RE-DEFINING THE ROLE OF CONCEPTUAL DESIGN FOR ENVIRONMENTAL RESTORATION ACTIVITIES

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ABSTRACT

This paper is concerned with the changing role of conceptual design in Department of Energy projects as their focus shifts from traditional civil and construction activities to environmental restoration. The paper discusses (1) using conceptual design to link the CERCLA RI/FS process with Title II design, (2) schedule and logic for sequencing activities, (3) management approaches to scoping and controlling preparation of Conceptual Design Reports for large, complex remedial activities, (4) administrative issues such as using the Conceptual Design Report to fulfill Federal Facility Agreement commitments for a Remedial Design Work Plan, and (5) streamlining approaches such as value engineering principles, the observation approach, and the data quality objectives process.

USING CONCEPTUAL DESIGN TO LINK THE CERCLA RI/FS PROCESS WITH TITLE II DESIGN

Traditionally on DOE projects, conceptual design focuses on the early phases of planning in order to support Congressional or internal budget appropriations. For large CERCLA projects, however, conceptual design can best serve as a vital link between the RI/FS and "Title" engineering. DOE Orders and Project Management Procedures define the various components and the goals of conceptual design. However, some of these definitions should only be used as guidelines when they are applied to conceptual design of environmental restoration projects. For example, a "Systems Requirements Document" would not be the logical basis for conceptual design. Instead, the Conceptual Design Report must be based on alternatives established in the feasibility study.

The feasibility study can set the framework for conceptual design because this study typically deals with "big picture" decisions, i.e., whether remediation is needed and identification of preferred treatment methods and technologies. Significant intermediate level decisions are often left to be worked out during later design phases. However, given the National Contingency Plan requirement to achieve continuous and substantive on-site remedial actions within 15 months of the Record of Decision (ROD), complex projects cannot afford to defer these important intermediate decisions to final design.

The ROD usually lags behind issuance of the RI/FS and Proposed Plan by as much as a year. Therefore, conducting conceptual design in parallel with the ROD process makes it possible to study the intermediate decisions before detailed "Title" design commences. In fact, conceptual design can aid in preparation of the ROD by providing a better understanding of how a preferred alternative, as identified in the proposed plan, will be carried out and how the applicable or relevant and appropriate (ARAR) requirements will effect implementation.

Those responsible for the decision as to whether or not conceptual design should proceed in parallel with the ROD need to consider whether conceptual design should include multiple feasibility study alternatives or only the components of the alternatives that are common to each. If conceptual design focuses only on the preferred alternative, there is obviously a risk that alternative will not be selected by the ROD process. At the same time, however, on a complex, long-term environmental restoration project, the benefit of shaving a year or so off the schedule may outweigh the cost of carrying multiple alternatives through the conceptual design process.

One of the biggest advantages of starting conceptual design as early as possible is that data needs, or other needs requiring long lead times (e.g., investigations, purchases, establishing agreements with other business or government organizations) can be identified early on. Data that have been adequate for a feasibility study may not be adequate for engineering calculations and designs. However, if sampling and testing requirements are identified in the conceptual design report, the needed activities can be undertaken before detail (Title II) design engineering begins. (Examples of how data gaps can be identified are discussed below under "Streamlining Approaches.")

SCHEDULE AND LOGIC FOR SEQUENCING ACTIVITIES

Another role of conceptual design in transition from the feasibility study to "Title" design is to detail the remediation schedule in the Cost and Schedule portions of the Conceptual Design Report. Sequencing the phases of a remedial action and performing a comprehensive systems analysis provides an early warning of critical path items which need to be addressed prior to the beginning of "Title" design work. Conceptual design provides a logical progression for site development planning and supports refinement of budgets and annual funding requirements.

Completion of the Conceptual Design Report, especially if it occurs at about the same time the ROD is signed, should constitute a project milestone that will trigger at least a major revision and possibly a re-baselining of the project configuration. Everyone knows how difficult it is to establish a realistic project baseline ahead of the ROD. The point in time when the ROD is signed and the Conceptual Design Report is finished may be the first opportunity to establish a good configuration management baseline.

MANAGEMENT APPROACHES TO SCOPING AND CONTROLLING PREPARATION OF CONCEPTUAL DESIGN REPORTS

The management approach to conceptual design should allow for plenty of flexibility. The number of alternative actions that should be carried through the conceptual design process (assuming that conceptual design and the ROD process are conducted in parallel) depends on site specific considerations and good judgement. A well balanced team of professionals that includes experts in scoping and planning and also experts in the various engineering and technical disciplines should be assembled. Scoping is critical to defining each design task, defining a consistent format for the conceptual design investigations and report (see discussion of streamlining below), and developing a systems approach. A well scope action plan which identifies all organizational interfaces is essential to maintaining control of a conceptual design project.

The scoping document delineates the overall objectives, states management and task responsibilities, provides lists of key references, and breaks the total design into manageable task segments. An annotated outline of the Conceptual Design Report should also be developed during scoping activities so that task leaders can know exactly how the report will be structured and how their portions will fit into the whole.

Pulling together all the components of a remedial design can be an extremely complex task. A small change in one design can affect many other efforts. Therefore, a systems approach needs to be implemented so that all parties can understand how various individual designs interface with each other. Task leaders should be picked on the basis of experience and expertise in environmental restoration, but they must also be able to interact well with other team members. Some engineers are detail oriented (separators) and some are conceptualizers (lumpers). Both "lumpers" and "separators" are needed and, in the right combination, they can produce high levels of project synergy.

ADMINISTRATIVE ISSUES

Planning and scoping a conceptual design effort should not be limited to the technical and personnel areas. Administrative issues should also be considered because it may be possible to use conceptual design deliverables to fulfill other project requirements.

For example, most Federal Facility Agreements specify that a Remedial Design Work Plan must be prepared for review by the EPA and/or state agencies. The Federal Facility Agreement normally specifies that this work plan must include design criteria and a design schedule, and it must identify post-ROD primary and secondary documents, including their target completion dates. Many of these requirements can be met as part of the Conceptual Design Report. If the EPA and state agencies agree, it makes sense to furnish this information in the Conceptual Design Report and avoid preparing a separate Federal Facilities Agreement deliverable.

STREAMLINING APPROACHES

The streamlined approach to conceptual design is aimed at achieving three objectives: (1) making and documenting the intermediate level decisions needed to design and carry out the remedial action, (2) identifying and managing uncertainties, and (3) defining at an early point any additional data needed to complete final design.

On large, complex environmental restoration projects, many intermediate level decisions will have to be made. Such decisions cannot, and should not, be made during the feasibility study process. At the same time, they cannot be deferred to Title II design. To manage these decision processes and ensure that comprehensive analyses are performed and the results effectively communicated, a very structured approach is required.

The first step toward achieving these three key objectives is to recognize the natural tendencies of engineers to rely on professional judgement in the early phases of the process to identify a preferred option and focus subsequent design analysis primarily on that option. Although this approach works very well in many areas of design, it is not appropriate in the environmental restoration field. In this field, the technical rationale and decision criteria behind every decision must be thoroughly documented in order to support the extensive review and oversight activities that are an inherent part of most large projects.

Since final design builds on conceptual design information, it is possible (some would say likely) that at the 90% final design stage, questions will be raised about certain components, pieces of equipment, or design approaches. Since decisions regarding such matters are often made during conceptual design, the conceptual design report should describe a process whereby a wide range of ideas or options (within the framework established by the feasibility study) are examined. The process should be both a sieve and a funnel, filtering out difficult issues and focusing the range of analysis required in final design.

In order to ensure that options and alternatives are analyzed comprehensively, a modified value engineering technique can be used. This technique borrows principles of traditional value engineering, but modified so that cost is not the sole driver for selection criteria. The technique is implemented by assembling a team of professionals for about a week to brainstorm ideas, define comparative criteria, and select the preferred alternative. It is important that the alternatives remain within the framework established by the feasibility study.

The primary advantage of this approach is that it provides a simple, structured mechanism to quickly document the analyses of various options. Although informal, the record of a session will ensure that a comprehensive analysis has been performed, provide reference material should questions arise in the future, and rank alternatives so that if the preferred alternative does not work out, the next highest ranking alternative can be pursued rather than starting the task over. Figure 1 displays an established format for summarizing the results of a modified value engineering session.

These tables can also serve as a format for presenting the results of the value engineering sessions in the Conceptual Design Report. The tables can facilitate presentation of the most complete information possible with regard to the authors' thoughts, analyses, and technical rationale and logic. If such information were presented as standard text, much of the technical rationale and comparative analysis information would likely be lost.

This is particularly important when the authors of the Conceptual Design Report will not also be performing Title

II design. In such a case, it is critical that the Conceptual Design Report recreate the thought process and analyses that have led to the conclusions and preferred approach. The modified value engineering technique provides an effective tool for accomplishing the analyses, and developing the tables provide a nice tool for presenting the results.

The second streamlining tool deals with handling a lack of data. This tool borrows principles from the observational approach. The observational approach is a technique for defining expected conditions, analyzing reasonably foreseeable deviations, establishing mechanisms to identify if/when these deviations occur, and preparing a contingency plan to mitigate any adverse effects of deviations. In conceptual design, this may involve identifying a preferred piece of equipment on the basis of reasonable assumptions (the expected conditions). Potential deviations are assessed and their impact on design, should they occur, is defined.

For instance, a minor deviation may be handled by modifying operating procedures. On the other hand, a major deviation may require specifying a different type of equipment or component.

For minor deviations (i.e., deviations involving low probability of occurrence, long response times, or minor impacts) only a general response plan is required. However, for major deviations (i.e., high probability of occurrence, short response times, or major impacts), either additional data must be collected so that the deviations and their implications can be fully understood, or a detailed response plan must be in place. This detailed plan must outline the technical, contractual, and administrative steps required to manage the deviations. Figure 2 is a suggested format for performing this type of analysis.

Use of the observational approach in this application will definitely strengthen the Conceptual Design Report. This type of analysis provides a structured mechanism for thinking through project uncertainties so that "what if" scenarios can be identified and plans can be developed in advance to resolve potential problems.

The third streamlining tool can be used to define data needs for final design. It borrows from the data quality objective process. The intent is to focus data collection activities to address exactly the information needed to advance the design process. Specific questions are developed that must be answered before design can proceed. This eliminates unnecessary and poorly defined data collection activities. Figure 3 summarizes the types of information developed using this approach.

In combination, these three approaches provide an excellent strategy for guiding conceptual design activities. The modified value engineering exercise forces development of various approaches and selection of a preferred one. The observational approach provides a broader look at the assumptions used in the design basis and forces creation of a plan to address deviations from the preferred approach. The data quality objectives effort focuses on those deviations. If a deviation is identified that would cause unacceptable risk to the design, data collection activities are pursued in a focused way to gain information necessary to determine the likelihood and impacts of the occurrence.

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Evaluation Criteria	List Alternatives	Advantages/Disadvantages	Preferred Alternative
✓	✓	✓	✓
✓	✓	✓	
✓	✓	✓	

Fig. 1. Results of modified value engineering.

Preferred Component	Expected Conditions	Potential Deviations	Probability for Occurrence	Affect on Design
✓	✓	✓	(Low, Medium, High)	✓
(From Figure 1)	✓	✓		✓
	✓	✓		✓

Fig. 2. Observational method.

List of Potential Deviations	Potential Deviations Affecting Design	Specific Questions to be Answered	Data Collection Activities
✓	✓	✓	✓
✓		✓	✓
✓		✓	✓
(From Figure 2)			

Fig. 3. Data quality objectives.