

**FINAL  
WORK PLAN FOR AREA OF CONCERN 65  
IN-SITU CHEMICAL OXIDATION BENCH-SCALE  
TEST**



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## ACRONYMS AND ABBREVIATIONS

AOC	Area of Concern
APPL	Agriculture & Priority Pollutants Laboratories, Inc.
CSSA	Camp Stanley Storage Activity
EE	Environmental Encyclopedia
FMC	FMC Environmental Solutions Corporation
HNO <sub>3</sub>	nitric acid
ISCO	in-situ chemical oxidation
KDT	Klozur Oxidant Demand Test
kg	kilogram
lb	pound
MSDS	Material Safety Data Sheet
PCE	tetrachloroethene
SOD	Soil Oxidant Demand
TCE	trichloroethene

## SECTION 1 INTRODUCTION

### 1.1 STATEMENT OF OBJECTIVE

This document serves as both an addendum to the existing Camp Stanley Storage Activity (CSSA) *Work Plan*, February, 1996 (see CSSA Environmental Encyclopedia (EE, www.stanley.army.mil), Volume 1-1, Work Plan) and Work Plan addenda contained therein, and an addendum to the existing CSSA *Field Sampling Plan*, February, 1996 (CSSA EE, Volume 1-4, Field Sampling Plan) and Sampling and Analysis Plan addenda contained therein. Results of the in-situ chemical oxidation (ISCO) bench-scale test will be documented in a technical memorandum specific to the activity described below.

### 1.2 PLANNED ACTIVITIES

This work plan provides a general description of the activities and requirements for completion of ISCO bench-scale testing at Area of Concern (AOC)-65:

- Collection of unimpacted bedrock samples correlative to media found within AOC-65 for Soil Oxidant Demand (SOD) testing;
- Collection of materials (gravel and clay) used in the construction of infiltration gallery for SOD testing;
- Collection of leachate from SOD testing for metals analysis; and
- Collection of uncontaminated groundwater for use in SOD testing.

Existing Work Plans and Quality Control Plans for current and previous CSSA task orders fulfilled by Parsons remain in effect and are available in the *CSSA EE, Volume 1-1, Work Plan*. General activities to be conducted will follow the provisions of those prior documents, as applicable. General descriptions of site history, geology, and hydrogeology are also found in the CSSA EE. The following paragraphs describe the planned field activities and procedures to be completed.

The collection of various samples (correlative bedrock/soil, groundwater, and construction materials) will be performed to facilitate SOD testing to determine appropriate ISCO oxidant/activator mixture for application within an infiltration gallery installed at AOC-65. The infiltration gallery consists of a 12 to 15-foot deep trench 42 inches wide and 300 feet long backfilled with quartz gravel and clay creating three discrete ISCO solution infiltration zones. The infiltration gallery design and installation requirements are provided within the Interim Removal Action workplan and associated appendices.

Klozur<sup>®</sup> sodium persulfate and subsequent activation utilizing high pH (via sodium hydroxide) has been selected for pilot-scale application treatability study testing at AOC-65 to determine the efficacy of ISCO for tetrachloroethene (PCE) and trichloroethene (TCE). Klozur activated persulfate is a strong oxidant capable of mineralizing a wide range of contaminants, including chlorinated solvents. Activation of the persulfate anion generates the sulfide radical, which drives the rapid destruction of the contaminants of concern. Prior to the initiation of an

ISCO treatability study, preliminary SOD tests should be performed to determine the oxidant demand likely to be encountered in the subsurface.

Chemical oxidants do not target specific compounds, rather will mineralize not only the contaminant of concern, but oxidize soil organics, reduce metals, and other organic species present. Additionally, activated persulfate will undergo auto-decomposition as a function of temperature, concentration, and activation method. Quantification of the demand upon the activated persulfate from these components is necessary to develop appropriate persulfate and activator dosing for field applications during treatability testing.

SOD analysis will be conducted by FMC Environmental Solutions Corporation (FMC) laboratories using FMC's Klozur Oxidant Demand Tests (KDT). KDT measures the consumption of activated persulfate after a 48 hour and 96 hour period when exposed to a non-contaminated, representative soil sample from the site. The test is performed using the selected persulfate activation chemistry (high pH) to account for the impact of the activator (sodium hydroxide) on the persulfate lifetime.

## SECTION 2 SAMPLE COLLECTION

### 2.1 GENERAL

Six samples will be collected for SOD testing. The samples will include both bedrock/soil samples and infiltration gallery construction materials (quartz gravel and clay). The inclusion of the construction materials for SOD testing will ensure that an appropriate mixture of oxidant and activator is achieved and maintained within the gallery prior to infiltration into the subsurface. A total of six (6) KDT tests will be performed. Additionally, one leachate sample will be collected following the completion of KDT testing.

### 2.2 SCOPE OF WORK

To facilitate the requirements of the soil oxidant demand likely to be encountered at AOC-65 upon the injection of the chemical oxidant Klozur and activated with sodium hydroxide, six samples will be collected and be subjected to FMC's KDT test. Bedrock samples will be collected from cores collected approximately 2,000 feet south-southeast from AOC-65 at the former waste water treatment plant. The geology at the former treatment plant correlates with the geology at AOC-65 and is not associated with chlorinated solvent contamination. Samples of the ISCO infiltration construction materials will also be subjected to KDT tests. Specific media for the six KDT tests is given in **Table 2.1**.

**Table 2.1**

**Soil Oxidant Demand Test Media and Quantity**

Sample ID	Media	Configuration
AOC65-KDT-01	Bedrock	Core (1 kg)
AOC65-KDT-02	Bedrock	Core (1 kg)
AOC65-KDT-03	Bedrock	Crushed (1 kg)
AOC65-KDT-04	Quartz Gravel	Gravel (1 kg)
AOC65-KDT-05	Clay	Compacted (1 kg)
AOC65-KDT-06	Bedrock/Gravel/Clay	Composite (0.33 kg each; 1 kg total)

### 2.3 KDT SAMPLE REQUIREMENTS

For each test one kilogram (kg, 2.2 pounds [lbs]) of representative media is required. Bedrock samples will be sent to the lab as 1 kg sections of intact core. As given in Table 2.1, three 1 kg samples of bedrock are required. Two of the three bedrock samples will be tested as cores; the third will be crushed at the lab and used to generate the most conservative SOD value

(SOD values are affected by surface area). Once crushed, there will be a much greater exposed surface than the original core. Currently, gravel intended for use as backfill for the infiltration gallery is stockpiled on site and a 1 kg sample will be required. Similarly, once on site, a sample of clay intended to separate the trench into three distinct infiltration zones will be collected. Finally, the composite sample of bedrock (intact core), gravel, and clay will be collected in three-part aliquots of 0.33 kg (0.73 lbs) each and mixed together in the sample container.

In addition to soil and construction material samples, the KDT tests require 2 liters (per sample) of unimpacted groundwater. To accommodate this requirement, 12 liters of raw groundwater will be collected from CS-10, approximately 5,000 feet north-northeast of AOC-65.

## 2.4 KDT SAMPLE SHIPPING

Containers containing soil samples shall be filled to the brim and sealed with tape, as appropriate. Bedrock core samples will be kept as intact as possible and shipped in zip-lock bags. Groundwater samples will be collected in four 1-gallon (3.8-liter) containers. The groundwater containers shall be filled and sealed with minimal headspace.

Collected samples will be placed in a cooler for shipping. Samples do not have to be packed in ice for shipping. An FMC KDT order form (**Appendix A**) will be completed and shipped with the samples. Samples will be shipped to:

FMC Corporation  
c/o: Eric Krueger  
78 Sawyer Ave.  
Tonawanda, NY 14150  
Office: (716) 879-0418  
Fax: (716) 879-0496

## 2.5 KDT LEACHATE SAMPLING

Following the completion of the KDT testing, a sample of the leachate will be collected for metals analysis. The leachate sample will be collected by FMC laboratory personnel from the Klozur/activator/groundwater mixture at the end of the 96 hour exposure period. A 250 milliliter sample bottle with nitric acid (HNO<sub>3</sub>) preservative will be provided by Agriculture & Priority Pollutants Laboratories, Inc. (APPL). Additionally, a material safety data sheet (MSDS) for the preservative (HNO<sub>3</sub>), labels and a partially completed chain of custody will be included with the sample containers shipped from APPL to FMC. The leachate sample bottle should be filled to approximately 90% capacity, labeled and clear packing tape placed over the label before packing for shipping.

Additionally, once the KDT testing is complete, one of the intact cores will be analyzed for metals. The core designated for metals analysis will be placed in a container (included in the sample bottle shipment) by FMC laboratory personnel and sent with a completed chain of custody to APPL. Analyzing one of the intact cores for metals following KDT analysis will be performed only if APPL is unable to analyze the KDT leachate due to elevated risks to equipment because of high oxidant/activator concentrations.



## **2.6 KDT LEACHATE SHIPPING**

The leachate sample bottle and intact core will be placed in a cooler and packed in ice. A completed chain of custody and HNO<sub>3</sub> MSDS will be included with the sample(s). Sample(s) should be shipped to:

APPL Laboratories  
Sample Receiving  
908 N. Temperance Ave.  
Clovis, CA 93611  
(559) 275-2175

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## SECTION 3 BENCH-SCALE TEST REPORTING

### 3.1 GENERAL

Upon receipt of laboratory data from FMC and APPL, a technical memorandum will be prepared outlining the results of SOD and metals analyses. This memorandum will also outline the planned infiltration volumes and target concentrations of oxidant and activator for ISCO application within the ISCO infiltration trench at AOC-65.

### 3.2 SOD ANALYSIS

Results of the KDT tests will be provided within an FMC report including documentation of:

- Performing Laboratory,
- Analytical Methods,
- Sample Handling Procedures,
- Results, and
- Conclusions

Oxidant/activator volumes and mixing ratios for future pilot-scale field testing will be based largely on the recommendations provided within the SOD testing report. Analysis of the KDT data will be presented in an ISCO bench-scale testing technical memorandum.

### 3.3 METALS ANALYSIS

Results of the leachate and/or core samples will be provided in a lab report provided by APPL. The leachate testing is designed to determine whether naturally occurring metals within the bedrock will be mobilized during ISCO treatment. Analysis of the lab data will be presented in an ISCO bench-scale testing technical memorandum.

**Appendix A**  
**Klozur<sup>®</sup> Oxidant Demand Test Information**

# FMC Environmental Solutions



## Klozur® Soil Oxidant Demand Test

### Background

When applying Klozur® persulfate to contaminated soil, a portion of the Klozur persulfate will be utilized reacting with the contaminants of concern. However, Klozur persulfate will also react to some extent with oxidizable components of the soil and groundwater, such as soil organics and reduced metals. This is known as the Soil Oxidant Demand (SOD), or Natural Oxidant Demand (NOD), and is a measure of how much additional activated persulfate is needed over the contaminant demand on the oxidant. The SOD is site dependent, and can vary with soil type and the amounts of organic fraction metals content in the soil. It is important to measure SOD for the site soils and groundwater prior to applying Klozur persulfate in the field. If SOD is not accounted for when determining the total persulfate demand for a site, then there is a possibility that the persulfate may be under dosed, resulting in incomplete contaminant destruction or rebound.

FMC's Klozur Soil Oxidant Demand Test (KDT) measures the consumption of activated persulfate after a 48 hour and 96 hour period when exposed to a non-contaminated, representative soil sample from the site. The test is run with the persulfate activation chemistry to account for the impact of the activator on the persulfate lifetime. It is important that the KDT test be performed with non-contaminated soil, because if the soil contains significant contaminant concentration, the apparent SOD demand will be inflated as a result of persulfate consumption from the contaminant. The contaminant demand is not quantified during a KDT test, and this would lead to an over-estimation of the total persulfate demand for a site.

### Test Cost

A KDT test costs \$600 per soil sample per activator. A report will be issued following the completion of the study.

### Sample Requirements

**Soil:** 1 kg of the representative soil. Please do not send more than 1 kg. Fill to the brim of the container with no airspace on top. Seal with tape. The samples do not need to be packed in ice.

**Groundwater:** 2 liters of groundwater. Please do not send more than 2 liters. Fill to the top of the container with minimal air bubble. Seal with tape. The samples do not need to be packed in ice.

**Note:** as this is not a treatability study, and the samples should not contain contaminant, there is no need to pack samples on ice and insure perfect seals on the containers.

# FMC Environmental Solutions

## Sample Shipping

Samples should be shipped to:

Eric Krueger  
FMC Corporation  
78 Sawyer Ave.  
Tonawanda, NY 14150  
716-879-0418 (office)  
716-879-0496 (fax)

*Please contact an FMC technical sales representative prior to shipping samples. Samples should include information regarding the number of tests to be run and which persulfate activator is being investigated.*

## Billing Information

Please include information as to billing:

Name  
Company  
Address  
Phone  
e-mail address

Billing will be done by invoice. **FMC does accept VISA and Master Card (no other cards accepted).**

**If not using a credit card and you have not previously purchased products or services from FMC, you will need to file a credit application form with FMC prior to the Klozur demand test is performed. The credit application form can be found below.**

# FMC Environmental Solutions

## KDT Order Form

If billing information is different:

Company: \_\_\_\_\_

\_\_\_\_\_

Address: \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

Contact Name: \_\_\_\_\_

\_\_\_\_\_

Telephone Number: \_\_\_\_\_

\_\_\_\_\_

Fax Number: \_\_\_\_\_

\_\_\_\_\_

E-Mail: \_\_\_\_\_

\_\_\_\_\_

Number of Soil Samples \_\_\_\_\_

Number of GW Samples \_\_\_\_\_

If more than one sample, do you want each soil sample tested separately or homogenized into one sample? \_\_\_\_\_

Site Identification (if report should identify site where samples are from) \_\_\_\_\_

Sample #	Sample Identification	Sample Note (special instructions, comments, etc)

Select which activators you wish tested:

High pH - 25% NaOH _____	High pH – lime _____	Other (please specify) _____
Hydrogen peroxide _____	FeEDTA _____	

Please identify FMC technical representative providing support: \_\_\_\_\_

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# FMC Environmental Solutions

## CREDIT APPLICATION

(please fill out and return to fax number below if you have not previously purchased FMC products or services)

### Credit Department

Phone: 215/299-6767

Fax: 215/299-5901

Attn: Tony Basile

In order to purchase on an open account basis, please complete the following application and return to the above address. Please attach a copy of your latest financial statement/annual report to this form.

Company Name \_\_\_\_\_ Phone \_\_\_\_\_

Street Address \_\_\_\_\_

City \_\_\_\_\_ State \_\_\_\_\_ Zip Code \_\_\_\_\_

Parent Company (if subsidiary) \_\_\_\_\_

Street Address \_\_\_\_\_

City \_\_\_\_\_ State \_\_\_\_\_ Zip Code \_\_\_\_\_

Purchasing Agent \_\_\_\_\_

Financial Representative \_\_\_\_\_

Bank Name \_\_\_\_\_ Account Number \_\_\_\_\_

Address \_\_\_\_\_ Phone \_\_\_\_\_

City \_\_\_\_\_ State \_\_\_\_\_ Zip Code \_\_\_\_\_

### Trade References

(1) Name \_\_\_\_\_ Phone \_\_\_\_\_

Address \_\_\_\_\_ FAX \_\_\_\_\_

City \_\_\_\_\_ State \_\_\_\_\_ Zip Code \_\_\_\_\_

(2) Name \_\_\_\_\_ Phone \_\_\_\_\_

Address \_\_\_\_\_ FAX \_\_\_\_\_

City \_\_\_\_\_ State \_\_\_\_\_ Zip Code \_\_\_\_\_

(3) Name \_\_\_\_\_ Phone \_\_\_\_\_

Address \_\_\_\_\_ FAX \_\_\_\_\_

City \_\_\_\_\_ State \_\_\_\_\_ Zip Code \_\_\_\_\_