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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 applies the DOE O 413.3A Design/Engineering requirements to Deactivation and Decommissioning (D&D) projects. A list of 41 activities for which Design/Engineering is generally required and which are relevant and common to many 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. This paper also discusses tailoring the application of the Order to a facility based on the complexity of the facility's engineered systems and the hazards existing in the facility.

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 the engineering and design activities of D&D projects. This paper summarizes the guidance developed to date.

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 (CD) points at the end of these phases.

The engineering and design expectations described herein describe a new D&D project management paradigm. Field organizations that follow this guidance will see a measurable improvement in the quality and confidence of their project baseline. In the past it was sometimes assumed that a proposal prepared in response to a Request for Proposals (RFP) provided sufficient detail for the project conceptual design, as defined below. Although an accepted proposal by itself is insufficient to meet the requirements of a complete conceptual design, the project team has the option of reviewing the accepted proposal and deciding which parts can be incorporated in the conceptual design.

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 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 in the CD process for a D&D project.
- D&D involves a significant amount of engineering. The types of engineering activities, 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 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.

Specific D&D Engineering and Design Activities

Boxes 1 through 6 of Fig. 1 show the steps and decisions to identify the possible need for significant early expenditure for project definition.

A significant aspect of project management responsibility is to recognize when a project presents technical challenges requiring special attention and to be aware of uncertainties needing resolution 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. Projects with these types of technical challenges usually manifest themselves by the need for either or both of two types of technical activities:

- 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. Sufficient characterization information is needed for purposes of worker safety, deciding on D&D methods, and waste management.
- Technology identification and development to support D&D activities. That is, identifying adaptation of existing technology or the need for new technology for any of several reasons; for example: material stabilization and removal, 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. Investigation and development may need to go well beyond the indicated CD-1 and CD-2 guidance prior to arriving at a high confidence baseline for the entire project. In such cases, the timing of the project's critical decisions should be adapted to resolve such issues.

The steps for distinguishing among engineering and 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 are shown in Boxes 7 through 20 of Fig 2.

It is a key responsibility of project management to know which engineering and design activities are critical to their projects because the activities address significant technological challenges and/or they represent a significant portion of the overall project scope. In addressing individual activities, the following considerations are recognized in creating 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 and design progress addressed in this guidance is to be applied on a smaller scale, usually associated with a major facility and its ancillary structures and associated systems. Clearly it does not make sense to hold up the start of field work until the CD process has been completed for all facilities in a large group.
- For a D&D project at a level lower than the PBS level, boxes 7, 8, and 10 through 14 in Fig 2. indicate the logic for those activities that must be well developed for a baseline. Shown in Table I, is a compilation of 41 typical activities conducted for D&D projects for which design/engineering is generally required. The activities in this list should be evaluated for applicability to the project. Other engineering and design activities, though not listed, are also likely to be applicable to specific projects. Only a few of these activities are likely to be truly significant to the development of a reliable project baseline. In many D&D projects, these few activities will be clearly recognizable because of the clear technical challenges to conducting work within the facility.
- Many D&D projects create engineering and design deliverables for specific activities 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. This is indicated in boxes 15, 16, 13 and 17 in Fig. 1.
- Many facilities 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 the review and approval process required at each CD. Similarly, some D&D projects are funded for activities to be initiated in the field independent 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). This is indicated in boxes 18 and 19 in Fig. 1.

Combining critical decisions shown in box 9 is discussed earlier. The decision to combine CDs relates to overall project planning versus individual engineering and design activities, which are the subject of this guidance.

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 CD milestones is essential to satisfying the requirements of the order.

Conceptual Design Phase, CD-1

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."

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 may 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 level of detail for meaningful review, clear comprehension of specifics, and confidence appropriate to this stage of project technical development.

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. Providing the level of detail recommended in the following discussions can result in conceptual design equivalence.

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.

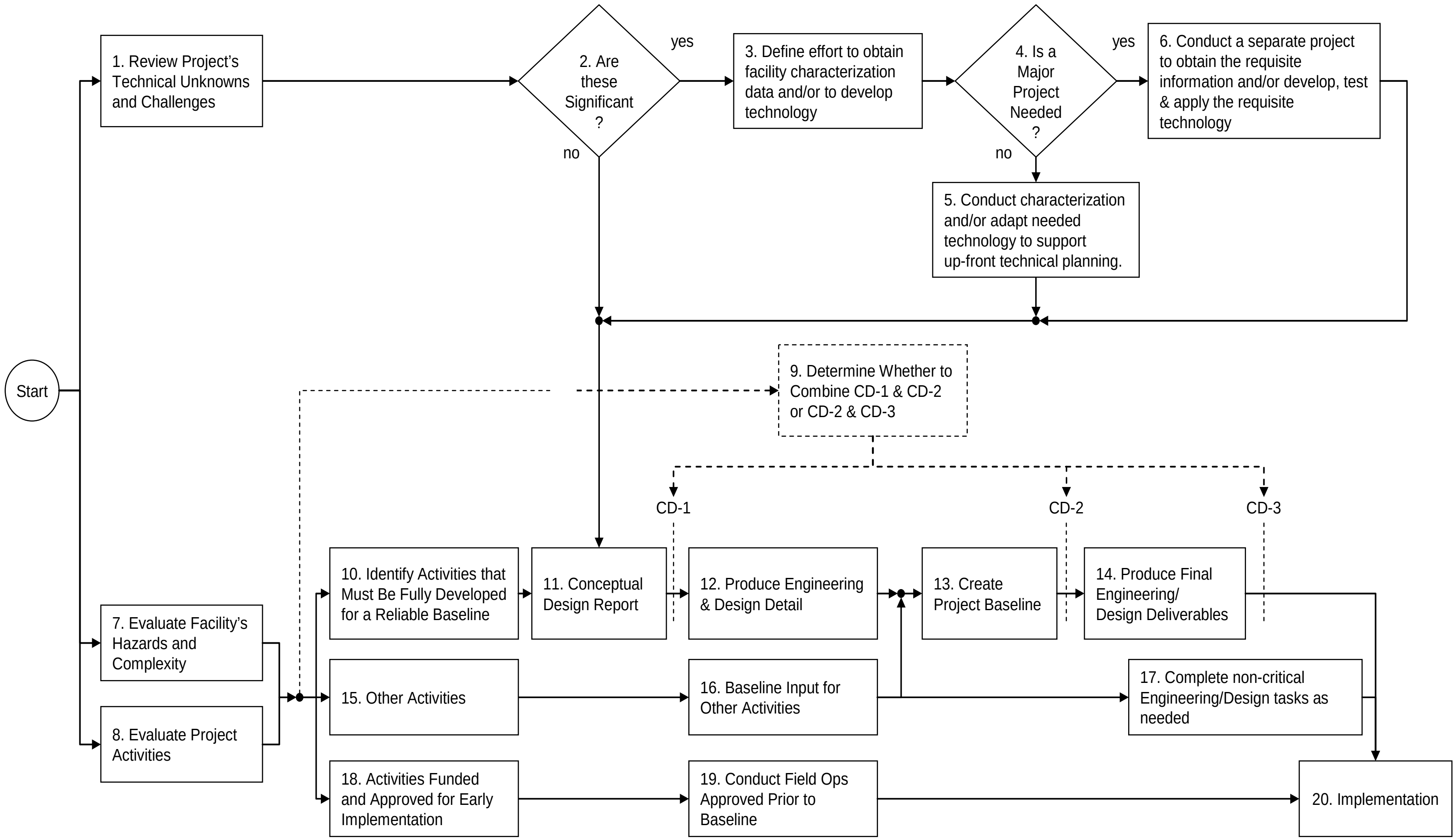

Fig. 1. – Decision Logic for Applying this Guidance

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 conditions to be achieved upon completion of a deactivation project; these conditions include: • end state, which is a vision of the overall facility status • end points, which are the detailed conditions to be achieved upon completion
3. Post-deactivation Surveillance & Maintenance (S&M) planning	For deactivation projects the purpose of this activity is to: • Layout the details of the deactivation activities for cases in which deactivation is to be followed by an extended S&M period. • Provide input to deactivation end points for which conditions are to be established to support post-deactivation S&M. • For decommissioning projects, to provide input for establishing physical conditions for activities that will be conducted after decommissioning is completed.
4. System deactivation and isolation	To establish the configuration for systems and equipment to be permanently shut down
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 preserved for future use.
6. Nuclear safety analyses	To evaluate safety of proposed activities involving nuclear materials and safety related SSCs • To evaluate the potential for Facility Hazard Category (FHC) reduction after hazard removal
7. Facility condition assessment	To ensure the safety of personnel during D&D by establishing the physical condition of the facility prior to initiation of D&D work • 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 provide input to waste management activities (see Activities #27 through #31) • To establish waste profiles for disposition planning
9. Characterization for compliance	To determine compliance with • Waste transportation regulations and disposal site Waste Acceptance Criteria (WAC) • End points verification • Decontamination to Resource Conservation and Recovery Act (RCRA) limits • Nuclear material accountability limits • Residual radiation and contamination requirements
10. Equipment dismantlement and removal planning	To identify what equipment must be removed to achieve the deactivation end points and their sequence and methods for removal
11. Size reduction	To cut equipment into smaller pieces for removal and/or shipping

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

Engineering/Design Activity	Purpose
12. Fluid systems drain, flush, and decontamination	To remove chemical and radioactive liquids and particulate from equipment and liquid systems for safe conduct of related D&D
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
14. Fixative application	To address contamination concerns through the use of fixatives to minimize potential for airborne contamination or prepare surfaces and/or equipment for demolition To engineer methods to achieve end points
15. Mockups	To improve operational proficiency for challenging stabilization, decontamination, and cleanout activities by providing worker input to processes and designs. Mockups are also used to debug and optimize application of technologies to specific situations
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. Shielding Design	To analyze, design and specify shielding as one element of radiological engineering
18. Building structural integrity	To verify that verify that structural integrity will support safe worker occupancy and D&D work, and 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 concealing equipment
25. 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

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

Engineering/Design Activity	Purpose
29. Waste conditioning and packaging	To address packaging configurations and necessary processing to satisfy both transportation requirements and disposal WAC
30. Waste staging	To ensure sufficient storage is available for waste management and support the logistics of container management
31. Waste transport and disposal	To comply with shipping regulations and disposal WAC
32. Facility isolation	To isolate a facility from all external utility systems
33. Temporary roads and access ways for heavy D&D equipment	To prepare site for the mobilization of heavy equipment needed for D&D
34. Temporary water for D&D	To provide water when needed for D&D activities
35. Completion verification survey	To verify that the decommissioning endpoints have been met with regard to residual contamination
36. Demolition method and sequence	To establish demolition method
37. Environmental requirements and controls for open air demolition	To insure that all required environmental analyses have been performed, regulatory permits obtained, and physical controls are in place and maintained during demolition
38. 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
39. Closure configuration	To specify materials and configurations to comply with an agreed upon end state
40. Decommissioning end state and end points	To specify the facility conditions to be achieved upon completion of a decommissioning project; these conditions include: • end state, which is a vision of the overall facility status • end points, which are the detailed conditions to be achieved upon completion
41. Operations and maintenance reduction	To reduce the operations, surveillance, and maintenance resources for the facility

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 required technical planning 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 to 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, radiation protection issues, and other project considerations.
- 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.
- 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 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.
- Identifying longer term monitoring systems, as applicable for a specified time period, where end states include "leave-in-place" conditions.
- 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.
- 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 of engineering and design activities 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 and 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 and design activities for CD-1 include:

- Identify the scope of facility isolation including facility 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 activities.
- 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 activities.
- 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 activities needed for equipment removal.
- Modeling potential airborne releases based upon approved remaining contaminant levels to demonstrate acceptability of the potential release.

Preliminary Design Phase, Approve Performance Baseline, CD-2

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. 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 Table I and other activities. Compared with a design-build project, most D&D BOEs will have considerably more labor 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 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 specifications for procurement of equipment and material, 5) details for on-site fabrication of components and assemblies, and others. Some engineering activities 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.

Following are sample activities for which to create these deliverables:

- 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, and equipment specifications.
- Specifying application of fixatives including location identification, selection of types, coverage specifications, and inspection requirements.
- 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, materials and package removal, dismantlement and demolition, including structural calculations and sketches or marked up drawings and/or photographs, sequence of steps, and reinforcing specifications.
- 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, and equipment specifications.
- 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, and detail attachments and supports.
- 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 single line diagrams, electrical termination and instrument loop schematics, and other documents as required.

Ready for Implementation, CD-3,

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." 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 for standard non-technically challenging activities are scheduled at a time prior to when they are needed.

TAILORING OF THIS GUIDANCE TO SPECIFIC PROJECTS

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 Identifying a Limited Number of Activities that are Significant to Baseline Development

Most of the activities listed in Table I will be applicable to most D&D projects. However, it is expected that for a typical project, only a few will be truly significant to the successful development of a reliable project baseline. Examination of the activities listed reveals that, for most projects, the scope of the activity and its implementation cost and schedule are adequately estimated by experienced project personnel. On the other hand, there will inevitably be a few activities specific to a project that have the potential for major impact on the project baseline, due to their known large scope or uncertainties associated with either the scope of the problem or the best method to resolve the problem. These activities must be identified and sufficient project resources applied to their development so that their contribution to the project baseline is reliably estimated.

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 on 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 $5M 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 in 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 fraction 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.

SUMMARY

DOE D&D projects are expected to meet the requirements of DOE O 413.3A. For D&D engineering and design activities only, this paper provides guidance for applying these requirements to the Order. A list of 41 typical D&D engineering and design activities has been provided. The Order divides projects into conceptual, preliminary and final design phases. Development of each of the 41 activities can also be organized in conceptual, preliminary and final levels. In general, at the conceptual level project engineers should be determining the what (i.e., the scope) for each activity. At the preliminary level they should be resolving how the activity will be accomplished. At the final level, all the engineering and design details for the activity should be completed so that the activity is ready to implement in the field. It may not be appropriate that development of each individual activity correspond to the current phase of the project. For example, at CD-2 (end of the preliminary design phase) not all activities need be developed to the same level of detail. Only those that are truly significant to the project baseline must be developed to the level of detail necessary to create a reliable project baseline.