is no description of a European repository because all of the remaining feasible reactor-based alternatives will use either domestic or Canadian reactors.

#### *2.2.4.1 High Level Waste Repository Facility*

The final facility for all of the alternatives which use domestic reactors is the High Level Waste (HLW) Repository Facility. After the appropriate length of time, the spent MOX fuel will be removed from the cooling pools at the reactor facilities and shipped to this facility for final disposal. The spent MOX fuel generated by the plutonium disposition mission will be a small fraction of the spent commercial fuel which will be handled each year. It is scheduled to be opened before any of the spent MOX fuel will be ready to be shipped to the facility. The facility schedule is discussed in Section 4.1.4.

#### *2.2.4.2 Canadian Geological Repository Facility*

The final facility for the two CANDU alternatives is the Canadian Geological Repository Facility. After the appropriate length of time, the spent MOX and/or CANFLEX fuel will be removed from the cooling pools or from dry cask storage at the reactor facility and shipped to this facility for final disposal. It is scheduled to be opened in 2025. The facility schedule is discussed in Section 5.1.4.

# 3. Schedule Analyses

## 3.1 Introduction

As discussed above, the NAS labeled the existing international regime for surplus plutonium to be a "clear and present danger" and urged that actions should be initiated to effect the disposition of surplus plutonium without delay. Thus, timeliness should be a primary determinant for the selection of approaches for plutonium disposition. The FMDP Reactor Alternative Team has interpreted timeliness to be comprised of three performance attributes:

- *Time to start disposition:* The mission starts when the first mission fuel is loaded into a reactor and the reactor returns to or has ascended to full power operation. For the existing LWR options, the mission begins when the first reactor is loaded with MOX fuel, after the initial irradiation of the lead use assemblies (LUAs). For the CANDU options, the mission begins when the first reactors are loaded with MOX fuel. For the partially-complete and evolutionary reactor options, the mission begins when the first reactor begins operating at full power using a full MOX core.
- *Time to complete:* For the reactor options, the mission is complete after the final load of MOX fuel in the reactor has been irradiated for a specified period. For the existing and partially-complete LWR options, a single reload cycle is sufficient. For the CANDU options, the mission is complete after the final Reference MOX or CANFLEX fuel bundles have been discharged from the reactors. For the evolutionary LWR option, the mission is complete after the first reshuffle of the last core load containing MOX fuel assemblies.
- *Schedule certainty:* A full uncertainty analysis of the implementation schedules was considered too premature for the analysis presented below. A qualitative assessment of the schedule certainty is included.

## 3.2 Schedule Elements

Each reactor-based plutonium disposition alternative deployment schedule has been developed by combining the schedules for each of the individual facilities involved in the alternative. In the sections following, the implementation schedule for each facility in an alternative will be developed using the elements shown below, then a summary schedule for the alternative will be shown. Chapter 4 will present the schedules for the existing LWR options; Chapter 5, the CANDU options; Chapter 6, the partially-complete LWR option; and Chapter 7, the evolutionary LWR option. A summary of all of the reactor-based options will be discussed in Chapter 8.

The major elements for each of the facility schedules are:

- Project definition and approval
- Siting, licensing and permitting
- Research, development, and demonstration
- Design
- Facility modification or construction, procurement and preoperational activities
- Operation
- Decontamination and decommissioning.

The completion of each of these facility elements must be sequenced properly with the other facilities. For example, the MOX fuel fabrication facility needs to have a sufficient supply of $PuO_2$ to operate, and the reactors require a sufficient supply of fuel to meet the reload schedule.

In defining the schedule elements for a government project, there are a number of activities required for federal projects that may not apply or are less important for a private sector project. The schedules reflect these complications which include the following elements:

- Congressional line item approval and funding authorization

- Compliance with the National Environmental Policy Act (NEPA)
- Special procurement and vendor selection rules and regulations.

## 3.3 General Assumptions and Bases

### 3.3.1 Record of Decision

The fissile materials disposition project officially starts with the issuance of the programmatic ROD. In the analyses presented below, the ROD is assumed to have been issued on December 9, 1996; the actual ROD was issued on January 14, 1997. Some of the R&D projects began earlier in October 1995.

After ROD, conceptual design of the PuP and MOX fuel fabrication facilities and the line item approval process begin. The line item approval process is assumed to have a three year duration and to proceed in stages. Contract negotiations with management & operating (M&O) contractors may start after two years. Detailed design of new and/or modified facilities may start once the line item funding is approved.

### 3.3.2 Licensing

All of the facilities in each alternative will be licensed by the NRC except for the plutonium processing facility which is assumed to be overseen by the Defense Nuclear Facilities Safety Board (DNFSB); and the Canadian and European facilities, which will be regulated by the appropriate national or European agency. The NRC licensing process used for each reactor facility follows the analysis presented in the Fluor Daniel Report: *Regulatory Plans for NRC Licensing of Fissile Materials Disposition Alternatives* (9). For the PuP facility, a five year DNFSB review period has been assumed, this review is assumed to begin immediately after ROD. For the MOX fuel fabrication facility and the collocated PuP and MOX fuel fabrication facility, the NRC licensing process is also assumed to be five years. The process for modifying the existing license of a European fuel fabrication facility for this mission is not discussed in this document due to the preliminary nature of this analysis. The five year licensing and permit schedule for the domestic fuel fabrication facility will be discussed in Section 4.1.2.2.

The licensing processes for the different reactors vary depending on several factors: reactor type, existing or new reactor, and fuel design.

- For the existing LWR reactors, the NRC license modification process is assumed to require 4.25 years for the PWR options which do not have integral neutron absorbers, and to require 5.25 years for the BWR option which includes integral neutron absorbers in the MOX fuel assembly. For all of the existing LWR options, the initial reload permit for MOX fuel is not granted until after the lead use assemblies (LUAs) have been irradiated for two cycles. There is also a three year LUA license process which begins part way through the fuel qualification and demonstration process before the LUA may be loaded into the reactor. However, this process is completed well in advance of the availability of domestically fabricated fuel, and a year after a European LUA would be available. The licensing and permitting schedule for the existing PWR options is discussed in Sections 4.1.3.2 and 4.3.3.1, and in Section 4.5.2.2 for the existing BWR option.
- For the partially-complete LWR option, the construction permit (CP) is transferred to the new contractor approximately one year after the contractor is selected. Once the CP is transferred the construction may proceed. The operating license for each reactor is granted after its completion. The LUAs for this reactor option will be irradiated in a sister reactor as soon as the assemblies are available. The licensing and permitting schedule for the partially-complete LWR option is discussed in Section 6.3.2.
- For the new evolutionary LWR option, a three year licensing process is assumed before any site preparations may begin. The combined construction permit and operating license is issued eighteen months later, after which, the first nuclear concrete may be poured. The licensing and permit schedule for the evolutionary LWR option is discussed in Section 7.3.2.
- For the CANDU HWR, the license modification process is based on analysis by AECB and Ontario Hydro and has been estimated to require four years. The process will begin after the intermediate congressional line item funding is approved.

### 3.3.3 Pu Availability and Production Facility

All the schedules assume sufficient $PuO_2$ will be available to fabricate any initial LUAs before the production facility at an existing DOE site is operational. For most of the options, the PuP facility operates for ten years.

For the quick start case, 50QSL5, the plutonium will be processed in a staged start, because this alternative requires plutonium oxide ($PuO_2$) feed before the PuP facility could provide it. It is expected that a sufficient quantity of $PuO_2$ will be available from the Advanced Recovery and Integrated Extraction System (ARIES) prototype, which is being developed to demonstrate the ARIES process and for design support for the production facility. Using the prototype ARIES line to process some of the mission material also shortens the operational duration of the production facility to 9.1 years.

## 3.4 Schedule impacts of transportation and packaging

In terms of significantly impacting the overall schedule of the fissile materials disposition mission, transportation and packaging provides no sensitivity to any of the end-to-end alternatives chosen. In general, it is a safe assumption that any transportation and packaging activities that could impact the schedule (e.g., delays in package certification, or delays due to insufficient number of available packages) will be eliminated by the fact that there is (a) sufficient time to design, develop, and certify appropriate packages and (b) sufficient planning and resources available to acquire adequate numbers of certified packages to accommodate the mission's schedule. Therefore, the schedule specifics of transporting material from one facility to another are not included in the schedule analysis except for transportation to and from Europe in the quick start case.

# 4. Existing Light Water Reactor Alternatives

The implementation schedules for each of five existing LWR options shown in Table 2.2 is presented below. For complete descriptions of each of the facilities and for the cost and other analyses for the existing LWR options, see the RASR, volume 1 (2).

## 4.1 Existing LWR Alternative Base Case, 50SFL5

The base case for the existing LWR alternative uses four separate facilities: a PuP facility to process the weapons-usable plutonium from the various feed materials to $PuO_2$, a federally-owned MOX fuel fabrication facility to convert the $PuO_2$ into MOX fuel, five existing PWRs to irradiate the MOX fuel, and a HLW repository for ultimate emplacement of the spent MOX fuel. The implementation schedule for each of these facilities is developed below, followed by a summary schedule for the overall alternative.

### 4.1.1 PuP Facility

#### *4.1.1.1 PuP Facility Design & Construction Schedule*

The duration and path of the design and construction tasks for the PuP facility are based on a generic DOE Major System Acquisition – Capital Construction Project. The design and construction process will begin at ROD with the start of the selection process for an Architect Engineering (AE) firm. This contractor will be responsible for developing the required designs for the facility modification and for completing these modifications. Work on the conceptual design will begin as soon as the AE contractor has been selected. The first key decision (KD-1) to start work on the Title I design will be made after the conceptual design is complete and the initial line item funding has been approved. With the approval of the Title I design (KD-2) and final line item funding approval, work on Title II design starts. The facility modifications and equipment procurement start after Title II has been approved (KD-3). The equipment installation will proceed in a staged process so that the preoperational checkout of the facility will start six-months before completion of the installation. The design and construction schedule is shown in Table 4.1 and in the PuP facility summary discussion in Section 4.1.1.5. A one-year site and facility selection process will begin after ROD to determine the most appropriate existing facility on a federal site for the PuP facility.

#### *4.1.1.2 PuP Facility Oversight & Permitting Schedule*

For this analysis, it has been assumed that the DNFSB oversight review will start at ROD and will require five years. The NEPA process and other site-specific permitting will require three years and will start after the site has been selected. The oversight and permitting schedule is shown in Table 4.2 and in the PuP facility summary discussion in Section 4.1.1.5.

#### *4.1.1.3 PuP Facility Operations Schedule*

The preoperational checkout of the PuP facility will start six-months before the equipment installation is complete and will take one year. The facility is scheduled to operate for ten years with an annual plutonium throughput of 5 MT. The first $PuO_2$ will be available for shipment two months after the start of operation. The operational schedule is shown in Table 4.3 and in the PuP facility summary discussion in Section 4.1.1.5.

#### *4.1.1.4 PuP Facility Decontamination & Decommissioning Schedule*

Decontamination and decommissioning is projected to take two years for removal of contaminated equipment and return of the building to an appropriate condition for general use.

**Table 4.1 PuP facility design and construction schedule**

| Task ID | Task Name | Duration (months) | Start | Finish |
|---|---|---|---|---|
| 1. | **R&D Funding Available** | | | 10/1995 |
| 2. | **FMDP Record of Decision** | | | 12/1996 |
| 3. | **Congressional Funding Approval** | 36 | 12/1996 | 12/1999 |
| 4. | Initial Funding Process | 24 | 12/1996 | 12/1998 |
| 5. | Final Line Item Funding Approval | 12 | 12/1998 | 12/1999 |
| 6. | **Research, Development & Demonstration** | 36 | 10/1995 | 9/1998 |
| 7. | **Site & Facility Selection** | 12 | 12/1996 | 12/1997 |
| 8. | **Design Process** | 61 | 12/1996 | 1/2002 |
| 9. | AE Selection | 3 | 12/1996 | 2/1997 |
| 10. | Conceptual Design | 25 | 3/1997 | 3/1999 |
| 11. | Approval of New Start (KD-1) | | | 3/1999 |
| 12. | Title I | 12 | 3/1999 | 3/2000 |
| 13. | Approval to Commence Title II (KD-2) | | | 3/2000 |
| 14. | Title II | 22 | 3/2000 | 1/2002 |
| 15. | **Facility Modification** | 48 | 1/2002 | 1/2006 |
| 16. | Approval to Start Construction (KD-3) | | | 1/2002 |
| 17. | Construction, Procurement & Equipment Installation | 48 | 1/2002 | 1/2006 |

**Table 4.2 PuP facility oversight and permitting schedule**

| Task ID | Task Name | Duration (months) | Start | Finish |
|---|---|---|---|---|
| 1. | **Oversight and Permitting** | 60 | 12/1996 | 12/2001 |
| 2. | DNFSB Review of Existing DOE Facility | 60 | 12/1996 | 12/2001 |
| 3. | Environmental / NEPA / DOE | 36 | 12/1997 | 12/2000 |

**Table 4.3 PuP facility operational schedule**

| Task ID | Task Name | Duration (months) | Start | Finish |
|---|---|---|---|---|
| 1. | **Preoperational Phase** | 12 | 8/2005 | 7/2006 |
| 2. | **Operation** | 120 | 7/2006 | 7/2016 |
| 3. | Approval to Commence Operation (KD-4) | | | 7/2006 |
| 4. | Pu Processing Duration | 120 | 7/2006 | 7/2016 |
| 5. | First $PuO_2$ Available | 2 | 7/2006 | 9/2006 |

#### *4.1.1.5 PuP Facility Schedule Summary*

The overall PuP facility implementation schedule is summarized in Table 4.4 and shown in Figure 4.1. This facility schedule is also shown in the discussion of the overall alternative schedule in Section 4.1.5. This schedule does not include any contingency for schedule slip due to site selection difficulties, redesign, construction delays, or a delay in the approval of line item funding.

The critical path through the development of this facility is through the design and construction process. If any of these tasks slip in their schedule, the rest of the implementation process will also be delayed. This critical path is shown in Figure 4.1. If the start of operations at the PuP facility slips more than three months, the start of operations at the MOX fuel fabrication facility will also slip because the $PuO_2$ will not be available to begin fuel fabrication.

**Table 4.4 PuP facility schedule summary**

| Task ID | Task Name | Duration (months) | Start | Finish |
|---|---|---|---|---|
| 1. | R&D Funding Available | | | 10/1995 |
| 2. | FMDP Record of Decision | | | 12/1996 |
| 3. | Congressional Funding Approval | 36 | 12/1996 | 12/1999 |
| 4. | Research, Development & Demos | 36 | 10/1995 | 9/1998 |
| 5. | Site & Facility Selection | 12 | 12/1996 | 12/1997 |
| 6. | Oversight and Permitting | 60 | 12/1996 | 12/2001 |
| 7. | Design Process | 61 | 12/1996 | 1/2002 |
| 8. | Facility Modification | 48 | 1/2002 | 1/2006 |
| 9. | Preoperational Phase | 12 | 8/2005 | 7/2006 |
| 10. | Facility Operation | 120 | 7/2006 | 7/2016 |
| 11. | Decontamination & Decommission | 24 | 8/2016 | 7/2018 |

### 4.1.2 MOX Fuel Fabrication Facility

#### *4.1.2.1 MOX Fuel Fabrication Facility Design & Construction Schedule*

The duration and path of the design and construction tasks for the MOX fuel fabrication facility are based on a generic DOE Major System Acquisition - Capital Construction Project. The design and construction process will begin at ROD with the conceptual design which will be completed by the National Laboratories in order to start the NRC licensing process as soon as possible. The one-year site and facility selection process to determine the most appropriate existing facility on a federal site for the MOX fuel fabrication facility will start after the completion of the conceptual design. The selection process for the M&O contractor will start after the intermediate approval for line item funding. This contractor will be responsible for developing the Title I and II designs and for completing the facility modifications required for the MOX fuel fabrication facility. Work on Title II starts after approval of the Title I design and final line item funding. The facility modifications and equipment procurement starts after completion of Title II design and up to one year before the completion of the NRC licensing process. However, no safety-related construction may be done until after the license has been granted. The design and construction schedule is shown in Table 4.5 and in the MOX fuel fabrication facility summary figure in Section 4.1.2.5.

The fuel qualification demonstration has begun with the production of the test assemblies and is scheduled to be completed in 2001.

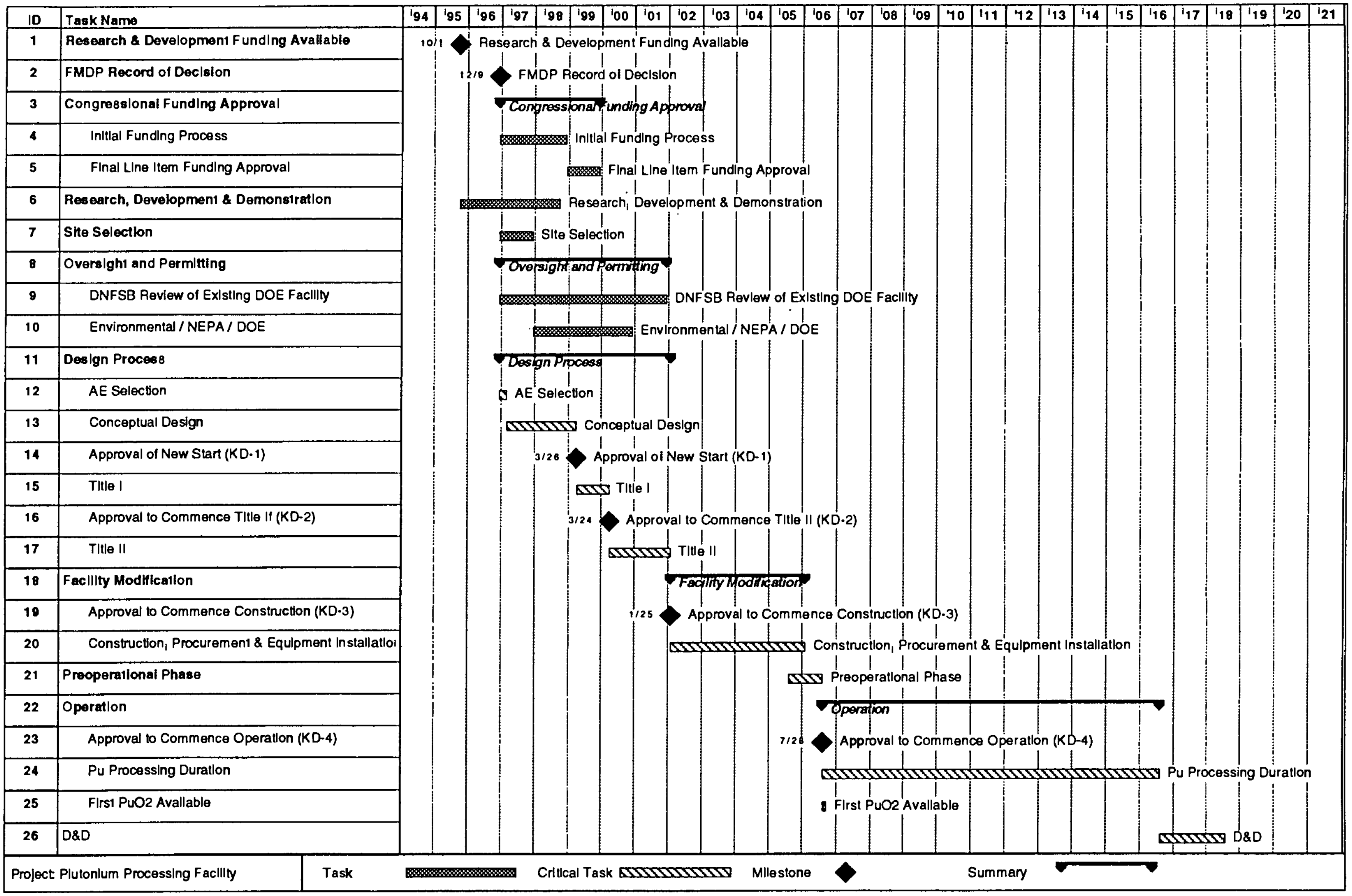


**Figure 4.1 PuP facility schedule summary**

Table 4.5 MOX fuel fabrication facility design and construction schedule

| Task ID | Task Name | Duration (months) | Start | Finish |
|---|---|---|---|---|
| 1. | **FMDP Record of Decision** | | | 12/1996 |
| 2. | **Congressional Funding Approval** | 36 | 12/1996 | 12/1999 |
| 3. | Initial Funding Process | 24 | 12/1996 | 12/1998 |
| 4. | Final Line Item Funding Approval | 12 | 12/1998 | 12/1999 |
| 5. | **Fuel Qualification Demonstration** | 60 | 4/1996 | 4/2001 |
| 6. | **Site and Facility Selection** | 12 | 12/1997 | 12/1998 |
| 7. | **Select M&O Contractor** | 12 | 12/1998 | 12/1999 |
| 8. | **Design Process** | 60 | 12/1996 | 11/2001 |
| 9. | Conceptual Design | 12 | 12/1996 | 12/1997 |
| 10. | Title I | 12 | 12/1999 | 12/2000 |
| 11. | Title II | 12 | 12/2000 | 11/2001 |
| 12. | **Facility Modification** | 36 | 12/2001 | 12/2004 |
| 13. | Construction | 36 | 12/2001 | 12/2004 |
| 14. | Procurement | 24 | 12/2001 | 12/2003 |
| 15. | Equipment Installation | 12 | 12/2003 | 12/2004 |

### *4.1.2.2 MOX Fuel Fabrication Facility Licensing & Permitting Schedule*

For this analysis, it has been assumed that the duration of the NRC licensing process will be five years and that the process will start after the conceptual design is complete. The NEPA process and the other site-specific permitting will require three years; each process will start after the site has been selected. The licensing schedule is shown in Table 4.6 and in the MOX fuel fabrication facility summary figure in Section 4.1.2.5.

Table 4.6 MOX fuel fabrication facility licensing and permitting schedule

| Task ID | Task Name | Duration (months) | Start | Finish |
|---|---|---|---|---|
| 1. | **Licensing and Permitting** | 60 | 12/1997 | 12/2002 |
| 2. | NRC Licensing | 60 | 12/1997 | 12/2002 |
| 3. | Environmental / NEPA / DOE | 36 | 12/1998 | 11/2001 |
| 4. | Permitting | 36 | 12/1998 | 11/2001 |

### *4.1.2.3 MOX Fuel Fabrication Facility Operations Schedule*

The preoperational checkout of the facility starts as soon as the construction is complete and will take two years. The LUAs are fabricated in the MOX fuel fabrication facility during the six-month start-up period. Then, this facility will operate for 9.8 years with an annual plutonium throughput rate of 5 MT, supplying fuel for the 5 existing PWRs at the specified loading rate. This throughput assumes an annual output of 280 assemblies for a mission total of 2756 assemblies. The operational schedule is shown in Table 4.7 and in the MOX fuel fabrication facility summary figure in Section 4.1.2.5.

### *4.1.2.4 MOX Fuel Fabrication Facility Decontamination & Decommissioning Schedule*

The duration for the decontamination and decommissioning of the MOX facility has been estimated to be two years.

**Table 4.7 MOX fuel fabrication facility operational schedule**

| *Task ID* | *Task Name* | *Duration (months)* | *Start* | *Finish* |
|---|---|---|---|---|
| 1. | **Preoperational Phase** | 24 | 12/2004 | 12/2006 |
| 2. | **PuP Facility Lead Time Complete** | | | 9/2006 |
| 3. | **MOX Facility Ready for $PuO_2$** | | | 12/2006 |
| 4. | **Operation** | 124 | 12/2006 | 4/2017 |
| 5. | MOX Facility Operation Start | | | 12/2006 |
| 6. | LUA Fabrication | 6 | 12/2006 | 6/2007 |
| 7. | Operation | 118 | 6/2007 | 4/2017 |

*4.1.2.5 MOX Fuel Fabrication Facility Schedule Summary*

The overall MOX fuel fabrication facility implementation schedule is summarized in Table 4.8 and shown in Figure 4.2. This facility schedule is also shown in the discussion of the overall alternative schedule in Section 4.1.5. This schedule does not include any contingency for schedule slip due to site selection difficulties, redesign, construction delays, or a delay in the approval of line item funding.

The critical path through the development of this facility is through the conceptual design and the NRC licensing process. If either of these tasks slip in their schedule, the rest of the implementation process will also be delayed. This critical path is shown in Figure 4.2.

**Table 4.8 MOX fuel fabrication facility schedule summary**

| *Task ID* | *Task Name* | *Duration (months)* | *Start* | *Finish* |
|---|---|---|---|---|
| 1. | FMDP Record of Decision | | | 12/1996 |
| 2. | Congressional Funding Approval | 36 | 12/1996 | 12/1999 |
| 3. | Fuel Qualification Demonstration | 60 | 4/1996 | 4/2001 |
| 4. | Site and Facility Selection | 12 | 12/1997 | 12/1998 |
| 5. | Select M&O Contractor | 12 | 12/1998 | 12/1999 |
| 6. | Licensing and Permitting | 60 | 12/1997 | 12/2002 |
| 7. | Design Process | 60 | 12/1996 | 11/2001 |
| 8. | Facility Modification | 36 | 12/2001 | 12/2004 |
| 9. | Preoperational Phase | 24 | 12/2004 | 12/2006 |
| 10. | PuP Facility Lead Time Complete | | | 9/2006 |
| 11. | MOX Facility Ready for $PuO_2$ | | | 12/2006 |
| 12. | LUA Fabrication | 6 | 12/2006 | 6/2007 |
| 13. | MOX Fuel Fabrication Operation Duration | 118 | 6/2007 | 4/2017 |
| 14. | Decontamination & Decommission | 24 | 4/2017 | 4/2019 |

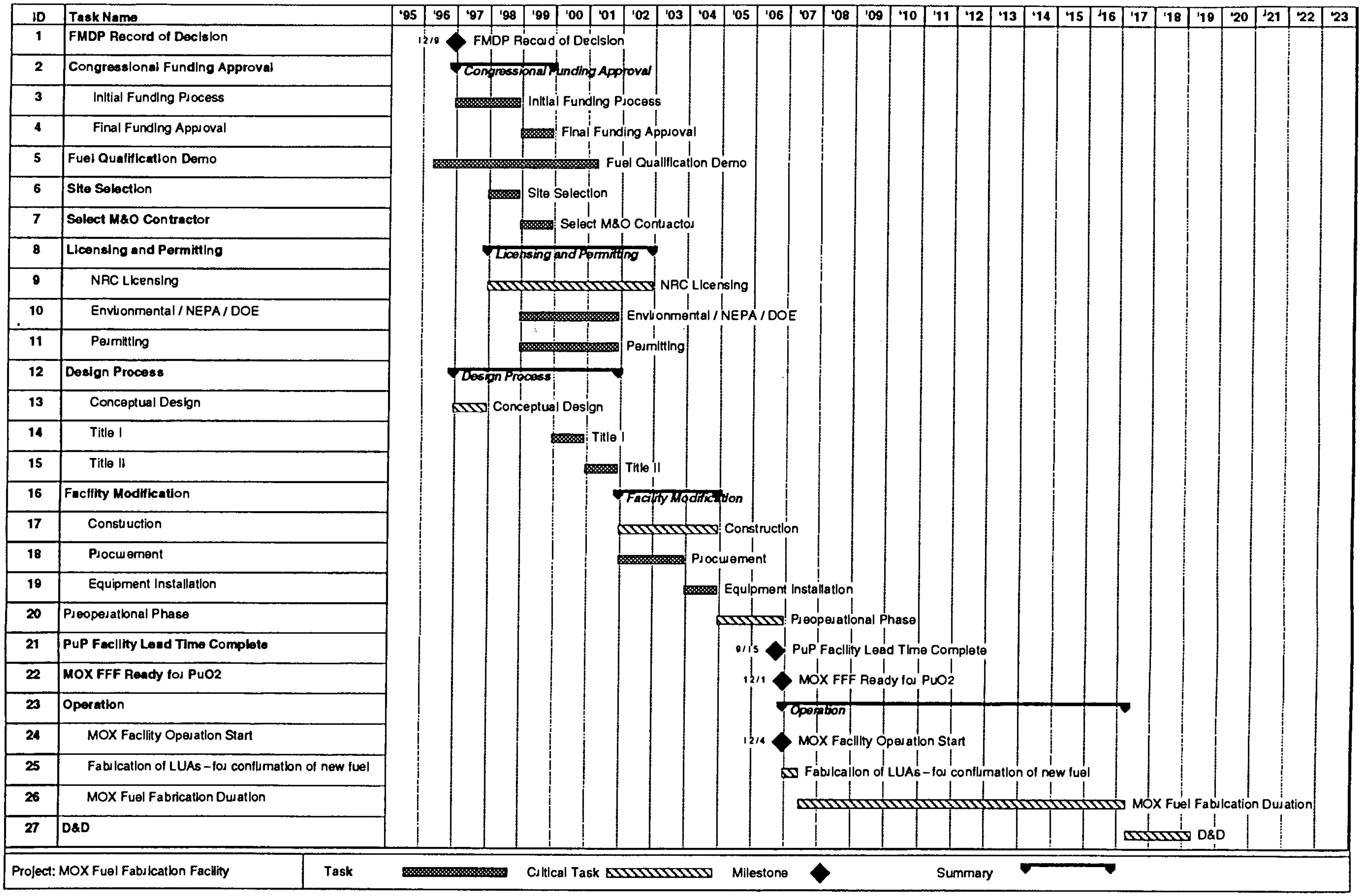


**Figure 4.2 MOX fuel fabrication facility summary schedule**

### 4.1.3 Existing PWR Facility

#### *4.1.3.1 Existing PWR Facility Design & Construction Schedule*

After the intermediate approval of line item funding, the project begins with a year-long process to select the utility or utilities. The reactor modifications, which primarily consist of the construction of a new fuel storage facility, are estimated to take four years. The design and construction schedule is listed in Table 4.9 and in the PWR reactor facility schedule shown in Section 4.1.3.4.

**Table 4.9 Existing PWR facility design and construction schedule**

| *Task ID* | *Task Name* | *Duration (months)* | *Start* | *Finish* |
|---|---|---|---|---|
| 1. | FMDP Record of Decision | | | 12/1996 |
| 2. | Intermediate Funding Approval | 24 | 12/1996 | 12/1998 |
| 3. | Utility Selection | 12 | 12/1998 | 12/1999 |
| 4. | Reactor Modifications | 48 | 12/1999 | 11/2003 |

#### *4.1.3.2 Existing PWR Facility Licensing and Permitting Schedule*

For this analysis, a schedule developed by Fluor Daniel (9) for modifying an existing LWR facility license to permit the use of MOX fuel without integral neutron absorbers was followed. The process to obtain a reload permit for a new fuel fabricator is also included in the permit schedule. The license and permit schedule is shown in Table 4.10 and Figure 4.3.

After the utility or utilities have been selected, the license amendment process is started with the preparation of the Safety Analysis Report (SAR), the license amendment application, and the Environmental Report (ER). The NRC issues the Safety Evaluation Report (SER) and the Environmental Assessment (EA) after completing the review of the application. The amended license is issued after the reactor facility modifications are complete. In addition, a reload license process is followed because of the use of a new MOX fuel fabrication facility. This analysis assumes a three year LUA license process is followed prior to inserting the LUAs into the reactor. After the LUAs have been irradiated for one cycle, 1.5 years in this case, a review of the LUA performance is completed. The reload permit for use of MOX fuel is granted after this review.

#### *4.1.3.3 Existing PWR Facility Operations Schedule*

The LUAs are loaded into the first unit as soon as they are available and during a normal refueling period for the reactor. After the completion of the LUA review during the second irradiation cycle, the first mission fuel is loaded at the next scheduled refueling period in May 2010. The MOX fuel load and discharge schedule for the five reactors was discussed in Section 2.2.3.1. After three irradiation cycles, 4.5 years, the spent MOX fuel assemblies are discharged from the reactors, and stored in the spent fuel storage pool for a minimum of ten years before being shipped to the HLW repository facility. The existing LWR facility operational schedule is shown in Table 4.11 and in the PWR reactor facility schedule shown in Section 4.1.3.4.

#### *4.1.3.4 Existing PWR Facility Schedule Summary*

The overall existing PWR facility implementation schedule is summarized in Table 4.12 and shown in Figure 4.4. This facility schedule is also shown in the discussion of the overall alternative schedule in Section 4.1.5. The critical path for this facility is the availability of the LUAs and is shown in Figure 4.4. The reactors are ready to accept MOX LUAs over three years before they are available.

Table 4.10 Existing PWR facility license and permit schedule

| *Task ID* | *Task Name* | *Duration (months)* | *Start* | *Finish* |
|---|---|---|---|---|
| 1. | **NRC Interactions** | 51 | 12/1999 | 2/2004 |
| 2 | Licensee Prepares SAR & License Amendment | 12 | 12/1999 | 12/2000 |
| 3 | Licensee Files Application | | | 12/2000 |
| 4 | Public Notice of App. for License Amendment | 3 | 12/2000 | 3/2001 |
| 5 | NRC Review | 9 | 3/2001 | 11/2001 |
| 6 | NRC Issues SER | | | 11/2001 |
| 7 | NRC Issues License Amendment | 3 | 12/2003 | 2/2004 |
| 8 | Notice of Amendment to Operating License | | | 2/2004 |
| 9 | **Environmental / NEPA / NRC** | 24 | 12/1999 | 11/2001 |
| 10 | Licensee Develops & Prepares ER | 6 | 12/1999 | 6/2000 |
| 11 | Licensee Files Report with NRC | | | 12/2000 |
| 12 | NRC Prepares & Issues Draft EA | 6 | 12/2000 | 6/2001 |
| 13 | NRC Issues Final EA | 3 | 9/2001 | 11/2001 |
| 14 | **LUA & Reload Licenses** | 126 | 12/1999 | 5/2010 |
| 15 | LUA Licensing | 36 | 12/1999 | 11/2002 |
| 16 | Reload Approval | 18 | 12/2008 | 5/2010 |
| 17 | **Reactor Modifications** | 48 | 12/1999 | 11/2003 |
| 18 | **Fuel Qualification - LUAs** | 54 | 6/2007 | 12/2011 |
| 19 | LUA Arrives | | | 6/2007 |
| 20 | LUA Irradiation | 54 | 6/2007 | 12/2011 |

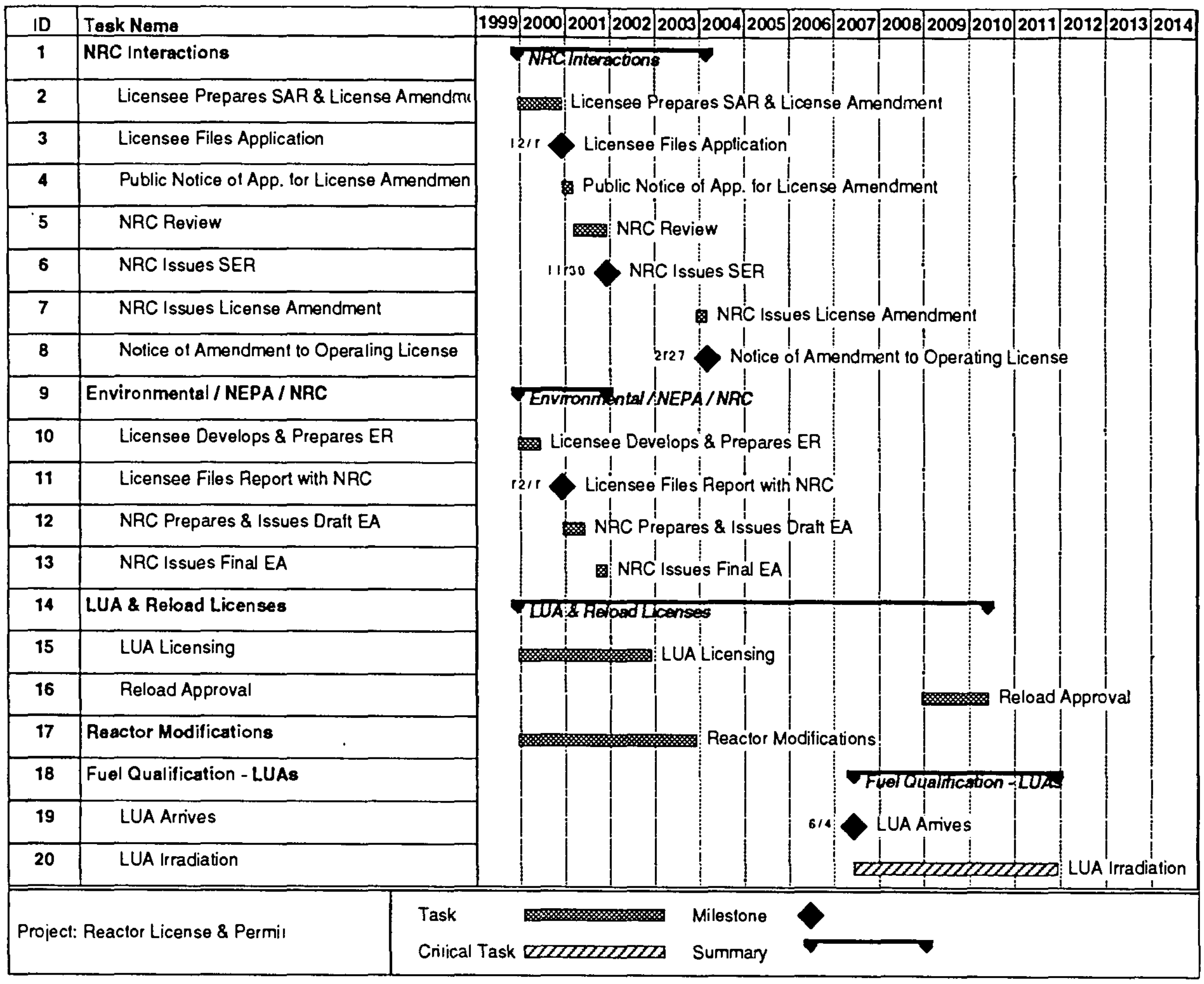


**Figure 4.3 Existing PWR Facility License and Permit Schedule**

**Table 4.11 Existing PWR Facility Operations Schedule**

| *Task ID* | *Task Name* | *Duration (months)* | *Start* | *Finish* |
|---|---|---|---|---|
| 1. | **Reactor "ready" to accept MOX** | | | 2/2004 |
| 2. | **Fuel Qualification** | 54 | 6/2007 | 12/2011 |
| 3. | **Reactor Facility Operation** | 171 | 5/2010 | 8/2024 |
| 4. | Unit 1 Loading Duration | 108 | 5/2010 | 5/2019 |
| 5. | Unit 2 Loading Duration | 108 | 10/2010 | 10/2019 |
| 6. | Unit 3 Loading Duration | 108 | 2/2011 | 2/2020 |
| 7. | Units 4&5 Loading Duration | 88 | 7/2011 | 11/2018 |
| 8. | **Last Assemblies - single cycle** | 18 | 3/2020 | 8/2021 |
| 9. | Last Assembly Discharged | 54 | 3/2020 | 8/2024 |
| 10. | **Spent Fuel Storage** | 237 | 12/2014 | 9/2034 |
| 11. | First MOX in Spent Fuel Pool | 120 | 12/2014 | 11/2024 |
| 12. | Last MOX | 120 | 9/2024 | 9/2034 |

**Table 4.12 Existing PWR facility schedule summary**

| *Task ID* | *Task Name* | *Duration (months)* | *Start* | *Finish* |
|---|---|---|---|---|
| 1. | FMDP Record of Decision | | | 12/1996 |
| 2. | Congressional Funding Approval | 36 | 12/1996 | 12/1999 |
| 3. | Utility Selection | 12 | 12/1998 | 12/1999 |
| 4. | Licensing and Permitting | 51 | 12/1999 | 2/2004 |
| 5. | Reactor Modifications | 48 | 12/1999 | 11/2003 |
| 6. | LUAs Arrive from MOX facility | | | 6/2007 |
| 7. | Fuel Qualification - LUAs | 54 | 6/2007 | 12/2011 |
| 8. | Reactor Operation | 171 | 5/2010 | 8/2024 |
| 9. | Last Assemblies - first cycle | 18 | 3/2020 | 8/2021 |
| 10. | Spent Fuel Storage | 237 | 12/2014 | 9/2034 |

### 4.1.4 HLW Repository Facility

For this analysis, it has been assumed that the licensing process for the HLW Repository facility will begin in March 2002 and will require 8.5 years to complete. The construction of this facility will begin in 2005 and will take 5.5 years to complete. The facility is scheduled to open in 2010 after completion of construction and granting of the license. The spent MOX fuel is scheduled to be delivered to the repository facility from December 2024 to September 2034. The HLW Repository facility schedule summary is shown in Table 4.13 and in the overall alternative schedule in Section 4.1.5.

**Table 4.13 HLW repository facility schedule summary**

| *Task ID* | *Task Name* | *Duration (months)* | *Start* | *Finish* |
|---|---|---|---|---|
| 1. | Licensing Process | 102 | 3/2002 | 8/2010 |
| 2. | Construction | 66 | 3/2005 | 8/2010 |
| 3. | Repository Opening Date | | | 8/2010 |
| 4. | Delivery of MOX to Repository | 118 | 12/2024 | 9/2034 |
| 5. | Transportation of first MOX to Repository | 1 | 12/2024 | 12/2024 |
| 6. | Transportation of last MOX | 1 | 9/2034 | 9/2034 |

### 4.1.5 Existing LWR Alternative Base Case Schedule Summary

The existing LWR alternative base case schedule is a combination of the individual facility schedules discussed above. This overall schedule is summarized in Table 4.14 and shown in Figure 4.5. The plutonium disposition mission begins when the first mission fuel is loaded into a reactor in May 2010 and is complete after the last core load, which contains MOX fuel assemblies, has been irradiated for a single cycle in August 2021. The overall mission time is 11.3 years and starts 13.5 years after ROD. The critical path for this alternative is the licensing, design and facility modifications for the MOX fuel fabrication facility.

Table 4.14 Existing LWR alternative schedule summary

| Task ID | Task Name | Duration (years) | Start | Finish |
|---|---|---|---|---|
| 1. | **FMDP Record of Decision** | | | 12/1996 |
| 2. | **Congressional Funding Process** | 3 | 12/1996 | 12/1999 |
| 3. | **PuP Facility** | 22.8 | 10/1995 | 7/2018 |
| 4. | R&D | 3 | 10/1995 | 9/1998 |
| 5. | Oversight, Permitting & Siting | 5 | 12/1996 | 12/2001 |
| 6. | Design | 5.1 | 12/1996 | 1/2002 |
| 7. | Facility Modification & Preoperation | 4.5 | 1/2002 | 7/2006 |
| 8. | Operation | 10 | 7/2006 | 7/2016 |
| 9. | Decontamination & Decommissioning | 2 | 8/2016 | 7/2018 |
| 10. | **MOX fuel fabrication facility** | 23 | 4/1996 | 4/2019 |
| 11. | Fuel Qualification | 5 | 4/1996 | 4/2001 |
| 12. | Licensing, Permitting & Siting | 5 | 12/1997 | 12/2002 |
| 13. | Design | 5 | 12/1996 | 11/2001 |
| 14. | Facility Modification & Preoperation | 5 | 12/2001 | 12/2006 |
| 15. | Fabrication of LUAs | 0.5 | 12/2006 | 6/2007 |
| 16. | Operation | 9.8 | 6/2007 | 4/2017 |
| 17. | Decontamination & Decommissioning | 2 | 4/2017 | 4/2019 |
| 18. | **Reactor Facility** | 35.7 | 12/1998 | 9/2034 |
| 19. | Utility Selection | 1 | 12/1998 | 12/1999 |
| 20. | Licensing | 4.2 | 12/1999 | 2/2004 |
| 21. | Reactor Modifications | 4 | 12/1999 | 11/2003 |
| 22. | Reactor "ready" to accept MOX | | | 2/2004 |
| 23. | Lead Use Assemblies | 4.5 | 6/2007 | 12/2011 |
| 24. | MOX Loading Duration | 9.75 | 5/2010 | 2/2020 |
| 25. | Single irradiation cycle of last MOX | 1.5 | 3/2020 | 8/2021 |
| 26. | Spent Fuel Pool Duration | 19.75 | 12/2014 | 9/2034 |
| 27. | **HLW Repository Facility** | | | |
| 28. | Licensing | 8.5 | 3/2002 | 8/2010 |
| 29. | Construction | 5.5 | 3/2005 | 8/2010 |
| 30. | MOX Delivery Duration | 9.75 | 12/2024 | 9/2034 |

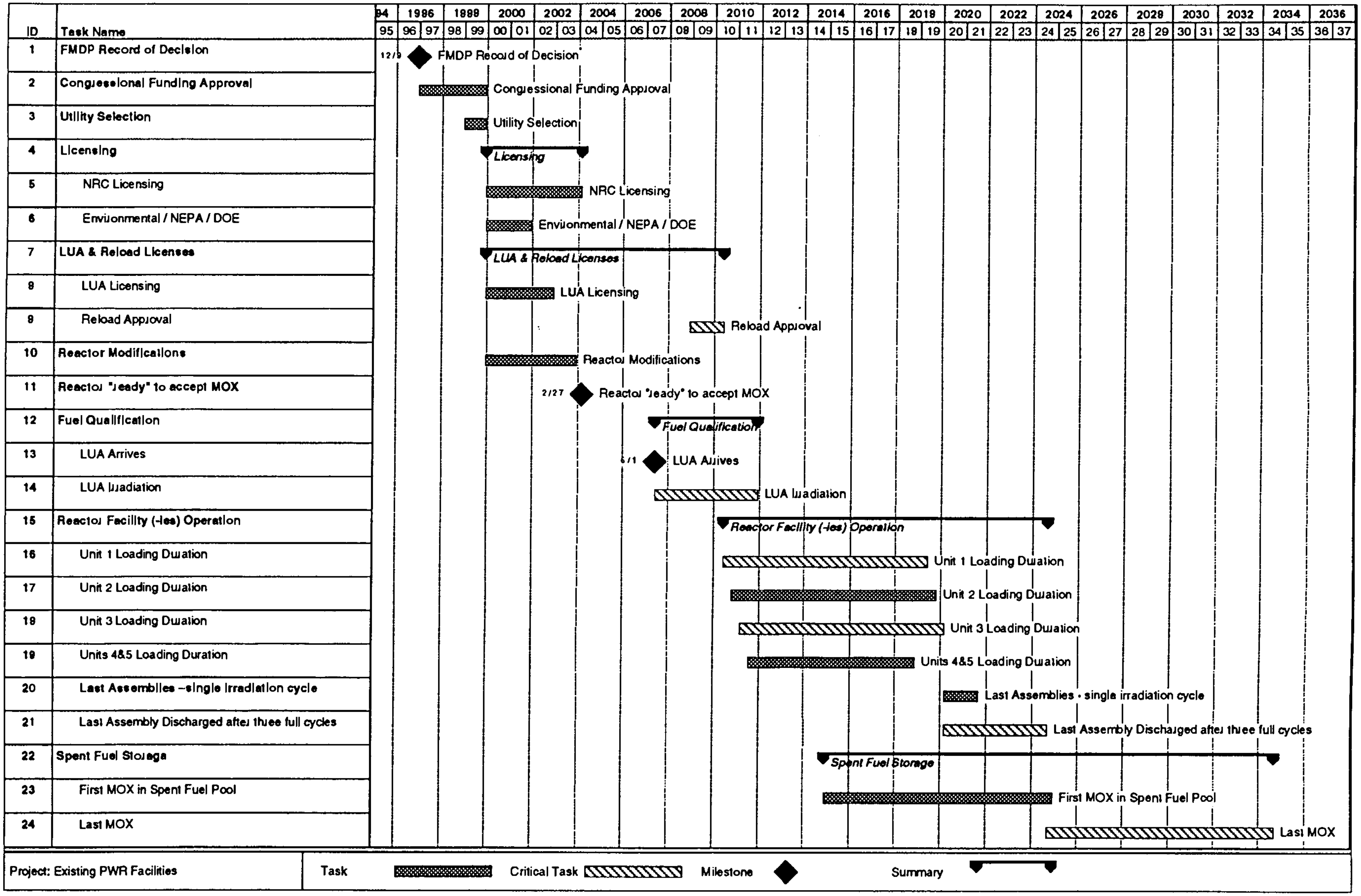


Figure 4.4 Existing PWR facility schedule summary

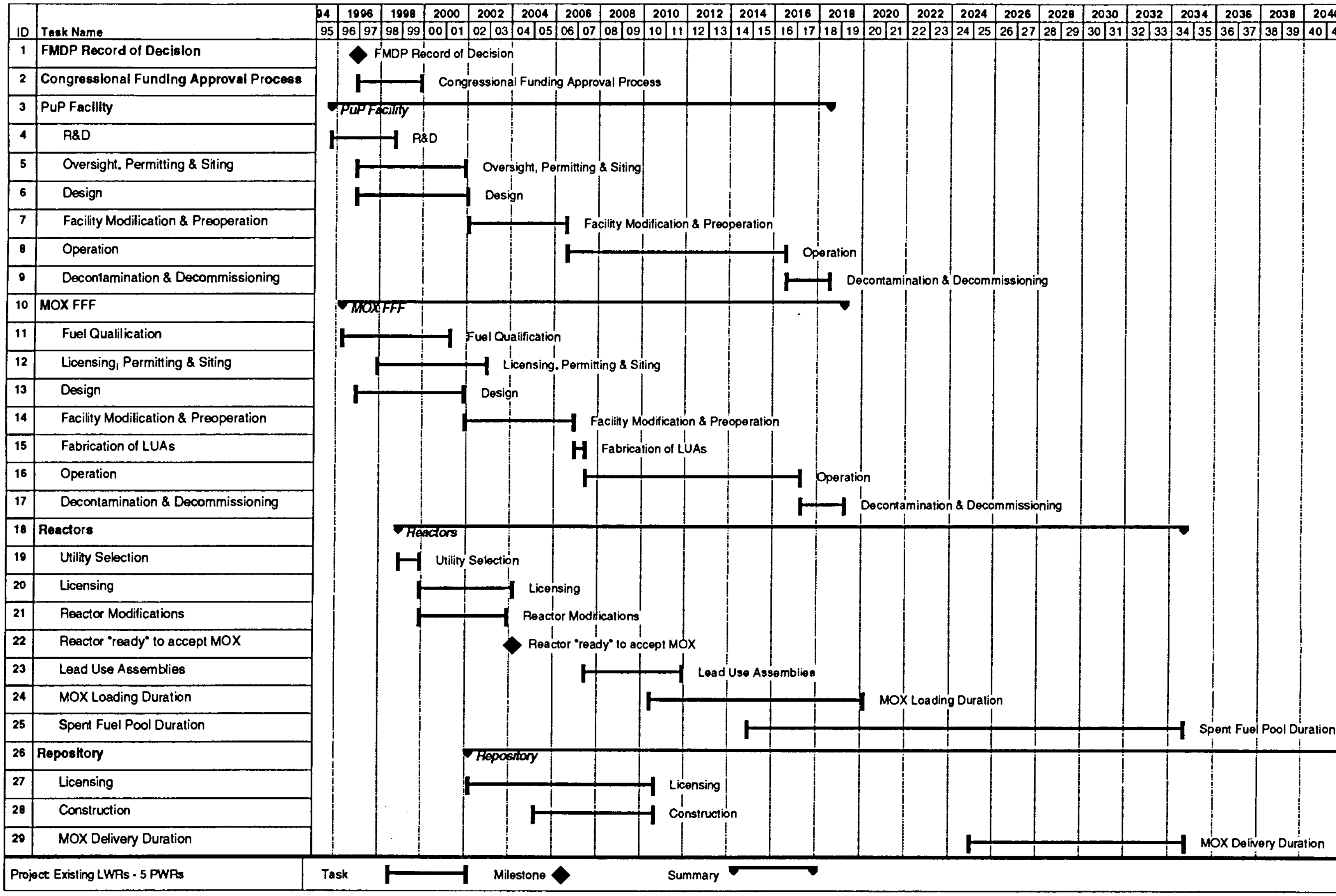


**Figure 4.5 Existing LWR alternative base case schedule summary**

## 4.2 Existing LWR Alternative Private MOX Plant, 50SPL5

The first variant case for the existing LWR alternative uses four separate facilities: a PuP facility to process the weapons-usable plutonium from the various feed materials to $PuO_2$, a privately-owned MOX fuel fabrication facility to convert the $PuO_2$ into MOX fuel, five existing PWRs to irradiate the MOX fuel, and a HLW repository for ultimate emplacement of the spent MOX fuel. These facilities are the same as discussed above in Section 4.1 except for the change in ownership of the MOX fuel fabrication facility. Thus only the schedule for the MOX fuel fabrication facility is presented below.

### 4.2.1 MOX Fuel Fabrication Facility, Private Ownership

For this option, the privately-owned MOX fuel fabrication facility is assumed to be a new facility located on an existing federal site. The duration and path of the license and permit process for the privately-owned MOX fuel fabrication facility has been assumed to follow the same schedule as the federally-owned MOX fuel fabrication facility discussed in Section 4.1.2.2. The duration of operations for the privately-owned MOX facility is the same schedule as the federally-owned MOX facility discussed in Section 4.1.2.3.

#### *4.2.1.1 MOX Fuel Fabrication Facility Design & Construction Schedule*

The duration and path of the design and construction tasks for the privately-owned MOX fuel fabrication facility are based on the same schedule as the federally-owned MOX facility discussed in Section 4.1.2.1. The only change is the issuing of a Request for Proposal (RFP) to select the private developer for this facility rather than a selection process for a M&O contractor. The design and construction schedule is shown in Table 4.15.

**Table 4.15 MOX fuel fabrication facility design and construction schedule**

| *Task ID* | *Task Name* | *Duration (months)* | *Start* | *Finish* |
|---|---|---|---|---|
| 1. | FMDP Record of Declsion | | | 12/1996 |
| 2. | Congresslonal Fundlng Approval | 36 | 12/1996 | 12/1999 |
| 3. | Fuel Quallflcatlon Demonstration | 60 | 4/1996 | 4/2001 |
| 4. | Slte Selection | 12 | 12/1997 | 12/1998 |
| 5. | Issue RFP & Select Private Contractor | 12 | 12/1998 | 12/1999 |
| 6. | Deslgn Process | 60 | 12/1996 | 11/2001 |
| 7. | Facllity Constructlon | 36 | 12/2001 | 12/2004 |

#### *4.2.1.2 Private MOX Fuel Fabrication Facility Schedule Summary*

The overall private MOX fuel fabrication facility implementation schedule is summarized in Table 4.16 and shown in Figure 4.6.

### 4.2.2 Existing LWR Alternative Private MOX Facility Case Schedule Summary

The existing LWR alternative private MOX fuel fabrication facility case schedule is a combination of the individual facility schedules discussed in above. The overall schedule is the same as for the existing LWR base case discussed in Section 4.1.5.

**Table 4.16 MOX fuel fabrication facility schedule summary**

| Task ID | Task Name | Duration (months) | Start | Finish |
|---|---|---|---|---|
| 1. | FMDP ROD | | | 12/1996 |
| 2. | Congressional Funding Approval | 36 | 12/1996 | 12/1999 |
| 3. | Fuel Qualification Demonstration | 60 | 4/1996 | 4/2001 |
| 4. | Site Selection | 12 | 12/1997 | 12/1998 |
| 5. | Issue RFP & Select Private Contractor | 12 | 12/1998 | 12/1999 |
| 6. | Licensing and Permitting | 60 | 12/1997 | 12/2002 |
| 7. | Design Process | 60 | 12/1996 | 11/2001 |
| 8. | Facility Construction | 36 | 12/2001 | 12/2004 |
| 9. | Preoperational Phase | 24 | 12/2004 | 12/2006 |
| 10. | PuP Facility Lead Time Complete | | | 9/2006 |
| 11. | MOX Facility Ready for $PuO_2$ | | | 12/2006 |
| 12. | LUA Fabrication | 6 | 12/2006 | 6/2007 |
| 13. | MOX Facility Operation Duration | 118 | 6/2007 | 4/2017 |
| 14. | Decontamination & Decommission | 24 | 4/2017 | 4/2019 |

## 4.3 Existing LWR Alternative Quick Start with EuroMOX, 50QSL5

The second variant case for the existing LWR alternative uses five separate facilities: a PuP facility to process the weapons-usable plutonium from the various feed materials to $PuO_2$, European and domestic MOX fuel fabrication facilities to convert the $PuO_2$ into MOX fuel, five existing PWRs to irradiate the MOX fuel, and a HLW repository for ultimate emplacement of the spent MOX fuel. An additional storage facility may be necessary to store the $PuO_2$ prior to shipment to Europe and then store the MOX fuel assemblies after shipment from Europe and prior to shipment to the reactor facilities. The preoperational schedules for these facilities are largely the same as discussed above for the existing LWR base case in Section 4.1, however the operational schedules are different. Also, there is the addition of an existing European fuel fabrication facility to the schedule. The schedule changes for each facility are presented below.

### 4.3.1 PuP Facility and Prototype

The preoperational schedule for the PuP facility is the same as described above for the existing LWR base case in Section 4.1.1. The set up of the ARIES demonstration is scheduled to be completed in July 1996.

#### *4.3.1.1 PuP Facility and Prototype Operations Schedule*

The ARIES prototype is scheduled to begin its operation in January 1998 and will operate for six years. A sufficient amount of $PuO_2$ will be available for shipment to the European MOX fuel fabrication facility in July 1999. The facility is scheduled to operate for just over nine years with an annual plutonium throughput of 5 MT. The first $PuO_2$ will be available for shipment two months after the start of operation. The operational schedule is shown in Table 4.17 and in the Pu activities in the summary figure in Section 4.3.1.2.

Table 4.17 PuP facility and prototype operational schedule

| *Task ID* | *Task Name* | *Duration (months)* | *Start* | *Finish* |
|---|---|---|---|---|
| 1. | **ARIES Demonstration and Prototype** | 78 | 10/1995 | 1/2004 |
| 2. | Set up ARIES Demonstration | 9 | 10/1995 | 7/1996 |
| 3. | ARIES Demonstration | 18 | 7/1996 | 1/1998 |
| 4. | ARIES Prototype Operation | 72 | 1/1998 | 1/2004 |
| 5. | Sufficient $PuO_2$ for shipment | 18 | 1/1998 | 7/1999 |
| 6. | **Operation** | 109 | 7/2006 | 7/2016 |
| 7. | Approval to Commence Operation (KD-4) | | | 7/2006 |
| 8. | Pu Processing Duration | 109 | 7/2006 | 9/2015 |
| 9. | First $PuO_2$ Available | 2 | 7/2006 | 9/2006 |

*4.3.1.2 PuP Facility and Prototype Schedule Summary*

The overall PuP facility and prototype implementation schedule is summarized in Table 4.18 and shown in Figure 4.7. This facility schedule is also shown in the discussion of the overall alternative schedule in Section 4.3.4. This schedule does not include any contingency for schedule slip due to site selection difficulties, redesign, construction delays, or a delay in the approval of line item funding.

The critical path through the development of this facility is shown in Figure 4.7. If the start of operations at the PuP facility slips more than three months, the start of operations at the MOX fuel fabrication facility will also slip because the $PuO_2$ will not be available to begin fuel fabrication at the domestic fuel fabrication facility. Similarly, if the ARIES prototype operation slips more than a year or its output is lower than expected, there may not be sufficient $PuO_2$ to ship to Europe to begin the early fuel fabrication.

Table 4.18 PuP facility and prototype schedule summary

| *Task ID* | *Task Name* | *Duration (months)* | *Start* | *Finish* |
|---|---|---|---|---|
| 1. | R&D Funding Available | | | 10/1995 |
| 2. | FMDP Record of Decision | | | 12/1996 |
| 3. | Congressional Funding Approval | 36 | 12/1996 | 12/1999 |
| 4. | ARIES Prototype Set Up & Operation | 78 | 10/1995 | 1/2004 |
| 5. | Site & Facility Selection | 12 | 12/1996 | 12/1997 |
| 6. | Oversight and Permitting | 60 | 12/1996 | 12/2001 |
| 7. | Design Process | 61 | 12/1996 | 1/2002 |
| 8. | Facility Modification | 48 | 1/2002 | 1/2006 |
| 9. | Preoperational Phase | 12 | 8/2005 | 7/2006 |
| 10. | Operation | 109 | 7/2006 | 9/2015 |
| 11. | Decontamination & Decommission | 24 | 9/2015 | 9/2017 |

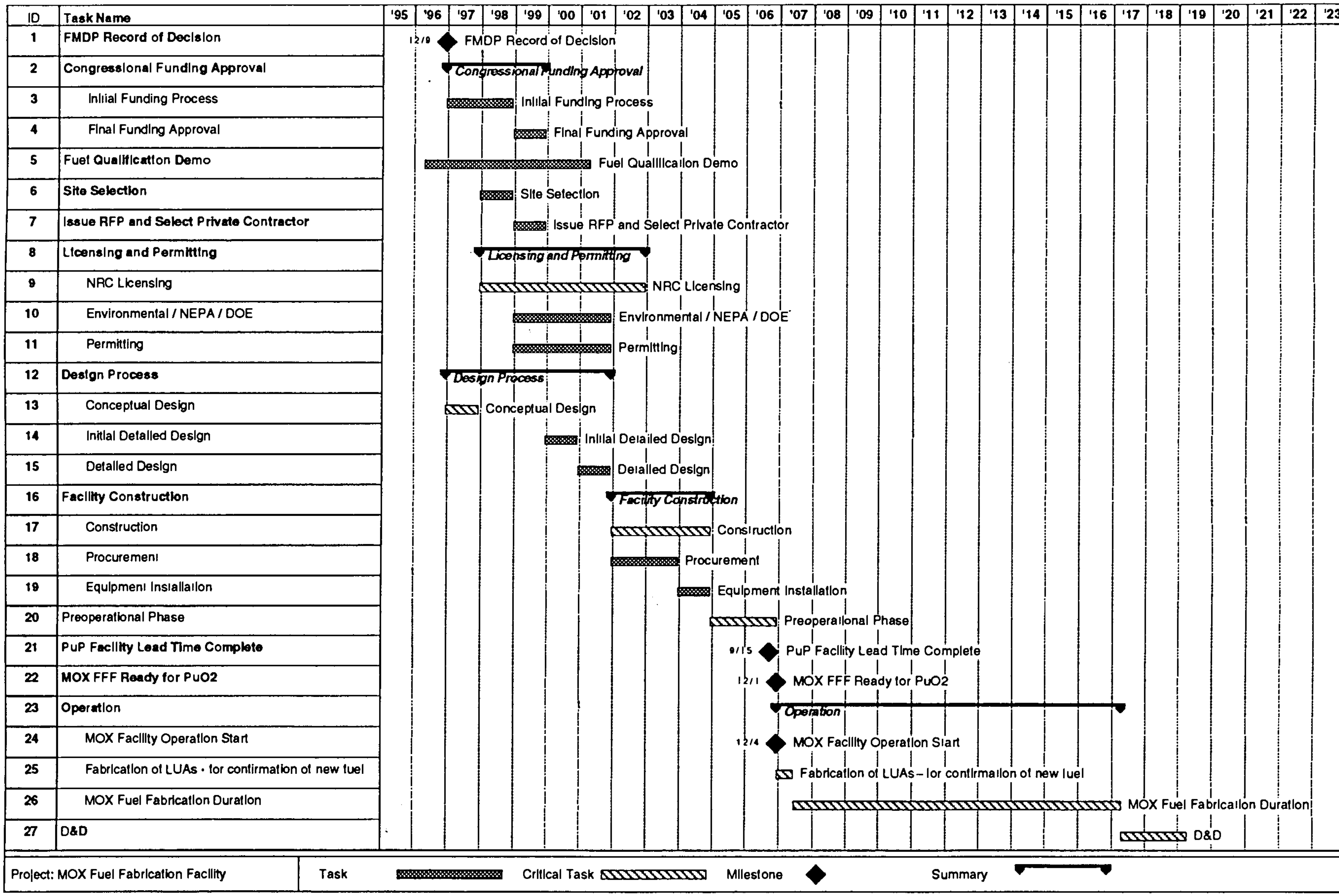


**Figure 4.6 Private MOX fuel fabrication facility schedule summary**

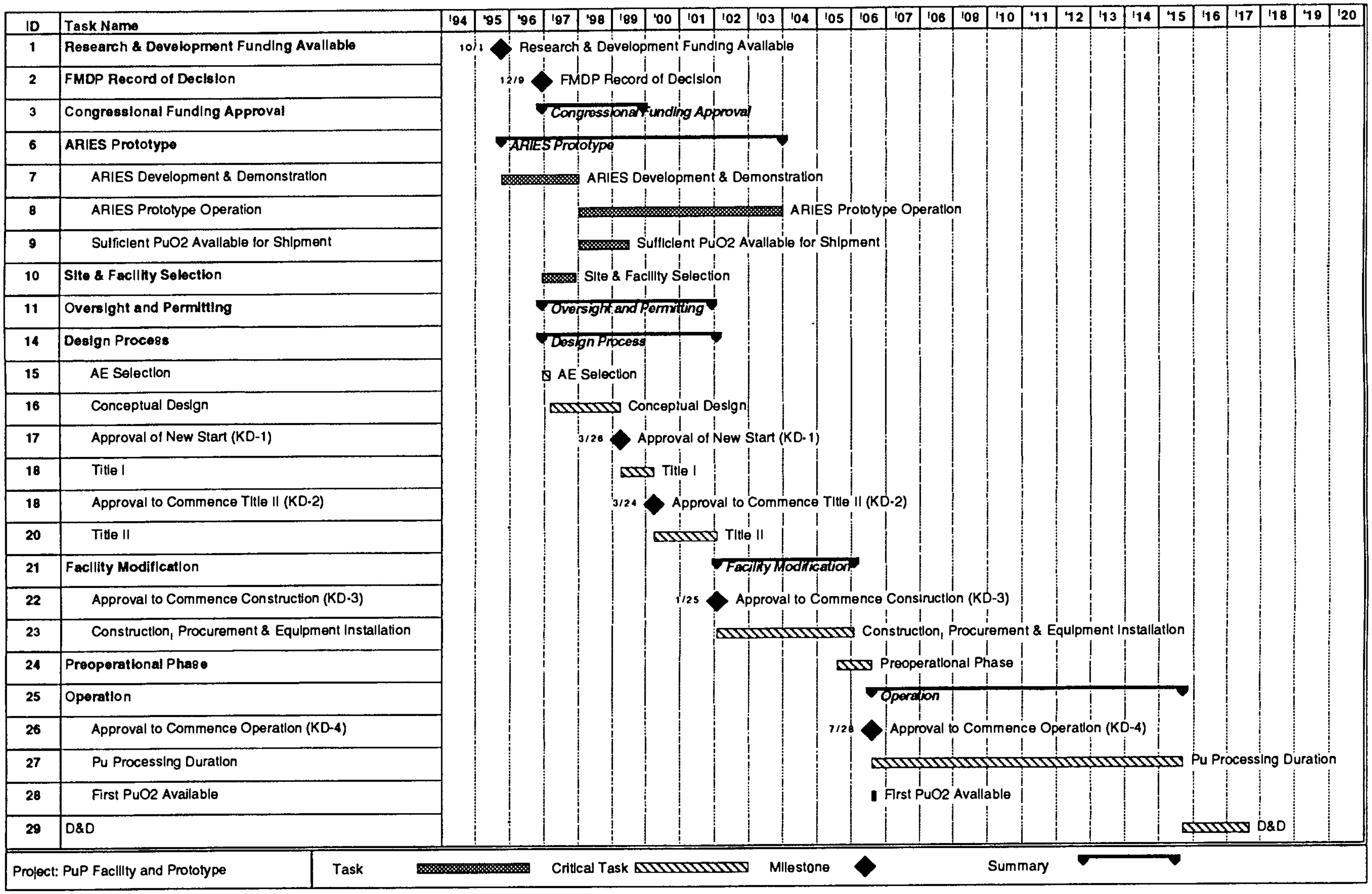


**Figure 4.7 PuP facility and prototype schedule summary**

### 4.3.2 MOX Fuel Fabrication Facility and EuroMOX Fuel Fabrication

The MOX fuel fabrication facility preoperational schedule for this alternative is the same as described above for the existing LWR base case in Section 4.1.2.

The contract negotiations with the European fuel fabricators and the licensing and permitting requirements for shipping $PuO_2$ to Europe are estimated to require 16 months and will begin after the approval of the intermediate line item funding.

#### *4.3.2.1 MOX Fuel Fabrication Facility Operations Schedule*

Fabrication of the LUAs will begin in Europe as soon as the first $PuO_2$ arrives in June 2000; after which, the European fuel fabrication facility will fabricate 85 assemblies a year for 4.4 years, which corresponds to an annual plutonium throughput rate of 1.5 MT and a mission total of 375 assemblies.

The preoperational checkout of the domestic MOX fuel fabrication facility starts as soon as the construction is complete and will take two years. The LUAs are fabricated in the facility during the six-month start-up period. Then, this facility will operate for 8.5 years with an annual plutonium throughput rate of 5 MT, supplying fuel for the 5 existing PWRs at the specified loading rate. This throughput assumes an annual output of 280 assemblies for a mission total of 2381 assemblies.

The operational schedule is shown in Table 4.19 and in the MOX fuel fabrication activities schedule summary figure in Section 4.3.2.2.

**Table 4.19 MOX fuel fabrication facility operational schedule**

| Task ID | Task Name | Duration (months) | Start | Finish |
|---|---|---|---|---|
| 1 | **European Facility Interactions** | 80 | 12/1998 | 8/2005 |
| 2 | Contract Negotiation & Approval | 16 | 12/1998 | 4/2000 |
| 3 | Initial $PuO_2$ Shipment to Europe | 2 | 4/2000 | 6/2000 |
| 4 | Fabrication of LUAs | 9 | 6/2000 | 3/2001 |
| 5 | LUA Shipment from Europe | 2 | 3/2001 | 6/2001 |
| 6 | Mission Fuel Fabrication | 53 | 3/2001 | 8/2005 |
| 7 | Initial Mission Fuel Shipped from Europe | 2 | 3/2001 | 6/2001 |
| 8. | **Domestic MOX Facility Operations** | 108 | 12/2006 | 12/2015 |
| 9. | MOX Facility Operation Start | | | 12/2006 |
| 10. | LUA Fabrication | 6 | 12/2006 | 6/2007 |
| 11. | Operation | 102 | 6/2007 | 12/2015 |

#### *4.3.2.2 MOX Fuel Fabrication Facility Schedule Summary*

The overall MOX fuel fabrication activities schedule is summarized in Table 4.20 and shown in Figure 4.8. These activities are also shown in the discussion of the overall alternative schedule in Section 4.3.4. This schedule does not include any contingency for schedule slip due to site selection difficulties, redesign, construction delays, or a delay in the approval of line item funding.

The critical path through the development of the domestic MOX fuel fabrication facility is through the conceptual design and the NRC licensing process. If either of these tasks slip in their schedule, the rest of the implementation process will also be delayed. This critical path is shown in Figure 4.8.

Table 4.20 MOX fuel fabrication activities schedule summary

| Task ID | Task Name | Duration (months) | Start | Finish |
|---|---|---|---|---|
| 1 | **FMDP Record of Decision** | | | 12/1996 |
| 2 | **Congressional Funding Approval** | 36 | 12/1996 | 12/1999 |
| 3 | **Fuel Qualification Demo** | 60 | 4/1996 | 4/2001 |
| 4 | **European Facility Interactions** | 80 | 12/1998 | 8/2005 |
| 5 | **Domestic MOX fuel fabrication facility** | 252 | 12/1996 | 12/2017 |
| 6 | Site & Facility Selection | 12 | 12/1997 | 12/1998 |
| 7 | Select M&O Contractor | 12 | 12/1998 | 12/1999 |
| 8 | Licensing and Permitting | 60 | 12/1997 | 12/2002 |
| 9 | Design Process | 60 | 12/1996 | 11/2001 |
| 10 | Facility Modification | 36 | 12/2001 | 12/2004 |
| 11 | Preoperational Phase | 24 | 12/2004 | 12/2006 |
| 12 | Operation | 108 | 12/2006 | 12/2015 |
| 13 | Decontamination & Decommission | 24 | 12/2015 | 12/2017 |

### 4.3.3 Existing PWR Facility

The existing PWR facility design and construction schedule for this alternative is the same as described above for the existing LWR base case in Section 4.1.3.1

#### *4.3.3.1 Existing PWR Facility Quick Start Licensing and Permitting Schedule*

The existing LWR facility licensing and permitting schedule for this alternative is the same as described above for the existing LWR base case in Section 4.1.3.2. However, the fuel qualification process begins 4.5 years earlier than in the base case because the European fabricated LUAs are available much sooner than the domestically fabricated LUAs. This change in the fuel qualification and reload permit schedule is shown in Table 4.21 and in Figure 4.9.

Table 4.21 Existing PWR facility quick start license and permit schedule

| Task ID | Task Name | Duration (months) | Start | Finish |
|---|---|---|---|---|
| 1. | **NRC Interactions** | 51 | 12/1999 | 2/2004 |
| 2 | **Environmental / NEPA / NRC** | 24 | 12/1999 | 11/2001 |
| 3 | **LUA & Reload Licenses** | 72 | 12/1999 | 11/2005 |
| 4 | LUA Licensing | 36 | 12/1999 | 11/2002 |
| 5 | Reload Approval | 18 | 5/2004 | 11/2005 |
| 6 | **Fuel Qualification - LUAs** | 126 | 6/2001 | 12/2011 |
| 7 | European LUAs Arrive | | | 6/2001 |
| 8 | European LUA Irradiation | 54 | 12/2002 | 6/2007 |
| 9 | Domestic LUAs Arrive | | | 6/2007 |
| 10 | Domestic LUA Irradiation | 54 | 6/2007 | 12/2011 |

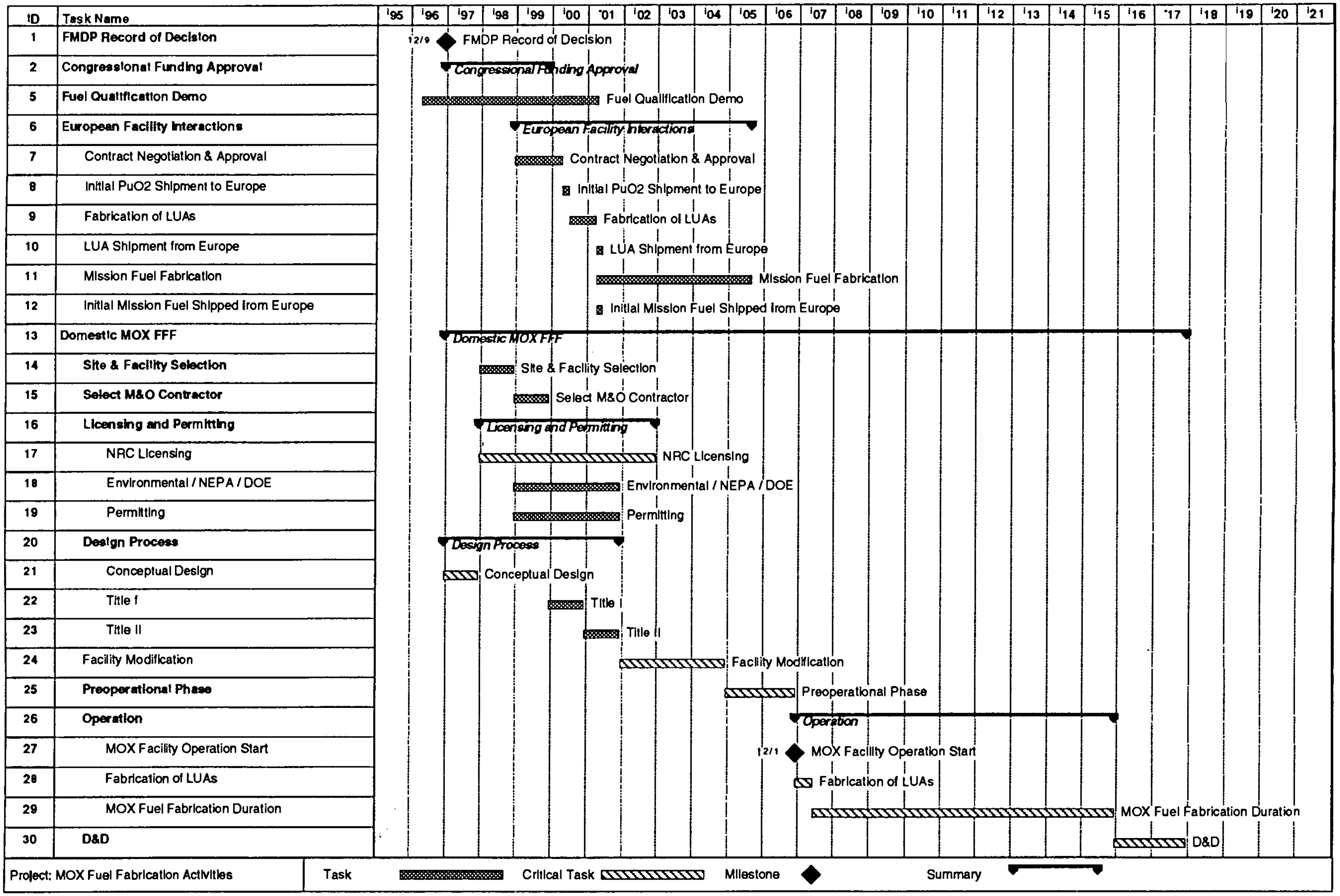


**Figure 4.8 MOX fuel fabrication activities schedule summary**

#### *4.3.3.2 Existing PWR Facility Operations Schedule*

The LUAs are loaded into the first unit as soon as the LUA license is granted and during a normal refueling period for the reactor. After the completion of the LUA review during the second irradiation cycle, the first European fabricated mission fuel is loaded at the next scheduled refueling period in November 2005. The MOX fuel loading schedule was discussed in Section 2.2.3.1. After three irradiation cycles, the spent fuel assemblies are discharged from the reactors and stored in the spent fuel storage pool for a minimum of ten years before being shipped to the HLW repository facility. The existing LWR facility operational schedule is shown in Table 4.22 and in the PWR facility schedule summary figure in Section 4.3.3.3.

#### *4.3.3.3 Existing PWR Facility Schedule Summary*

The overall existing PWR facility implementation schedule is summarized in Table 4.23 and shown in Figure 4.9. This facility schedule is also shown in the discussion of the overall alternative schedule in Section 4.3.4. The critical path for this facility is the intermediate line item funding approval, utility selection and completion of the LUA license. The critical path for this facility is shown in Figure 4.9.

**Table 4.22 Existing PWR facility quick start operations schedule**

| *Task ID* | *Task Name* | *Duration (months)* | *Start* | *Finish* |
|---|---|---|---|---|
| 1. | **Reactor "ready" to accept MOX** | | | 2/2004 |
| 2 | **Reactor Facllity Operatlon** | 211 | 11/2005 | 7/2023 |
| 3 | **Unlt 1** | | | |
| 4 | European MOX Loading Duration | 54 | 11/2005 | 5/2010 |
| 5 | American MOX Loading Duration | 90 | 5/2010 | 11/2017 |
| 6 | **Unit 2** | | | |
| 7 | European MOX Loading Duration | 54 | 4/2006 | 10/2010 |
| 8 | American MOX Loading Duration | 90 | 10/2010 | 4/2018 |
| 9 | **Unlt 3** | | | |
| 10 | European MOX Loading Duration | 54 | 8/2006 | 2/2011 |
| 11 | American MOX Loading Duration | 90 | 2/2011 | 8/2018 |
| 12 | **Unlt 4** | | | |
| 13 | European MOX Loading Duration | 54 | 1/2007 | 7/2011 |
| 14 | American MOX Loading Duration | 90 | 7/2011 | 1/2019 |
| 15 | **Unlt 5** | | | |
| 16 | European MOX Loading Duration | 54 | 1/2007 | 7/2011 |
| 17 | American MOX Loading Duration | 72 | 7/2011 | 7/2017 |
| 18 | **Last Assemblies - slngle cycle** | 18 | 1/2019 | 7/2020 |
| 19 | **Last Assembly Dlscharged** | 54 | 1/2019 | 7/2023 |
| 20 | **Spent Fuel Storage** | 277 | 5/2010 | 7/2033 |
| 21 | First MOX in Spent Fuel Pool | 120 | 5/2010 | 5/2020 |
| 22. | Last MOX | 120 | 7/2023 | 7/2033 |

**Table 4.23 Existing PWR facility quick start schedule summary**

| *Task ID* | *Task Name* | *Duration (months)* | *Start* | *Finish* |
|---|---|---|---|---|
| 1 | FMDP Record of Decision | | | 12/1996 |
| 2 | Congressional Funding Approval | 36 | 12/1996 | 12/1999 |
| 3 | Utility Selection | 12 | 12/1998 | 12/1999 |
| 4 | Licensing | 51 | 12/1999 | 2/2004 |
| 5 | Reactor Modifications | 48 | 12/1999 | 11/2003 |
| 6 | LUA & Reload Licenses | 72 | 12/1999 | 11/2005 |
| 7 | Fuel Qualification | 126 | 6/2001 | 12/2011 |
| 8 | Reactor Facility Operation | 211 | 11/2005 | 7/2023 |
| 9 | European MOX Loading Duration (Units 1-5) | 54 | 11/2005 | 5/2010 |
| 10 | American MOX Loading Duration (Units 1-5) | 103 | 5/2010 | 1/2019 |
| 11 | Last Assemblies - single irradiation cycle | 18 | 1/2019 | 7/2020 |
| 12 | Last assembly discharged after three cycles | 54 | 1/2019 | 7/2023 |
| 13 | Spent Fuel Storage | 277 | 5/2010 | 7/2033 |
| 14 | First MOX in Spent Fuel Pool | 120 | 5/2010 | 5/2020 |
| 15 | Last MOX | 120 | 7/2023 | 7/2033 |

### 4.3.4 HLW Repository Facility

The HLW Repository facility schedule for this alternative is the same as described above for the existing LWR base case in Section 4.1.4 except for the spent MOX fuel delivery schedule. The first spent fuel will arrive at the HLW repository facility in June 2020 and the last delivery is scheduled in August 2033.

### 4.3.5 Existing LWR Alternative Quick Start with EuroMOX Schedule Summary

The existing LWR alternative quick start case schedule is a combination of the individual facility schedules discussed above. This overall schedule is summarized in Table 4.24 and shown in Figure 4.10. The plutonium disposition mission begins when the first mission fuel is loaded into a reactor in November 2005 and is complete after the last core load, which contains MOX fuel assemblies, has been irradiated for a single cycle in July 2020. The overall mission time is 14.6 years and starts 9 years after ROD.

The critical path for this alternative is the line item approval, utility selection, and LUA licensing for the LWR facility. However, if there are any delays in the ARIES prototype development or a reduction in the ARIES prototype throughput, there may be insufficient $PuO_2$ to supply the European fuel fabrication activity at the required rate.

**Table 4.24 Existing LWR quick start alternative schedule summary**

| *Task ID* | *Task Name* | *Duration (years)* | *Start* | *Finish* |
|---|---|---|---|---|
| 1 | **FMDP Record of Decision** | | | 12/1996 |
| 2 | **Congressional Funding Process** | 3 | 12/1996 | 12/1999 |
| 3 | **PuP Facility and Prototype** | 21.9 | 10/1995 | 9/2017 |
| 4 | R&D and Facility Design | 6.3 | 10/1995 | 1/2002 |
| 5 | Prototype Operation | 6 | 1/1998 | 1/2004 |
| 6 | Licensing, Permitting & Siting | 5 | 12/1996 | 12/2001 |
| 7 | Facility Modification & Preoperation | 4.5 | 1/2002 | 7/2006 |
| 8 | Production Facility Operation | 9.1 | 7/2006 | 9/2015 |
| 9 | Decontamination & Decommissioning | 2 | 9/2015 | 9/2017 |
| 10 | **European MOX fuel fabrication facility** | 6.8 | 12/1998 | 9/2005 |
| 11 | Contract Negotiation | 1.4 | 12/1998 | 4/2000 |
| 12 | Fabricate and Ship LUAs | 1.1 | 4/2000 | 6/2001 |
| 13 | Mission Fuel Fabrication | 4.5 | 3/2001 | 9/2005 |
| 14 | **Domestic MOX fuel fabrication facility** | 21.6 | 4/1996 | 12/2017 |
| 15 | Fuel Qualification | 5 | 4/1996 | 4/2001 |
| 16 | Licensing, Permitting & Siting | 5 | 12/1997 | 12/2002 |
| 17 | Facility Design, Modification & Preoperation | 10 | 12/1996 | 12/2006 |
| 18 | Fabrication of LUAs | .5 | 12/2006 | 6/2007 |
| 19 | Operation | 8.5 | 6/2007 | 12/2015 |
| 20 | Decontamination & Decommissioning | 2 | 12/2015 | 12/2017 |
| 21 | **Reactors** | 34.6 | 12/1998 | 7/2033 |
| 22 | Utility Selection | 1 | 12/1998 | 12/1999 |
| 23 | LUA Licensing | 3 | 12/1999 | 11/2002 |
| 24 | European Lead Use Assemblies | 4.5 | 12/2002 | 6/2007 |
| 25 | American Lead Use Assemblies | 4.5 | 6/2007 | 12/2011 |
| 26 | MOX Loading Duration | 13.1 | 11/2005 | 1/2019 |
| 27 | Spent Fuel Pool Duration | 23.1 | 5/2010 | 7/2033 |
| 28 | **Repository** | | | |
| 29 | Licensing & Construction | 8.5 | 3/2002 | 8/2010 |
| 30 | MOX Delivery Duration | 13.1 | 6/2020 | 8/2033 |

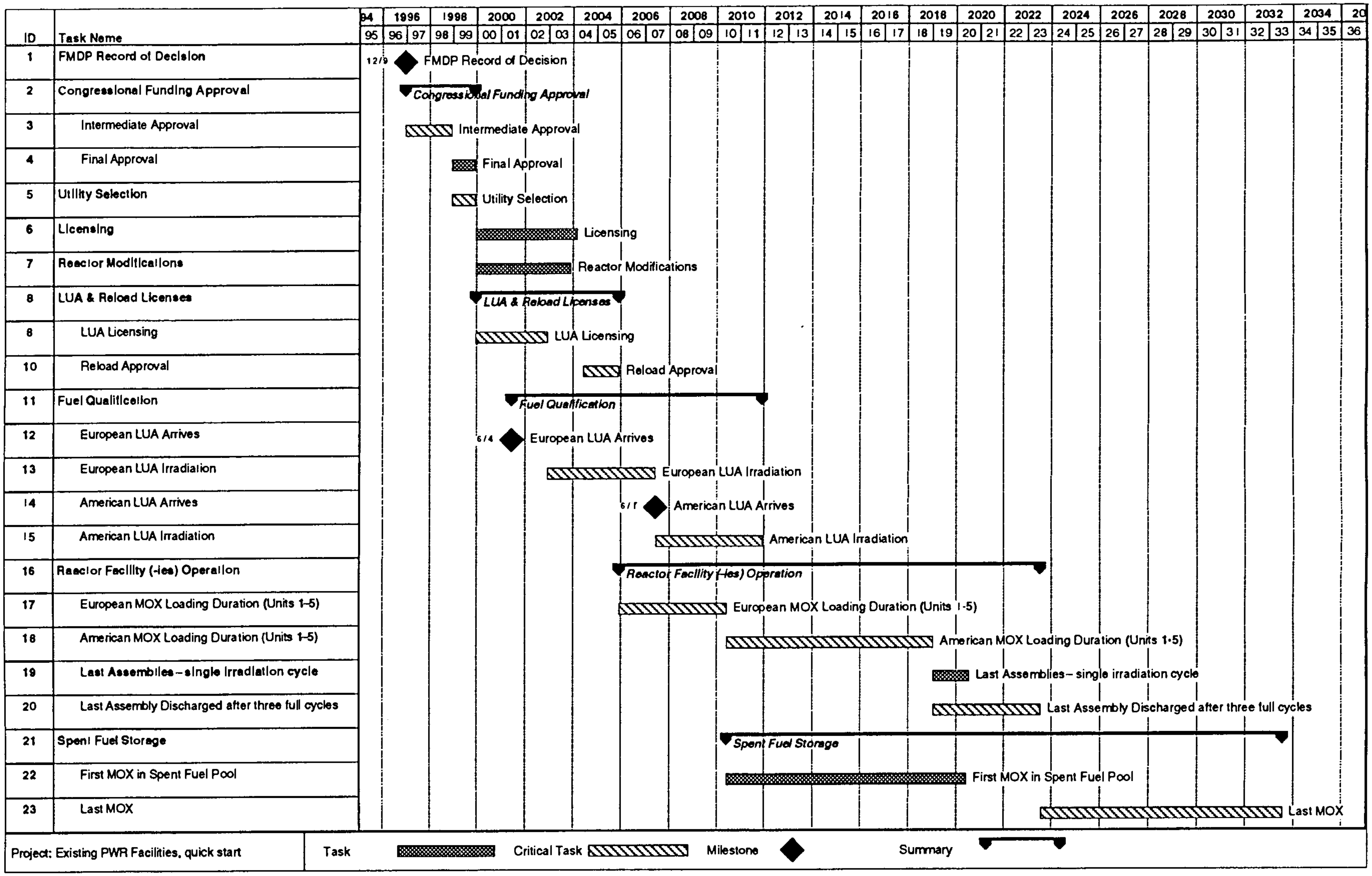


Figure 4.9 Existing PWR facility quick start schedule summary

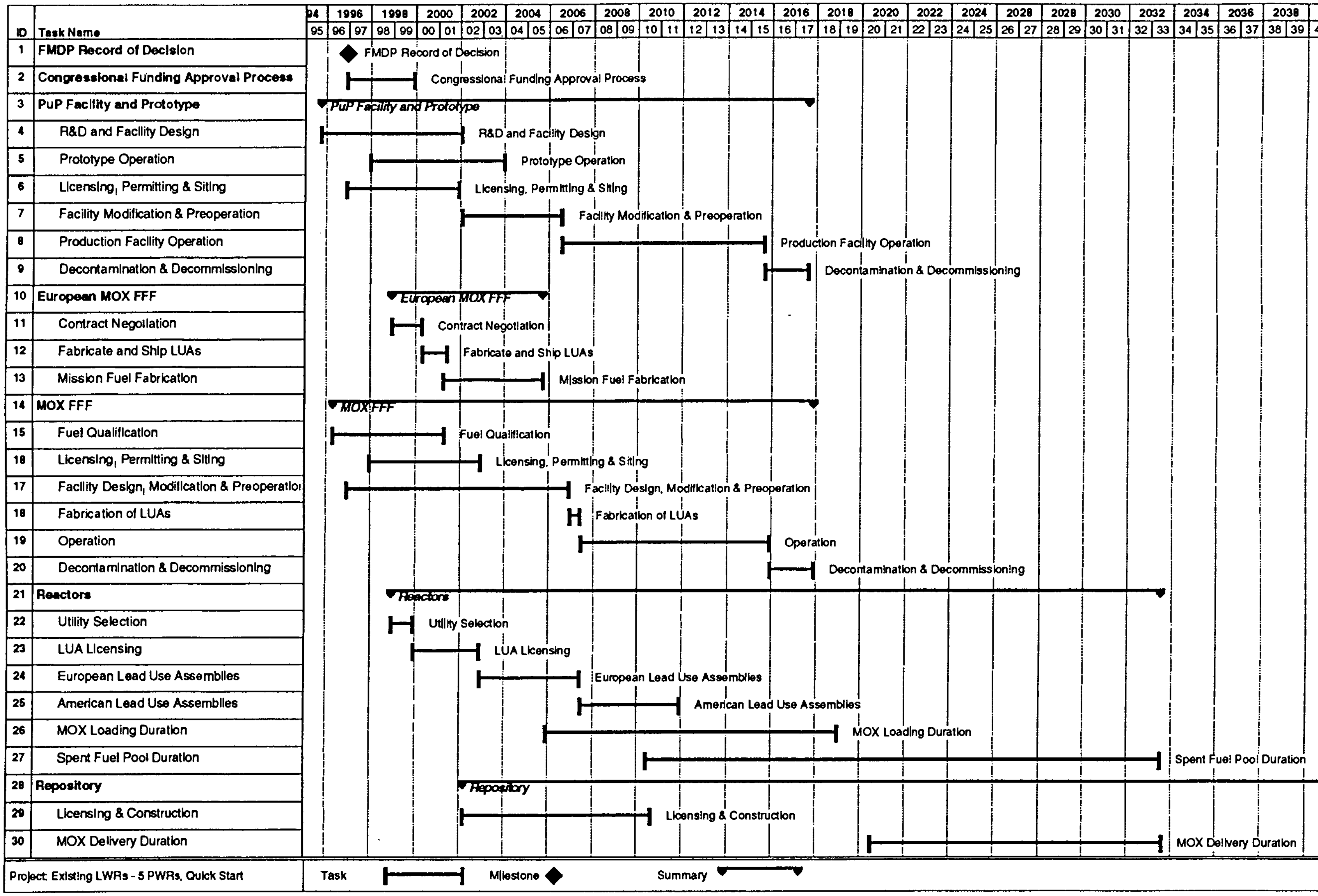


**Figure 4.10 Existing LWR alternative quick start case schedule summary**

## 4.4 Existing LWR Alternative 32.5 MT Hybrid, 33SFL3

The third variant case for the existing LWR alternative will dispose of 32.5 MT of the surplus weapons-usable plutonium. The other 17.5 MT of Pu will be disposed of using one of the immobilization-based disposition alternatives, which are described in the Immobilization Alternatives Technical Summary Reports (4). The reactor-based part of this alternative uses four separate facilities: a PuP facility to process the weapons-usable plutonium from the various feed materials to $PuO_2$, a domestic fuel fabrication facility to convert the $PuO_2$ into MOX fuel, three existing PWRs to irradiate the MOX fuel, and a HLW repository for ultimate emplacement of the spent MOX fuel. The preoperational schedules for these facilities are the same as discussed above for the existing LWR base case in Section 4.1, however, the operational schedules are different. The schedule changes for each facility are presented below.

### 4.4.1 PuP Facility

The overall PuP facility implementation schedule for this alternative is the same as described above for the existing LWR base case in Section 4.1.1. The annual PuP facility output is split between the MOX fuel fabrication facility and the immobilization disposition option with 3.25 MT/yr. going to the MOX facility and 1.75 MT/yr. going to the immobilization facility. The PuP facility schedule summary is shown in the alternative summary table and figure in Section 4.4.5.

### 4.4.2 MOX Fuel Fabrication Facility

The preoperational MOX fuel fabrication facility implementation schedule for this alternative is the same as described above for the existing LWR base case in Section 4.1.2. The MOX fuel fabrication facility will begin operations in December 2007. The LUAs are fabricated at the MOX fuel fabrication facility during the six-month start-up period. Then, this facility will operate for 10.7 years with an annual plutonium throughput rate of 3.1 MT, supplying fuel for the 3 existing PWRs at the specified loading rate. This throughput assumes an annual output of 170 assemblies for a mission total of 1819 assemblies. The MOX fuel fabrication facility schedule summary is shown in the alternative summary table and figure in Section 4.4.5.

### 4.4.3 Existing PWR Facility

The preoperational existing PWR facility implementation schedule for this alternative is the same as described above for the existing LWR base case in Section 4.1.3. Only three reactor units are used in this alternative because the annual $PuO_2$ output of the PuP facility will not support five reactors and the immobilization feed requirement. The reactor loading and discharge schedule was discussed in Section 2.2.3.1. The first mission fuel will be loaded into a reactor in June 2007 and the last MOX fuel will be loaded in November 2020. The existing PWR facility schedule summary is shown in Table 4.25 and in the alternative summary figure in Section 4.4.5.

### 4.4.4 HLW Repository Facility

The overall HLW Repository facility schedule for this alternative is the same as described above for the existing LWR base case in Section 4.1.4 except for the spent MOX fuel delivery schedule. The first spent fuel is scheduled to be delivered in December 2024 and the last spent fuel will arrive in June 2035. This schedule is shown in the alternative summary table and figure in Section 4.4.5.

### 4.4.5 Existing LWR Alternative Hybrid Schedule Summary

The existing LWR alternative 32.5 MT case schedule is a combination of the individual facility schedules discussed above. This overall schedule is summarized in Table 4.26 and shown in Figure 4.11. The plutonium disposition mission begins when the first mission fuel is loaded into a reactor in May 2010 and is complete after the last core load, which contains MOX fuel assemblies, has been irradiated for a single cycle in May 2022. The overall mission time is 12 years and starts 13.5 years after ROD. The critical path for this alternative is the licensing, design and facility modifications for the MOX fuel fabrication facility.

Table 4.25 Existing PWR facility, three reactor schedule summary

| *Task ID* | *Task Name* | *Duration (months)* | *Start* | *Finish* |
|---|---|---|---|---|
| 1. | Fuel Qualification - LUAs | 54 | 6/2007 | 12/2011 |
| 2. | Reactor Operations | 180 | 5/2010 | 5/2025 |
| 3. | Unit 1 Loading Duration | 126 | 5/2010 | 11/2020 |
| 4. | Unit 2 Loading Duration | 108 | 11/2010 | 11/2019 |
| 5. | Unit 3 Loading Duration | 108 | 5/2011 | 5/2020 |
| 6. | Last Assemblies - first irradiation cycle | 18 | 11/2020 | 5/2022 |
| 7. | Spent Fuel Storage | 246 | 11/2014 | 6/2035 |

Table 4.26 Existing LWR hybrid alternative schedule summary

| *Task ID* | *Task Name* | *Duration (years)* | *Start* | *Finish* |
|---|---|---|---|---|
| 1. | **FMDP Record of Decision** | | | 12/1996 |
| 2. | **Congressional Funding Process** | 3 | 12/1996 | 12/1999 |
| 3. | **PuP Facility** | 22.8 | 10/1995 | 7/2018 |
| 4. | R&D | 3 | 10/1995 | 9/1998 |
| 5. | Oversight, Permitting & Siting | 5 | 12/1996 | 12/2001 |
| 6. | Design | 5.1 | 12/1996 | 1/2002 |
| 7. | Facility Modification & Preoperation | 4.5 | 1/2002 | 7/2006 |
| 8. | Operation | 10 | 7/2006 | 7/2016 |
| 9. | Decontamination & Decommissioning | 2 | 8/2016 | 7/2018 |
| 10. | **MOX fuel fabrication facility** | 23.8 | 4/1996 | 2/2020 |
| 11. | Fuel Qualification | 5 | 4/1996 | 4/2001 |
| 12. | Licensing, Permitting & Siting | 5 | 12/1997 | 12/2002 |
| 13. | Design | 5 | 12/1996 | 11/2001 |
| 14. | Facility Modification & Preoperation | 5 | 12/2001 | 12/2006 |
| 15. | Fabrication of LUAs | 0.5 | 12/2006 | 6/2007 |
| 16. | Operation | 10.7 | 6/2007 | 2/2018 |
| 17. | Decontamination & Decommissioning | 2 | 2/2018 | 2/2020 |
| 18. | **Reactor Facility** | 36.5 | 12/1998 | 6/2035 |
| 19. | Utility Selection | 1 | 12/1998 | 12/1999 |
| 20. | Licensing | 4.2 | 12/1999 | 2/2004 |
| 21. | Reactor Modifications | 4 | 12/1999 | 11/2003 |
| 22. | Reactor "ready" to accept MOX | | | 2/2004 |
| 23. | Lead Use Assemblies | 4.5 | 6/2007 | 12/2011 |
| 24. | MOX Loading Duration | 10.5 | 5/2010 | 11/2020 |
| 25. | Single irradiation cycle of last MOX | 1.5 | 11/2020 | 5/2022 |
| 26. | Spent Fuel Pool Duration | 20.5 | 12/2014 | 6/2035 |
| 27. | **HLW Repository Facility** | | | |
| 28. | Licensing | 8.5 | 3/2002 | 8/2010 |
| 29. | Construction | 5.5 | 3/2005 | 8/2010 |
| 30. | MOX Delivery Duration | 10.5 | 12/2024 | 6/2035 |

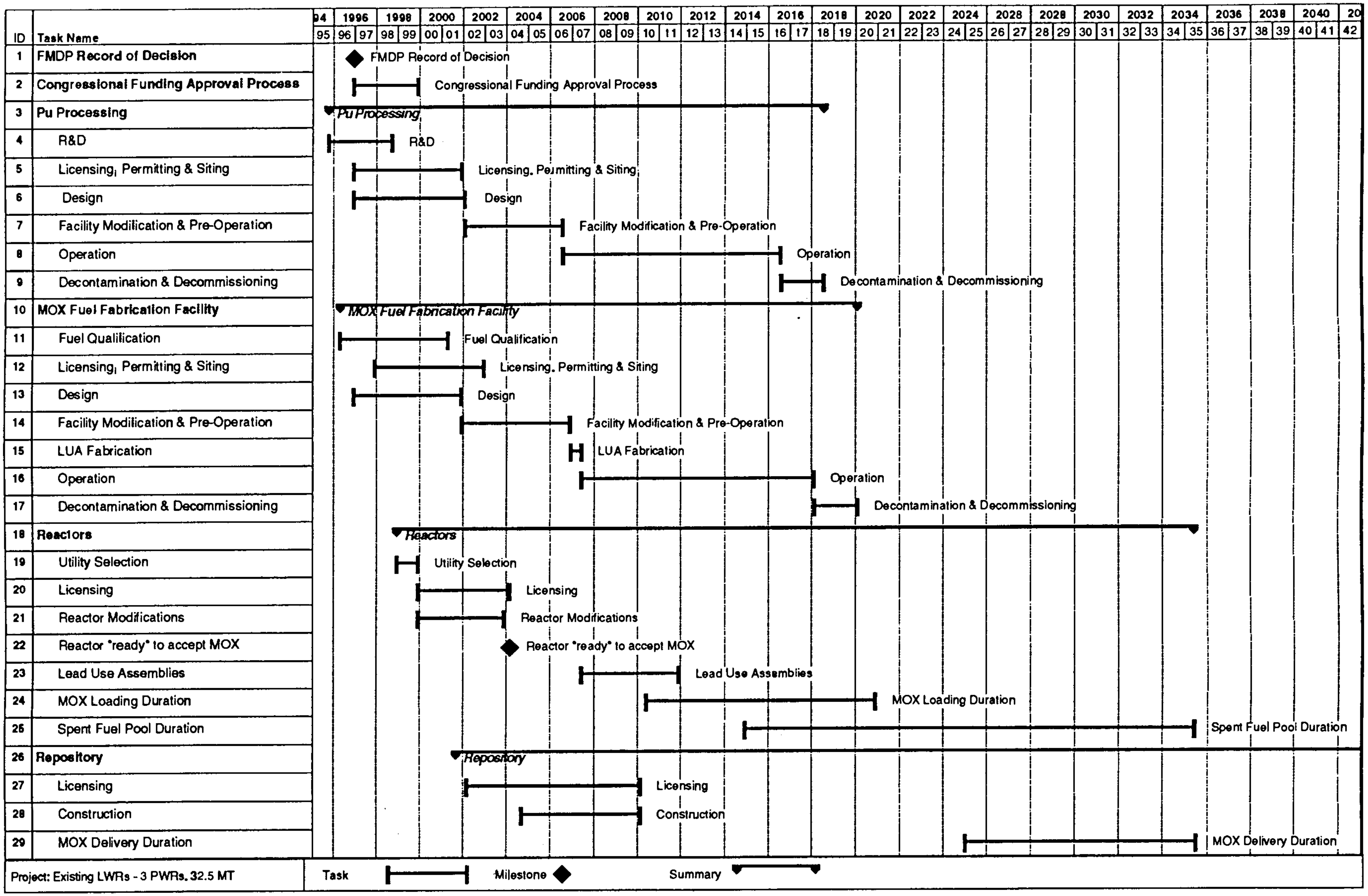


**Figure 4.11 Existing LWR alternative hybrid case schedule summary**

## 4.5 Existing LWR Alternative Collocated PuP/MOX, 50COL4

The fourth variant for the existing LWR alternative uses three separate facilities: a collocated PuP and MOX fuel fabrication facility to process the weapons-usable plutonium from the various feed materials into MOX fuel, four existing BWRs to irradiate the MOX fuel, and a HLW repository for ultimate emplacement of the spent MOX fuel. The implementation schedule for each of these facilities is discussed below, followed by a summary schedule for the overall alternative.

### 4.5.1 Collocated PuP and MOX Fuel Fabrication Facility

The collocated PuP and MOX fuel fabrication facility is a combination of the two facilities discussed above for the existing LWR base case in Sections 4.1.1 and 4.1.2.

#### *4.5.1.1 Collocated PuP and MOX Facility Design & Construction Schedule*

The duration and path of the design and construction tasks for the collocated PuP and MOX fuel fabrication facility are a combination of the tasks discussed for the existing LWR base case in Sections 4.1.1.1 and 4.1.2.1. The combined design and construction schedule is shown in Table 4.27 and in the facility schedule summary figure in Section 4.5.1.5.

**Table 4.27 Collocated PuP and MOX facility design and construction schedule**

| *Task ID* | *Task Name* | *Duration (months)* | *Start* | *Finish* |
|---|---|---|---|---|
| 1. | R&D Fundlng Available | | | 10/1995 |
| 2. | FMDP Record of Declslon | | | 12/1996 |
| 3. | Congresslonal Fundlng Approval | 36 | 12/1996 | 12/1999 |
| 4. | Fuel Qualificatlon Demo | 60 | 4/1996 | 4/2001 |
| 5. | Research & Development | 36 | 10/1995 | 9/1998 |
| 6. | Site Selectlon | 12 | 12/1997 | 12/1998 |
| 7. | Select M&O Contractor | 12 | 12/1998 | 12/1999 |
| 8. | Deslgn Process | 60 | 12/1996 | 11/2001 |
| 9. | Conceptual Design | 25 | 12/1996 | 1/1999 |
| 10. | Title I | 12 | 12/1999 | 12/2000 |
| 11. | Title II | 12 | 12/2000 | 11/2001 |
| 12. | Facllity Constructlon | 53 | 1/2002 | 6/2006 |
| 13. | Construction | 53 | 1/2002 | 6/2006 |
| 14. | Procurement | 36 | 1/2002 | 12/2004 |
| 15. | Equipment Installation | 17 | 1/2005 | 6/2006 |

#### *4.5.1.2 Collocated PuP and MOX Facility Licensing and Permitting Schedule*

For this analysis, it has been assumed that the duration of the NRC licensing process will be five years and that the process will start one year before the conceptual design is complete. The NEPA process and the other site-specific permitting will require three years; each process will start after the site has been selected. The licensing schedule is shown in Table 4.28 and in the facility schedule summary figure in Section 4.5.1.5.

**Table 4.28 Collocated PuP and MOX facility licensing and permitting schedule**

| *Task ID* | *Task Name* | *Duration (months)* | *Start* | *Finish* |
|---|---|---|---|---|
| 1. | Licensing and Permitting | 60 | 1/1998 | 1/2003 |
| 2. | NRC Licensing | 60 | 1/1998 | 1/2003 |
| 3. | Environmental / NEPA / DOE | 36 | 12/1998 | 11/2001 |
| 4. | Permitting | 36 | 12/1998 | 11/2001 |

#### *4.5.1.3 Collocated PuP and MOX Fuel Fabrication Facility Operations Schedule*

The preoperational checkout of the collocated PuP and MOX fuel fabrication facility will start one year before the equipment installation is complete and will take two years. The Pu processing section of the facility will operate for ten years with an annual plutonium throughput of five MT. The LUAs are fabricated in the MOX fuel fabrication section of the facility during the six-month start-up period. Then, this section of the facility will operate for 15.6 years with an annual plutonium throughput rate of 3.2 MT. This throughput assumes an annual output of 602 assemblies for a mission total of 9416 assemblies and will supply fuel for the four existing BWRs at the specified loading rate. The operational schedule is shown in Table 4.29 and in the facility schedule summary figure in Section 4.5.1.5.

**Table 4.29 Collocated PuP and MOX fuel fabrication facility operational schedule**

| Task ID | Task Name | Duration (months) | Start | Finish |
|---|---|---|---|---|
| 1. | Preoperational Phase | 24 | 6/2005 | 6/2007 |
| 2. | Operation | 193 | 6/2007 | 7/2023 |
| 3. | Facility Operation Start | | | 6/2007 |
| 4. | LUA Fabrication | 6 | 6/2007 | 12/2007 |
| 5. | Pu Processing Operation | 120 | 6/2007 | 6/2017 |
| 6. | MOX Operation | 187 | 12/2007 | 7/2023 |

#### *4.5.1.4 Collocated PuP and MOX Facility Decontamination & Decommissioning Schedule*

The duration for the decontamination and decommissioning of the facility has been estimated to be two years.

#### *4.5.1.5 Collocated PuP and MOX Fuel Fabrication Facility Schedule Summary*

The overall collocated PuP and MOX fuel fabrication facility implementation schedule is summarized in Table 4.30 and shown in Figure 4.12. This facility schedule is also shown in the discussion of the overall alternative schedule in Section 4.5.4. This schedule does not include any contingency for schedule slip due to site selection difficulties, redesign, construction delays, or a delay in the approval of line item funding.

The critical path through the development of this facility is through the conceptual design and the NRC licensing process. If either of these tasks slip in their schedule, the rest of the implementation process will also be delayed. This critical path is shown in Figure 4.12.

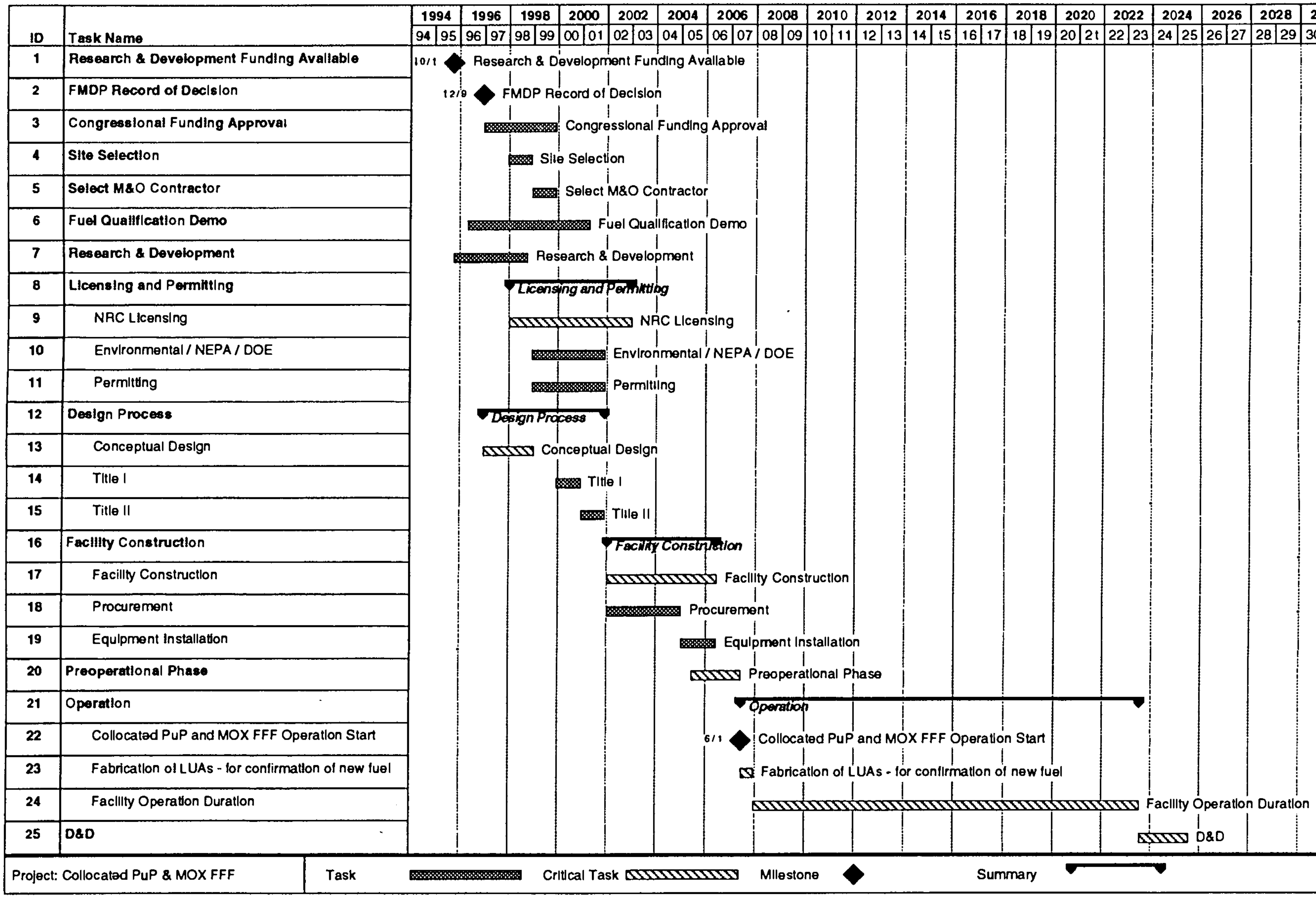


**Figure 4.12 Collocated PuP and MOX fuel fabrication facility schedule summary**

Table 4.30 Collocated PuP and MOX fuel fabrication facility schedule summary

| *Task ID* | *Task Name* | *Duration (months)* | *Start* | *Finish* |
|---|---|---|---|---|
| 1. | FMDP Record of Decision | | | 12/1996 |
| 2. | Congressional Funding Approval | 36 | 12/1996 | 12/1999 |
| 3. | Fuel Qualification Demonstration | 60 | 4/1996 | 4/2001 |
| 4. | Site and Facility Selection | 12 | 12/1997 | 12/1998 |
| 5. | Select M&O Contractor | 12 | 12/1998 | 12/1999 |
| 6. | Licensing and Permitting | 60 | 1/1998 | 1/2003 |
| 7. | Design Process | 60 | 12/1996 | 11/2001 |
| 8. | Facility Construction | 53 | 1/2002 | 6/2006 |
| 9. | Preoperational Phase | 24 | 6/2005 | 6/2007 |
| 10. | LUA Fabrication | 6 | 6/2007 | 12/2007 |
| 11. | Pu Processing Operation | 120 | 6/2007 | 6/2017 |
| 12. | MOX Fuel Fabrication Operation Duration | 187 | 12/2007 | 7/2023 |
| 13. | Decontamination & Decommission | 24 | 7/2023 | 7/2025 |

### 4.5.2 Existing BWR Facility

#### *4.5.2.1 Existing BWR Facility Design & Construction Schedule*

The design and construction tasks for the existing BWR facility have been assumed to be the same as the tasks described above in Section 4.1.3.1 for the existing PWR facility.

#### *4.5.2.2 Existing BWR Facility Licensing & Permitting Schedule*

For this analysis, a schedule developed by Fluor Daniel (9) for modifying an existing LWR facility license to permit the use of MOX fuel with integral neutron absorbers was followed. The process to obtain a reload permit for a new fuel fabricator is also included in the permit schedule. The license and permit schedule is shown in Table 4.31 and Figure 4.13.

The license amendment (LA) process for the use of MOX fuel with integral neutron absorbers is longer than the process used for the license amendment for the use of MOX fuel without integral neutron absorbers, discussed above for the existing LWR base case in Section 4.1.3.2. The license and permit process for the BWR case includes the possibility of full discovery and a hearing process by an Atomic Safety Licensing Board (ASLB) as well as a longer license preparation time.

After the utility or utilities have been selected, the license amendment (LA) process is started with the preparation of the safety analysis report, the LA application, and the environmental report. The NRC issues the safety evaluation report and the environmental assessment after completing the review of the application. The schedule includes a provision for a year-long full discovery period and an eighteen-month hearing and decision process by an ASLB. The requirements for these processes are subject to petitions for a hearing on specific issues. After a decision is issued by the ASLB, the NRC issue the license amendment to the Operating License (OL).

In addition, a reload license process is followed because of the use of a new MOX fuel fabrication facility. This analysis assumes a three year LUA license process is followed prior to inserting the LUAs into the reactor. After the LUAs have been irradiated for one cycle, 1.2 years for the BWR, a review of the LUA performance is completed. The reload permit for use of MOX fuel is granted after this review.

Table 4.31 Existing BWR facility license and permit schedule

| Task ID | Task Name | Duration (months) | Start | Finish |
|---|---|---|---|---|
| 1 | **NRC Interactlons** | 63 | 12/1999 | 3/2005 |
| 2 | Licensee Prepares SAR & License Amendment | 18 | 12/1999 | 6/2001 |
| 3 | Licensee Files Application | | | 6/2001 |
| 4 | Public Notice of Application for LA | 3 | 6/2001 | 9/2001 |
| 5 | NRC Review | 12 | 9/2001 | 9/2002 |
| 6 | NRC Issues SER | | | 9/2002 |
| 7 | Full Discovery | 12 | 6/2002 | 6/2003 |
| 8 | Hearing by ASLB | 9 | 6/2003 | 3/2004 |
| 9 | Decision by ASLB | 9 | 3/2004 | 12/2004 |
| 10 | ASLB Issues Decision | | | 12/2004 |
| 11 | NRC Issues License Amendment | 3 | 12/2004 | 3/2005 |
| 12 | Notice of Amendment to Operating License | | | 3/2005 |
| 13 | **Environmental / NEPA / NRC** | 33 | 12/1999 | 9/2002 |
| 14 | Licensee Develops & Prepares ER | 12 | 12/1999 | 12/2000 |
| 15 | Licensee Files Report with NRC | | | 6/2001 |
| 16 | NRC Prepares & Issues Draft EA | 6 | 6/2001 | 12/2001 |
| 17 | NRC Issues Final EA | 3 | 6/2002 | 9/2002 |
| 18 | **LUA & Reload Llcenses** | 124 | 12/1999 | 4/2010 |
| 19 | LUA Licensing | 36 | 12/1999 | 11/2002 |
| 20 | Reload Approval | 14 | 2/2009 | 4/2010 |
| 21 | **Fuel Quallficatlon - LUAs** | 73 | 12/2007 | 12/2013 |
| 22 | LUA Arrives | | | 12/2007 |
| 23 | LUA Irradiation | 73 | 12/2007 | 12/2013 |

*4.5.2.3 Existing BWR Facility Operations Schedule*

The LUAs are loaded into the first unit as soon as they are available and during a normal refueling period for the reactor. After the completion of the LUA review during the second irradiation cycle, the first mission fuel is loaded at the next scheduled refueling period in April 2010. After full irradiation of the MOX fuel, the spent fuel assemblies are discharged from the reactors and stored in the spent fuel storage pool for a minimum of ten years before being shipped to the HLW repository facility. The existing BWR facility operational schedule is shown in Table 4.32 and in the BWR facility schedule summary figure in Section 4.5.2.4.

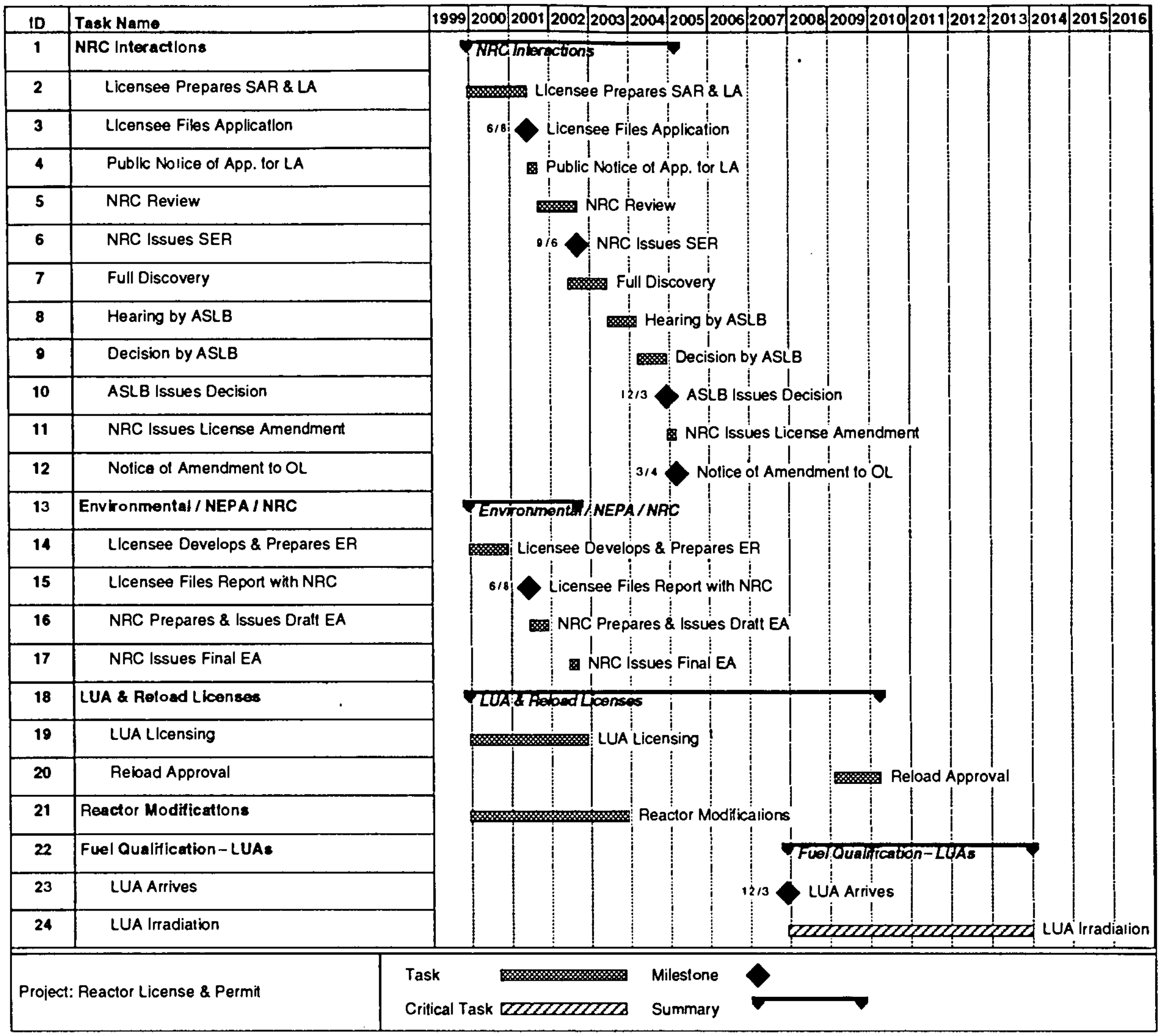


Figure 4.13 Existing BWR facility license and permit schedule

Table 4.32 Existing BWR facility operations schedule

| *Task ID* | *Task Name* | *Duration (months)* | *Start* | *Finish* |
|---|---|---|---|---|
| 1. | **Reactor "ready" to accept MOX** | | | 3/2005 |
| 2. | **Fuel Qualification** | 73 | 6/2007 | 12/2013 |
| 3. | **Reactor Facility Operation** | 268 | 4/2010 | 8/2032 |
| 4. | Unit 1 Loading Duration | 199 | 4/2010 | 10/2026 |
| 5. | Unit 2 Loading Duration | 185 | 4/2011 | 8/2026 |
| 6. | Unit 3 Loading Duration | 171 | 4/2012 | 6/2026 |
| 7. | Unit 4 Loading Duration | 157 | 4/2013 | 5/2026 |
| 8. | **Last Assemblies - single cycle** | 14 | 10/2026 | 12/2027 |
| 9. | Last Assembly Discharged | 70 | 10/2026 | 8/2032 |
| 10. | **Spent Fuel Storage** | 330 | 3/2015 | 8/2042 |
| 11. | First MOX in Spent Fuel Pool | 120 | 3/2015 | 2/2025 |
| 12. | Last MOX | 120 | 8/2032 | 8/2042 |

*4.5.2.4 Existing BWR Facility Schedule Summary*

The overall existing BWR facility implementation schedule is summarized in Table 4.33 and shown in Figure 4.14. This facility schedule is also shown in the discussion of the overall alternative schedule in Section 4.5.4. The critical path for this facility is the availability of the LUAs and is shown in Figure 4.14. The reactors are ready to accept MOX LUAs almost three years before the LUAs are available.

**Table 4.33 Existing BWR facility schedule summary**

| *Task ID* | *Task Name* | *Duration (months)* | *Start* | *Finish* |
|---|---|---|---|---|
| 1. | FMDP Record of Decision | | | 12/1996 |
| 2. | Congressional Funding Approval | 36 | 12/1996 | 12/1999 |
| 3. | Utility Selection | 12 | 12/1998 | 12/1999 |
| 4. | Licensing and Permitting | 63 | 12/1999 | 3/2005 |
| 5. | LUA & Reload Licenses | 124 | 12/1999 | 4/2010 |
| 6. | Reactor Modifications | 48 | 12/1999 | 12/2003 |
| 7. | Reactor "ready" to accept MOX | | | 3/2005 |
| 8. | Fuel Qualification | 73 | 12/2007 | 12/2013 |
| 9. | Reactor Operation | 268 | 4/2010 | 8/2032 |
| 10. | Last Assemblies – single cycle | 14 | 10/2026 | 12/2027 |
| 11. | Spent Fuel Storage | 330 | 3/2015 | 8/2042 |

### 4.5.3 HLW Repository Facility

The HLW repository facility schedule is the same as described for the existing LWR base case in Section 4.1.4, except the spent MOX fuel is scheduled to be delivered to the repository facility from March 2025 to September 2042.

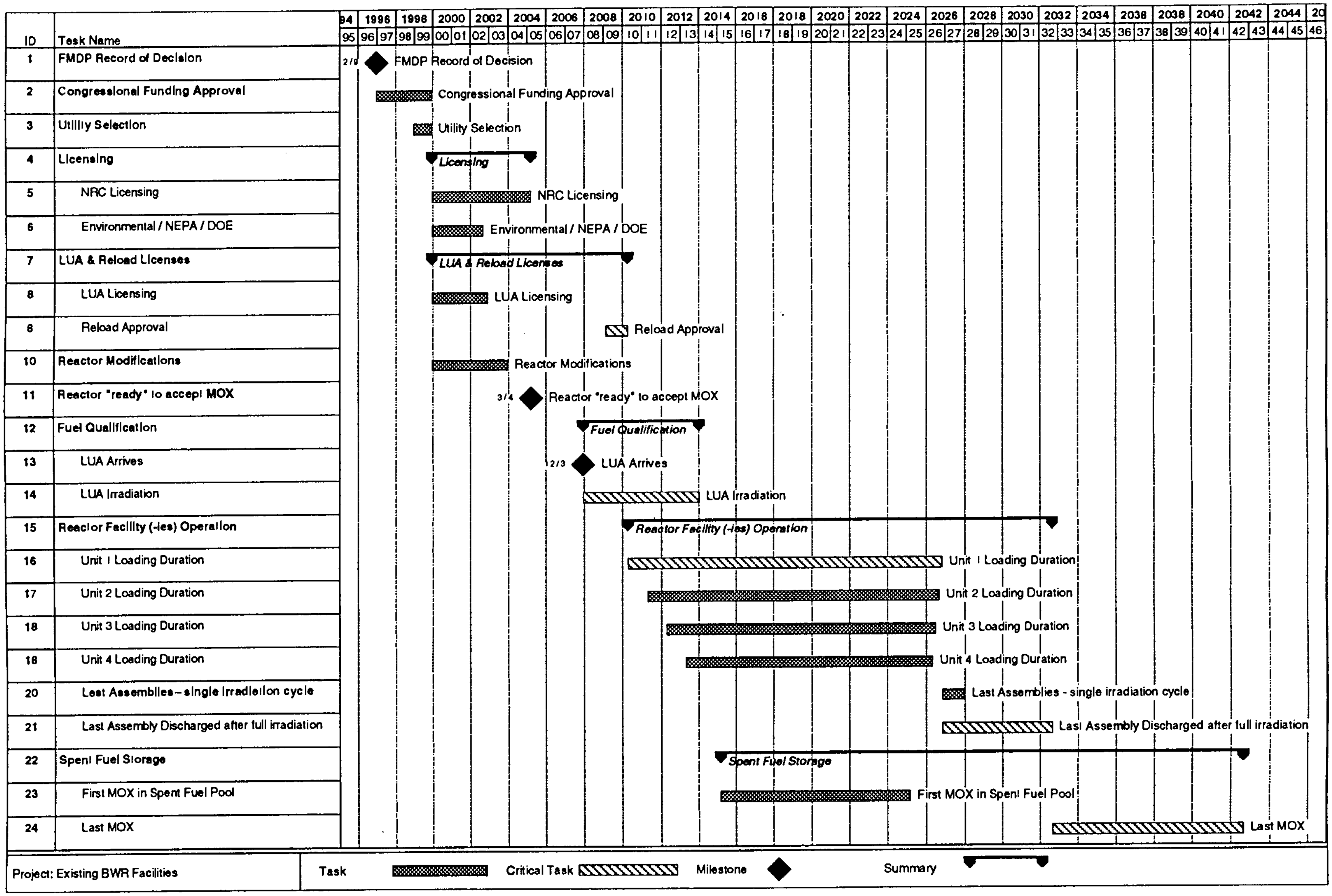


**Figure 4.14 Existing BWR facility schedule summary**

### 4.5.4 Existing LWR Alternative Collocated PuP and MOX Facility Summary

The existing BWR alternative collocated PuP and MOX fuel fabrication facility schedule is a combination of the individual facility schedules discussed above. This overall schedule is summarized in Table 4.34 and shown in Figure 4.15. The plutonium disposition mission begins when the first mission fuel is loaded into a reactor in April 2010 and is complete after the last core load, which contains MOX fuel assemblies, has been irradiated for a single cycle in December 2027. The overall mission time is 17.7 years and starts 13.3 years after ROD. The critical path for this alternative is the licensing, design and construction of the new collocated PuP and MOX fuel fabrication facility.

**Table 4.34 Existing LWR alternative with collocated PuP and MOX facility summary**

| *Task ID* | *Task Name* | *Duration (years)* | *Start* | *Finish* |
|---|---|---|---|---|
| 1. | **FMDP Record of Decision** | | | 12/1996 |
| 2. | **Congressional Funding Process** | 3 | 12/1996 | 12/1999 |
| 3. | **Collocated PuP & MOX Facility** | 29.8 | 10/1995 | 7/2025 |
| 4. | Fuel Qualification Process | 5 | 4/1996 | 4/2001 |
| 5. | R&D | 3 | 10/1995 | 9/1998 |
| 6. | Licensing, Permitting & Siting | 5 | 1/1998 | 1/2003 |
| 7. | Design | 5.1 | 12/1996 | 1/2002 |
| 8. | Facility Modification | 4.4 | 1/2002 | 6/2006 |
| 9. | Preoperation | 2 | 6/2005 | 6/2007 |
| 10. | Fabrication of LUAs | 0.5 | 6/2007 | 11/2007 |
| 11. | Operation | 15.6 | 12/2007 | 7/2023 |
| 12. | Decontamination & Decommissioning | 2 | 7/2023 | 7/2025 |
| 13. | **Existing BWR Facility** | 43.7 | 12/1998 | 8/2042 |
| 14. | Utility Selection | 1 | 12/1998 | 12/1999 |
| 15. | Licensing | 5.2 | 12/1999 | 3/2005 |
| 16. | Reactor Modifications | 4 | 12/1999 | 12/2003 |
| 17. | Reactor "ready" to accept MOX | | | 3/2005 |
| 18. | Lead Use Assemblies | 6.1 | 12/2007 | 12/2013 |
| 19. | MOX Loading Duration | 16.6 | 4/2010 | 10/2026 |
| 20. | Single irradiation cycle of last MOX | 1.2 | 10/2026 | 12/2027 |
| 21. | Spent Fuel Pool Duration | 27.5 | 3/2015 | 8/2042 |
| 22. | **HLW Repository Facility** | | | |
| 23. | Licensing | 8.5 | 3/2002 | 8/2010 |
| 24. | Construction | 5.5 | 3/2005 | 8/2010 |
| 25. | MOX Delivery Duration | 17.5 | 3/2025 | 9/2042 |

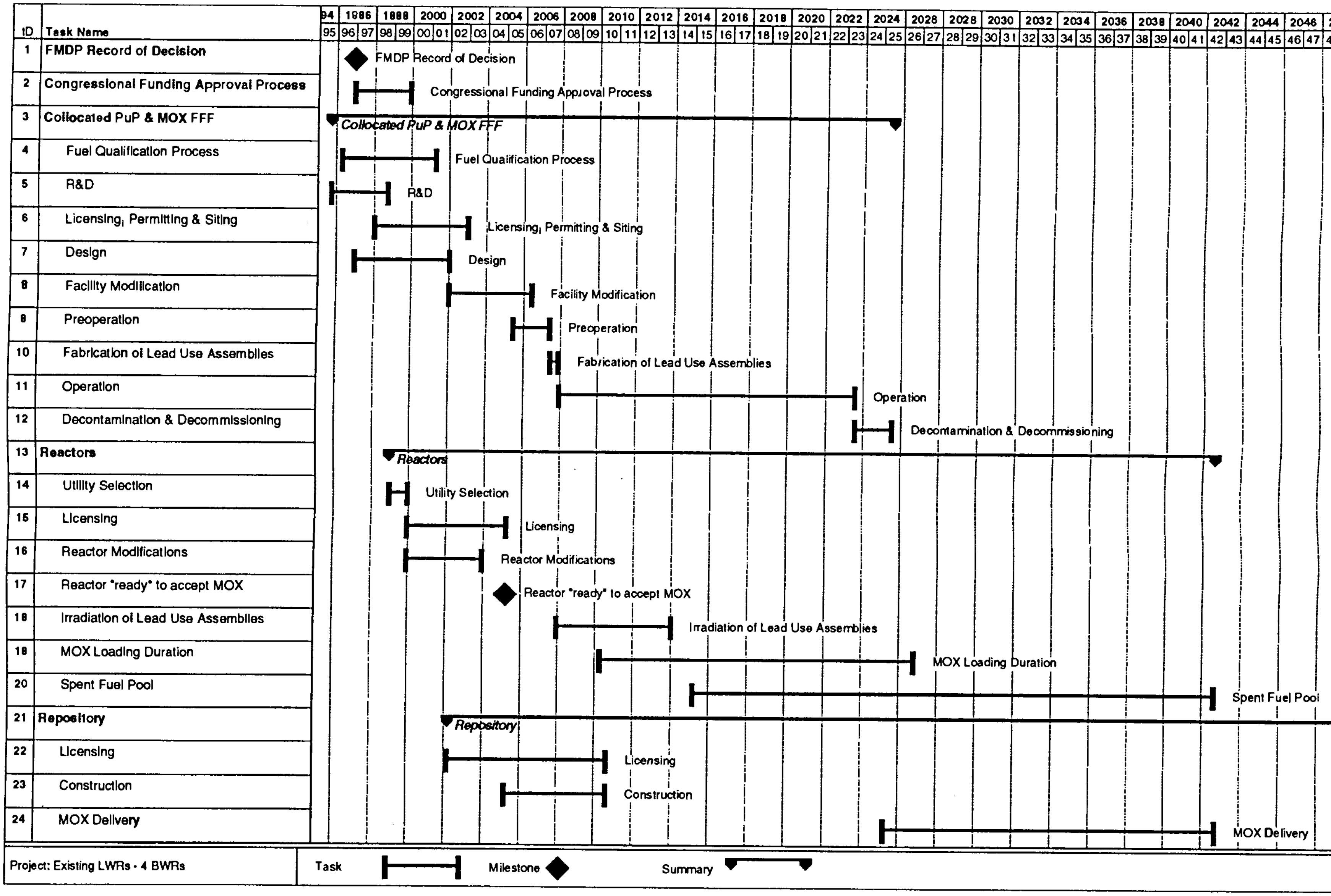


**Figure 4.15 Existing LWR alternative collocated PuP and MOX facility summary**

## 4.6 Existing LWR Alternative Summary

The plutonium disposition schedules for the four 50 MT existing LWR alternative cases are summarized in Table 4.35 and shown in Figure 4.16.

The schedule risk for all of these alternatives is similar. The PuP facilities, MOX fuel fabrication facilities and HLW repositories for the different alternatives are the same except for the duration of operations. A similar schedule for utility selection and reactor facility modifications will be used for both PWRs and BWRs. The primary differences in the existing LWR schedules are the license modification process and the fuel loading schedule. There is a higher schedule risk in the license modification process for the existing LWRs using MOX fuel with integral neutron absorbers than for the LWRs using MOX fuel without integral neutron absorbers. However, this risk has been addressed in the schedules by including a longer license modification procedure for the former case.

The critical path facility for all of the existing LWR alternatives, except the quick start case, is the MOX fuel fabrication facility. For the quick start case, the process to obtain a permit for placing the LUAs in the core is the critical path.

**Table 4.35 Existing LWR disposition alternatives schedule summary**

| | Option | | | |
|---|---|---|---|---|
| | Base Case | Private MOX | Collocated PuP & MOX facility | Quick Start |
| **PuP Facility** | | | | |
| prototype | NA | NA | NA | 1/1998 |
| start processing at production facility | 7/2006 | 7/2006 | 6/2007 | 7/2006 |
| **MOX fuel fabrication facility** | | | | |
| start LUA fabrication | 12/2006 | 12/2006 | 7/2007 | 6/2000 |
| mission fuel fabrication start | 6/2007 | 6/2007 | 12/2007 | 3/2001 |
| mission fuel finish | 4/2017 | 4/2017 | 7/2023 | 12/2015 |
| **Reactor Facility** | | | | |
| reactor type | PWR | PWR | BWR | PWR |
| reactor "ready" | 3/2004 | 3/2004 | 3/2005 | 3/2004 |
| start irradiating European LUA | NA | NA | NA | 12/2002 |
| start irradiating American LUA | 6/2007 | 6/2007 | 12/2007 | 6/2007 |
| mission start | 5/2010 | 5/2010 | 4/2010 | 11/2005 |
| last assembly loaded | 2/2020 | 2/2020 | 10/2026 | 1/2019 |
| mission finish | 8/2021 | 8/2021 | 12/2027 | 7/2020 |
| **Mission duration (yr.)** | 11.3 | 11.3 | 17.7 | 14.6 |
| **ROD to mission start (yr.)** | 13.5 | 13.5 | 13.3 | 9.0 |

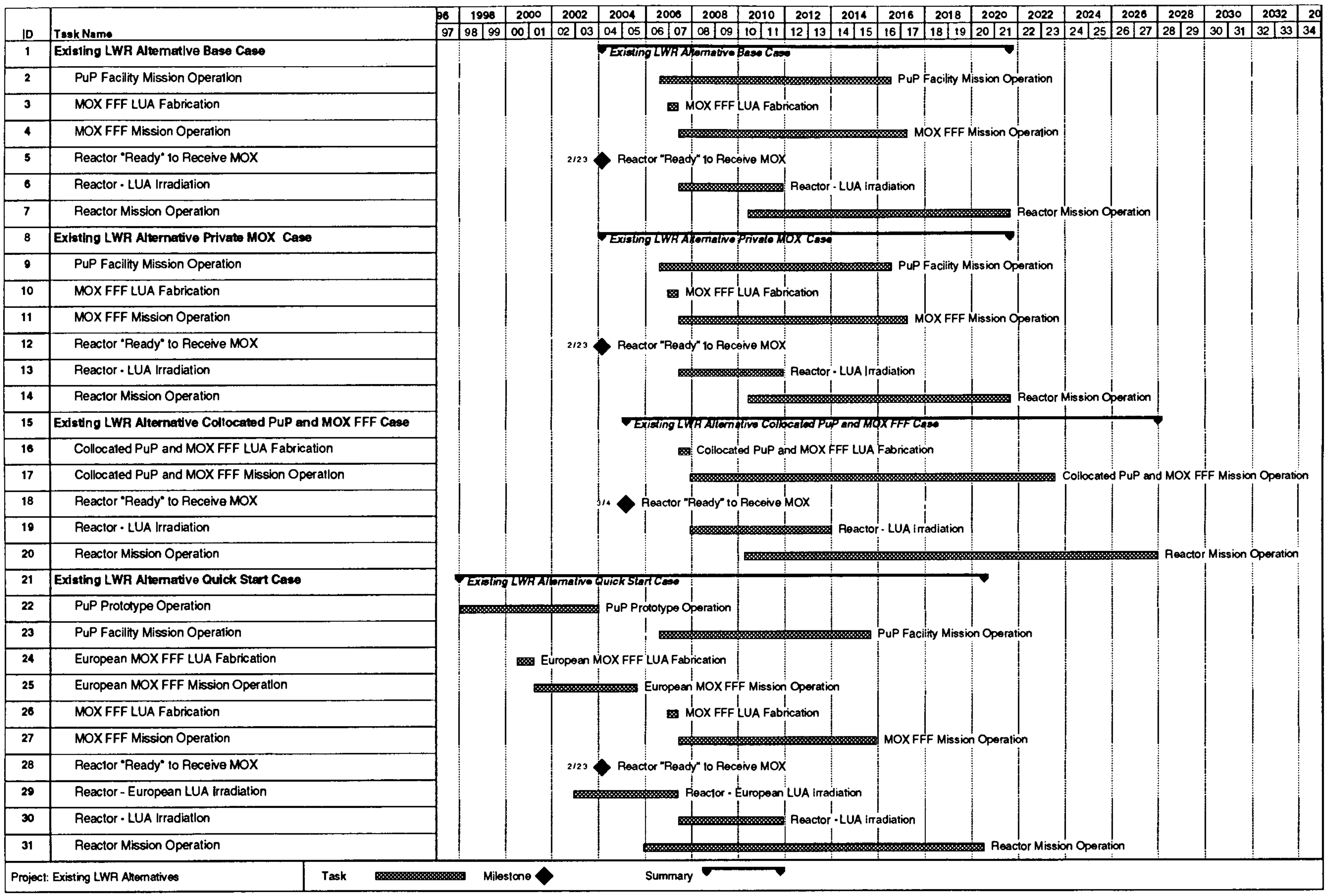


**Figure 4.16 Existing LWR disposition alternatives schedule summary**

# 5. CANDU Heavy Water Reactor Alternatives

The implementation schedules for the two CANDU HWR options shown in
Table 2.2 is presented in this section. For complete descriptions of each of the facilities and for the cost and other analyses for the CANDU options, see the RASR, volume 2 (2).

## 5.1 CANDU HWR Alternative Base Case, 50SFC2-4

The base case for the CANDU HWR alternative uses four separate facilities: a PuP facility, a MOX fuel fabrication facility, several of the CANDU reactor units at Bruce-A, and the Canadian geologic repository. The implementation schedules for each of these facilities is presented below.

### 5.1.1 PuP Facility

The PuP facility for the CANDU base case is the same as described for the existing LWR base case in Section 4.1.1 above.

### 5.1.2 MOX Fuel Fabrication Facility

The preoperational schedule for the MOX fuel fabrication facility is the same as described for the existing LWR base case in Sections 4.1.2.1 and 4.1.2.2.

#### *5.1.2.1 MOX Fuel Fabrication Facility Operations Schedule*

To supply fuel for the two CANDU reactors with Reference MOX fuel bundles, the MOX fuel fabrication facility will operate for five years with an annual plutonium throughput rate of 3 MT. This throughput assumes an annual output of 9050 bundles for a mission total of 45,250 bundles. Then the production lines will be converted to fabricate CANFLEX fuel to supply four CANDU reactors with an annual plutonium throughput of 4.9 MT for 7.2 years; this corresponds to an annual output of 10,500 CANFLEX bundles, for a mission total of 75,279 bundles. A sufficient number of Reference MOX bundles for the initial loads will be available six months after the start of operation. The operational schedule is shown in Table 5.1 and in the MOX fuel fabrication facility schedule summary figure in Section 5.1.2.2.

**Table 5.1 MOX fuel fabrication facility operational schedule**

| *Task ID* | *Task Name* | *Duration (months)* | *Start* | *Finish* |
|---|---|---|---|---|
| 1. | **Operation** | 152 | 12/2006 | 2/2019 |
| 2. | MOX Facility Operation Start | | | 12/2006 |
| 3. | Fabrication of Initial Loads | 6 | 12/2006 | 6/2007 |
| 4. | Reference MOX Fuel Fabrication | 60 | 12/2006 | 12/2011 |
| 5. | CANFLEX Fuel Fabrication | 86 | 12/2011 | 2/2019 |

#### *5.1.2.2 MOX Fuel Fabrication Facility Schedule Summary*

The overall MOX fuel fabrication facility implementation schedule is summarized in Table 5.2 and shown in Figure 5.1. This facility schedule is also shown in the overall alternative schedule figure in Section 5.1.5. This schedule does not include any contingency for schedule slip due to site selection difficulties, redesign, construction delays, or a delay in the approval of line item funding.

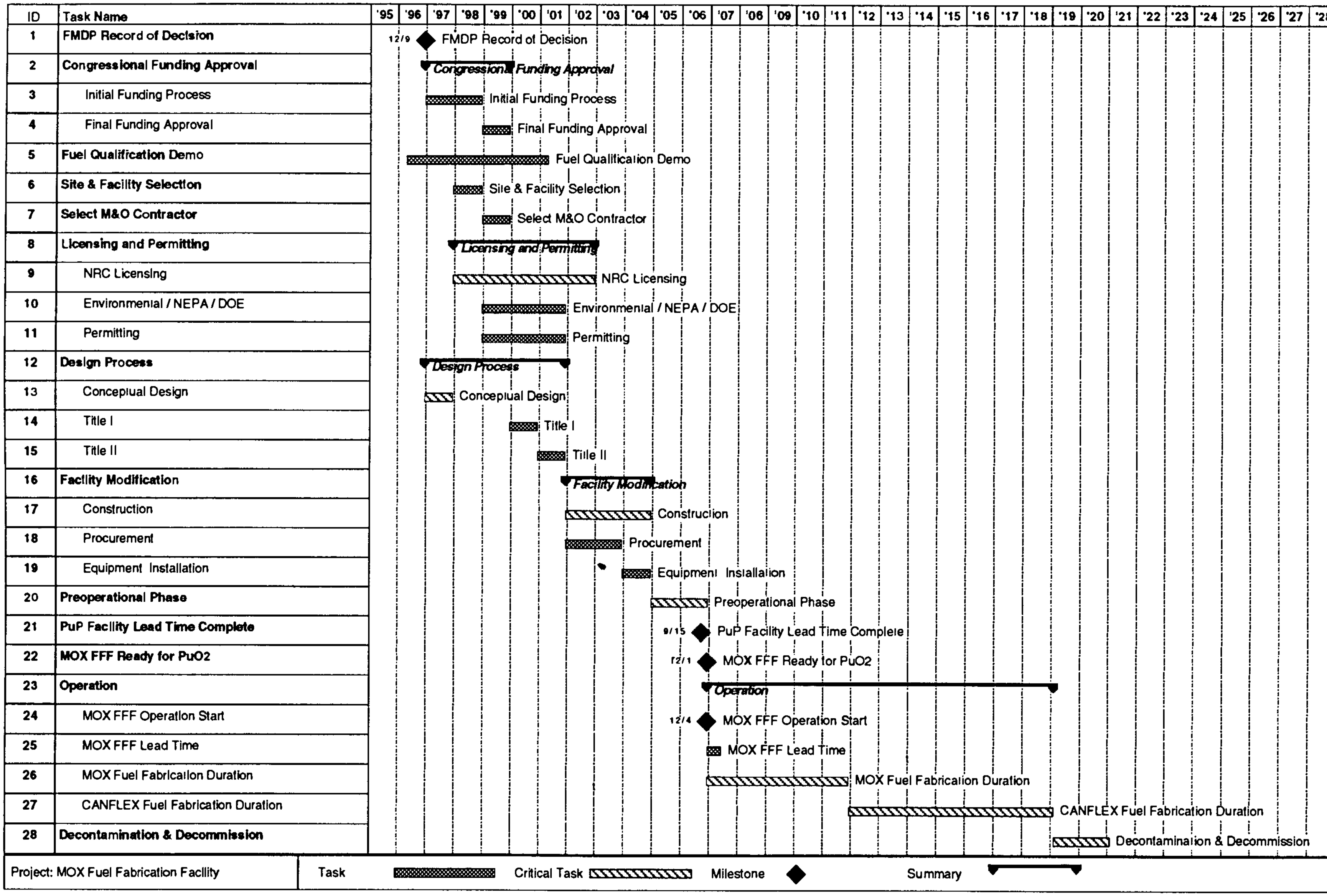


**Figure 5.1 MOX fuel fabrication facility schedule summary**

**Table 5.2 MOX fuel fabrication facility schedule summary**

| *Task ID* | *Task Name* | *Duration (months)* | *Start* | *Finish* |
|---|---|---|---|---|
| 1. | FMDP Record of Decision | | | 12/1996 |
| 2. | Congressional Funding Approval | 36 | 12/1996 | 12/1999 |
| 3. | Fuel Qualification Demonstration | 60 | 4/1996 | 4/2001 |
| 4. | Site and Facility Selection | 12 | 12/1997 | 12/1998 |
| 5. | Select M&O Contractor | 12 | 12/1998 | 12/1999 |
| 6. | Licensing and Permitting | 60 | 12/1997 | 12/2002 |
| 7. | Design Process | 60 | 12/1996 | 11/2001 |
| 8. | Facility Modification | 36 | 12/2001 | 12/2004 |
| 9. | Preoperational Phase | 24 | 12/2004 | 12/2006 |
| 10. | PuP Facility Lead Time Complete | | | 9/2006 |
| 11. | MOX Facility Ready for $PuO_2$ | | | 12/2006 |
| 12. | Reference MOX Operation | 60 | 12/2006 | 12/2011 |
| 13. | CANFLEX Operation | 86 | 12/2011 | 2/2019 |
| 14. | Decontamination & Decommission | 24 | 2/2019 | 1/2021 |

### 5.1.3 CANDU HWR Facility

#### *5.1.3.1 CANDU HWR Facility Design & Construction*

The duration and path of the design and construction tasks are based on information from Atomic Energy of Canada, Ltd. (AECL). After approval of intermediate line item funding, the project begins with completion of the required design and reactor facility modifications and construction of the new fuel storage building. The design and construction schedule is listed in Table 5.3 and shown in the CANDU facility schedule summary figure in Section 5.1.3.4.

**Table 5.3 CANDU facility design and construction schedule**

| *Task ID* | *Task Name* | *Duration (months)* | *Start* | *Finish* |
|---|---|---|---|---|
| 1. | **FMDP Record of Decision** | | | 12/1996 |
| 2. | **Intermediate Funding Approval** | 24 | 12/1996 | 12/1998 |
| 3. | **Reactor & Design Modifications** | 48 | 12/1998 | 11/2002 |
| 4. | Design Modifications | 24 | 12/1998 | 12/2000 |
| 5. | Reactor Modifications | 24 | 12/2000 | 11/2002 |

#### *5.1.3.2 CANDU HWR Facility Licensing and Permitting*

There are two licensing and permitting tasks for the CANDU facility: the required interactions with the AECB and the environmental assessment for using MOX fuel in the reactors and for building the new fuel storage building. These tasks are listed in Table 5.4 and shown in the CANDU facility schedule summary figure in Section 5.1.3.4.

**Table 5.4 CANDU facility license and permit schedule**

| Task ID | Task Name | Duration (months) | Start | Finish |
|---|---|---|---|---|
| 1. | **Licensing and Permitting** | 72 | 12/1996 | 11/2002 |
| 2. | AECB Interactions | 48 | 12/1998 | 11/2002 |
| 3. | Environmental Assessment | 24 | 12/1996 | 12/1998 |

*5.1.3.3 CANDU HWR Facility Operations Schedule*

After completion of the preoperational phase, the CANDU reactors are ready to accept Reference MOX fuel in February 2002; however, the MOX fuel fabrication facility will not produce a sufficient supply of fuel bundles to begin continuous operation until June 2007. At this time, two reactor units at Bruce-A start operating with Reference MOX fuel and operate with this fuel for five years. At the end of the five year period, the first two units and two additional units are switched to irradiating CANFLEX fuel. These four units are loaded with CANFLEX fuel for 7.2 years. After a residence time of 450 days, the spent MOX and CANFLEX fuel bundles are placed in the spent fuel pool for a minimum of ten years. As the Canadian geological repository facility is not scheduled to open until 2025, the spent MOX and CANFLEX fuel may be moved to dry cask storage after ten years in the pools. The CANDU facility operational schedule is shown in Table 5.5 and in the CANDU facility schedule summary figure in Section 5.1.3.4.

**Table 5.5 CANDU facility operations schedule**

| Task ID | Task Name | Duration (months) | Start | Finish |
|---|---|---|---|---|
| 1. | **MOX Facility Lead Time** | 6 | 12/2006 | 6/2007 |
| 2. | **Preoperational Phase** | 3 | 12/2002 | 2/2003 |
| 3. | **Reactor Facility Operation** | 161 | 6/2007 | 10/2020 |
| 4. | Units 1&2 Reference MOX Loading Duration | 60 | 6/2007 | 6/2012 |
| 5. | Units 1-4 CANFLEX Loading Duration | 86 | 6/2012 | 8/2019 |
| 6. | Irradiation of last CANFLEX Bundles | 15 | 8/2019 | 10/2020 |
| 7. | **Spent Fuel Storage** | 274 | 10/2014 | 7/2037 |
| 8. | First MOX in Spent Fuel Pool | 120 | 8/2008 | 8/2018 |
| 9. | Last CANFLEX | 120 | 11/2020 | 11/2030 |

*5.1.3.4 CANDU HWR Facility Schedule Summary*

The overall CANDU facility implementation schedule is summarized in Table 5.6 and shown in Figure 5.2. This facility schedule is also shown in the discussion of the overall alternative schedule in Section 5.1.5.

Table 5.6 CANDU HWR facility schedule summary

| *Task ID* | *Task Name* | *Duration (months)* | *Start* | *Finish* |
|---|---|---|---|---|
| 1. | FMDP Record of Decision | | | 12/1996 |
| 2. | Congressional Funding Approval | 36 | 12/1996 | 12/1999 |
| 3. | Fuel Design and Development | 62 | 10/1996 | 11/2001 |
| 4. | MOX Facility Lead Time | 24 | 12/2006 | 11/2008 |
| 5. | Licensing and Permitting | 72 | 12/1996 | 11/2002 |
| 6. | Reactor & Design Modifications | 48 | 12/1998 | 11/2002 |
| 7. | Preoperational Phase | 3 | 12/2002 | 2/2003 |
| 8. | Reactors "ready" to accept MOX | | | 2/2003 |
| 9. | Units 1&2 Reference MOX Loading | 60 | 6/2007 | 6/2012 |
| 10. | Units 1-4 CANFLEX Loading Duration | 86 | 6/2012 | 8/2019 |
| 11. | Full Irradiation of Last CANFLEX Bundles | 15 | 8/2019 | 10/2020 |
| 12. | Spent Fuel Storage | 266 | 8/2008 | 11/2030 |

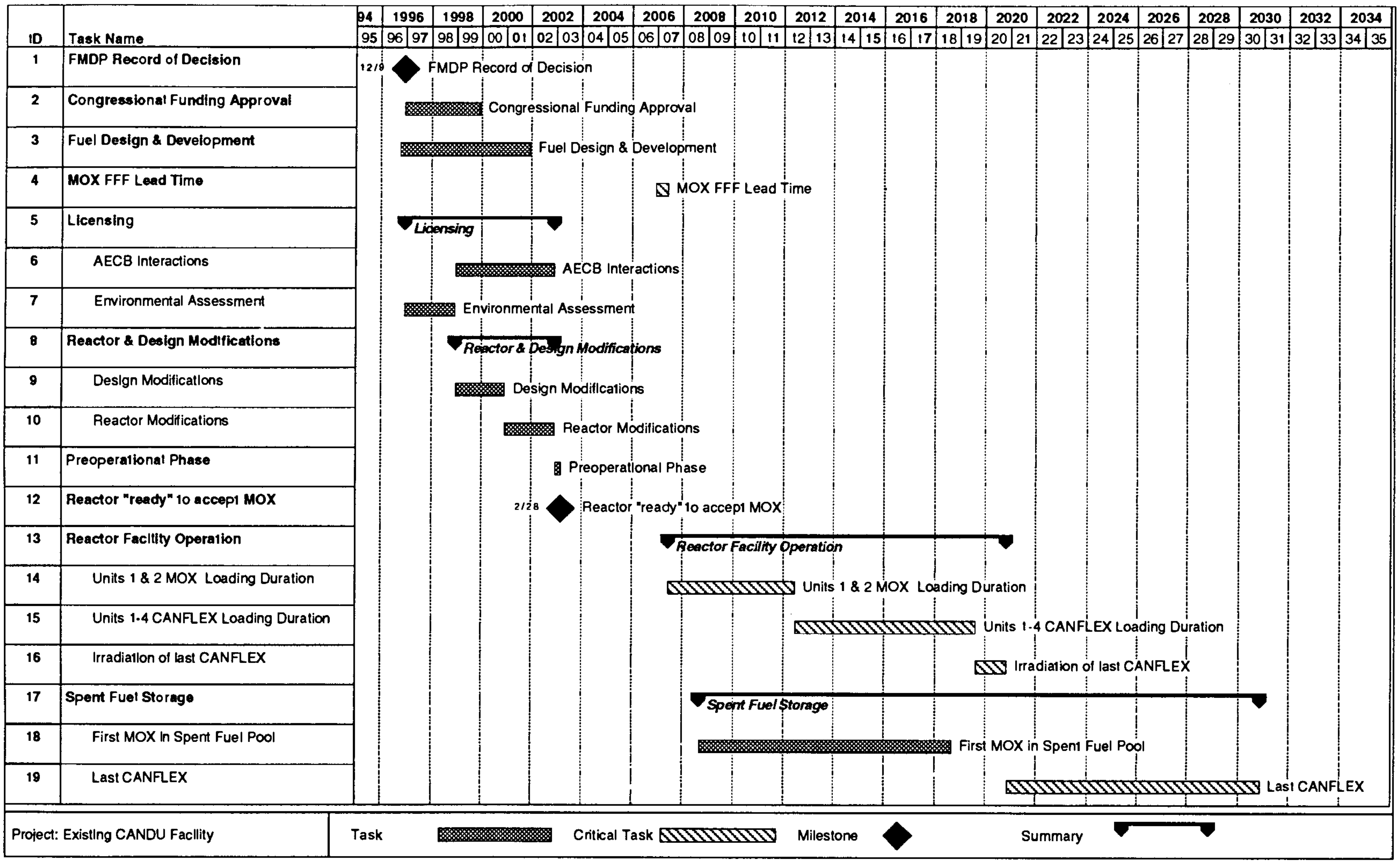


**Figure 5.2 CANDU HWR facility schedule summary**

### 5.1.4 Canadian Geological Repository Facility

*5.1.4.1 Canadian Geological Repository Facility Design & Construction Schedule*

The duration and path of the design and construction tasks are based on information from AECL. The design activities have been estimated to require ten years and will begin in 2004. The siting and construction activities are estimated to take 27 years and will begin in 1998.

*5.1.4.2 Canadian Geological Repository Facility Licensing and Permitting*

The duration of the license and permitting activities tasks are estimated by AECL to begin in 2002 and take to ten years to complete.

*5.1.4.3 Canadian Geological Repository Facility Operations Schedule*

The Canadian Geological Repository facility is scheduled to open in 2025. The Reference MOX and CANFLEX fuel delivery schedule is shown in Table 5.7 and in the alternative schedule summary figure in Section 5.1.5.

**Table 5.7 Canadian geological repository facility operations schedule**

| *Task ID* | *Task Name* | *Duration (months)* | *Start* | *Finish* |
|---|---|---|---|---|
| 1. | **Reposltory Openlng Date** | | | 1/2025 |
| 2. | **Dellvery of MOX & CANFLEX Fuel** | 71 | 1/2025 | 11/2030 |
| 3. | Transportation of first MOX to Repository | 1 | 1/2025 | 1/2025 |
| 4. | First MOX bundle arrives | | | 1/2025 |
| 5. | Transportation of last CANFLEX | 1 | 11/2030 | 11/2030 |
| 6. | Last CANFLEX bundle arrives | | | 11/2030 |

### 5.1.5 CANDU HWR Base Case Alternative Schedule Summary

The CANDU alternative schedule is a combination of the individual facility schedules discussed earlier above. The overall schedule is summarized in Table 5.8 and shown in Figure 5.3. The plutonium disposition mission begins when the first Reference MOX is loaded into the CANDU reactors in June 2007 and is complete after the last CANFLEX bundles are fully irradiated in October 2020. The overall mission time is 13.3 years and starts 10.5 years after ROD.

The critical path for the alternative is the licensing, design, and construction of the MOX fuel fabrication facility. The CANDU reactors are ready to accept the Reference MOX fuel five years before the fuel is available.

The schedule risk for the PuP and MOX fuel fabrication facilities are the same as for the other reactor-based alternatives. The schedule risk for modifying the existing CANDU reactor facility is the same as for modifying existing LWR facilities for MOX fuel.

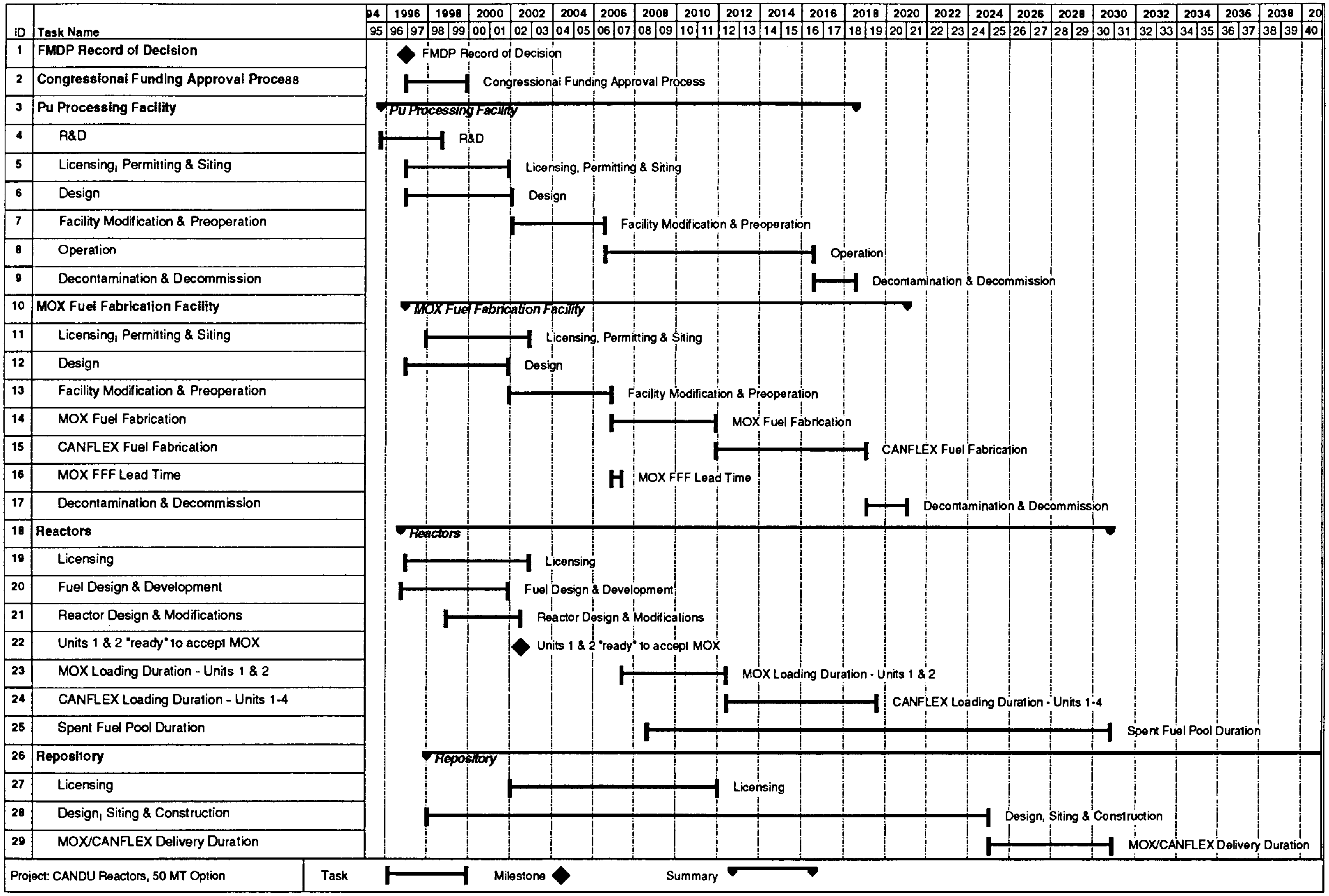


Figure 5.3 CANDU HWR base case alternative schedule summary

Table 5.8 CANDU HWR base case alternative schedule summary

| Task ID | Task Name | Duration (years) | Start | Finish |
|---|---|---|---|---|
| 1. | **FMDP Record of Decision** | | | 12/1996 |
| 2. | **Congressional Funding Process** | 3 | 12/1996 | 12/1999 |
| 3. | **Pu Processing Activities** | 22.8 | 10/1995 | 7/2018 |
| 4. | R&D | 3 | 10/1995 | 9/1998 |
| 5. | Licensing, Permitting & Siting | 5 | 12/1996 | 12/2001 |
| 6. | Design | 5.1 | 12/1996 | 1/2002 |
| 7. | Facility Modification & Preoperation | 4.5 | 1/2002 | 7/2006 |
| 8. | Operation | 10 | 7/2006 | 7/2016 |
| 9. | Decontamination & Decommissioning | 2 | 8/2016 | 7/2018 |
| 10. | **MOX Fuel Fabrication Facility** | 24.1 | 4/1996 | 1/2021 |
| 11. | Licensing, Permitting & Siting | 5 | 12/1997 | 12/2002 |
| 12. | Design | 5 | 12/1996 | 11/2001 |
| 13. | Facility Modification & Preoperation | 5 | 12/2001 | 12/2006 |
| 14. | MOX Facility Lead Time | 0.5 | 12/2006 | 6/2007 |
| 15. | MOX Operation | 5 | 12/2006 | 12/2011 |
| 16. | CANFLEX Operation | 7.2 | 12/2011 | 2/2019 |
| 17. | Decontamination & Decommissioning | 2 | 2/2019 | 1/2021 |
| 18. | **Reactors** | 34.1 | 9/1996 | 11/2030 |
| 19. | Licensing | 6 | 12/1996 | 11/2002 |
| 20. | Fuel Design & Development | 5.2 | 9/1996 | 11/2001 |
| 21. | Reactor Design & Modifications | 3.6 | 12/1998 | 7/2002 |
| 22. | Units 1 & 2 "ready" to accept MOX | | | 7/2002 |
| 23. | MOX Loading Duration - Units 1 & 2 | 5 | 6/2007 | 6/2012 |
| 24. | CANFLEX Loading Duration - Units 1-4 | 7.2 | 6/2012 | 8/2019 |
| 25. | Last CANFLEX bundles irradiated for 1.2 yr. | | | 10/2020 |
| 26. | Spent Fuel Pool Duration | 22.2 | 8/2008 | 11/2030 |
| 27. | **Repository** | | | |
| 28. | Licensing | 10 | 1/2002 | 1/2012 |
| 29. | Design Activities | 10 | 1/2004 | 1/2014 |
| 30. | Siting Issues and Construction | 27 | 1/1998 | 1/2025 |
| 31. | MOX/CANFLEX Delivery Duration | 5.9 | 1/2025 | 11/2030 |

## 5.2 CANDU HWR Alternative Hybrid Case, 33SFC2

The hybrid case for the CANDU HWR alternative is the same as the base CANDU HWR case, except only 32.5 MT of weapons-usable plutonium will be converted to MOX fuel, and only two CANDU reactor units will be used. Also, there will be no shift to the new CANFLEX fuel type. The changes to the various facilities operational schedules from the base CANDU case are discussed below.

### 5.2.1 PuP Facility

The overall PuP facility implementation schedule for this alternative is the same as was presented for the existing LWR hybrid case above in Section 4.4.1. This schedule is also summarized in the overall alternative schedule summary table and figure in Section 5.2.5.

### 5.2.2 MOX Fuel Fabrication Facility

The overall MOX fuel fabrication facility design, construction, licensing and permitting schedules are the same as were presented above for the existing LWR base case in Sections 4.1.2.1 and 4.1.2.2. To supply fuel for the two CANDU reactors with Reference MOX fuel bundles, the MOX fuel fabrication facility will operate for 10.9 years with an annual plutonium throughput rate of 3 MT. This throughput assumes an annual output of 9050 bundles for a mission total of 98485 bundles. This schedule is summarized in the overall alternative schedule summary table and figure in Section 5.2.5.

### 5.2.3 CANDU HWR Facility

The overall CANDU HWR design, construction, licensing and permitting schedules for the 32.5 MT case are the same as were presented for the 50 MT case above in Sections 5.1.3.1 and 5.1.3.2. Only two CANDU reactors will be used for this alternative. Reference MOX fuel will be loaded into these two reactors for 10.9 years. This schedule is summarized in the overall alternative schedule summary table and figure in Section 5.2.5.

### 5.2.4 Canadian Geological Repository Facility

The overall Canadian Geological Repository design, construction, licensing and permitting schedules for the 32.5 MT case are the same as were presented for the 50 MT case above in Section 5.1.4. Spent Reference MOX fuel is scheduled to be delivered to the facility starting in 2025 and continuing for 4.6 years. This schedule is summarized in the overall alternative schedule summary table and figure in Section 5.2.5.

### 5.2.5 CANDU HWR Hybrid Alternative Schedule Summary

The overall schedule for the CANDU HWR 32.5 MT alternative is summarized in Table 5.9 and shown in Figure 5.4. The plutonium disposition mission begins when the first Reference MOX is loaded into the CANDU reactors in June 2007 and is complete after the last Reference MOX fuel bundles are fully irradiated in July 2019. The overall mission time is 12.1 years and starts 10.5 years after ROD.

Table 5.9 CANDU HWR hybrid alternative schedule summary

| *Task ID* | *Task Name* | *Duration (years)* | *Start* | *Finish* |
|---|---|---|---|---|
| 1. | **FMDP Record of Decision** | | | 12/1996 |
| 2. | **Congressional Funding Process** | 3 | 12/1996 | 12/1999 |
| 3. | **Pu Processing Activities** | 22.8 | 10/1995 | 7/2018 |
| 4. | R&D | 3 | 10/1995 | 9/1998 |
| 5. | Licensing, Permitting & Siting | 5 | 12/1996 | 12/2001 |
| 6. | Design | 5.1 | 12/1996 | 1/2002 |
| 7. | Facility Modification & Preoperation | 4.5 | 1/2002 | 7/2006 |
| 8. | Operation | 10 | 7/2006 | 7/2016 |
| 9. | Decontamination & Decommissioning | 2 | 8/2016 | 7/2018 |
| 10. | **MOX Fuel Fabrication Facility** | 24.1 | 4/1996 | 1/2021 |
| 11. | Licensing, Permitting & Siting | 5 | 12/1997 | 12/2002 |
| 12. | Design | 5 | 12/1996 | 11/2001 |
| 13. | Facility Modification & Preoperation | 5 | 12/2001 | 12/2006 |
| 14. | Operation | 10.9 | 12/2006 | 10/2017 |
| 15. | MOX Facility Lead Time | 0.5 | 12/2006 | 6/2007 |
| 16. | Decontamination & Decommissioning | 2 | 10/2017 | 10/2019 |
| 17. | **Reactors** | 32.8 | 9/1996 | 7/2029 |
| 18. | Licensing | 6 | 12/1996 | 11/2002 |
| 19. | Fuel Design & Development | 5.2 | 9/1996 | 11/2001 |
| 20. | Reactor Design & Modifications | 3.6 | 12/1998 | 7/2002 |
| 21. | Units 1 & 2 "ready" to accept MOX | | | 7/2002 |
| 22. | MOX Loading Duration | 10.9 | 6/2007 | 4/2018 |
| 23. | Last MOX bundles irradiated for 1.2 yr. | | | 7/2019 |
| 24. | Spent Fuel Pool Duration | 20.9 | 8/2008 | 7/2029 |
| 25. | **Repository** | | | |
| 26. | Licensing | 10 | 1/2002 | 1/2012 |
| 27. | Design & Construction | 27 | 1/1998 | 1/2025 |
| 28. | MOX Delivery Duration | 4.6 | 1/2025 | 8/2029 |

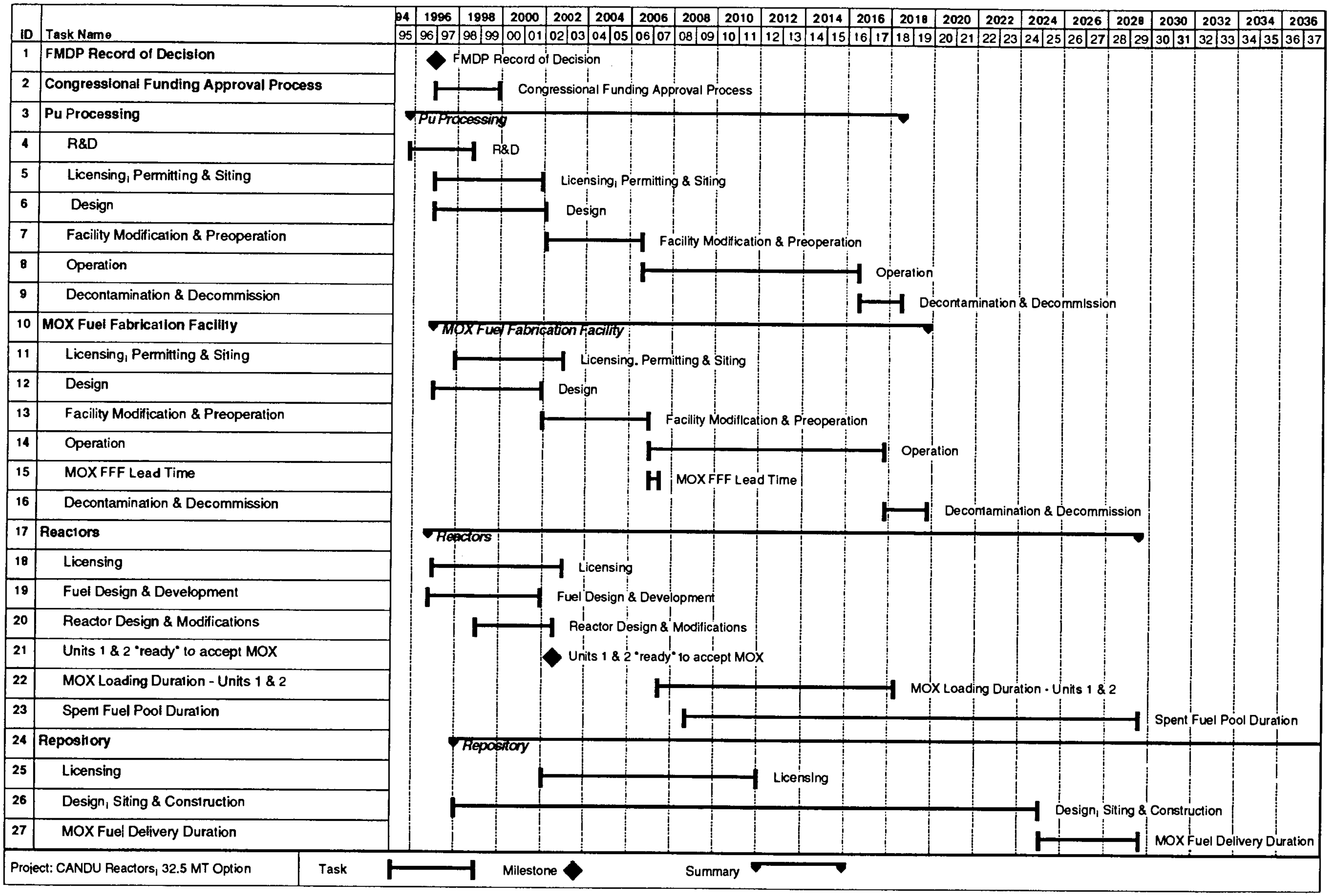


**Figure 5.4 CANDU HWR hybrid alternative schedule summary**

# 6. Partially-Complete Light Water Reactor Alternative

The implementation schedule for the partially-complete LWR option, 50SFP2, shown in
Table 2.2 is presented in this section. This alternative uses four separate facilities: a PuP facility, a MOX fuel fabrication facility, a reactor facility with two partially-complete PWR units, and the HLW repository. Two ABB-CE System 80 reactors have been chosen as surrogate representatives for fuel throughput calculations for this alternative. For complete descriptions of each of the facilities, and for the cost and other analyses for the partially-complete LWR option, see the RASR, volume 3 (2).

## 6.1 PuP Facility

The PuP facility for the partially-complete LWR case is the same as described for the existing LWR base case in Section 4.1.1 above.

## 6.2 MOX Fuel Fabrication Facility

The preoperational schedule for the MOX fuel fabrication facility is the same as described for the existing LWR base case in Sections 4.1.2.1 and 4.1.2.2.

### 6.2.1 MOX Fuel Fabrication Facility Operations Schedule

To supply fuel for two ABB-CE System 80 reactors at the specified loading rate, the MOX fuel fabrication facility will operate for 17.1 years with an annual plutonium throughput rate of 2.9 MT. This throughput assumes an annual output of 157 assemblies for a mission total of 2692 assemblies. The LUAs will be ready to load into a sister reactor six months after the start of operations at the MOX fuel fabrication facility. A sufficient number of MOX fuel assemblies for the initial core loads will be available thirty-one months after the start of operations. The operational schedule is shown in Table 6.1 and in the MOX facility schedule summary figure in Section 6.2.2.

**Table 6.1 MOX fuel fabrication facility operational schedule**

| *Task ID* | *Task Name* | *Duration (months)* | *Start* | *Finish* |
|---|---|---|---|---|
| 1. | **Operatlon** | 211 | 12/2006 | 7/2024 |
| 2. | MOX Facility Operation Start | | | 12/2006 |
| 3. | LUA Fabrication | 6 | 12/2006 | 6/2007 |
| 4. | Fabrication of Initial Core Loads | 25 | 6/2007 | 6/2009 |
| 5. | Operation | 205 | 6/2007 | 7/2024 |

### 6.2.2 MOX Fuel Fabrication Facility Schedule Summary

The overall MOX fuel fabrication facility implementation schedule is summarized in Table 6.2 and shown in Figure 6.1. This facility schedule is also shown in the discussion of the overall alternative schedule in Section 6.5. This schedule does not include any contingency for schedule slip due to site selection difficulties, redesign, construction delays, or a delay in the approval of line item funding.

Table 6.2 MOX fuel fabrication facility schedule summary

| Task ID | Task Name | Duration (months) | Start | Finish |
|---|---|---|---|---|
| 1. | FMDP Record of Decision | | | 12/1996 |
| 2. | Congressional Funding Approval | 36 | 12/1996 | 12/1999 |
| 3. | Fuel Qualification Demonstration | 60 | 4/1996 | 4/2001 |
| 4. | Site and Facility Selection | 12 | 12/1997 | 12/1998 |
| 5. | Select M&O Contractor | 12 | 12/1998 | 12/1999 |
| 6. | Licensing and Permitting | 60 | 12/1997 | 12/2002 |
| 7. | Design Process | 60 | 12/1996 | 11/2001 |
| 8. | Facility Modification | 36 | 12/2001 | 12/2004 |
| 9. | Preoperational Phase | 24 | 12/2004 | 12/2006 |
| 10. | PuP Facility Lead Time Complete | | | 9/2006 |
| 11. | MOX Facility Ready for $PuO_2$ | | | 12/2006 |
| 12. | LUA Fabrication | 6 | 12/2006 | 6/2007 |
| 13. | MOX Facility Lead Time | 25 | 6/2007 | 6/2009 |
| 14. | MOX Facility Operation Duration | 205 | 6/2007 | 7/2024 |
| 15. | Decontamination & Decommission | 24 | 7/2024 | 7/2026 |

## 6.3 Partially-Complete PWR Facility

### 6.3.1 Partially-Complete PWR Facility Design & Construction

The duration and path of the design and construction tasks are based information from Fluor Daniel and Tennessee Valley Authority (TVA). After the intermediate approval of line item funding, the project begins selection of the M&O contractor and project mobilization. The completion of the first unit has been set to coincide with the availability of the initial core load of fuel assemblies from the MOX fuel fabrication facility in June 2009. If construction on the first unit started directly after the transfer of the construction permit to the new contractor without waiting for the MOX fuel fabrication facility, the reactors would be complete three years sooner. The second unit is scheduled to be completed one year later than the first unit. The design and construction schedule is listed in Table 6.3 and shown in the facility schedule summary figure in Section 6.3.4.

Table 6.3 Partially-complete PWR facility design and construction schedule

| Task ID | Task Name | Duration (months) | Start | Finish |
|---|---|---|---|---|
| 1. | **FMDP Record of Decision** | | | 12/1996 |
| 2. | **Intermediate Line Item Approval** | 24 | 12/1996 | 12/1998 |
| 3. | **Mobilization & Select M&O Contractor** | 27 | 12/1998 | 3/2001 |
| 4. | **Reactor Construction** | 66 | 12/2004 | 6/2010 |
| 5. | Complete Unit 1 | 54 | 12/2004 | 6/2009 |
| 6. | Complete Unit 2 | 51 | 3/2006 | 6/2010 |

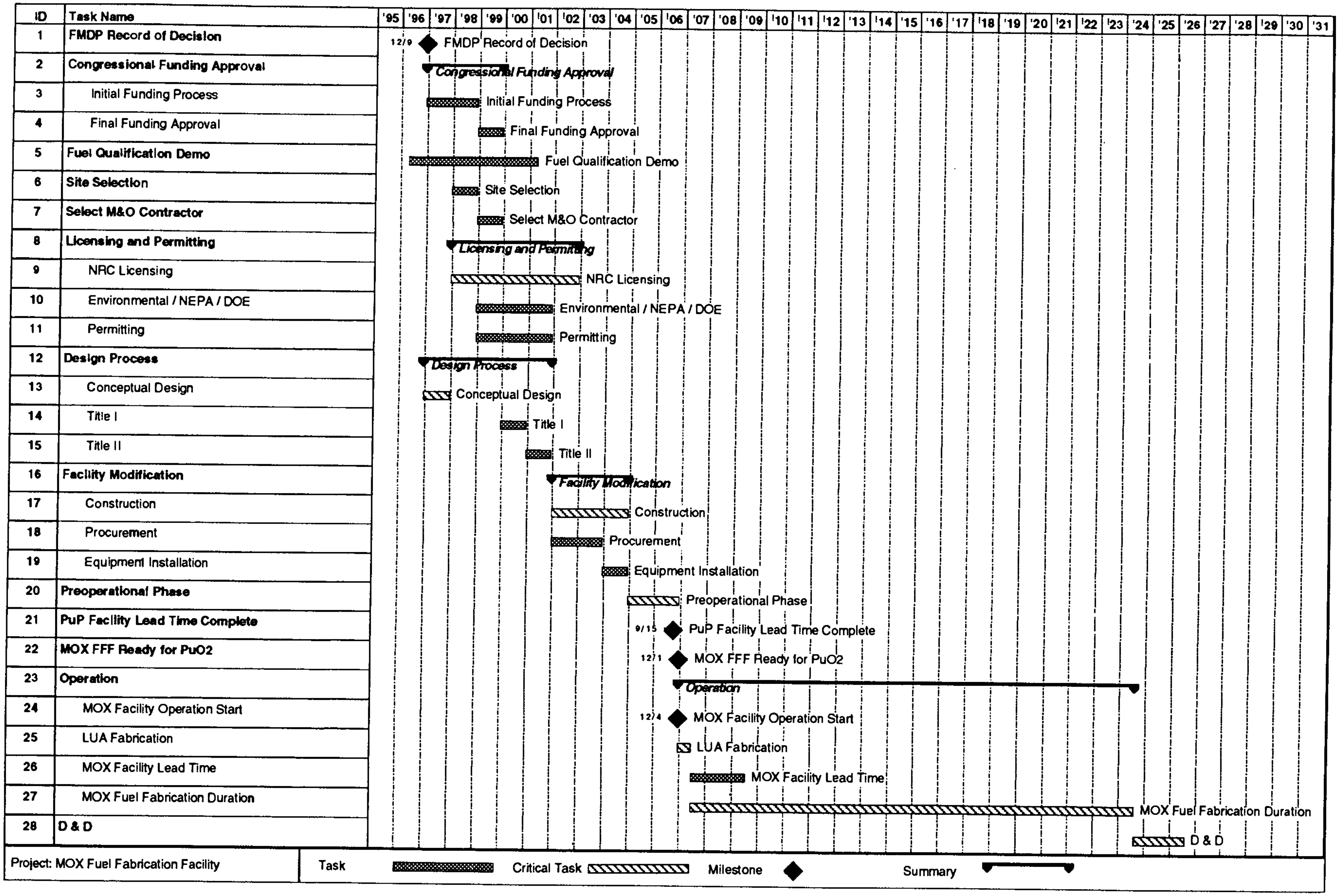


**Figure 6.1 MOX fuel fabrication facility schedule summary**

### 6.3.2 Partially-Complete PWR Facility Licensing and Permitting

For this analysis a licensing schedule developed by Fluor Daniel (9) for a partially-complete LWR facility was followed. The licensing schedule is shown in Table 6.4 and Figure 6.2.

To begin the licensing process, the application for transferring the construction permit (CP) to the new contractor is developed and filed with the NRC. The NRC reviews the application and approves the transfer of the CP. Once the CP is transferred, construction may resume on the reactor facility. At the same time, work on the application for the operating license (OL) and ER is started. After the application for the OL and the ER is filed with the NRC, the NRC conducts technical reviews of the OL application and develops the EIS and the SER. The schedule includes a provision for a year-long full discovery period and a one-year hearing and decision process by an ASLB. The requirement for these processes are subject to petitions for a hearing on specific issues. After a decision is issued by the ASLB, the NRC grants the OL.

**Table 6.4 Partially-complete PWR facility license and permit schedule**

| *Task ID* | *Task Name* | *Duration (months)* | *Start* | *Finish* |
|---|---|---|---|---|
| 1. | NRC Licensing Process | 65 | 3/2001 | 7/2006 |
| 2. | Prepare and File Application for Transfer of CP | 3 | 3/2001 | 6/2001 |
| 3. | Public Notice of Application for Transfer of CP | 1 | 6/2001 | 6/2001 |
| 4. | NRC Review of CP Transfer | 6 | 7/2001 | 12/2001 |
| 5. | NRC Approves of CP Transfer | 1 | 12/2001 | 1/2002 |
| 6. | Licensee Prepares & Files OL Application | 12 | 1/2002 | 1/2003 |
| 7. | Public Notice of Application for License | | | 1/2003 |
| 8. | NRC Performs Tech. Reviews for OL Application | 12 | 1/2003 | 1/2004 |
| 9. | NRC Issues SER | | | 1/2004 |
| 10. | Pre Hearing Conference | 6 | 1/2003 | 7/2003 |
| 11. | Full Discovery | 12 | 7/2003 | 7/2004 |
| 12. | Hearing by ASLB | 12 | 7/2004 | 7/2005 |
| 13. | Decision Issued by ASLB | 12 | 7/2005 | 7/2006 |
| 14. | NRC Issues Operating License | | | 7/2006 |
| 15. | NRC Environmental/NEPA Process | 24 | 1/2002 | 1/2004 |
| 16. | Licensee Prepares & Files OL ER | 12 | 1/2002 | 1/2003 |
| 17. | NRC EIS Process for OL Application | 12 | 1/2003 | 1/2004 |
| 18. | NRC Issues EIS | | | 1/2004 |

### 6.3.3 Partially-Complete PWR Facility Operations Schedule

After completion of the first unit in June 2009, which is when the MOX fuel fabrication facility lead time will be complete, the reactor is loaded with the initial core load of MOX fuel and additional physics tests are performed before ascending to full power in September 2009. The second unit is loaded with fuel one year later. After two cycles of irradiation, 3.33 years, the spent MOX fuel assemblies are discharged from the reactors and are stored in the spent fuel storage pool for ten years before being shipped to the HLW repository facility. The partially-complete LWR facility operational schedule is shown in Table 6.5 and in the facility schedule summary figure in Section 6.3.4.

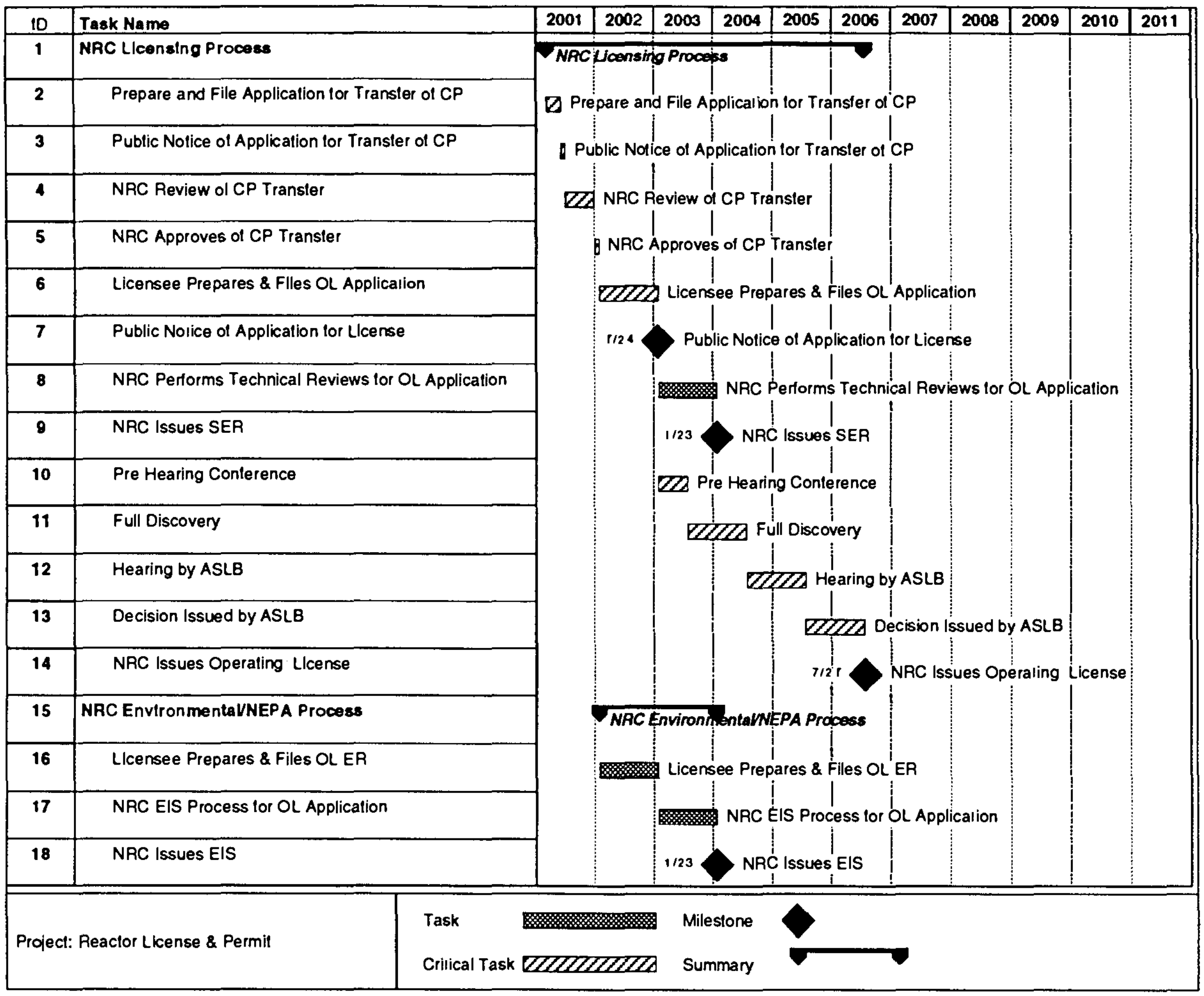


**Figure 6.2 Partially-complete PWR facility license and permit schedule**

**Table 6.5 Partially-complete PWR facility operations schedule**

| *Task ID* | *Task Name* | *Duration (months)* | *Start* | *Finish* |
|---|---|---|---|---|
| 1. | **MOX Facility Lead Time** | 25 | 6/2007 | 6/2009 |
| 2. | **Reactor Facility Operation** | 225 | 6/2009 | 3/2028 |
| 3. | Unit 1 Loading Duration | 188 | 6/2009 | 2/2025 |
| 4. | Unit 1 Full Power | | | 9/2009 |
| 5. | Unit 2 Loading Duration | 169 | 6/2010 | 8/2024 |
| 6. | Single cycle of Last Assemblies | 18 | 2/2025 | 9/2026 |
| 7. | Last MOX Fuel Discharged | 37 | 2/2025 | 3/2028 |
| 8. | **Spent Fuel Storage** | 323 | 4/2011 | 2/2038 |
| 9. | First MOX in Spent Fuel Pool | 120 | 4/2011 | 4/2021 |
| 10. | Last MOX in Spent Fuel Pool | 120 | 3/2028 | 3/2038 |

### 6.3.4 Partially-Complete PWR Facility Schedule Summary

The overall partially-complete PWR facility implementation schedule is summarized in Table 6.6 and shown in Figure 6.3. This facility schedule is also shown in the discussion of the overall alternative schedule in Section 6.5. This schedule does not include any contingency for schedule slip due to redesign, construction delays, or a delay in the approval of line item funding.

The critical path for the partially-complete LWR facility deployment is shown in Figure 6.3. The start of construction on the reactor facility is dependent on the expected completion date of the MOX facility and subsequent lead time requirements to ensure sufficient fuel is available. However, if this constraint is removed from the start of construction, the critical path for the facility is through the line item funding process, program mobilization, and the NRC licensing process before construction may restart.

**Table 6.6 Partially-complete PWR facility schedule summary**

| *Task ID* | *Task Name* | *Duration (months)* | *Start* | *Finish* |
|---|---|---|---|---|
| 1. | FMDP Record of Decision | | | 12/1996 |
| 2. | Congressional Funding Approval | 36 | 12/1996 | 12/1999 |
| 3. | MOX Facility Lead Time | 25 | 6/2007 | 6/2009 |
| 4. | Mobilization & Select M&O Contractor | 27 | 12/1998 | 3/2001 |
| 5. | Licensing and Permitting | 65 | 3/2001 | 7/2006 |
| 6. | Reactor Construction Completion | 66 | 12/2004 | 6/2010 |
| 7. | Reactor Facility Operation | 225 | 6/2009 | 3/2028 |
| 8. | Last Assemblies - first cycle | 18 | 2/2025 | 9/2026 |
| 9. | Spent Fuel Storage | 323 | 4/2011 | 3/2038 |

## 6.4 HLW Repository Facility

The HLW repository facility schedule is the same as described for the existing LWR base case in Section 4.1.4, except the spent MOX fuel is scheduled to be delivered to the facility for 17 years, from May 2025 to April 2038.

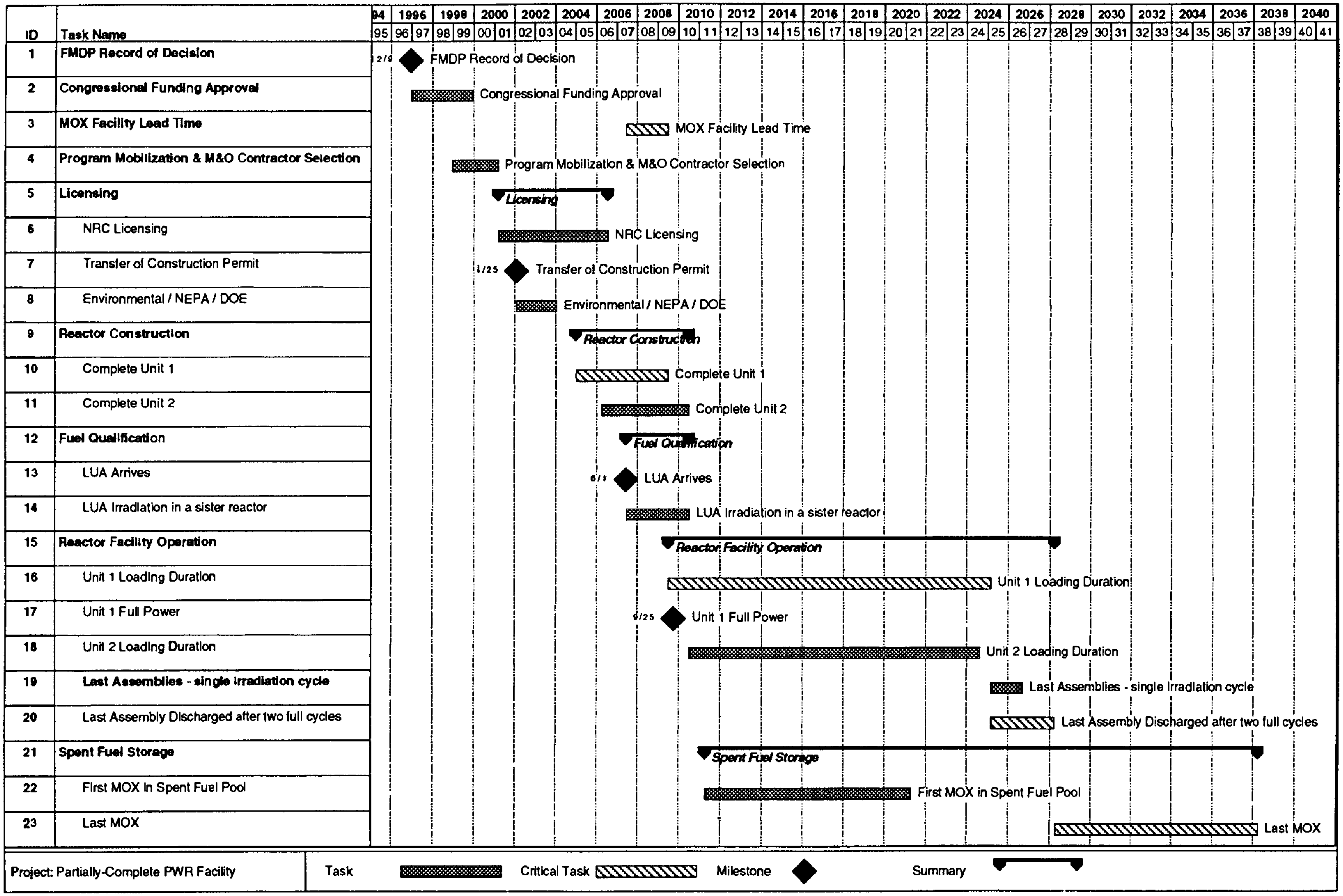


**Figure 6.3 Partially-complete PWR facility schedule summary**

## 6.5 Partially-Complete LWR Alternative Schedule Summary

The partially-complete LWR alternative schedule is a combination of the individual facility schedules discussed above. This overall schedule is summarized in Table 6.7 and shown in Figure 6.4. The plutonium disposition mission begins when the first reactor attains full power in September 2009 and is complete after the last core load, which contains MOX fuel assemblies, has been irradiated for a single cycle in September 2026. The overall mission time is 16.9 years and starts 12.8 years after ROD.

The critical path for the alternative is the licensing, design and facility modifications of the MOX fuel fabrication facility. The schedule risk for completing a partially-complete reactor facility is higher than the schedule risk for modifying existing reactors because of the uncertainties completing the reactor facility.

**Table 6.7 Partially-complete LWR alternative schedule summary**

| *Task ID* | *Task Name* | *Duration (years)* | *Start* | *Finish* |
|---|---|---|---|---|
| 1. | **FMDP Record of Decision** | | | 12/1996 |
| 2. | **Congressional Funding Process** | 3 | 12/1996 | 12/1999 |
| 3. | **PuP Facility** | 22.8 | 10/1995 | 7/2018 |
| 4. | R&D | 3 | 10/1995 | 9/1998 |
| 5. | Licensing, Permitting & Siting | 5 | 12/1996 | 12/2001 |
| 6. | Design | 5.1 | 12/1996 | 1/2002 |
| 7. | Facility Modification & Preoperation | 4.5 | 1/2002 | 7/2006 |
| 8. | Operation | 10 | 7/2006 | 7/2016 |
| 9. | Decontamination and Decommission | 2 | 8/2016 | 7/2018 |
| 10. | **MOX Fuel Fabrication Facility** | 30.3 | 4/1996 | 7/2026 |
| 11. | Fuel Qualification | 5 | 4/1996 | 4/2001 |
| 12. | Licensing, Permitting & Siting | 5 | 12/1997 | 12/2002 |
| 13. | Design | 5 | 12/1996 | 11/2001 |
| 14. | Facility Modification & Preoperation | 5 | 12/2001 | 12/2006 |
| 15. | LUA Fabrication for use in a Sister Reactor | 0.5 | 12/2006 | 6/2007 |
| 16. | MOX Fuel Fabrication Lead Time | 2.1 | 6/2007 | 6/2009 |
| 17. | Operation | 17.1 | 6/2007 | 7/2024 |
| 18. | Decontamination and Decommission | 2 | 7/2024 | 7/2026 |
| 19. | **Reactors** | 39.3 | 12/1998 | 3/2038 |
| 20. | Mobilization and M&O Contractor Selection | 2.2 | 12/1998 | 3/2001 |
| 21. | Licensing & Permitting | 5.4 | 3/2001 | 7/2006 |
| 22. | Reactor Design and Construction Completion | 6.5 | 12/2003 | 6/2010 |
| 23. | LUA Irradiation in a Sister Reactor | 3.1 | 6/2007 | 7/2010 |
| 24. | MOX Loading Duration | 15.7 | 6/2009 | 2/2025 |
| 25. | Unit 1 Full Power | | | 9/2009 |
| 26. | Last Assemblies – First Cycle | 1.5 | 2/2025 | 9/2026 |
| 27. | Last MOX Discharged to Spent Fuel Pool | | | 3/2028 |
| 28. | Spent Fuel Pool Duration | 27 | 4/2011 | 3/2038 |
| 29. | **Repository** | | | |
| 30. | Licensing | 8.5 | 3/2002 | 8/2010 |
| 31. | Construction | 5.5 | 3/2005 | 8/2010 |
| 32. | MOX Delivery Duration | 17 | 5/2021 | 4/2038 |

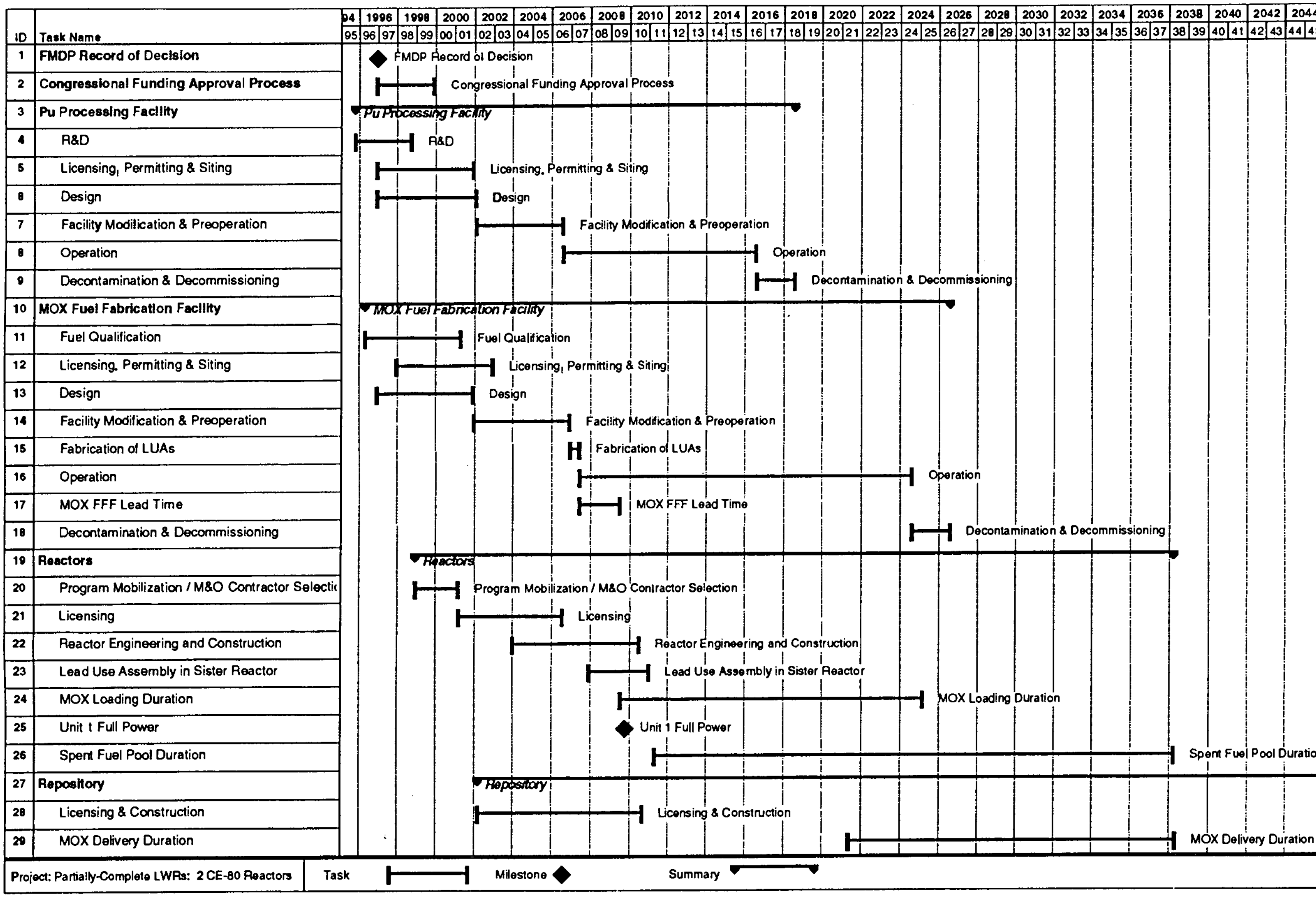


**Figure 6.4 Partially-complete LWR alternative schedule summary**

# 7. Evolutionary Light Water Reactor Alternative

The implementation schedule for the evolutionary LWR option, 50SFE2, shown in Table 2.2, is presented in this section. This alternative uses four separate facilities: a PuP facility, a MOX fuel fabrication facility, two ABB-CE System 80+ evolutionary PWR units, and the HLW repository. For complete descriptions of each of the facilities and for the cost and other analyses for the evolutionary LWR option see the RASR, volume 4 (2). As mentioned in Section 2.1, other evolutionary and advanced reactor designs could also be used for this alternative. If an evolutionary LWR option had been selected at ROD, further analysis would be required to examine the trade-offs between the various designs.

## 7.1 PuP Facility

The PuP facility for the evolutionary LWR case is the same as described for the existing LWR base case in Section 4.1.1 above.

## 7.2 MOX Fuel Fabrication Facility

The preoperational schedule for the MOX fuel fabrication facility is the same as described for the existing LWR base case in Sections 4.1.2.1 and 4.1.2.2.

### 7.2.1 MOX Fuel Fabrication Facility Operations Schedule

To supply fuel for the two new ABB-CE System 80+ reactors at the specified loading rate, the MOX fuel fabrication facility will operate for fourteen years with an annual plutonium throughput of 3.57 MT. This throughput assumes an annual output of 129 assemblies for a mission total of 1807 assemblies. A sufficient number of MOX assemblies for the initial core loads will be available 22 months after the start of operation. The operational schedule is shown in Table 7.1 and in the MOX facility schedule summary figure in Section 7.2.2. This operational schedule would be modified for a different reactor type and loading schedule.

**Table 7.1 MOX fuel fabrication facility operational schedule**

| *Task ID* | *Task Name* | *Duration (months)* | *Start* | *Finish* |
|---|---|---|---|---|
| 1. | Operatlon | 168 | 12/2006 | 12/2020 |
| 2. | MOX Facility Operation Start | | | 12/2006 |
| 3. | Fabrication of Initial Core Loads | 23 | 12/2006 | 10/2008 |
| 4. | MOX Fuel Fabrication Duration | 168 | 12/2006 | 12/2020 |

### 7.2.2 MOX Fuel Fabrication Facility

The overall MOX fuel fabrication facility implementation schedule is summarized in Table 7.2 and shown in Figure 7.1. This facility schedule is also shown in the discussion of the overall alternative schedule in Section 7.5. This schedule does not include any contingency for schedule slip due to site selection difficulties, redesign, construction delays, or a delay in the approval of line item funding.

The critical path through the development of this facility is through the conceptual design and the NRC licensing process. If either of these tasks slip in their schedule, the rest of the implementation process will also be delayed. This critical path is shown in Figure 7.1. If a combination of a delay in the start of operations at the MOX fuel fabrication facility and an earlier completion date of the reactors is longer than 17 months, the overall alternative schedule will begin to slip.

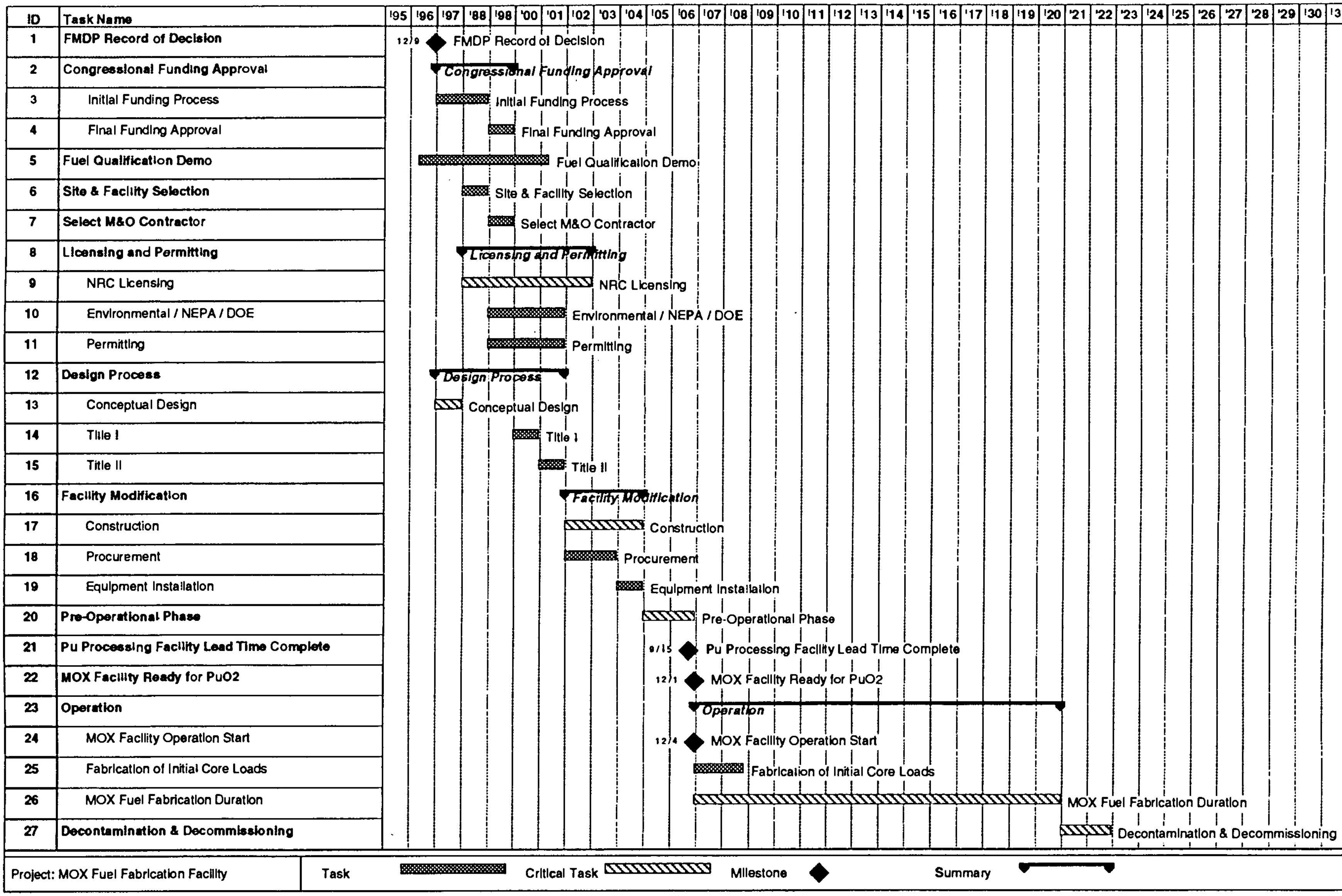


**Figure 7.1 MOX fuel fabrication facility schedule summary**

Table 7.2 MOX fuel fabrication facility schedule summary

| *Task ID* | *Task Name* | *Duration (months)* | *Start* | *Finish* |
|---|---|---|---|---|
| 1. | FMDP Record of Decision | | | 12/1996 |
| 2. | Congressional Funding Approval | 36 | 12/1996 | 12/1999 |
| 3. | Fuel Qualification Demonstration | 60 | 4/1996 | 4/2001 |
| 4. | Site and Facility Selection | 12 | 12/1997 | 12/1998 |
| 5. | Select M&O Contractor | 12 | 12/1998 | 12/1999 |
| 6. | Licensing and Permitting | 60 | 12/1997 | 12/2002 |
| 7. | Design Process | 60 | 12/1996 | 11/2001 |
| 8. | Facility Modification | 36 | 12/2001 | 12/2004 |
| 9. | Preoperational Phase | 24 | 12/2004 | 12/2006 |
| 10. | PuP Facility Lead Time Complete | | | 9/2006 |
| 11. | MOX Facility Ready for $PuO_2$ | | | 12/2006 |
| 12. | Operation | 168 | 12/2006 | 12/2020 |
| 13. | Decontamination & Decommission | 24 | 12/2020 | 12/2022 |

## 7.3 Evolutionary PWR Facility

### 7.3.1 Evolutionary PWR Facility Design & Construction

The duration and path of the design and construction tasks are based on the construction of a new evolutionary reactor facility developed by Fluor Daniel (9). Depending on the specific reactor design selected, this design and construction schedule might be shortened if an already certified design exists, or if modular construction techniques are used.

After the intermediate approval of line item funding, the project begins with the selection processes for the M&O contractor, reactor vendor, and the appropriate federal site. After completion of these tasks the reactor design work begins. Site preparation begins 16 months before the license process is complete. After the combined license is granted, the first nuclear concrete is poured. The design and construction schedule is shown in Table 7.3 and Figure 7.2. Construction on the second reactor unit starts one year after construction starts on the first unit and proceeds following the same schedule.

### 7.3.2 Evolutionary PWR Facility Licensing and Permitting

For this analysis a licensing schedule developed by Fluor Daniel (9) for a large evolutionary LWR was followed. The licensing schedule is shown in Table 7.4 and Figure 7.3.

To begin the licensing process, the site specific ER and combined license application are developed and submitted to the NRC. The NRC conducts technical reviews of the combined license application and develops the EIS and the SER. The schedule includes a provision for a year-long full discovery period and a two-year hearing and decision process by an ASLB. The requirement for these processes are subject to petitions for a hearing on specific issues. After a decision is issued by the ASLB, the NRC grants the combined license and the safety-related construction of the reactor facility may begin. The NRC will also conduct Inspections, Tests, and Analyses of Acceptance Criteria (ITAAC) during the construction process.

Table 7.3 Evolutionary PWR facility design and construction schedule

| Task ID | Task Name | Duration (months) | Start | Finish |
|---|---|---|---|---|
| 1. | FMDP Record of Declslon | | | 12/1996 |
| 2. | Intermedlate Funding Approval | 24 | 12/1996 | 12/1998 |
| 3. | Moblllzatlon & Select M&O Contractor | 33 | 12/1998 | 8/2001 |
| 4. | Slte Selectlon | 18 | 12/1998 | 6/2000 |
| 5. | Reactor Deslgn | 78 | 9/2001 | 2/2008 |
| 6. | Design to Procurement & License Support | 30 | 9/2001 | 2/2004 |
| 7. | Post Procurement Design & License Support | 48 | 3/2004 | 2/2008 |
| 8. | Constructlon, Procurement, Installatlon | 81 | 3/2004 | 11/2010 |
| 9. | Procurement of Reactor System | 48 | 3/2004 | 2/2008 |
| 10. | Unlt 1 | 60 | 11/2004 | 11/2009 |
| 11. | Site Preparation | 16 | 11/2004 | 2/2006 |
| 12. | Construct from 1st Nuclear Concrete to Equipment Delivery (ED) | 23 | 2/2006 | 1/2008 |
| 13. | Complete Construction | 22 | 1/2008 | 11/2009 |
| 14. | Unlt 2 | 60 | 10/2005 | 11/2010 |
| 15. | Site Preparation | 16 | 10/2005 | 2/2007 |
| 16. | Construct from 1st Nuclear Concrete | 23 | 2/2007 | 1/2009 |
| 17. | Complete Construction | 22 | 1/2009 | 11/2010 |

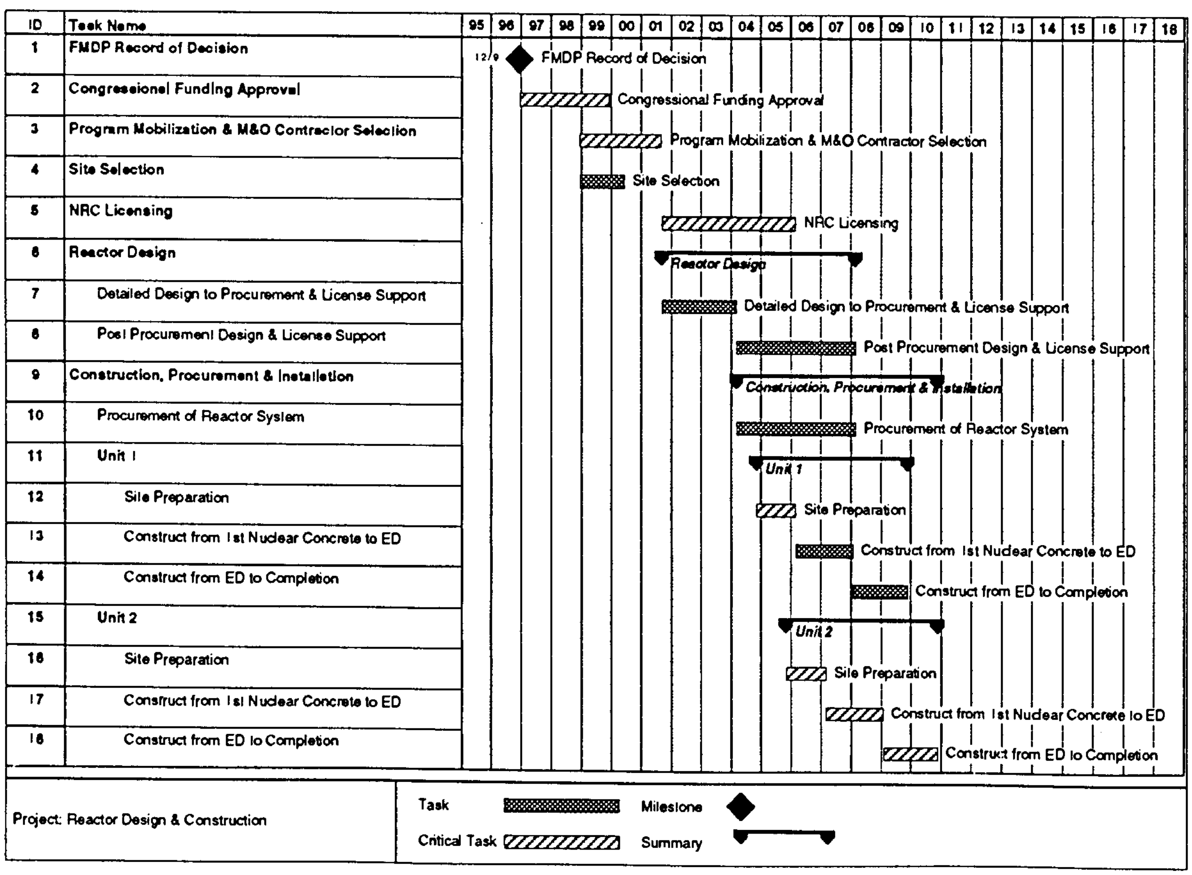


Figure 7.2 Evolutionary PWR facility design and construction schedule

Table 7.4 Evolutionary PWR facility license and permit schedule

| Task ID | Task Name | Duration (months) | Start | Finish |
|---|---|---|---|---|
| 1. | **NRC Licensing Process** | 54 | 9/2001 | 2/2006 |
| 2. | DOE Prepares & Files Comb. License App. | 12 | 9/2001 | 8/2002 |
| 3. | Public Notice of Application for License | | | 8/2002 |
| 4. | NRC Performs Tech. Reviews for License | 12 | 9/2002 | 8/2003 |
| 5. | NRC Issues SER | | | 8/2003 |
| 6. | Pre Hearing Conference | 6 | 9/2002 | 2/2003 |
| 7. | Full Discovery | 12 | 3/2003 | 2/2004 |
| 8. | Hearing by ASLB | 12 | 3/2004 | 2/2005 |
| 9. | Decision Issued by ASLB | 12 | 2/2005 | 2/2006 |
| 10. | NRC Issues Combined License | | | 2/2006 |
| 11. | **NRC Environmental / NEPA Process** | 24 | 9/2001 | 8/2003 |
| 12. | DOE Prepares and Files ER | 12 | 9/2001 | 8/2002 |
| 13. | NRC EIS Process for Combined License | 12 | 9/2002 | 8/2003 |
| 14. | NRC Issues EIS | | | 8/2003 |
| 15. | **Site Permits** | 24 | 9/2001 | 8/2003 |

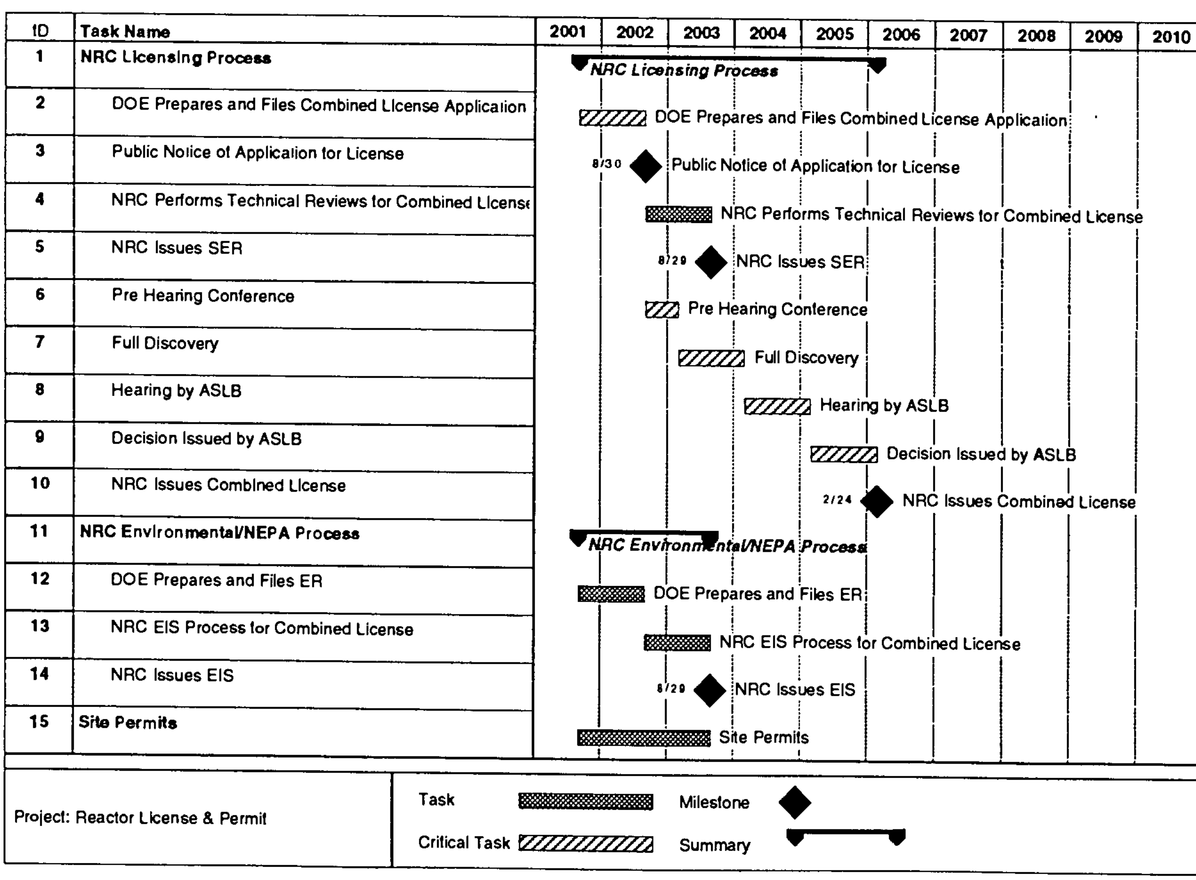


Figure 7.3 Evolutionary PWR facility license and permit schedule

### 7.3.3 Evolutionary PWR Facility Operations Schedule

After completion of the first unit, the preoperational checkout and start-up testing begins. The fuel is loaded into the reactor vessel in June 2010 and additional physics tests are performed prior to ascending to full power. Fuel is loaded into the second reactor unit two years later than the first unit. After the MOX fuel has been irradiated for the full cycle of 3.75 years, the spent fuel assemblies are discharged from the reactors and stored in the spent fuel storage pool for a minimum of ten years before being shipped to the HLW repository facility. The evolutionary PWR facility operational schedule is shown in Table 7.5 and in the facility schedule summary figure in Section 7.3.4. This operational schedule would be modified for a different reactor type or loading schedule.

**Table 7.5 Evolutionary PWR facility operations schedule**

| *Task ID* | *Task Name* | *Duration (months)* | *Start* | *Finish* |
|---|---|---|---|---|
| 1. | **MOX Facility Lead Time** | 24 | 12/2006 | 11/2008 |
| 2. | **Preoperational & Startup Testing** | 7 | 11/2009 | 6/2010 |
| 3. | **Reactor Facility Operation** | 205 | 6/2010 | 7/2027 |
| 4. | Unit 1 Loading Duration | 142 | 6/2010 | 4/2022 |
| 5. | Unit 1 Full Power | | | 1/2011 |
| 6. | Unit 2 Loading Duration | 136 | 6/2012 | 10/2023 |
| 7. | Last Assemblies - first reshuffle | 9 | 10/2023 | 7/2024 |
| 8. | Last MOX Discharged after full irradiation | 45 | 10/2023 | 7/2027 |
| 9. | **Spent Fuel Storage** | 274 | 10/2014 | 7/2037 |
| 10. | First MOX in Spent Fuel Pool | 120 | 10/2014 | 10/2024 |
| 11. | Last MOX | 120 | 8/2027 | 7/2037 |

### 7.3.4 Evolutionary PWR Facility Schedule Summary

The overall evolutionary PWR facility implementation schedule is summarized in Table 7.6 and shown in Figure 7.4. This facility schedule is also shown in the discussion of the overall alternative schedule in Section 7.5. This schedule does not include any contingency for schedule slip due to site selection difficulties, redesign, construction delays, or a delay in the approval of line item funding.

The critical path through the development of this facility is through the line item funding process, program mobilization, and the NRC licensing process. If any of these tasks slip in their schedule, the rest of the implementation process also will be delayed. This critical path is shown in Figure 7.4. If the program mobilization process proceeds more quickly, or the ASLB hearing process is reduced in scope, the reactor would be ready earlier than shown in this schedule. If the overall duration of the preoperational tasks for the reactor facility is reduced by more than 17 months, the start of reactor operations will be delayed by the MOX fuel fabrication facility operations.

## 7.4 HLW Repository Facility

The HLW repository facility schedule is the same as described for the existing LWR base case in Section 4.1.4, except the spent MOX fuel is scheduled to be delivered to the repository facility from November 2024 to August 2037.

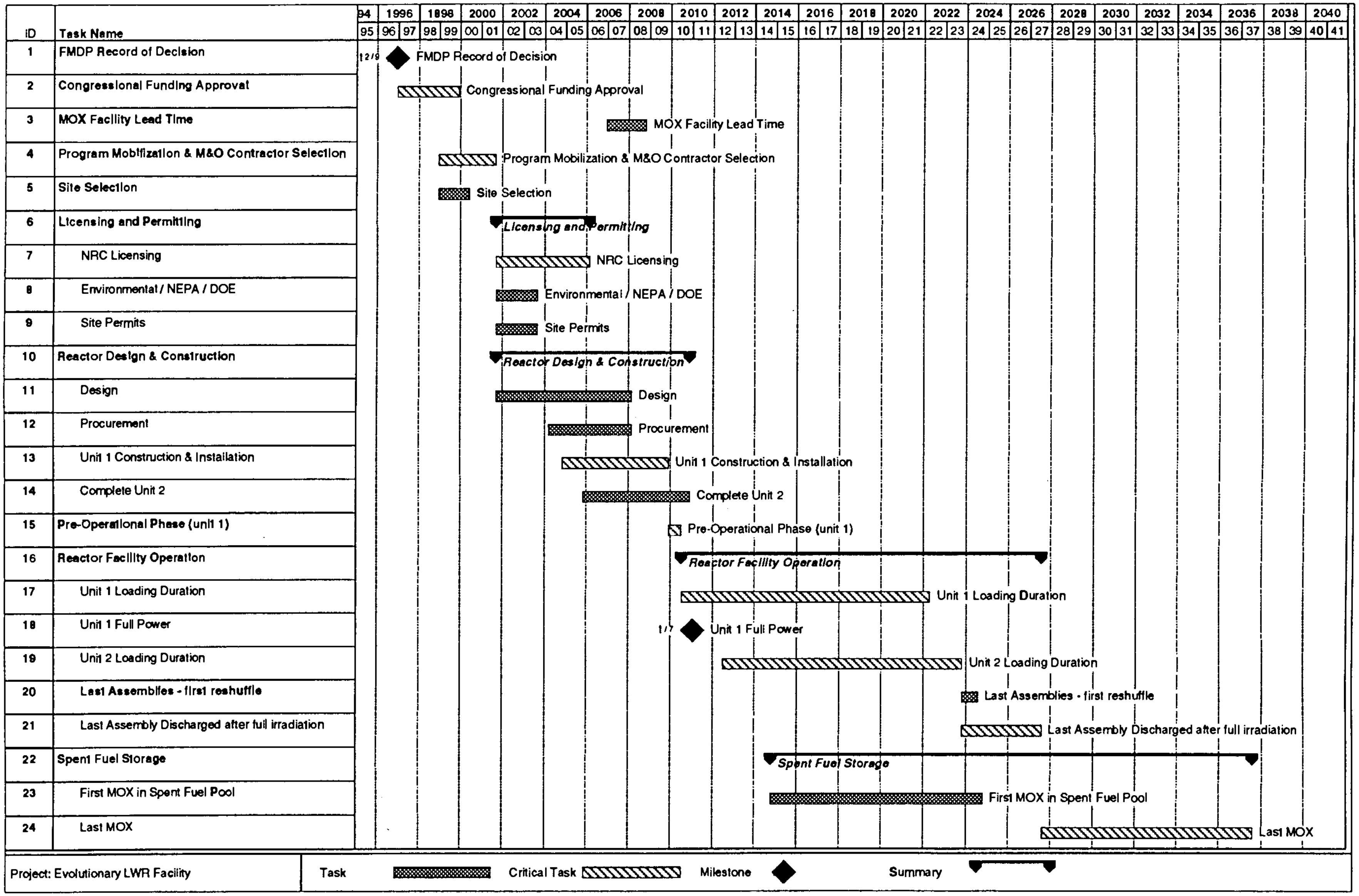


Figure 7.4 Evolutionary PWR facility schedule summary

**Table 7.6 Evolutionary PWR facility schedule summary**

| *Task ID* | *Task Name* | *Duration (months)* | *Start* | *Finish* |
|---|---|---|---|---|
| 1. | FMDP Record of Decision | | | 12/1996 |
| 2. | Congressional Funding Approval | 36 | 12/1996 | 12/1999 |
| 3. | MOX Facility Lead Time | 24 | 12/2006 | 11/2008 |
| 4. | Mobilization & Select M&O Contractor | 33 | 12/1998 | 8/2001 |
| 5. | Site Selection | 18 | 12/1998 | 6/2000 |
| 6. | Licensing and Permitting | 54 | 9/2001 | 2/2006 |
| 7. | Preoperational Phase (unit 1) | 7 | 11/2009 | 6/2010 |
| 8. | Reactor Facility Operation | 205 | 6/2010 | 7/2027 |
| 9. | Last Assemblies - first reshuffle | 9 | 10/2023 | 7/2024 |
| 10. | Spent Fuel Storage | 274 | 10/2014 | 7/2037 |

## 7.5 Evolutionary LWR Alternative Schedule Summary

The evolutionary LWR alternative schedule is a combination of the individual facility schedules discussed above. This overall schedule is summarized in Table 7.7 and shown in Figure 7.5. The plutonium disposition mission begins when the first reactor attains full power in January 2011, and is complete after the last core load, which contains MOX fuel assemblies, is reshuffled for the first time in July 2024. The overall mission time is 13.5 years and starts 14 years after ROD.

The critical path for the alternative is the licensing, design and construction of the reactor facility. However, as discussed above, delays in the construction of the MOX fuel fabrication facility or PuP facility may move either of these facilities into the critical path.

The schedule risk for the PuP facility and MOX fuel fabrication facility are the same as for the other reactor-based alternatives. The schedule risk for building an evolutionary reactor facility is higher than the schedule risk for modifying existing reactors because of the uncertainties in siting and building new nuclear power reactors.

**Table 7.7 Evolutionary LWR alternative schedule summary**

| *Task ID* | *Task Name* | *Duration (years)* | *Start* | *Finish* |
|---|---|---|---|---|
| 1. | **FMDP Record of Decision** | | | 12/1996 |
| 2. | Congressional Funding Process | 3 | 12/1996 | 12/1999 |
| 3. | Pu Processing Activities | 22.8 | 10/1995 | 7/2018 |
| 4. | R&D | 3 | 10/1995 | 9/1998 |
| 5. | Licensing, Permitting & Siting | 5 | 12/1996 | 12/2001 |
| 6. | Design | 5.1 | 12/1996 | 1/2002 |
| 7. | Facility Modification & Pre-Operation | 4.5 | 1/2002 | 7/2006 |
| 8. | Operation | 10 | 7/2006 | 7/2016 |
| 9. | Decontamination & Decommissioning | 2 | 8/2016 | 7/2018 |
| 10. | **MOX Fuel Fabrication Facility** | 26.6 | 4/1996 | 12/2022 |
| 11. | Fuel Qualification | 5 | 4/1996 | 4/2001 |
| 12. | Licensing, Permitting & Siting | 5 | 12/1997 | 12/2002 |
| 13. | Design | 5 | 12/1996 | 11/2001 |
| 14. | Facility Modification & Pre-Operation | 5 | 12/2001 | 12/2006 |
| 15. | MOX Fuel Fabrication Lead Time | 1.9 | 12/2006 | 10/2008 |
| 16. | Operation | 14 | 12/2006 | 12/2020 |
| 17. | Decontamination & Decommissioning | 2 | 12/2020 | 12/2022 |
| 18. | **Reactors** | 38.6 | 12/1998 | 7/2037 |
| 19. | Mobilization and M&O Contractor Selection | 2.7 | 12/1998 | 8/2001 |
| 20. | Licensing | 4.5 | 9/2001 | 2/2006 |
| 21. | Reactor Design and Construction | 9.2 | 9/2001 | 11/2010 |
| 22. | Unit 1 "ready" to accept MOX | | | 6/2010 |
| 23. | MOX Loading Duration | 13.3 | 6/2010 | 10/2023 |
| 24. | Unit 1 Full Power | | | 1/2011 |
| 25. | Last Assemblies – First Reshuffle | | | 7/2024 |
| 26. | Last MOX Discharged to Spent Fuel Pool | | | 7/2027 |
| 27. | Spent Fuel Pool Duration | 22.8 | 10/2014 | 7/2037 |
| 28. | **Repository** | | | |
| 29. | Licensing | 8.5 | 3/2002 | 8/2010 |
| 30. | Construction | 5.5 | 3/2005 | 8/2010 |
| 31. | MOX Delivery Duration | 12.8 | 11/2024 | 8/2037 |

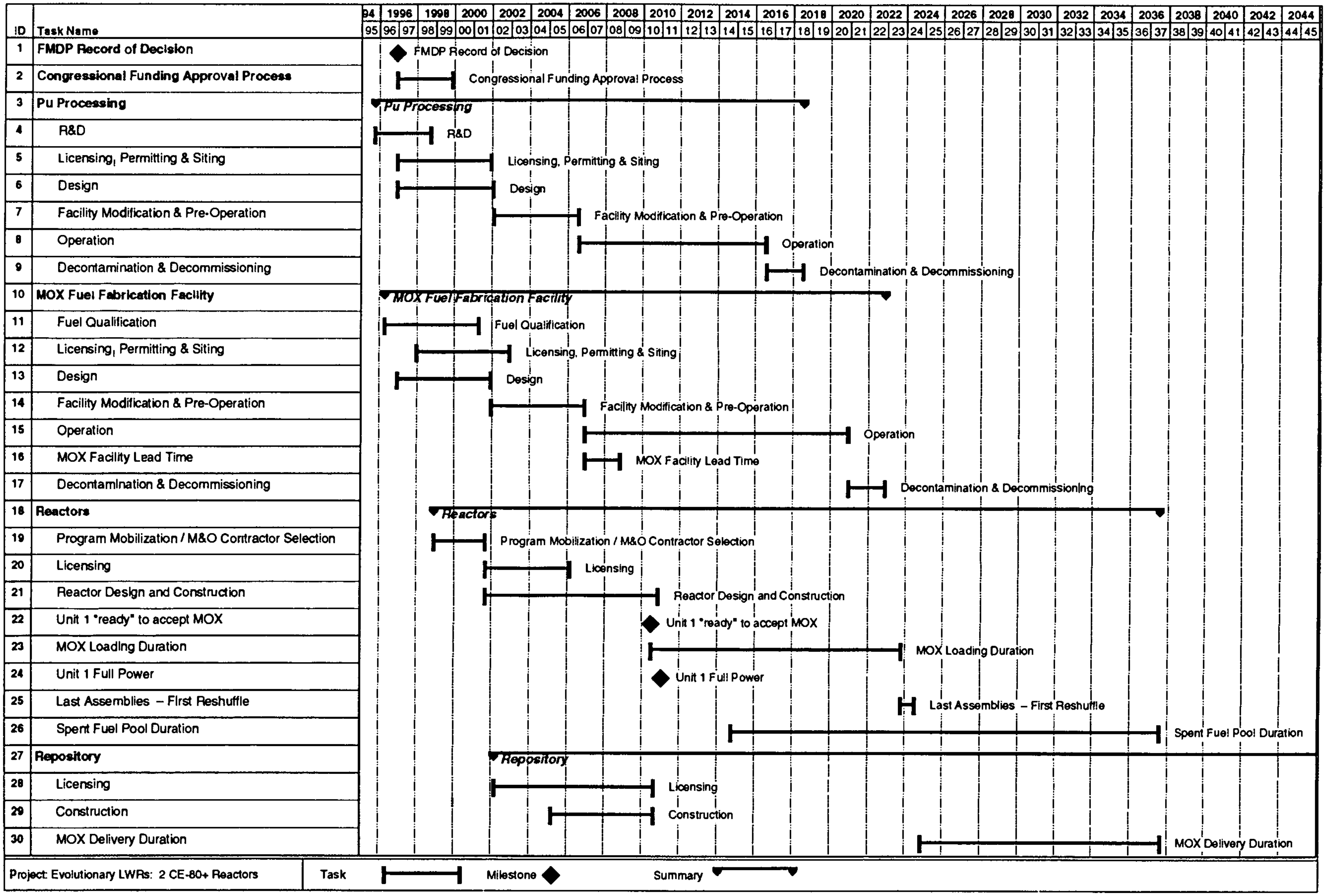


Figure 7.5 Evolutionary LWR alternative schedule summary

# 8. Schedule Summaries

The overall alternative schedules are based on combining the individual facility schedules. The individual facility schedules were developed using estimates of the time required for the design, engineering, and construction phases based on previous experience. For the plutonium processing, MOX fuel fabrication, and collocated facilities, the NRC licensing process and DNFSB oversight process were assumed to take five years. For the various reactor facilities, the appropriate NRC reactor licensing process and schedule described in the Fluor Daniel Report (9) was used. Also, a two-stage congressional line item approval constraint is included in each facility schedule. The first stage of the approval has been assumed to require two years. No Title I or detailed design work may start prior to this time for the processing facilities. For the reactor facilities, no utility selection, site selection, or licensing processes are started before this date. The construction of any new facility may begin as soon as a year before a license is granted, however, no safety related construction may begin until after the license is granted.

The alternative with the shortest mission time is the existing LWR base case, 50SFL5. The earliest mission start is the existing LWR quick start alternative, 50QSL5. A summary table of the nine options is shown in Table 8.1.

The critical path through the facilities for all of the alternatives, except for the evolutionary LWR, is through the MOX fuel fabrication facility. For the options which use only American fabricated fuel, the existing PWRs are ready to start-up six years before the LUA irradiation is complete, and the BWRs are ready to start-up five years before. The CANDU reactors are ready to start-up five years before the fuel fabrication facility lead time is

**Table 8.1 Reactor-based disposition alternatives schedule summary**

| | Option | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 50SFL5 50SPL5 | 50COL4 | 50QSL5 | 50SFP2 | 50SFE2 | 50SFC2-4 | 33SFL3 | 33SFC2 |
| **Pu Processing Facility** | | | | | | | | |
| prototype | NA | NA | Jan-98 | NA | NA | NA | NA | NA |
| start processing at production facility | 8/2006 | 6/2007 | 8/2006 | 8/2006 | 8/2006 | 8/2006 | 8/2006 | 8/2006 |
| **MOX Fuel Fabrication Facility** | | | | | | | | |
| start LUA fabrication | 12/2006 | 7/2007 | 6/2000 | 12/2006 | NA | NA | 12/2006 | NA |
| mission fabrication start | 6/2007 | 12/2007 | 3/2001 | 6/2007 | 12/2006 | 12/2006 | 6/2007 | 12/2006 |
| mission fuel finish | 4/2017 | 7/2023 | 12/2015 | 7/2024 | 12/2020 | 2/2019 | 2/2018 | 10/2017 |
| **Reactor Facility** | | | | | | | | |
| reactor type | PWR | BWR | PWR | System 80 | System 80+ | CANDU | PWR | CANDU |
| reactor "ready" to accept MOX | 3/2004 | 3/2005 | 3/2004 | 6/2009 | 6/2010 | 7/2002 | 2/2004 | 7/2002 |
| start irradiating European LUA | NA | NA | 12/2002 | NA | NA | NA | NA | NA |
| start irradiating American LUA | 6/2007 | 12/2007 | 6/2007 | 6/2007 | NA | NA | 6/2007 | NA |
| mission start | 5/2010 | 4/2010 | 11/2005 | 9/2009 | 1/2011 | 6/2007 | 5/2010 | 6/2007 |
| last assembly loaded | 2/2020 | 10/2026 | 1/2019 | 2/2025 | 10/2023 | 8/2019 | 11/2020 | 4/2018 |
| mission finish | 8/2021 | 12/2027 | 7/2020 | 9/2026 | 7/2024 | 10/2020 | 5/2022 | 7/2019 |
| **Mission duration (yr.)** | 11.3 | 17.7 | 14.6 | 16.9 | 13.5 | 13.3 | 12.0 | 12.1 |
| **ROD to mission start (yr.)** | 13.5 | 13.3 | 9.0 | 12.8 | 14.1 | 10.5 | 13.5 | 10.5 |

complete. The first partially-complete LWR could be ready to start-up three years before a sufficient number of fuel assemblies have been fabricated to supply the two reactors at the specified rate. For the evolutionary light water reactor alternative, a sufficient supply of MOX fuel is ready eighteen months before the reactor construction is complete.

Using European fabricated fuel to initiate the mission moves the start date 4.5 years earlier for the existing PWR base case. If European fabricated LUAs were used, without using European mission fuel, the mission start could occur one irradiation cycle earlier because the reload license would be granted after one cycle of the American LUA instead of two cycles. However, for the BWR option and the partially-complete LWR option, which use integral neutron absorbers, European fabricated LUAs are unlikely to be available. For the CANDU reactors, the time to start the mission would also be improved if the initial fuel could be fabricated in Europe. However, as the European fuel fabricators do not currently fabricate CANDU fuel, it is unlikely that this would occur without a full fuel development program. For the evolutionary LWR option, an earlier start of the mission would be achieved if the reactor licensing and construction could start sooner. Also, the mission duration could be shortened by building an additional reactor, however, this would have a substantial impact on the cost of this option.

The schedule risk for the existing BWR option is slightly higher than the schedule risk for the existing PWR options because the MOX fuel design includes integral neutron absorbers. For the partially-complete LWR alternative, there are several schedule elements which involve a higher degree of schedule risk than in the existing LWR options. For example, completing the reactors involves some uncertainties such as whether a hearing by an ASLB is required. The fuel qualification process for the new fuel design containing integral neutron absorbers also involves some schedule risk. The schedule risk for the evolutionary LWR alternative is higher than the partially-complete reactor because building a new reactor has even more schedule uncertainties than completing a partially-complete reactor. The CANDU options have about the same schedule risk as the existing LWR options.

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