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A Proposed Framework For Planning Deactivation And Decommissioning Engineering And Design Activities To Meet The Requirements Of DOE Order 413.3A, Program And Project Management For The Acquisition Of Capital Assets

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ABSTRACT

This paper provides guidance in applying the requirements of DOE O 413.3A to Deactivation and Decommissioning (D&D) projects. A list of 41 engineering and design activities relevant to D&D projects was generated. For several activities in this list, examples of the level of development and/or types of deliverables that might be expected at the completion of the conceptual, preliminary and final project design phases described in the Order are provided.

INTRODUCTION

DOE Order 413.3A provides direction to project managers involved in the acquisition of capital assets for DOE facilities. The goal of the order is the delivery of projects on schedule, within budget, and which are fully capable of meeting mission needs. DOE Environmental Management (EM) is committed to applying the principles of the project management order to environmental cleanup projects. The EM Office of D&D and Facility Engineering Programs funded SRNL to develop guidance for Federal Project Directors at the various DOE field sites to use in applying the principles of the Order specifically to D&D projects. This paper summarizes the preliminary guidance developed to date.

This preliminary guidance is in advance of more detailed guidance under development to provide direction for the implementation of DOE O 413.3A requirements for engineering and design progress during the execution of a D&D project.

As its name implies, the DOE project management order is focused on projects to acquire new capital assets (i.e. construction of new facilities). In contrast, the goal of D&D projects is to dispose of excess facilities, typically by demolition or in situ disposal (e.g., entombment). Although the goals of the two types of projects are quite different, the principles of sound project management required by the Order can and must be applied to both. The difficulty arises in applying some of the details of the Order, particularly relating to the activities that are to be performed during the project phases defined by the Order and deliverables to be produced at the critical decision points (CD) at the end of these phases.

DIFFERENCES BETWEEN D&D AND FACILITY CONSTRUCION PROJECTS

Many aspects of D&D projects are very different than the design-build model upon which the DOE project management order is based. For D&D projects, the fraction of the engineering effort devoted to classical design activities is typically much lower (and may be zero). Regardless, there is a need for comparable skill, planning detail, engineering rigor, and disciplined, forward-looking performance to:

a) develop the project conceptual design
b) create a preliminary design sufficient to establish a high confidence baseline
c) establish the final design so as to be ready for implementation

Some key activities of a design-build project such as creating design drawings are rarely significant in D&D projects. In general, the following differences are noted:

- There is relatively little traditional design work of systems, structures and components (SSCs) for D&D. The amount of engineering leading to design drawings and specifications is usually limited relative to the overall project scope. Such design efforts would be a minor factor in the CD process for a D&D project.
- Although, D&D involves a significant amount of engineering, the types of engineering activities 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 also include nuclear safety and radiological engineering.
- Activities tend to be heavy in operations and services types of activities 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 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.

Creating a project's basis-of-estimate (BOE) leading to the performance baseline must address the cost impacts related to these and other differences.

Specific D&D Engineering and Design Activities

For D&D projects in general and for purposes here, "design" represents a broader context that includes all engineering aspects of a D&D project development. Shown in Table I is a compilation of 41 typical engineering and design activities conducted for D&D projects. All of these activities can provide input to establishing the project baseline, procurement, Quality Assurance, procedures, training, and other follow-on activities that occur for all projects.

The numbering and order of listing does not imply priority or operational sequence. It should be understood that any specific project may not require all the activities in this table; and undoubtedly some will have activities that are not listed. It is the responsibility of project management to address which apply and their importance, as discussed further under the tailoring discussion.

While the end-state[1] of a D&D project has generally been determined at the onset of project planning, requisite knowledge of facility physical conditions (e.g. building structural integrity, system configuration, accessibility limitations due to radiation or contamination) and of 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.

[1] In simple terms, "end state" can be deactivation followed by long-term surveillance and maintenance, or demolition, or in-situ decommissioning (entombment).

Table I. Engineering and Design Activities for D&D Projects

Engineering/Design Activity	Purpose
1. Alternatives analyses and selection	For decommissioning, to identify and select an approach and the decommissioning end state For deactivation, alternatives are limited. One purpose is to evaluate if the deactivation effort will reduce the facility hazard category
2. Facility deactivation end state and end points	• To specify the facility deactivation end state; that is, a vision of the overall facility status upon completion • To specify the deactivation end points. They are the detailed conditions to be achieved upon completion
3. Post-Deactivation S&M Planning	• To layout the details of the deactivation activities for cases in which deactivation is to be followed by an extended S&M period • To provide input to deactivation end points in that S&M planning will require certain conditions to be established
4. System deactivation and isolation	To establish the configuration for systems and equipment to be permanently shut down. Permanent shutdown of process systems also reduces the need for facility-specific knowledge of how to operate non-conventional equipment and processes
5. End points for operable and mothballed equipment	To establish the configuration and modes of operation for equipment/systems that will remain operable or be mothballed
6. Nuclear Safety Analyses	• To evaluate the potential for Facility Hazard Category (FHC) reduction after hazard removal • To evaluate safety of proposed activities involving nuclear materials and safety related Structures, Systems, and Components (SSCs)
7. Facility Condition Assessment	• To ensure the safety of personnel during D&D • To determine current physical conditions for establishing the project baseline
8. Characterization of SSCs and associated process materials likely to be disposed as waste	• To characterize SSCs and their contents (wet and dry solids, and liquids, nuclear materials, etc.) to plan activities to achieve relevant deactivation end points • To establish waste profiles for disposition planning
9. Characterization for Compliance	To determine compliance with • Waste transportation regulations and disposal site WAC (Waste Acceptance Criteria) • End points verification • Decontamination to RCRA limits • Nuclear material accountability limits
10. Equipment dismantlement and Removal planning	To identify what equipment must be removed to achieve the deactivation end points
11. Size Reduction	To cut specified equipment into smaller pieces for the purpose of removal from a facility or to facilitate waste packaging
12. Fluid Systems Drain, Flush, and Decontamination	• To identify SSCs that are likely to contain materials that must be removed to achieve deactivation end points • To engineer methods to achieve end points
13. Surface Decontamination	• To identify surfaces with contamination that needs to be removed to meet deactivation end points • To engineer methods to achieve end points

Engineering/Design Activity	Purpose
14. Fixative Application	• To identify surfaces with contamination that needs to be fixed to meet deactivation end points or prepare for demolition • To engineer methods to achieve end points
15. Mockups	To improve operational proficiency for challenging activities required to achieve deactivation end points by providing worker input to processes and designs
16. Technology Development	To plan and conduct proof-of-principle testing/demonstration for application of new technology or adaptation of existing technology to project conditions
17. Radiological Engineering	To conduct ALARA analyses and reasonably minimize personnel radiation exposure
18. Building Structural Integrity	To verify that planned D&D activities will not adversely impact the building structure which could result in • worker injury • storm water in-leakage • inadvertent collapse • transport of contaminants to the environment
19. Temporary Electrical	To provide electrical power for lighting, tools and equipment when installed circuits are de-energized for deactivation
20. Replacement Electrical	To provide electrical power when installed circuits are to be isolated
21. Ventilation modifications	To maintain contamination control as ventilation systems are reconfigured
22. Temporary Ventilation	To support contamination control and in some cases to improve habitability conditions for workers
23. Breathing air	To provide supplied air when required for respiratory protection
24. Temporary enclosures and containments	To provide enclosures when required for contamination control or hiding equipment
25. Job Hazards Analyses	To ensure worker safety
26. Hazard Abatement	To remove non-radiological hazards for purpose of • Personnel health and safety • Environmental protection • Disposal WAC
27. Liquid Waste Management	To identify sources of liquid waste in the facility and plan for their disposal
28. Waste Identification & Planning	To identify and quantify all wastes to be generated by the project for project baseline planning
29. Waste Conditioning & Packaging	To identify packaging configurations and necessary treatment to satisfy both transportation requirements and disposal WAC
30. Waste Staging	To ensure sufficient storage is available for waste management
31. Waste Transport & Disposal	To comply with shipping regulations and disposal WAC
32. Structural Analysis	To determine demolition method and removal impact on adjacent facilities
33. Facility Isolation	To isolate a facility from all external utility systems

Engineering/Design Activity	Purpose
34. Temporary Roads and access ways for heavy D&D equipment	To prepare site for the mobilization of heavy equipment needed for D&D
35. Temporary Water for D&D	To provide water when needed for D&D activities
36. Post-decommissioning surveillance planning	To provide input to disposition end points specification
37. Decommissioning end points	To specify requirements to validate demolition completion
38. Demolition Method and Sequence	To establish demolition method to minimize project cost while protecting workers, environment and adjacent facilities
39. Environmental requirements and controls for demolition	To insure that all required environmental analyses have been performed, regulatory permits obtained, and physical controls are in place and maintained during demolition
40. Site/Civil activities during and after final disposition	To plan for general civil engineering activities needed during and after the demolition or in situ disposal of the facility structure to achieve the final decommissioning end state.
41. Closure Configuration	To specify materials and configurations to comply with an agreed upon end state

It is the specific responsibility of project management to recognize when a project presents technical challenges that require special attention and to be aware of unknowns and uncertainties that need to be resolved to support detailed planning, engineering and design. This is especially the case for projects that are technically complex, first-of-a-kind, or one-of-a-kind. These situations usually result in the need for either or both of two types of technical activities:

- Activities associated with assessing the physical condition of the facility and characterization of the facility's SSCs for residual radiological and/or chemical contamination. Sufficient characterization information is needed for purposes of worker safety, deciding on D&D methods, and waste management.
- Technology development to support D&D activities. Technology development needs can be for any of several reasons such as material stabilization, SSC size reduction, process design, characterization, and others.

Either of these may require substantial early expenditures before a host of decisions can be made regarding the best way to conduct the project.

Applicability

This guidance provided is in general applicable to many D&D projects; but not all apply to all projects. Which of these activities identified in this guidance are appropriate to a specific project depends on the attributes of the project; it is a project management responsibility to evaluate and decide. See Fig. 1 for the steps in applying this guide to a D&D project. (The elements of this diagram are discussed throughout this guide.)

Significant engineering and design elements of D&D projects may use this guide as a tool to support design execution equivalent to the requirements of DOE O 413.3A. This guidance is to be used as a supplement to other DOE guides and handbooks that address D&D activities [1-5].

PROJECT PHASES DEFINED IN THE PROJECT MANAGEMENT ORDER

DOE O 413.3A defines three sequential phases of design (conceptual, preliminary, and final) that culminate respectively with CD-1, -2, and -3. Regardless of the differences between D&D and design-build projects, discussed above, meeting the *intent* of the critical decision milestones is essential to satisfying the requirements of the order.

This preliminary guidance provides a suggested level of detail for that purpose by addressing engineering and design activities (listed in Table I) that are typical of D&D projects. Other engineering and design activities specific to a project, but not listed in the table, should be similarly addressed.

CD-1, Conceptual Design Phase

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."

DOE defines Systems Engineering 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 efforts
> - 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 [6].

This guidance serves as one 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:

- Using the approach to conceptual, preliminary, and final design described herein provides the basis for meeting the first element.
- Applying this guidance using DOE contractor qualified project planning and engineering staff, along with systematic management control procedures 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 above applies to the D&D life cycle. The "users" of a D&D project are the deactivation, demolition crews, and closure crews that conduct the work. In all D&D projects these users are very much involved in providing input to the technical planners and engineering/design staff.

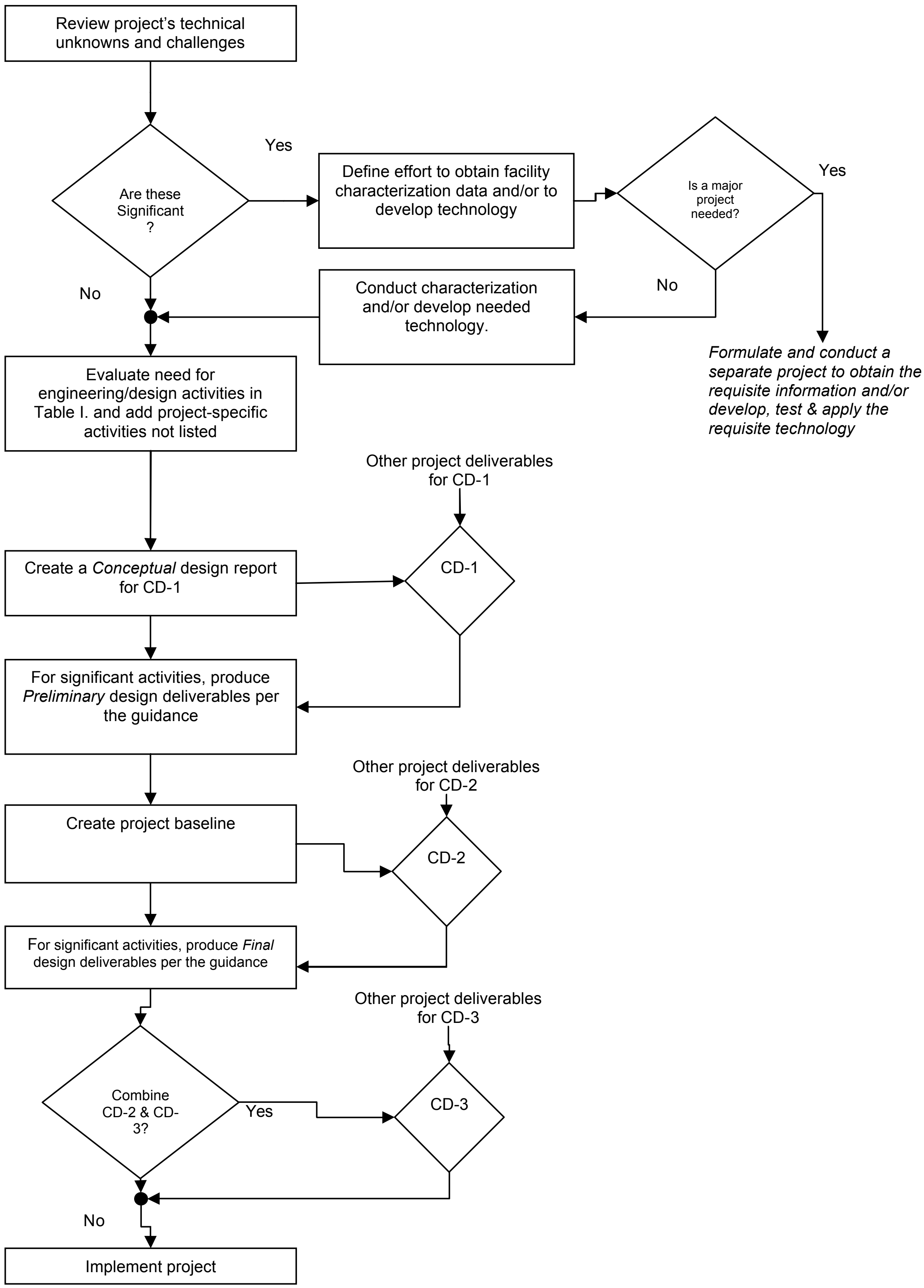

Fig. 1. – Decision Logic for Applying this Guidance

The Conceptual Design Report (CDR) should describe the D&D end state, identify technical challenges that are extraordinary or require special attention (as indicated at the top of Fig. 1), and present the overall technical approach to the project as reflected in technical planning activities. 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. It is essential that the detailed results of the conceptual design activities 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 that will support the needs of project definition at CD-1.

Technical Planning – Getting to CD-1 requires considerable technical planning that does not necessarily result in customary design deliverables, but nevertheless requires substantial engineering skills. Examples of technical planning required include:

- Specifying end points for systems, spaces, and outbuildings and features and conditions to be achieved, whether for deactivation or for decommissioning. End points typically specify systems as remaining operational, to be isolated and abandoned, or mothballed. Similarly, 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.
- Evaluating the need to revise the Authorization Basis (A/B) and conducting the supporting safety analyses is preferably completed by CD-1. Establishing the conditions for the A/B change, such as fissile material removal, may be conducted prior field work following CD-3.
- Describing the selected decommissioning alternative; in some cases this may be a result of a Record of Decision for a Comprehensive Environmental Response, Compensation, and Liability Act (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, ALARA issues, etc.
- Evaluating and identifying the scope of anticipated overall characterization activities 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, as illustrated at the top of Fig. 1.
- Specifying the overall physical conditions to be achieved for decommissioning completion (e.g., grouted basement, slab-on-grade, etc.) and the criteria for acceptable levels of contamination that may remain to meet the completion requirements.

CD-2, Preliminary Design Phase, Approve Performance Baseline

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."

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.

For a design-build project, preliminary design is generally viewed as 60-65% of the design deliverables (which inherently includes the engineering required to get to that point). For D&D, the percentage of design completion cannot be estimated by the fraction of drawings and other deliverables completed. 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 BOE is also needed. In the case of a D&D project, the BOE will include technical assumptions in addressing the Table I and other activities. Compared with a design-build project, most D&D basis-of-estimates will have considerably more labor elements and considerably fewer quantities of materials.

Technical Planning – As with the CDR, preliminary design may require a considerable amount of technical planning to get to create the project baseline. Technical planning activities 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, if the facility is to be in a post-deactivation 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.
- Using characterization data for planning, engineering and specifying equipment selection, radiological safety, decontamination, size reduction, equipment removal, and other field activities.
- Specifying the methods for verification of completion of decommissioning, for example, the survey methods for residual contamination (e.g., MARSSIM survey and analysis).

Engineering and 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. These deliverables should be created by:

- Identifying the locations of the isolation points and specifying methods to be addressed in design. This is coordinated with the end points details (next).
- Specifying *how* to achieve end points that require 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.
- Engineering and specifying flushing and decontamination of systems and surfaces, for example, with isometric drawings showing flush paths and connection points, decontamination system performance requirements, equipment specifications, etc.
- Specifying application of fixatives including location identification, selection of types, coverage specifications, inspection requirements, etc.
- Shielding and other radiation control measures requiring physical installations including material requirements and configurations.
- Engineering and designing structural reinforcements and modifications needed for worker protection, prevention of structural component failure, dismantlement and demolition, including structural calculations and sketches or marked up drawings and/or photographs, sequence of steps, reinforcing specifications, etc.
- Engineering and designing modifications and installations to support equipment and materials removal, including structural calculations and sketches or marked up drawings and/or photographs, sequence of steps, reinforcing specifications, equipment specifications, etc.
- Engineering and 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 and designing facility and systems isolation to show physical configuration, specify components and materials, detail attachments and supports, etc.
- Engineering and 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 flow sheets, process & instrument diagrams, piping and equipment arrangement drawings, electrical one-line diagrams, electrical termination and instrument loop schematics, and other documents as required.

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

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."

CD-3 for a D&D project is appropriately called "Ready for Implementation." To be equivalent to the CD-3 milestone for design-build projects, the goal should be 90% complete for engineering and design output documents were started in preliminary design.

For final design there should be relatively little technical planning as it should have been essentially completed at preliminary design to support baseline development. Additional planning will arise during conduct of the project as previously unknown conditions or unexpected situations manifest themselves.

Therefore, final design includes completing the engineering and design output documents that were initiated during preliminary design; that is:

- Design drawings and sketches.
- Specifications for equipment and materials.
- Analyses that will dictate the conduct of work or procurement of equipment.
- All others specific to the project needs.

D&D projects need considerable engineering effort to create one-time procedures and work packages to support operational type activities as well as removal and demolition or closure. In general project-specific procedures that would be needed soon after initiation of field work should be complete by CD-3. However, project-specific procedures for which the D&D activity is far off in the project's schedule may be deferred. Detailed work packages are scheduled at a time prior to when they are needed.

Combining Critical Decisions

Many D&D projects combine CD-2 and CD-3 when there is relatively little technical development needed between the two decision points. Similarly, some design activities proceed from project concept to CD-3, "ready for implementation", without the need for an intermediate stage or deliverable. In these cases, the level of detail described below for CD-2 and CD-3 is applicable to a CD-2/3 combined approach.

TAILORING OF THIS GUIDANCE

As part of the project tailoring, CD milestones are sometimes combined (e.g., CD-2&3). However, in all cases of large and/or complex projects these critical decisions should be addressed separately. The structuring of project reviews and approvals is the responsibility of the Federal Project Director and the Integrated Project Team.

Tailoring by Prioritizing for Baseline Development

With regard to the activities listed in Table I, because of the variability of D&D projects, the Project Manager should state the engineering and design results from these activities that are needed for a reliable scope, schedule, and cost baseline. This can be done by:

- Identifying each activity in Column 1 applicable to the project
- For the identified activities, decide which have results and deliverables that are important to a high confidence BOE and baseline development. For deciding what is important, select engineering and design activities that: a) address a complex field problem, and/or b) support a significant amount of field work.
- Identify the specific deliverables from these activities that must be completed

Tailoring by Complexity and Hazard

Guidance for such tailoring can be based on two dominant factors that affect the degree of difficulty of a facility D&D project. These are: a) complexity of the facility's engineered systems; and b) magnitude of the hazards associated with the materials it contains. These factors can be put in context as shown in Fig. 2.

Complexity ↓ / Hazard →	Low	High
Low	Office Buildings	Radioactive & Chemical Storage Facilities
High	Lightly Contaminated Research Facilities	Reactors, Canyons, etc.

Fig. 2. – Facilities Categorized by Hazard-Complexity

These categories form the basis for tailoring the project management requirements of DOE Order 413.3A to D&D projects. The following guidance is provided based which categories in Fig. 2 that a project's facilities fall in.

- **Low Complexity/Low Hazard facilities**, such as clean office buildings, require very little rigor in engineering and technical planning for D&D. These projects are relative straightforward and well within the "skill of the craft" such that there is no need to organize the project by the phases and critical decisions called for in DOE O 413.3A. Many such projects will cost less than the threshold set for application of the Order. Similarly, no benefit is gained by addressing the suggested activities in Table I and formally documenting the results.
- **High Complexity/High Hazard facilities** at the opposite end of the degree of difficulty spectrum are exemplified by reactors, canyons, and other process facilities. These require the highest level of rigor in engineering and technical planning for D&D. For these facilities, the project should be organized by the phases and critical decisions called for in DOE O 413.3A. Essentially all of the activities shown Table I should be addressed at each project phase and the results documented appropriately.
- **Low Complexity/High Hazard facilities** are those in which the safety and project risks are associated with the facility hazards, not the risks that derive from the complexity of the facility's engineered systems. This type of facility is one with a limited number of simple, but highly contaminated systems. An example is the heat source plutonium facility at the Savannah River Site. Only a small faction of the facility is contaminated with Pu-238 oxide, but because of the nature of the material

(high specific activity and small particle size), it is a high hazard facility. Rigor should be applied to those aspects of the facility that are the major contributors to its hazardous categorization.

- **High Complexity/Low Hazard facilities** are exemplified by a lightly contaminated research facility that may have employed complex process systems of piping and vessels but processed only cold or slightly contaminated chemicals. The safety and project risks are associated with the complexity of the process systems. Activities associated with nature and extent of contamination may not be significant challenges. Rigor should be applied to those aspects of the facility that are the major contributors to its complexity.

There are DOE facilities that would typically be considered low hazard facilities, but due to their age and/or lack of maintenance, their physical condition requires that they be managed as high hazard facilities. For example, there are facilities that would typically be considered high complexity/low hazard, but due to years of rain water intrusion and the resultant structural deterioration of floors, walls and roof, at least some areas of the facility are not safe for D&D worker entry. Such facilities should be managed as high complexity/high hazard facilities, although the inventory of hazardous materials that they contain may be low.

REFERENCES

1. "Implementation Guide for Surveillance and Maintenance during Facility Transition and Disposition", DOE G 430.1-2, U. S. Department of Energy (1999).
2. "Deactivation Implementation Guide", DOE G 430.1-3, U. S. Department of Energy (1999).
3. "Decommissioning Implementation Guide", DOE G 430.1-4, U. S. Department of Energy (1999).
4. "Transition Implementation Guide", DOE G 430.1-5, U. S. Department of Energy (2001).
5. "Decommissioning Handbook - Procedure and Practices for Decommissioning", DOE/EM-0383, U. S. Department of Energy (2000).
6. "Project Management for the Acquisition of Capital Assets", DOE M 413.3-1, U. S. Department of Energy (2003).