Tailoring Deactivation & Decommissioning Engineering/Design Activities to the Requirements of DOE Order 413.3A

Volume I

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1. INTRODUCTION

The Department of Energy and the Office of Environmental Management have recognized the critical importance of a robust and disciplined approach for nuclear facility construction projects leading to the conduct of conceptual designs at Critical Decision-1; preliminary designs for the performance baseline at Critical Decision-2; and the approved start of construction at Critical Decision-3. This is exemplified by important, substantial and numerous dialogue and technical development during 2006 and 2007, resulting in guidance and direction to better integrate safety into design of projects early in the life cycle; specifically to ensure that safety issues are addressed early in the overall design process[1]. As such, the conceptual and preliminary designs must be sufficiently mature to have addressed and analyzed projected safety systems. The culmination of these efforts is the April 2008 issuance of DOE-STD-1189, *Integration of Safety into the Design Process*[2].

The specific focus of this effort and concomitant standard addresses the adequacy of conceptual and preliminary designs for nuclear facility construction projects; it is however clear that this approach and philosophy is equally applicable to the conduct of deactivation and decommissioning projects. Similarly, applying the approach and philosophy of DOE's project management order (DOE O 413.3A, *Program and Project Management for the Acquisition of Capital Assets*) to the technical aspects of deactivation and decommissioning projects provides the opportunity to improve the entire scope of technical planning, engineering, and design for these projects; resulting in the iterative, sequential development of more detailed and dynamic conceptual, preliminary and final designs.

One central theme is apparent: EM management has placed a renewed interest in, and expectation for, enhanced rigor in the planning and engineering/design of its projects, including those for deactivation and decommissioning. This expectation raises the bar and makes clear that "business as usual" is not acceptable; the guidance provided in this document is intended to assist in the implementation of these stated expectations.

1.1 Purpose

DOE O 413.3A, defines three sequential phases of design (conceptual, preliminary, and final) that coincide respectively with Critical Decisions -1, -2 and -3 (CD-1, -2, -3). Regardless of the fact that there are many differences between D&D[3] and the design-build model upon which the order is based (see Section 1.2), meeting the *intent* of the CD milestones and satisfying the requirements of the order is essential. Conducting engineering/design and creating the related documentation must be accomplished to a sufficiently increasing level of detail at each stage to: 1) create a project's conceptual design; 2) develop a preliminary design sufficient to establish a high confidence baseline; and 3) establish a final design ready for implementation. As used here, "design" in the context of DOE 413.3A represents a broad perspective that includes all of the many types of D&D technical planning and engineering.

To ensure development of appropriate levels of engineering detail, DOE-EM's Office of Deactivation and Decommissioning and Facility Engineering (EM-44) has prepared this guidance for

This guidance serves as a tool for use in D&D project planning and provides a roadmap and process for evaluating and integrating engineering and design into the project baseline and execution.

The degree of applicability and its use is the responsibility of the Federal Project Director (FPD) and the Integrated Project Team (IPT), understanding that the primary objective is to provide sufficiently detailed technical input needed for the project's scope, schedule, and cost baseline.

[1] Memorandum for Distribution, Dr. Inés R. Triay, *Interim Guidance on Safety Integration into Early Phases of Nuclear Facility Design*, July 18, 2006.
[2] This guidance document does not address safety as a primary subject. See DOE-STD-1189 for details of its application.
[3] As described in definitions in Section 6, D&D should be taken in a general context.

tailoring a D&D project's engineering/design to meet the objectives of the CD milestones. The enhanced rigor in planning and systematic, forward looking approach to engineering/design recommended in this guidance is intended to ensure that the level of detail in technical planning and technical development, integrated with other project aspects such as safety basis modifications, leads to a high confidence that the engineered system as a whole will function as designed. As the level of detail iteratively increases as D&D project development progresses and matures from CD-1 through CD-3, the extent of uncertainty and risk proportionally decrease and a measurable improvement in project definition, quality, and confidence in the baseline is established.

Project Scope Context for this Guidance

Single projects within DOE-EM often encompass many large and small facilities, either by contract or as a Project Baseline Summary (PBS); in many of these, the CD process is applied on this larger scale. Users of this guidance need to understand that engineering/design progress addressed in this guidance is to be applied at a level usually associated with a major facility, its ancillary structures, and its associated systems. Similarly, those conducting CD project reviews and providing recommendations to senior decision makers must clearly understand that it is generally counter-productive to hold up the start of field work until the CD process has been completed for all of a large group of facilities that comprise a PBS or contract scope.

For situations in which major engineering tasks (e.g., characterization) and related decisions are delaying the CD process, one approach is to manage the sequence of critical decisions to obtain a "CD-3A" approval to start field work for a specific facility's D&D scope while the overall CD-2/3 process continues for the total PBS or contract scope. Another approach would be to approve a combined CD-2/3 package at the PBS or contract level and utilize facility-specific requirements that subsequent reviews be conducted of the engineering/design aspects for each major facility prior to approval to commence substantial D&D field work. Precedents for both these approaches have been established.

Organization of this Guidance

This guidance document is organized into two volumes. Volume I contains the guidance and is comprised of the following six sections:

- Section 1 provides the background and the purpose, and lists related guidance.
- Section 2 relates the design phase language of DOE O 413.3A to D&D engineering/design and suggests an overall approach to meeting the intent of the order, as well as DOE-EM management's expectations for a high confidence project baseline.
- Section 3 presents a Project Management[4] decision framework for tailoring engineering/design activities to D&D projects, including recognition that most field work and its related engineering support does not follow the classic design-build type of schedule.
- Section 4 provides a method for selecting D&D project activities for which a high level of engineering/design detail is important for achieving a reliable, well-defined baseline.
- Section 5 provides independent reviewers with perspectives for D&D engineering/design activities and deliverables.
- Section 6 includes definitions and acronyms used in this guidance.

Volume II contains example material that illustrates application of the guidance, but is not specifically guidance, per se. The sections are:

[4] Within this document, the use of "project management" refers to the Integrated Project Team (IPT) that includes the Federal Project Director, EM field managers, and contractor project managers.

- Section II-1 describes engineering/design levels of detail for 48 activities typical of D&D projects.
- Section II-2 provides independent reviewers with example lines-of-inquiry for D&D engineering/design activities and deliverables.
- Section II-3 contains a fictitious example of a project to which the process in Section 4 has been applied to demonstrate use of the method.
- Section II-4 contains an example of a single activity (#10, Equipment Removal) that is fully developed with regard to describing deliverables input to the WBS and schedule logic that can be used to support baseline development.

1.2 Differences between D&D Engineering/Design and Design-Build Projects

D&D projects are subject to DOE O 413.3A, and for the purposes of this guidance, specifically to the "design" requirements. However, the order was developed based on new construction capital projects, which differ considerably from D&D. Generally, new construction projects benefit from a large number of "known" attributes related to planning, design, engineering, physical construction (how big, how many floors, how many rooms, etc.), and the type, size and capacity of systems (process, utility, support systems). Conversely, D&D projects are frequently characterized by several "unknown" attributes, which in many instances represent significant risks for the project baseline. However, some D&D projects also have the benefit of knowledge of original designs, modifications, as-built drawing (to some degree), facility operating history, contamination measurements, etc.

Although the end-state[5] of a D&D project is generally determined at the onset of project planning and within a context of area-wide and site-wide decisions, requisite knowledge of facility physical conditions (e.g., building structural integrity, system configuration, or accessibility limitations due to radiation or contamination) and the types and extent of contamination may not be available. Obtaining the information needed will often require a step-wise, iterative process as project planning matures.

Much of the engineering efforts in facility construction projects are devoted to classic design tools, such as development of drawings, specifications, calculations, analyses, evaluations and application of codes and standards. For D&D projects, the fraction of the engineering effort devoted to classical design tools is typically much lower (may be zero) and is rarely significant. In general, the following differences are noted:

- There is relatively little traditional design work for new systems, structures, and components (SSCs) for D&D. The amount of engineering leading to design drawings and specifications is usually limited to reconfiguring systems or structures to support worker habitability and is relatively small compared to the overall project scope. Such design efforts would generally be a minor factor and review consideration in the CD process for a D&D project. (An exception is for cases when major refurbishment or SSC modifications are a required pre-requisite to D&D.)
- D&D involves a significant amount of engineering. The types of engineering tools, however, are for the most part different from design-build engineering. Deactivation of equipment and systems, equipment removal, demolition, operational safety analyses, and material stabilization are a few examples of D&D activities for which engineering is practiced. In addition to the traditional structural, mechanical, chemical, and electrical disciplines, skills required will in many cases also include nuclear safety and radiological engineering.

[5] In simple terms, "end state" can be deactivation followed by long-term surveillance and maintenance, or demolition, or in-situ decommissioning (entombment), the latter two followed by free release or by long-term institutional control.

- D&D tends to be heavy in operations and services types of work and light on fabrication or new construction, resulting in a labor mix that is very different from construction. Also, with the exception of decommissioning equipment (e.g., excavators, cutting equipment), the need for new equipment is low. The need for materials is heavily weighted towards consumable items, much of which will become radioactive or hazardous waste.
- Pre-existing conditions may be extremely variable from facility to facility because of differences in vintage of construction and nature of operations that have been conducted.

Another difference worth noting is that, unlike traditional engineering that is done predominantly by an engineering "department," many D&D engineering tasks use workers to provide input and feedback during engineering/design. This approach to project development utilizes facility operating experience as well as serving the objectives of Integrated Safety Management and readily fits in with the iterative approach recommended by the guidance provided within this document.

As already mentioned, but to reiterate this guiding principle; regardless of these differences, meeting the intent of the critical decision process and milestones is essential to preparing documentation of appropriate and sufficiently increasing level of detail to support each critical decision stage and to satisfy the requirements of DOE O 413.3A.

1.3 EM Approach to Capital vs. Operating Budget

In June 2009, EM management initiated a strategy that clearly differentiates EM capital asset projects from non-capital asset activities that include EM programs and facility operations. The highlighted box that follows describes the strategy as it applies to D&D.

This new strategy does not negate the principles in this guidance related to establishing sufficient engineering/design that supports a high confidence baseline. However, reviews of the operational phases of a project, such as for deactivation, will only be conducted by EM for appropriate engineering/design. The capital asset phase for decommissioning will continue to be subject to external reviews by the Office of Engineering and Construction Management (OECM) as well as within EM.

Memorandum[6] Excerpts

Capital asset projects being executed as cleanup projects involve the construction phase of environmental restoration (i.e., soil and water remediation) and facility decommissioning and demolition.

Operations includes non-capital asset activities including: the stabilization, packaging, storage, transportation and disposition of waste and nuclear materials; the operation of environmental remediation systems such as groundwater treatment systems; post-construction and post-closure care of remediated land burial sites; long-term environmental stewardship including environmental monitoring and institutional controls; and facility shutdown and deactivation activities designed to place the inactive structures, systems and components in a safe and stable configuration pending final decommissioning.

One significant intended effect of this strategy is to make more efficient the approval process for those portions of D&D projects that are operationally funded by modifying the external review cycle as specified by DOE O 413.3A. However, EM will continue to embody the Order's principles in the conduct of business operations. This new structure is based on, and more succinctly aligned with, existing Federal and Departmental asset management requirements.

[6] This is addressed in a June 5 memorandum from Ines R. Triay, Assistant Secretary for Environmental Management to Ingrid Kolb (Director, Office of Management) with a subject of "Restructuring Office of Environmental Management Projects."

1.4 Design Phase Completion Progress

Traditionally a design-build project's overall design roughly corresponds to 30%, 60%, and 90% at the end of the conceptual, preliminary, and final design phases, respectively. However, the overall status of design completion does not require that all individual design disciplines be at that state. For example, at CD-2, the civil structural deliverables of a design-build project may be 80% to 90% complete when the electrical design may be, say 30%.

DOE M 413.3-1 is not prescriptive regarding percentage completion for the respective design phases. It recognizes that there is wide variation among projects. This recognition in the manual is in fact the case for a D&D project; the number of drawings cannot estimate the percentage of completion and other deliverables completed. This guidance identifies technical deliverables when planning or reviewing progress equivalent to conceptual, preliminary, and final design status. The overriding point, however, is that there must be technical specificity at these design milestones. Conceptual development cannot simply be a discussion of D&D principles and generalities; it must represent a state of technical development that represents approximately 20% to 30% completion of engineering/design. In addition, the level of detail for baseline development must be proportionately greater.

1.5 Related Guidance

This guide does not replace other existing guidance and is to be used in combination with other DOE guides and handbooks that address D&D related work, including those listed below:

- DOE G 430.1-2, Implementation Guide for Surveillance and Maintenance during Facility Transition and Disposition (Sept. 1999)
- DOE G 430.1-3, Deactivation Implementation Guide (Sept. 1999)
- DOE G 430.1-4, Decommissioning Implementation Guide (Sept. 1999)
- DOE G 430.1-5, Transition Implementation Guide (Apr. 2001)
- DOE G 413.3-8, EM Clean-up Projects (Sept. 2008)

2. D&D CONCEPTUAL, PRELIMINARY, AND FINAL DESIGN

This section recommends approaches and suggests levels of detail for D&D project engineering/design that will meet the intent of DOE O 413.3A requirements. Figure 1 illustrates the theme of this guidance, which is to start early development of D&D projects' technical detail to create a comprehensive technical project concept at CD-1 and to increase the level of detail sufficiently to provide a reliable scope, schedule, and cost performance baseline at CD-2, and to be ready for implementation at CD-2 or CD-2/3.

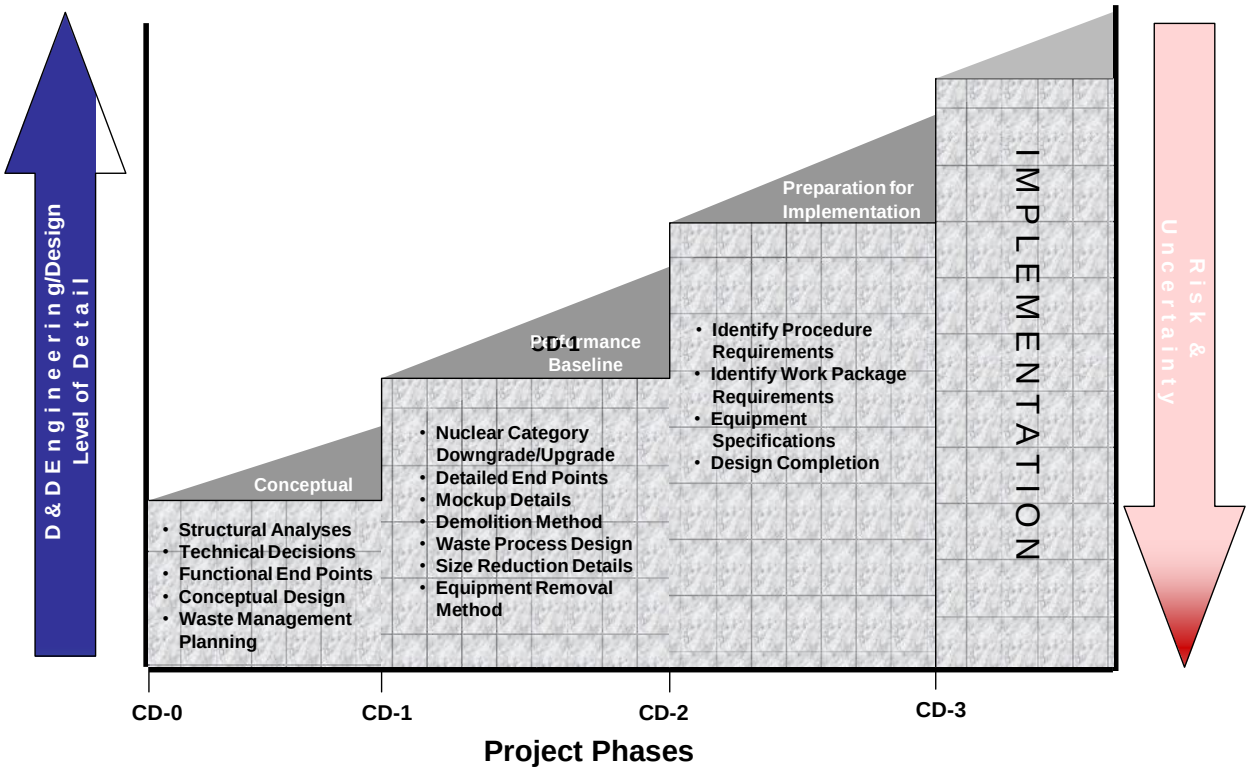

Figure 1 – Overview of D&D Engineering/Design Increasing Level of Detail

This guidance recognizes that many D&D project engineering/design activities are conducted after CD-3. Nevertheless, it is important to identify project activities for which a high level of technical detail is needed at CD-2/3. Sections 3 and 4 address identification of such activities. . (For a more detailed understanding of the relationship between different CD levels see DOE Order 413.3A Guide 8 Attachment 3)[7]

Note that the bulleted lists in the figure are examples; more complete examples are provided in this section and Volume II.

Section Approach

This section relates engineering/design typical of D&D projects to the requirements of DOE O 413.3A by first citing the order's language followed by a recommended approach. Section 2.1 describes how following this guidance for a D&D project can meet the "systems engineering" requirements of DOE O 413.3A. The subsequent three subsections recommend an approach to complying with the Order for a

[7] U.S. Department of Energy, Environmental Management (EM) Cleanup Projects: DOE Order 413.3-8, April 24, 2008, pg. 61

D&D project's conceptual, preliminary, and final design phases and their related critical decisions. In Section 2.5, the order's engineering phases are compared with similar phases defined by CERCLA.

Combining Critical Decisions

Many D&D projects combine CD-1/2 or CD-2/3 when there is relatively little technical development needed between the two decision points. In some cases, a combined CD-1/2/3 can be appropriate for a facility with low hazard and complexity. In these cases, the level of detail described in Section 2 for CD-1 and CD-2 is applicable for a combined CD-1/2; and similarly to a CD-2/3 combined approach. Combining Critical Decisions and structuring of related project reviews and approvals is the responsibility of the Federal Project Director and the Integrated Project Team (IPT), taking into account the project's complexity.

2.1 Integrated Systems Engineering Requirements

DOE O 413.3A Statements[8]

Section 5.2.3 of DOE M 413.3-1, *Project Management for the Acquisition of Capital Assets*, defines Systems Engineering as follows: A system is an integrated composite of people, products, and processes that provides a capability to satisfy a need or objective. Systems engineering is an interdisciplinary collaborative approach that is accomplished by integrating three major elements:

- Development phasing that controls the design process and provides baselines that coordinate design effort
- A process that provides a structure for solving design problems and tracking requirements flow through the design effort
- Life-cycle integration that involves users in the design process and ensures that the developed product is viable throughout its life

Each of these elements is necessary to achieve proper management of a development effort. The primary goal of the systems engineering process is to transform mission operational requirements or remediation into system architecture, performance parameters, and design details. The application of systems approach is tailored to the project's needs. A project need not be a system to use a systems methodology. Systems engineering is a tool that consists of iterative processes, such as requirements analysis, alternative studies, and functional analysis and allocation.

Recommended Approach

This guidance serves as an element of system engineering by tailoring the approach and deliverables for project technical planning and engineering/design of D&D projects. This is accomplished as follows with regard to the three elements above:

- Tailoring the approach to conceptual, preliminary, and final design to D&D projects provides the basis for meeting the first element. This includes activities such as recognizing the need for up-front characterization and technology development discussed in Section 3.4, and prioritizing significant engineering/design activities that must be done early and thoroughly to support a reliable baseline.
- DOE and contractor qualified project planning and engineering staff applying systematic management control procedures, for which incorporating this guidance is only one element, serves the second element.
- With regard to the third element, because D&D projects are beyond the end of the mission of a facility, the life cycle element stated above (from the manual) applies to the D&D life cycle. The "users" of a D&D project are the deactivation, demolition, and closure teams that conduct the

[8] DOE O 413.3A statements in Sections 2.1 through 2.4 are verbatim quotes.

work. In all D&D projects, these users are very much involved in providing input to the technical planners and engineering/design staff.

2.2 Conceptual Design Phase, Approve Alternative Selection and Cost Range, CD-1

DOE O 413.3A Statements

The description for CD-1 in DOE O 413.3A is:

> "CD-1 approval marks the completion of the project Definition Phase, during which time the conceptual design is developed. This is an iterative process to define, analyze, and refine project concepts and alternatives."

The specific DOE O 413.3A requirement is:

> "Prepare a Conceptual Design Report which is an integrated systems-engineering effort that results in a clear and concise definition of the project. [9]"

Recommended Approach

The Conceptual Design Report (CDR) should describe the D&D end state, identify technical challenges that are extraordinary or require special attention (see Section 4.2), and present the overall technical approach to the project as reflected in technical planning results. Equally important; the CDR should describe what is known about the facility/D&D project (characterization, extent of contamination, physical/structural integrity, systems dependence/interdependence, etc.), what is not known, and how each affects the confidence in the engineering/design discussed in the CDR. As appropriate, the plans, schedule, etc., for compiling data acquisition needed to decrease project design uncertainty should be provided in the CDR.

The CDR will likely be a summary of the detailed results of technical planning, engineering, and design, all of which would be too massive to include in a single document. That is, the CDR can be a "road map" to much of the detail that is contained in other documents. Regardless, the CDR document must contain a cohesive technical description at a level of detail for meaningful review and clear comprehension of specifics. It must provide confidence appropriate to this stage of project technical development and should reference the documents that provide the bases for the concepts described.

It is essential that the detailed results of the conceptual design be maintained and available as needed for follow on work as well as for reviewers, just as would be the case for a design-build project.

Providing the level of detail recommended in the following discussions can result in a conceptual design sufficient for a rough order of magnitude cost estimate[10] that will support the needs of project definition at CD-1.

It should *not* be assumed, as has been suggested, that a proposal prepared for D&D project in response to an RFP provides sufficient detail for CD-1. The project team has the option of reviewing an accepted proposal and deciding which parts can be incorporated in the conceptual design.

Engineering/design activities listed below for the conceptual and preliminary design phases are grouped as *Technical Planning* and *Engineering/Design*. The difference is that Technical Planning primarily supports decision making, contrasted with engineering/design that directly creates design deliverables for implementation. Both involve technical activities performed by engineers (as well as other project staff, with input from field workers) and both are equally important in sequentially creating, analyzing,

[9] It is important to reiterate and understand that while the conceptual design report can first address the overall project consisting of many facilities, it must also "drill down" and initiate the conceptual design process for individual facilities of significance within the broader project.

[10] For D&D projects, rough order of magnitude estimates (ROM) represent a range of uncertainty generally given as -25% to +75%; however, this will depend on the project's scope, stage of estimate, degree of unknowns, as well as the estimating organization's standard practice.

describing, and presenting project concepts integrated into system level solutions. With regard to technical planning, the appropriate level of detail depends on the nature of the project and which of the facility's characteristics, type and degree of contamination, structures and systems, etc., are important for project definition. With regard to engineering, the level of detail is functional (e.g., "identify") for CD-1. During conceptual development the project team needs to identify those engineering/design activities that are important for the baseline.

Technical Planning – Getting to CD-1 requires considerable technical planning. Examples of technical planning during this phase include:

- Specifying end points for systems, spaces, and outbuildings and features; that is, conditions to be achieved, whether for deactivation or for decommissioning[11]. End points refer to detailed specifications; typically they specify systems as remaining operational, to be isolated and abandoned, or preserved for possible future use (i.e., "mothballed"). Similarly, the status of spaces is typically specified as being accessible for surveillance and maintenance or "access not necessary." The status of ancillary buildings and structures is variable. At the conceptual stage, end points functionally state "what" is to be achieved; "how" they are to be implemented is the follow-on design effort leading to CD-2 and beyond.
- Identifying longer term monitoring systems, as applicable for a specified time period, where end states include "leave-in-place" conditions.
- Evaluating the need to revise the Authorization Basis (A/B) and conducting the supporting safety analyses. Establishing the conditions for the A/B change, such as fissile material removal, may be conducted prior to commencing field work following CD-3. In particular, the guidance in DOE-STD-1189, *Integration of Safety into the Design Process*, should be used for a nuclear safety design strategy and specification of nuclear safety analytical methods.
- Describing the selected decommissioning alternative. In some cases this may be a result of a Record of Decision for a CERCLA action. In the case of a project that includes deactivation, the overall end state vision should be described.
- Evaluating sufficiency of characterization data to decide on D&D methods, major equipment needs, technological challenges, radiation protection issues, and other project considerations.
- Evaluating and identifying the scope of anticipated overall characterization efforts needed for regulatory compliance, worker protection, and waste management. In some cases, a major effort may have preceded the current project to obtain characterization data.
- Specifying the overall physical conditions to be achieved for decommissioning completion (e.g., grouted basement, slab-on-grade) and the criteria for acceptable levels of contamination that may remain to meet the completion requirements.
- Identifying waste streams, estimating quantities by type, and identifying disposition pathways. Wastes without a disposition pathway need to be highlighted along with how they are to be addressed.
- Identifying new SSC installations or existing SSC modifications to support worker habitability and intended methods for D&D.
- Identifying anticipated prototypes, mockups, and/or proof of application for technology development that will be needed to arrive at preliminary designs, tool application, or operational methods.

[11] The end points method is a way to translate broad mission statements into explicit goals that are readily understood by engineers and craft personnel who do the work.

- Identifying the scope of equipment to remain and that to be removed prior to facility demolition, major dismantlement, or in-situ decommissioning. (This provides input to developing end points specifications.)

Engineering/Design – In addition to technical planning, the CDR should also include the results at a conceptual level that describe the "what" of the technical features of the project, but not necessarily the details of "how" these features will be implemented. Conceptual engineering/design deliverables can take a variety of forms that include evaluation results and recommendations, calculations, written descriptions, tabulations, sketches, marked up facility drawings, and others.

Examples of D&D engineering/design activities for CD-1 include:

- Identify the scope of facility isolation including building systems to be isolated and/or abandoned.
- Identify scope of modifications to current facilities and/or temporary systems needed for electric power, breathing air, and ventilation to support D&D work.
- Identify facility areas and portions of systems where decontamination and flushing will be required.
- Identify need for fixatives and primary locations where fixative will be required.
- Identify anticipated floor, roof, and wall structural evaluations and engineering needed to support D&D work.
- Identify locations and operations for which shielding and extraordinary radiation control measures are anticipated to be needed, along with the characterization information that provide the bases.
- Identify scope of size reduction efforts needed for equipment removal.
- Evaluate by computer simulation potential airborne releases based upon approved remaining contaminant levels to demonstrate acceptability of the potential release.
- Specifying methods for in-situ nondestructive assay (NDA) for residual nuclear materials.

2.3 Preliminary Design Phase, Approve Performance Baseline, CD-2

DOE O 413.3A Statements

The description for CD-2 in DOE O 413.3A is:

> "Completion of preliminary design is the first major milestone in the project Execution Phase. Preliminary design is complete when it provides sufficient information for development of the Performance Baseline in support of CD-2. The Performance Baseline is developed based on a mature design, a well-defined and documented scope, a resource-loaded detailed schedule, a definitive cost estimate, and defined Key Performance Parameters. Approval of CD-2 authorizes submission of a budget request for the total project cost."

The specific DOE O 413.3A requirement is:

> "Prepare a Preliminary Design. This stage of the design is complete when it provides sufficient information to support development of the Performance Baseline."

Recommended Approach

Simply put, the goal of CD-2 is to establish a baseline scope, cost, and schedule at a level of confidence sufficient for approval and budgeting, regardless of the nature of the project. This is the phase where execution plans, cost analyses, and schedules are refined and finalized. Project risk management analyses and plans during this phase can identify critical engineering/design issues. Providing the level of detail

recommended in the following discussions can result in a preliminary design equivalent to that needed for the performance baseline.

A well-documented basis of estimate (BOE) is also needed. In the case of a D&D project, the BOE will include technical assumptions in addressing the project activities, such as those in Volume II, Section 1, and others important to the project. Compared with a design-build project, most D&D basis-of-estimates will have considerably more labor cost elements and considerably different materials cost elements (i.e., little materials of construction and much greater consumables and disposable materials).

Technical Planning – As with the CDR, preliminary design may require a considerable amount of technical planning to create the project baseline. Technical planning tasks during this phase include:

- Specifying how each deactivation and decommissioning end point is to be physically achieved.
- Creating a post-deactivation surveillance and maintenance (S&M) plan for purposes of deciding the specifics of end points for a deactivation project, in particular if the facility is to be in an S&M mode for an extended period of time.
- Creating plans that provide details of work sequences for removal of equipment and materials, and for demolition or closure.
- Evaluating characterization data for purpose of planning, engineering and specifying equipment selection, radiological safety, decontamination, size reduction, equipment removal, and other field work. Site data is considered when it affects activities (e.g., meteorology constraints on open air demolition).
- Specifying the methods for verification of completion of decommissioning, for example, the survey methods for residual contamination (e.g., Multi-Agency Radiation Survey and Site Investigation Manual [MARSSIM] survey and analysis).

Engineering/Design – For the activities listed below, design output documents can include: 1) engineering analyses, 2) design sketches, 3) drawings, 4) technical specification for procurement of equipment and material, 5) details for on-site fabrication of components and assemblies, and others. As discussed in Section 3.5, some engineering tasks are conducted after CD-3 in time for field implementation. The key point for such deferral is that the supported activities must be well understood to the extent that the engineering detail is not required for a reliable baseline.

The list below provides examples of engineering/design activities, and related deliverables for the preliminary design:

- Specifying "how" end points are to be achieved by identifying the locations of the isolation points and specifying methods to be addressed in design for physical modifications and installations. Examples of outputs include marked up location drawings and/or photographs, material specifications for flanges, plugs, and weld caps, gapping requirements, sequence instructions, inspection requirements, and others.
- Conduct safety analyses for design of new equipment/systems to support D&D, and for operations related to removal/decontamination of nuclear materials.
- Engineering and specifying flushing and decontamination of systems and surfaces, e.g., with isometric drawings showing flush paths and connection points, decontamination system performance requirements, and equipment specifications.
- Specifying application of fixatives including location identification, selection of types, coverage specifications, and inspection requirements.
- Engineering/designing shielding and other radiation control measures requiring physical installations (including material requirements and configurations).

- Engineering/designing structural reinforcements and modifications needed for worker protection, prevention of structural component failure, materials and package removal, dismantlement and demolition; these can require structural calculations and sketches or marked up drawings and/or photographs, sequence of steps, reinforcing specifications, and equipment specifications.
- Engineering/designing modifications and installations to support size reduction and waste management, which can include design for room reconfiguration, specification of size reduction equipment, layout of material flow paths, fixtures for staging, ventilation exhaust, pneumatic and electrical power sources, installation of detectors, and others.
- Engineering/designing modifications to the facility and systems and/or installation of temporary systems needed for electric power, breathing air, ventilation, water supplies, and water treatment. Design output documents should show physical configuration, specify components and materials, detail attachments and supports, etc., through use of flowsheets, process and instrument diagrams, piping and equipment arrangement drawings, electrical one-line diagrams, electrical termination and instrument loop schematics, and other documents as required.
- Decisions on the timing and significance of the level of detail for any of these (and other) examples are inherent to the project management process.

2.4 Final Design Phase, Approve Start of Construction (Ready for Implementation), CD-3

DOE O 413.3A Statements

The description for CD-3 in DOE O 413.3A is:

> "With design and engineering essentially complete, a final design review performed, all environmental and safety criteria met, and all security concerns addressed, the project is ready to begin construction, implementation, procurement, or fabrication. CD-3 provides authorization to complete all procurement and construction and/or implementation activities and initiate all acceptance and turnover activities. Approval of CD-3 authorizes the project to commit all the resources necessary, within the funds provided, to execute the project."

The specific DOE O 413.3A requirement is:

> "Complete and review Final Design or determine that the design is sufficiently mature to start procurement or construction."

Recommended Approach

CD-3 for a D&D project is appropriately called "Ready for Implementation." For final design, relatively little additional technical planning should be necessary as it should have been substantially completed at preliminary design to support baseline development. Additional planning will arise during conduct of the project as previously unknown conditions or unexpected situations become clear, and to support needed implementation decisions.

For the most part, final design includes completing the engineering/design output documents that were initiated during preliminary design. These may include:

- Design drawings and sketches.
- Specifications for equipment and materials.
- Analyses that will dictate the conduct of work or procurement of equipment.
- All other engineering efforts specific to the project needs (see examples in Volume II, Section 1).

D&D projects need considerable engineering effort to create one-time procedures and work packages to support operational type tasks as well as removal and demolition or closure. Project-specific procedures

needed as soon as field work is initiated should be complete by CD-3. However, project-specific procedures for which the D&D work is far off in the project's schedule may be deferred. In general, detailed work packages are scheduled at a time prior to when they are needed.

2.5 CERCLA Engineering/Design Phases

Most decommissioning (not deactivation) projects within DOE-EM are conducted as a Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Non-Time-Critical Removal Action. Direct analogs between DOE 413.3A critical decisions and CERCLA stages include:

- Pre-Record of Decision (ROD) deliverables such as Remedial Investigation/Feasibility Study (RI/FS) and Engineering Evaluation/Cost Analysis (EE/CA) are equivalent to those leading to CD-1.
- Post-ROD Remedial Design/Remedial Action (RD/RA) Work Plan development activities can be equivalent to those leading to a CD-2 performance baseline.

The specific challenge is to align the sequences and schedules of CERCLA and DOE O 413.3A activities. That said, the intent here is not to duplicate efforts; as such, engineering/design results developed to satisfy CERCLA requirements can/should be used to meet the requirements of DOE O 413.3A and the intent of this guidance where equivalency in the level of detail and rigor can be shown.

Federal Facility Agreements, plus results of negotiations with the Environmental Protection Agency and stakeholders that address the overall site and area strategy are major factors in deciding the end state of facilities subject to CERCLA actions. Technical considerations resulting from strategic decisions can be drivers for project specific-functions and requirements; as such they must be integrated with project planning and engineering.

3. GUIDANCE FOR PROJECT MANAGEMENT DECISIONS

This section presents a decision framework for tailoring engineering/design activities to D&D projects; in particular to recognize that most field work and its related engineering does not follow the classic design-build type of schedule.

3.1 Project Management Responsibility for Establishing Priorities

The overriding principle for this guidance is that engineering/design must be conducted sufficiently early for a facility undergoing D&D to: 1) identify information needed for proceeding, 2) recognize technological challenges and initiate resolution, and 3) develop a high confidence scope, schedule, and cost baseline. Current perceptions may be that this is already the case; reviews of the conduct of EM projects indicate otherwise and that prior to major fieldwork, a greater fidelity of project definition is needed in order to reduce project/technical uncertainties and achieve excellence. The D&D engineering/design expectations described herein represent a departure from some past cases and aim to significantly improve the technical detail and documentation that provides the bases for the project baseline.

3.2 Considerations of Project Complexities

Within the framework of entire D&D project, with potentially hundreds of major tasks, some tasks may pose constraints and complexities that can delay the ability to provide detailed engineering/design results in a timely manner. Recognizing and adapting to such situations is the responsibility of the FPD and the IPT. Examples of complexities and constraints that can hinder completion of engineering/design include:

- Long-lead decisions – The existence of a particular waste stream (such as mercury) that has no disposition pathway, and for which proceeding with project planning and execution cannot await resolution of a long-lead decision for which engineering/design for dealing with the waste stream. Interim solutions may be needed in this case.
- Site wide interfaces – Utility services that must be reconfigured to serve facilities that will remain operational; or utility routing that controls the sequence in which facilities can be isolated (so that buildings needing services such as water and electricity are not prematurely cut off) are examples for which site-wide engineering and planning may be prerequisite for D&D planning of one or more of the facilities. If the site-wide schedule cannot accommodate individual facilities' project schedules, planning assumptions or engineering of interim solutions may be called for.
- Technology development – Adapting remote technology devices to a project-specific configuration, such as for disassembling/cutting reactor internals, or for placement of detectors and cameras are examples where designs may not be finalized and fabrication completed before it is necessary to start work to prepare for their installation.
- Access for characterization – A project that requires removing materials, equipment and/or building structure to gain access for collection of characterization information (e.g., the need to measure nuclear material holdup in equipment or systems) is an example where complete knowledge to plan the project cannot be obtained without first doing some work. Once access is gained and information collected, baseline assumptions and planning can be validated or modified. Engineering/design activities (e.g., structural reinforcement, systems isolation, temporary systems placement, or a demolition sequence) that depend on the information can then be completed.

For these and other such situations, when the need for results is considered "significant" to the baseline (per Section 4 of this guide), compensating for uncertainty is addressed with risk management and contingency determination. However, engineering/design should still be conducted to the degree feasible because partial results that accommodate a range of assumptions and/or partial solutions with interim

measure. It is incumbent upon the FPD and the IPT to complete other significant engineering/design activities that do not have such constraints.

3.3 Sequence for Managing this Guidance for a D&D Project

Figure 2 shows the logical set of steps in applying this guide in a tailored manner. Each step is described in Table 1. The following is an overview discussion of the upper and lower portions of the figure. Section 4 and Volume II, Section 1 of this guidance document address the engineering/design aspects of these steps.

3.4 Possible Need for Substantial Up-Front Characterization or Technology Application

Decisions to identify the possible need for significant early expenditure for project definition are indicated in Steps 1 through 6 of Figure 2. An important aspect of project management responsibility is to recognize technical challenges requiring special attention and to be aware of uncertainties needing resolution to support detailed planning and engineering/design. This is especially the case for projects that are technically complex, first-of-a-kind, or one-of-a-kind. Projects with these types of technical challenges usually need either or both of two types of technical input, which are:

- Up-front characterization associated with assessing the physical condition of the facility and characterization of the facility's SSCs for residual radiological and/or chemical contamination. Characterization information is needed for purposes of worker safety, environmental protection, deciding on D&D methods, and waste management.
- Identifying and applying technologies to support D&D work. That is, adaptation of existing technology or the need for new technology for any of several reasons; for example: material stabilization and removal, SSC size reduction, remote and/or robotic operations, process design, characterization, and others.

Timing Issues – Considerable up-front characterization and technology application may be required before key decisions can be made regarding the best way to conduct the project. As a result, considerable expenditures for investigation and development can occur well in advance of the CD-1 and CD-2. In such cases, the budget authorization and timing of the project's critical decision should be tailored to the need for such development.

3.5 Relating Engineering/Design Activities/Deliverables to Project Phases

It is a key responsibility of project management to decide which engineering/design activities are critical to their projects because they have significant technological content and/or they represent a significant portion of the overall project scope. Steps 9 through 17 of Figure 2 are for distinguishing among engineering/design activities that must be substantially completed to support the project baseline, versus those that can occur at other times during conduct of a project.

The logic shown in the lower section of Figure 2 can be viewed as follows:

- Steps 10 through 13 indicate those activities that must be well developed for a baseline. Section 4 of this guidance provides a checklist and process for identifying those activities for which engineering/design detailed development is critical to support the baseline. In many D&D projects, these activities will be clearly recognizable because of the technical challenges to conducting work within the facility.
- Step 8 relates to combining critical decisions as part of overall project planning versus individual engineering/design activities (see Section 2).
- Steps 14 and 15 relates to many project activities for which engineering/design deliverables are provided well after project implementation has started but sufficiently in advance of their actual need. This is acceptable for activities that are well known and for which the ability to create a high confidence project baseline does not rely on their detail.

- Steps 16 and 17 relate to many facilities that continue to have operational requirements (e.g., to maintain safety) aside from those field activities directly associated with a D&D project. Those operations must continue regardless of CD approvals. Similarly, some D&D projects are funded for activities to be initiated in the field prior to completion of the CD process. These include activities that are necessary to define the project (such as characterization), conducted under operations budgets (such as removal of nuclear materials and flushing of systems containing hazardous chemicals), and those for which the scope, schedule, and cost are well understood (such as stand-alone equipment removal and permanent shutdown, road grading for heavy equipment access, isolation of a piping system).

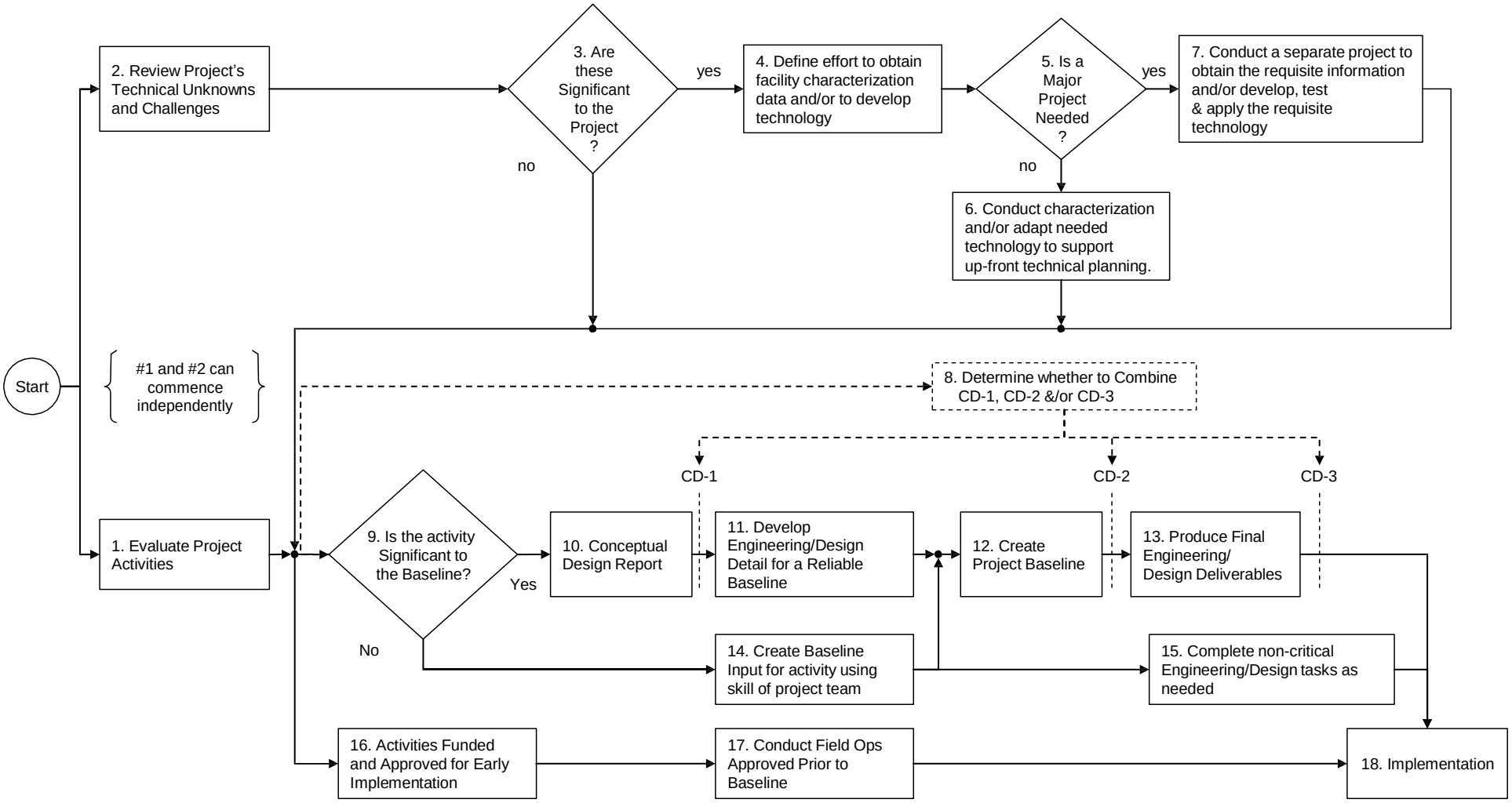

Figure 2 – Logic for Using this Guidance

Table 1 – Description of Project Logic Steps

No.	Title	Description	Text Location (sections)
1	Evaluate Project Activities	Goes hand in hand with setting up the project WBS. With regard to this guidance, the purpose is to identify project activities that need engineering/design skills for their conduct.	3.4, 4
2	Review Project's Technical Unknowns and Challenges	Goes hand in hand with early phases of project risk management. Evaluate uncertainties associated with the project with specific focus on: • adequacy of characterization of all SSCs for support of D&D operations of for waste management planning • potential for technology adaptation to address physical conditions that pose an unusual safety threat or will be costly to overcome in terms of personnel exposure or dollars	3.1, 3.4
3	Are These Significant to the Project?	Decide whether these facility and engineering/design uncertainties present significant risks (i.e. unacceptable level of uncertainty) to safety or to the project cost or schedule if they are not resolved prior to project initiation.	3.1, 3.4
4	Define effort to obtain facility characterization data and/or develop technology	Define the type and magnitude of effort required to address the outstanding issues that increase project uncertainty. Evaluate the scope, cost and schedule for the required activities. Consult other D&D programs and resources for solutions to similar challenges.	3.1, 3.4
5	Is a Major Project Needed?	Decide if resolving the issues contributing to uncertainty is of sufficient magnitude to delay proceeding with the Conceptual Design.	3.1, 3.4
6	Conduct characterization and/or adapt needed technology	Initiate tasks and/or small projects to resolve the uncertainties/reduce the project risk to acceptable levels. Overall project schedules may need to be revised to reflect these changes if they cannot be completed in parallel with other scheduled project tasks.	3.1, 3.4
7	Conduct Separate Project to obtain the requisite information or develop, test and apply technology	Conduct a major effort to resolve uncertainties, monitoring the progress of development to ensure that overall project needs are being met and appropriate alternative approaches are being considered where novel strategies are required.	3.1, 3.4
8	Determine whether to combine CD phases	Based on the complexity and expected duration of the project, the Integrated Project Team and Federal Project Director should determine whether it is appropriate to combine CD review phases and document expectations for those evaluations.	2
9	Is the activity significant to the baseline?	Decide which of the planned activities for which engineering/design deliverables are critical to developing a reliable baseline scope, cost, and schedule. These activities must be well advanced for BOE and baseline input and completed prior to project initiation.	4.1, Vol II, Sect.1

No.	Title	Description	Text Location (sections)
10	Conceptual Design Report	Identify alternatives and select preferred alternative with end points. Use the DOE M 413.3-1 Guidance for CDR content (Section 5.2.4). Develop ROM budget and schedule estimates for project.	2.2, 3.5
11	Develop Engineering/Design Detail	Produce engineering/design deliverables at a level of details sufficient for project scope, schedule and cost baseline definition.	2.3, 3.5
12	Create Project Baseline	Complete project BOE, cost estimate and develop project schedule.	2.3, 3.5
13	Produce Final Engineering/Design Deliverables	Complete engineering/design deliverables that were begun in Step 11.	2.4, 3.5
14	Create Baseline Input for activity using skill of project team	This represents routine engineering/design activities that represent common practice and can be developed later. The baseline input for the activity can be based on skill and judgment of the project's engineers, estimators, and schedulers, using standard estimating techniques.	3.5 Vol. II, Sect. 1
15	Complete non-critical Engineering/Design tasks as needed	Those activities identified in Step 14 can be completed at any time prior to the need for their implementation. This may be before CD-3, but in most cases will be later.	3.5 Vol. II, Sect. 1
16	Activities Funded and Approved for Early Implementation	This represents engineering support for: • Facilities that enter a D&D project with ongoing mission • For when it has been recognized that activities should start early because their results will be needed for the baseline (e.g., SSC characterization). • Activities are prerequisites to D&D (e.g., site preparation, access, staging areas). • Funds are available for obvious actions (e.g., cleanout of legacy waste, removal of recyclable materials). These items are funded outside of the baseline, or alternately should be included in the baseline from some stated initiation date.	3.4, 3.5
17	Conduct Field Ops Approved Prior to Baseline	Implement activities identified in Step 16.	3.4, 3.5
18	Implementation	Implement approved actions per project schedule.	Vol. II, Sect. 1

4. TAILORING AND REVIEW OF ENGINEERING/DESIGN ACTIVITIES

This section provides a process for selecting those D&D project activities for which high level of engineering/design detail is important to a well-defined project with a reliable baseline[12].

4.1 Examples of Project Activities with Engineering/Design Deliverables

To provide specificity for the principles put forth in Sections 1 through 3, a "catalog" of 48 typical D&D project activities is provided in Volume II, Section 1, all of which require engineering involvement. These are applicable to many D&D projects[13] in general; but not all apply to all projects. Which activities are suitable to a specific project depends on the attributes of the project.

The discussion of each of the 48 activities describes engineering/design deliverables corresponding to: a) concept development, b) support for the project baseline, and c) ready for implementation. It is important to keep clear the difference between engineering/design progress for *individual activities* and the overall engineering/design status for the *project*. Engineering detail/deliverables needed for the projects' conceptual or baseline development do not require the corresponding deliverables for all project activities; only for those activities judged to be "significant" to the project. When deemed as not significant, the baseline can be based on skill and judgment of the project's engineers, estimators, and schedulers; for example for cost estimating using rough-order-of-magnitude (ROM) methods.

Table 2 provides a checklist template for designating a project activity as significant; primarily from a baseline development perspective. (A simpler version of the table is shown with the project example in Volume II, Section 3.) The checkmarks in Table 2 indicate preliminary judgments of significance based on the individual descriptions in Volume II, Section 1. However, as illustrated in the hypothetical project in Volume II, Section 3, the activities of significance for any specific project will vary from those indicated in Table 2; the project team must make such decisions.

4.2 Evaluation Steps

The following three steps are suggested for identifying engineering/design deliverables needed to support the baseline. Volume II, Section 3 contains a fictitious example of a project to which these three steps have been applied as a test of its usability and a demonstration of how the method is used.

Step 1: Identify Activities for Which Engineering/Design Deliverables are needed

1.1 Identify project activities for which engineering/design deliverables are needed[14]. Sources include the project Work Breakdown Structure (WBS) and schedule.

1.2 Select those applicable to the project based on the descriptions in Volume II, Section 1.

1.3 Add as appropriate project activities not in Volume II, Section 1 that require technical deliverables.

1.4 Provide a greater level of detail for activities that are on the list but for which the description in Volume II, Section 1 is too general.

[12] As discussed in Section 3.3, D&D baseline development must also consider engineering-dependent project activities that are not keyed to a CD-2 milestone. These include activities associated with operations, maintenance, characterization, technology application, and others that are in progress prior to CD-1/2. On the other end of the timeline, baseline development is without deliverables for engineering that is conducted after CD-3.

[13] Projects subject to DOE O 413.3A are those for which the total project cost exceeds $5 million.

[14] It is understood that there are more activities of significance to the project than only those requiring engineering/design detail. However, the scope of this guidance is limited to engineering/design.

Step 2: Identify Activities for Which Engineering/Design Deliverables are Significant to the Baseline

2.1 Create a table for the project using the template in Table 2.

2.2 Identify activities for which engineering/design is significant to the baseline using the following checklist:

- ☐ Based on knowledge of the project, experience, instinct and/or judgment
- ☐ Is indicated as significant in the descriptions in Volume II, Section 1
- ☐ Is indicated as significant in the activities identified by the project team
- ☐ Requires adaptation or development of technology
- ☐ Has some unique challenge that makes it a first-of-a-kind or one-of-a-kind effort compared with past experience
- ☐ Is operationally complex; for example, difficulty of access, extreme operating conditions (temperature, pressure, flow, chemistry)
- ☐ Is engineering/design-wise complex
- ☐ Requires detailed specifications for procurement of materials and/or equipment
- ☐ Has been identified as a significant project risk element
- ☐ Other reason _____

2.3 Using the checklist above for each activity and observing the example in Section II-3, provide an explanation in the second column as to why the activity is "significant"; meaning that substantial engineering/design is needed for the baseline development.

2.4 Then, check the third column of the project equivalent as appropriate in Table 2.

Step 3: Record Results and Specify Deliverables

3.1 Table 3 is a template for recording the results; it is based on the format used for individual activities in Volume II, Section 1.

3.2 Record details of the selected activity in the Table 3 template.

3.3 Specify the deliverables that must be completed for each project phase in the Table 3 template.

4.3 Use of Evaluation Results

It is left to each project team to determine how and if they want to incorporate this approach in their own methods. Regardless of the process used, providing the indicated information will result in more substantive reviews by others not directly involved in the project. The results of the steps described above can be used within the project for creating the specified deliverables and their use to support:

- Technical planning; including feasibility determination, and conceptual design development.
- The basis of estimate and the technical baseline.
- Risk assessment; one of the inputs to the identification of project technical challenges should be the results of the risk assessment.
- Field work; technical requirements for operations, construction, decontamination, demolition, and development of related procedures.
- Procurement; functional and technical details for specifications for solicitation, contracts, and purchases.

Table 2 – Deciding which Project Activities Require Early Engineering/Design (Shading is for reading convenience.)		
Type of Activity	**Bases for Significance or Not**	**Significant**
1. Alternatives Analyses and Selection		
2. Deactivation End State and End Points		
3. Post-D&D Surveillance & Maintenance		
4. Process System Deactivation and Isolation		
5. End Points for Operable and Mothballed Systems and Equipment		
6. Nuclear Safety Analyses		
7. Facility Condition Assessment		
8. Characterization of SSCs and Process Materials Likely to be Disposed as Waste		
9. Characterization for Compliance		
10. Equipment Dismantlement and Removal		
11. Size Reduction		
12. Liquid Flush and Drain		
13. Surface Decontamination		
14. Fixative Application		
15. Mockups		
16. Technology Application		
17. Shielding Design		
18. Building Structural Integrity		
19. Temporary Electrical Service		
20. Replacement Electrical		
21. Ventilation Modifications		
22. Temporary Ventilation		
23. Breathing Air		
24. Temporary Enclosures and Containments		
25. Hazards Analysis		
26. Hazardous Material Abatement		
27. Liquid Waste Management		
28. Waste Identification & Planning		
29. Waste Conditioning & Packaging		
30. Waste Staging		
31. Waste Transport & Disposal		
32. Facility Isolation		

Table 2 – Deciding which Project Activities Require Early Engineering/Design (Shading is for reading convenience.)		
Type of Activity	**Bases for Significance or Not**	**Significant**
33. Temporary Roads and Access Ways for Heavy D&D Equipment		
34. Temporary Water for D&D		
35. Completion Verification Survey		
36. Demolition Method and Sequence		
37. Environmental Requirements and Controls for Open Air Demolition		
38. Site/Civil Work During and After Final Disposition		
39. Closure Configuration		
40. Decommissioning End State and End Points		
41. Operations and Maintenance Reduction		
42. Radiological Engineering		
43. Trade-off Studies		
44. Reconfigure Security Boundary		
45. Waste Treatment		
46. In-Situ Decommissioning Grouting/Void Fill Analysis		
47. In-Situ Decommissioning Cover Systems		
48. Authorization Basis Step-Out Criteria		

Table 3 – Recording a Significant Activity (See Section II-1 for examples)
Activity Title and Description
Engineering/Design Indicators of Significance – Briefly describe the reason that engineering/design detail is or is not needed for the baseline. (second column of Table 2)
Concept Development for Key Engineering/Design Deliverables (CD-1) – Identify key, specific engineering/design deliverables (functional requirements, analyses, evaluations, concept drawings, walkdown/survey reports, others)
Development of Baseline for Key Engineering/Design Deliverables (CD-2) – Identify key, specific engineering/design deliverables (performance requirements, drawings, calculations, equipment lists, equipment specifications, sequencing requirements, others)
Ready for Implementation for Key Engineering/Design Deliverables (CD-3) – It is assumed that deliverables identified above will be developed in further detail. If there are key deliverables not previously identified, describe them here.

5. LINES-OF-INQUIRY FOR INDEPENDENT REVIEW

5.1 Perspectives for Reviewers

The purpose of this section is to provide independent reviewers with example lines-of-inquiry (LOI) related to D&D project engineering/design activities and deliverables.

Independent reviewers should become familiar with the logic in Figure 2 to gain an understanding when inquiring about engineering/design tasks needed prior to CD-1. As a first step, the following questions should be discussed with regard to the overall project:

- Is characterization sufficient to support detailed planning? Is a major characterization sub-project needed?
- Is a major technology sub-project needed?

The results of such discussions will provide insights into whether or not these two potential issues will require significant expenditure to obtain information and technical detail before the baseline can be fully assembled; or whether either is recognized as a high risk, with contingency assigned to acknowledge the uncertainty.

Understanding the principles in Sections 1 through 3, and the process in Section 4 (along with the example in Volume II, Section 3) should provide insights for inquiry regarding engineering/design results and deliverables for the project's significant activities.

Reviewers should also gain an understanding of the timing of the project's planning discussed in Section 3. For many activities a high degree of certainty for the baseline does not require complete engineering details; their scope, schedule, and cost can be based on skill, experience, and judgment of the project's engineers, estimators, and schedulers. These activities include continuing operations and maintenance, plus those for which engineering/design is to be conducted after CD-3 and prior to their implementation.

5.2 Example LOI

As a starting point for reviewers, Volume II, Section 2 lists example LOI for: a) the process steps for deciding which activities are important to the baseline, and b) engineering/design expectations for the activities in Volume II, Section 1. The descriptions of each activity in Volume II, Section 1 can aid reviewers in developing their own LOI.

In practice, engineering/design LOI should be developed to focus on those activities deemed "significant," have a high degree of uncertainty, or are needed early in the project. Table 2 and the "Indicators of Significance" for each of the activities in Volume II, Section 1 can be used by reviewers for insights into systematically identifying key projects. In addition, for project activities that are not significant, the LOI in Volume II, Section2 can be used as a starting point for reviews of engineering/design activities at the time they are needed.

Volume II, Section 2 focuses the LOI on the recommended/appropriate level of technical detail development at CD-1 and CD-2. LOI for CD-3 is not addressed separately because it is expected that engineering/ design for CD-3 is the continuation and completion of that initiated for CD-1 and developed for CD-2.

Note that a generic line-of-inquiry at CD-2 for all activities is: "Have the results of engineering, design, and analysis been incorporated in the Basis of Estimate, as well as in the scope, schedule, and cost baseline?" Since this applies to all activities, it has not been repeated for each in Volume II.

6. DEFINITIONS AND ACRONYMS

6.1 Definitions of Action Verbs Specific to this Guidance

To avoid confusion regarding specific action verbs used in this guidance, the following meanings are stated. The intent here is not to create inflexible "definitions," but rather to differentiate among terms that in other instances may be used with less specificity. Their use is most important in Sections 2.2, 2.3, 2.4 and in Volume II, Section 1 where they convey and differentiate between the expected levels of detail associated with engineering/design activities.

Verb	As used in this Guidance
Analyze	Conduct an engineering analysis using calculations, evaluation of data, and/or review of inspection results to arrive at a conclusion and to provide recommendations for a course of action, design, procedures, and other technical requirements.
Create	Includes technical planning, engineering, and design activities to produce an engineering or design product.
Describe	Record in a project document what has already been decided, selected, specified, or designed.
Design	"Design" creates documents to support field work. For D&D, design should be taken in a broader context than typically what would otherwise be mostly drawings, specifications, and other design output documents for a design-build project.
Evaluate	Conduct and document engineering investigation of options to arrive at the performance requirements, design features, SSCs selections, and other project requirements. Reviews, which are more abbreviated in the above description, are nevertheless encompassed by "evaluate."
Engineer	Apply engineering skills and disciplines to create products of design such as specifications, drawings, installation and fabrication instructions, etc. and other technical documents such as plans, operational procedures, and evaluations.
Identify	Conduct and document the results of document reviews, facility walkdowns, operations and maintenance staff interviews, and other actions for purposes of design development, installation, removal, operations, maintenance, and other tasks.
Plan	Produce a plan that can address actions ranging from broad facility and campaign (e.g., waste campaign) strategies to individual procedural requirements for specific field work.
Specify	Formally state and document detailed technical requirements such as materials, size, fabrication methods, field methods, and other requirements for procurement, installation, establishing conditions, conducting field work, and typical project activities.

6.2 D&D Specific Definitions

Use of "D&D"

"D&D" is used as a general acronym for which it is unnecessary to explicitly define each "D." In the context of the project management order, and in this guidance, deactivation and decommissioning are the primary foci because each can be a separate project or can be a phase of a combined project. The following are formal definitions of these two D's plus decontamination and demolition. Additional notes are provided regarding the usage of deactivation and demolition.

For purpose of this guidance, it should be clearly understood that regardless of the use of these terms ("deactivation," "decontamination," "demolition," "decommissioning") to characterize specific projects, the requirement for preparing engineering/design specifications consistent with the guidance provided remains applicable.

Deactivation

Source: DOE O 430.1B – Placing a facility in a stable and known condition including the removal of hazardous and radioactive materials to ensure adequate protection of workers, public health and safety, and the environment, thereby limiting the long-term cost of surveillance and maintenance. Actions include the removal of fuel, draining and/or de-energizing nonessential systems, removal of stored radioactive and hazardous materials, and related actions. Deactivation does not include all decontamination necessary for the dismantlement and demolition phase of decommissioning (e.g., removal of contamination remaining in the fixed structures and equipment after deactivation).

Note Regarding Deactivation

For a variety of reasons, the scope of deactivation beyond the above description varies among sites as well as facilities. For example:

- At Savannah River, deactivation for some facilities refers to complete cleanout and decontamination such that demolition can proceed as an industrial facility.
- At Hanford, and Savannah River, deactivation is commonly used to describe the work associated with removal of equipment for the purpose of hazard mitigation and other preparatory operations such as utility isolation. The end state is a facility that is "inactive" or "shut down."

Decommissioning

Source: DOE O 430.1B – The process of closing and securing a nuclear facility or nuclear materials storage facility to provide adequate protection from radiation exposure and to isolate radioactive contamination from the human environment. It takes place after deactivation and includes surveillance, maintenance, decontamination, [demolition, entombment (in-situ decommissioning),] and/or dismantlement. These actions are taken at the end of the life of a facility to retire it from service with adequate regard for the health and safety of workers and the public and protection of the environment. The ultimate goal of decommissioning is unrestricted release or restricted use of the site.

Decontamination

Source: DOE O 430.1B – The removal or reduction of residual chemical, biological, or radiological contaminant and hazardous materials by mechanical, chemical or other techniques to achieve a stated objective or end condition. *[Clarification: This is a universal action and may be conducted, to some extent, during any phase of facility disposition.]*

Demolition

Source: ANSI A10.6; Safety Requirements for Demolition Operations – The dismantling, razing, or wrecking of any fixed building or structure or any part thereof. *[Clarification: See also 10 CFR 1926, Subpart T, Demolition.]*

Note regarding Demolition

Beyond the action of bringing down a structure, "Demolition" is often used to characterize a decommissioning project phase for which achieving a demolished end state is the primary objective. However, from an overall project perspective, many activities occur before the actual demolition to prepare the facility (e.g., asbestos abatement), and many activities occur afterwards to achieve the final specified conditions for the site.

6.3 Acronyms

Acronym	Definition
A/B	Authorization Basis
ALARA	As Low as Reasonably Achievable
BOE	Basis of Estimate
CD	Critical Decision
CDR	Conceptual Design Report
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
D&D	Deactivation and Decommissioning
DOE EM	Department of Energy Office of Environmental Management
DQO	Data Quality Objectives
EE/CA	Engineering Evaluation/Cost Analysis
HEPA	High Efficiency Particulate Air
IPT	Integrated Project Team
ISOCS	In-Situ Object Counting System
ISD	In-Situ Decommissioning
LOI	Lines-of-Inquiry
LOTO	Lockout-Tagout
LTS	Long-Term Stewardship
MARSSIM	Multi-Agency Radiation Survey and Site Investigation Manual
NCSE	Nuclear Criticality Safety Evaluation
NDA	Nondestructive Assay
O&M	Operations and Maintenance
PBS	Project Baseline Summary
RCRA	Resource Conservation and Recovery Act
REVCOM	Review and Comment
RI/FS	Remedial Investigation/Feasibility Study
ROD	Record of Decision
ROM	Rough Order of Magnitude
S&M	Surveillance and Maintenance
SSC	Systems, Structures, and Components
SWB	Standard Waste Box
TRU	Transuranic Waste
USQ	Unreviewed Safety Question
WAC	Waste Acceptance Criteria
WBS	Work Breakdown Structure