Design Considerations for In Situ Chemical Oxidation

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Module 1: Purpose

Learning Objectives

By the end of this section, you will be able to:

- **Identify** the core challenges associated with the lack of standardized design formats for in situ remediation systems.
- **Evaluate** the primary components of the framework provided for the design and planning of In Situ Chemical Oxidation (ISCO) systems.

Executive Summary: This course establishes a standardized framework for the design, planning, and implementation of ISCO systems, bridging the gap between less mature in situ technologies and established ex situ remediation standards by incorporating best practices and lessons learned from a variety of hazardous waste sites.

Design Framework and Objectives

Most **in situ remediation systems**, specifically **In Situ Chemical Oxidation (ISCO)**, are technically less mature than established **ex situ** methods like pump-and-treat or conventional wastewater treatment systems. Consequently, the industry faces a lack of consistent design information, formats, and standards. This inconsistency often leads to design submittals that vary significantly between projects, complicating the regulatory review and implementation process.

The primary objectives of this technical framework include:

- **Establishing a Design Basis**: Providing a consistent structure for planning and designing ISCO systems.
- **Best Practices**: Summarizing industry-proven methods for ISCO design to ensure technical efficacy.
- **QA/QC Integration**: Defining appropriate **Quality Assurance (QA)** and **Quality Control (QC)** measures necessary for successful project outcomes.
- **Resource Consolidation**: Listing available standards and references to streamline the design process.

💡 **Design Tip:** While in situ designs are less standardized than ex situ systems, leveraging lessons learned from established hazardous waste sites allows for a design format that is both professional and scalable to the specific scope of your project.

Checkpoint Quiz

1. **Why do design submittals for ISCO systems currently vary widely between projects?**
   a) Lack of chemical reagents available on the market.
   b) In situ technologies are more mature than ex situ systems.
   c) Lack of readily available or consistent design standards and formats.
   d) ISCO is only used for small-scale projects.

Answer: (c). Design information and standards for in situ systems are not as readily available or consistent as those for ex situ systems.

2. **Which of the following is a primary purpose of this course framework?**
   a) To mandate a single proprietary injection tool for all sites.
   b) To provide a summary of best practices and QA/QC measures for ISCO design.
   c) To replace the need for site-specific engineering judgment.
   d) To focus exclusively on ex situ wastewater treatment.

Answer: (b). The course provides a framework for design, best practices, and QA/QC measures.

3. **How should the information provided in this framework be utilized by a Professional Engineer?**
   a) It must be used as a rigid template regardless of site conditions.
   b) It should be ignored if ex situ options are available.
   c) It can be incorporated into a design format suitable to the specific project scope.
   d) It is intended only for academic research, not field application.

Answer: (c). The information is designed to be readily incorporated into a format that fits the specific scope of the engineering project.

Module 2: Remedial Design Documents

Learning Objectives

By the end of this section, you will be able to:

- **Identify** the minimum required components for a remedial design document package.
- **Evaluate** the appropriate application of streamlined submittal approaches, such as the Work Plan or Design-Build methods.
- **Select** the correct design phase (Conceptual vs. Final) based on project complexity and execution requirements.

Executive Summary: Successful ISCO implementation requires a structured set of design documents—ranging from the Basis of Design to detailed Monitoring Plans—that can be streamlined via Work Plan or Design-Build approaches to address site-specific uncertainties and project-specific procurement needs.

Minimum Components of Remedial Design

At a minimum, remedial design documents must comprise the following elements to ensure technical and regulatory compliance:

- **Basis of Design**: Includes the conceptual site model (CSM), design rationale, supporting calculations, and a comprehensive description of the design.
- **Drawings**: Detailed prescriptive or performance-based drawings describing system construction, operation, and maintenance (O&M).
- **Specifications**: Performance-based details for the construction and O&M of the system.
- **QA/QC Plans**: A project-specific Contractor Quality Control (CQC) Plan featuring provisions for construction monitoring.
- **Monitoring Plans**: Comprehensive details regarding process and performance monitoring, including specific locations, parameters, and sampling frequency.
- **Schedule and Milestones**: A phased timeline of the design and implementation process.
- **Cost Estimate**: In specific cases, a construction cost estimate with +/- 10% accuracy for bidding.

Phased Design Submittals

Remedial designs are typically executed in distinct phases based on the level of detail provided:

- **Conceptual Design (10% to 15%)**: Provides basic project information, including the conceptual site plan and preliminary drawings.
- **Preliminary Design (35% to 50%)**: Conveys the complete design in a preliminary manner. While not finalized, this level of detail is often sufficient for environmental project execution.

- **Detailed/Final Design (90% to 100%)**: A highly detailed package required for complex projects, including all necessary execution details and accepted revisions.

Streamlining Submittal Approaches

Due to the relatively simple nature of many in situ systems, submittals can be streamlined without sacrificing the core design components.

Work Plan Approach

This involves combining all design components into a single work plan format for a three-phase review (draft, draft-final, and final).

- **Draft Review**: Typically corresponds to 15% to 35% design (Conceptual).
- **Draft-Final Review**: Typically corresponds to 50% to 60% design (Preliminary).
- **Final Submittal**: Corresponds to 90% to 100% design.

💡 **Design Tip:** One contractor may develop the conceptual design to bid the project, while a second contractor (such as a Remedial Action Contract or RAC contractor) finalizes the design after the award is made.

Design-Build (DB) Approach

The DB approach is less prescriptive and combines drawings with performance-based specifications.

⚠️ **Safety Constraint:** A Design-Build approach is appropriate when site uncertainties—such as data gaps or "treatment train" methods—require the design to evolve even after construction has begun.

Evaluation for Design-Build Contracts

- **Award Criteria**: Based on "Best Value" rather than "Lowest Price" to account for technical variations caused by site uncertainty.
- **Technical Metrics**: Understanding is demonstrated through experience with the remedy, similar site conditions, and innovative technical approaches.
- **Regulatory Limits**: Internal design reviews are at the client's discretion within limits set by CERCLA, RCRA, or other state permits.

Checkpoint Quiz

1. **Which design phase is often considered sufficient for the execution of environmental projects, even if the drawings are not finalized?**
   a) 10% to 15% Design
   b) 35% to 50% Design
   c) 70% to 80% Design
   d) Only 100% Design

Answer: (b). For many environmental projects, the level of detail in the 35% to 50% package is sufficient for project execution.

2. **In a Design-Build approach, what is the primary objective of using performance-based language rather than prescriptive requirements?**
   a) To reduce the total number of required drawings.
   b) To avoid including a Basis of Design.
   c) To avoid limiting the range of options available to the remediation contractor.
   d) To eliminate the need for regulatory agency approval.

Answer: (c). This allows the design to evolve with site uncertainties.

3. **When a project is competitively bid under a Design-Build approach, how is the award typically determined to account for site uncertainties?**
   a) Lowest price only.
   b) Fastest delivery schedule.
   c) Best Value evaluation (technical understanding and price).
   d) Geographic proximity of the contractor.

Answer: (c). This accounts for approach variations and technical understanding.

Purchase this course to see the remainder of the technical materials.