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USACE / NAVFAC / AFCEC **UFGS-02 51 19 (February 2021)**

Preparing Activity: USACE **Superseding without Revision UFGS-02 55 00 (February 2010)**

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated July 2024
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SECTION 02 51 19

SOLIDIFICATION AND STABILIZATION DECONTAMINATION
02/21

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NOTE: This guide specification covers the requirements for solidification/stabilization (S/S) of contaminated materials.

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).

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PART 1 GENERAL

1.1 UNIT PRICES

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NOTE: This paragraph should be deleted if the work is in one lump sum contract or there is a separate Measurement and Payment Section. Batch processing is likely to use weight as the method of measurement. In situ processes are more likely to use volume as the method of measurement.

****

a. Payment will be based on the Contract unit price schedule for each [in situ] [metric ton ton] [cubic meter cubic yard] of contaminated material entering the S/S process. Include the cost for materials, equipment, waste feed processing, S/S operations, stockpiles, testing,

and all other work associated with the S/S process in this unit cost.

b. No payment will be made for materials or labor required to reprocess any processed material not meeting the physical and chemical testing requirements outlined in this section. Deduct reprocessed material from the daily production rate.

1.2 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

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The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM D1556/D1556M	(2015; E 2016) Standard Test Method for Density and Unit Weight of Soil in Place by Sand-Cone Method
ASTM D1633	(2000; R 2007) Standard Test Methods for Compressive Strength of Molded Soil-Cement Cylinders
ASTM D4832	(2016; E 2018) Standard Test Method for Preparation and Testing of Controlled Low Strength Material (CLSM) Test Cylinders
ASTM D5084	(2016a) Standard Test Methods for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter

U.S. ENVIRONMENTAL PROTECTION AGENCY (EPA)

EPA SW-846.3-3	(1999, Third Edition, Update III-A) Test Methods for Evaluating Solid Waste: Physical/Chemical Methods

1.3 SYSTEM DESCRIPTION

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NOTE: The Contractor is sometimes required to provide treatability study test results prior to performing work at the site. Treatability study test results should include the proposed reagents and mix ratios to be used during full scale treatment. The test results submitted should verify that the mix design proposed meets the post-treatment criteria listed in Table 1. Consideration should also be given to the need to monitor off-gas and dust emissions during the treatability study. Detailed information on testing requirements, test methods, detection limits, and off-gas and dust emission testing requirements should be presented in the appropriate section and referenced here.

At projects where strict testing protocols are required to adequately determine the effectiveness of the process being tested, the Contractor should be required to provide a "Treatability Study Work Plan" for approval prior to performing the treatability study.

Prior to performing any treatability study, the untreated samples should be tested to verify that they contain the contaminants of concern at high enough concentrations and these contaminants leach at levels which are representative of the materials found on-site. Additional testing may be needed to verify that physical properties of the samples are also representative of site conditions.

The last two sentences of this paragraph should be omitted if a specific method of treatment (in situ or ex-situ) is desired.

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Use an [in situ] [pug mill] [ex-situ] [_____] S/S system that provides a safe, reliable method to treat contaminated material so that the treated material conforms to paragraph PERFORMANCE REQUIREMENTS. A system or procedure, other than described in this section, may be used if the approved SUBMITTALS demonstrate equivalent capabilities. Such approval does not relieve the Contractor of responsibility for meeting specified requirements for safety, reliability, and performance.

1.3.1 Work Plan

Submit an S/S Work Plan within [60] [_____] days after notice to proceed. Do not perform S/S of contaminated material until the work plan is approved. Allow a period of [30] [_____] days in the schedule for Government review and approval of the work plan. Address the technical requirements listed in this section in the work plan. The technical

requirements include, but are not limited to the following:

a. Contractor Experience: Information to demonstrate that the S/S Contractor meets the qualification requirements outlined in Paragraph QUALIFICATIONS.

b. Mix Design: The proposed mix design and method of mixing to be used in treating the contaminated material. Identify the proposed source of water to be used for the S/S process.

c. Equipment: Specifications for the proposed homogenization and mixing equipment, batching equipment, and process control instrumentation. Include process flow diagrams, mixing times, and processing rates. Identify anticipated pretreatment of the contaminated material.

d. Drawings: Drawings indicating dimensions and layout of the S/S system on the site. Drawings must be to scale.

e. Emissions: Identify and estimate air emissions, dust, and noise from the system. Describe control systems required to maintain compliance with local, state, and federal regulations. Also describe air emissions, dust, and noise testing protocol to be performed during the test run and full scale operations.

f. Quality Control: A quality control plan which addresses control and documentation of batch proportions, mixing time, mixing speed, sample collection, sample curing, and post-treatment testing.

g. Demobilization: A post-treatment cleanup and sampling plan for the treatment area.

h. Stockpile Design: A proposed stockpile design which meets the criteria outlined in this section.

1.3.2 Other Submittal Requirements

Submit the following:

a. Resumes of key personnel at least [5] [_____] working days prior to the personnel assuming duties on site.

b. Daily batch proportion and mixing quality control data.

c. Results of post-treatment tests performed.

d. The field demonstration report including pre-treatment and post-treatment test results. Document other relevant field demonstration data including but not limited to: batch proportions, mixing time, and mixing speed. Include off-gas, dust, and noise test results.

e. Reagent composition, certificates of analysis, and SDS documentation. A confidentiality agreement may be requested if proprietary reagents are being used.

1.3.3 Performance Requirements

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NOTE: The post-treatment testing criteria listed in

Table 1 are only examples. Chemical and physical test criteria should be determined on a site specific basis. Post-treatment criteria may be based on federal regulatory criteria, site specific risk analyses, or site specific criteria based on state and local regulations.

****

Perform the [Toxicity Characteristic Leaching Procedure as specified in EPA SW-846.3-3] [_____] on representative samples of treated material. The extract must meet the chemical post-treatment testing criteria listed in Table 1. Conduct chemical testing required in this section in accordance with [_____]. The treated material must also meet the physical testing criteria listed in Table 1. Perform the tests listed in Table 1 on samples that have been cured for [3] [_____] days.

Table 1 - POST-TREATMENT TEST CRITERIA

TEST	TEST VALUE
Arsenic	[_____] mg/L
Cadmium	[_____] mg/L
Chromium (Total)	[_____] mg/L
Lead	[_____] mg/L
Min. Unconfined Compressive Strength ASTM D1633	[_____] kPa
Max. Permeability ASTM D5084	[_____] cm/s
Maximum Volume Increase	[_____] percent

1.3.3.1 Disposal of Treated Material

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NOTE: Reference the appropriate section which describes requirements for disposal of treated material, including manifests for off-site disposal. Identify onsite disposal locations on the drawings.

****

Dispose the treated material, upon meeting the physical and chemical testing criteria, as required by Section [02 81 00 TRANSPORTATION AND DISPOSAL OF HAZARDOUS MATERIALS] [_____].

1.3.3.2 Emission Controls

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NOTE: Site specific requirements should be added to this paragraph.

****

Include control apparatus necessary to meet local, state, and/or federal

regulations for air emissions and dust in the S/S system.

1.3.3.3 Noise Control

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NOTE: Different day and night noise restrictions may be appropriate.
****

The S/S system must [meet state and local noise pollution control regulations] [not exceed [_____] decibels at any site boundary].

1.4 SUBMITTALS

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NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.
****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Work Plan
Qualifications

Equipment
Quality Control Tests
Key Personnel
Batch Proportions

SD-06 Test Reports

Post Treatment Testing
Field Demonstration

SD-07 Certificates

Reagents

1.5 QUALIFICATIONS

1.5.1 Contractor Experience

Have successfully completed at least [5] [_____] S/S projects of comparable size and scope in accordance with local, state, and federal requirements using the proposed system or a similar system.

1.5.2 Key Personnel

Provide key personnel with a minimum of [3] [_____] years of S/S field experience. Include system operators, quality control personnel, and supervisory engineering and technical staff involved with the S/S system operation in key personnel.

1.6 PROJECT/SITE CONDITIONS

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NOTE: Pertinent site characterization data should be placed in the appendix of the specifications or on the drawings and referenced here. Indicate the detail to which site characterization has been performed and indicate where obvious data gaps exist.

Site specific conditions should be considered when determining allowable temperatures at which S/S and curing may take place. Treatability studies can be used to address this issue.
****

The physical conditions indicated on the drawings and in the specifications are the result of site investigations. While the site investigation data is representative of subsurface conditions at a specific location, variations in the contaminated materials are expected to exist. Do not perform S/S in an ambient temperature below [4] [_____] degrees C [40] [_____] degrees F without approval. Make provisions to maintain the temperature of the treated material above freezing while curing. Do not treat contaminated material if it contains any frozen material. The temperature of the S/S material immediately after treatment must not exceed [32] [_____] degrees C [90] [_____] degrees F without approval. Do not perform S/S during periods of heavy rainfall as this will result in the addition of excess water to the mixture.

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 Water

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NOTE: It may be appropriate to require chemical testing of the proposed water source when the water is of questionable quality.
****

Water containing concentrations of oil, acid, salt, alkali, organic matter, or other deleterious substances which will be detrimental to the successful execution of the S/S treatment process is prohibited. Use potable water where available. The Government may require the Contractor to perform chemical analyses on representative water samples if the water appears to be of questionable quality.

2.1.2 Reagents

Provide the chemical composition of reagents used. Provide a certificate of analysis supplied by the vendor with each shipping unit of reagent. Ship reagents in properly labeled containers with instructions for handling and storage. Strictly adhere to the instructions.

2.1.3 Mix Design

****
NOTE: In most instances, the Government will have conducted treatability studies prior to advertisement for bids. Results of these treatability studies are generally provided to bidders and included in the contract documents.
****

Select a mix design which meets the performance criteria listed in Table 1 for use during full scale treatment. [A preliminary treatability study has been performed on the contaminated materials. Results of this study are provided in Appendix [_____] for information only.] [No Government treatability studies were performed.]

2.2 EQUIPMENT

2.2.1 Mixing Equipment

Provide mixing equipment with a minimum capacity adequate to meet performance and schedule requirements and with positive means for controlling the mix proportions, maintaining the time of mixing constant, and maintaining the appropriate speed of rotation of the mixer.

2.2.2 Reagent Feed Units

Provide satisfactory means, incorporating weighing, metering or volumetric measurement to separately batch the required amount of each reagent. Equip and operate silos and feeders so that no caking of material or variation in feed occurs. Make provisions so that each reagent can be easily sampled.

2.2.3 Accuracy of Measurement Equipment

Provide scales, meters, and volumetric measuring devices used for measuring contaminated material, reagents, and water for S/S processing that are accurate to plus or minus [0.1] [_____] percent of the quantity being measured. Calibrate measuring equipment once every [5] [_____] working days.

PART 3 EXECUTION

3.1 STOCKPILES

****

NOTE: Delete this paragraph if stockpiles are not required. More elaborate stockpile requirements may be needed based on site-specific regulatory criteria.

In addition to leachate collected from stockpiles, water from other sources (decontamination water, surface runoff, etc.) is also sometimes used in the S/S process.

****

Construct stockpiles for storing contaminated material [prior to] [and] [following] treatment. Construct stockpiles to include:

a. A geomembrane liner with a minimum thickness of 1.0 mm 40 mils. Protect the liner from vehicles using a [540] [_____] g/square m [16] [_____] ounce/square yard geotextile and a traffic surface layer consisting of gravel, concrete, or other material which will not damage the geomembrane. Place the geomembrane on a ground surface that is smooth and free of rocks greater than 13 mm 0.5 inches in diameter or any other object that could damage the geomembrane.

b. Slope the liner to a low point to allow leachate to be collected. Analyze leachate collected from the stockpile and, if necessary, treat to meet applicable local, state, and federal regulations. Leachate collected from the stockpile may be used in the S/S process provided the treated material to which the leachate was added meets the physical and chemical post-treatment test criteria.

c. A geomembrane cover with a minimum thickness of 0.25 mm 10 mils to prevent precipitation from entering the stockpile.

d. Berms surrounding the stockpile that are a minimum of 300 mm 12 inches in height.

3.2 OPERATION

3.2.1 Dissimilar Materials

Do not mix together dissimilar materials that testing has indicated need different mix ratios.

3.2.2 Oversize Material

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NOTE: Indicate the method and location of disposal of treated oversize material.

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Reduce contaminated material that exceeds the maximum allowable particle size of the S/S mixing unit and that is amenable to treatment to a size that the mixing unit can accept. Treat oversize material that cannot be reduced to an allowable size for the S/S unit in accordance with [40 CFR 268] [_____]. After treatment, dispose the material [_____]. Dispose hazardous residual produced in treating the oversize material in accordance with applicable local, state and federal regulations.

3.3 FIELD DEMONSTRATION

Prior to full-scale operations, perform a field demonstration. Process at least [500] [_____] cubic meters cubic yards of contaminated material and perform the tests listed in Table 2 on [5] [_____] representative samples of the treated material. Perform a field demonstration on each distinctive type of material or contaminant to be treated.

3.3.1 Full-Scale Processing Equipment

Use the full-scale processing equipment for the field demonstration. Use the same reagents, mix ratios, and mixing procedures used during the field demonstration for the remainder of the work.

3.3.2 Sampling Locations

****

NOTE: Sampling protocols for the field demonstration should be the same as the sampling protocols used for full scale treatment. Specify the method, location and depth at which samples for the field demonstration will be obtained. Chemical testing should generally be performed to verify that the materials to be used for the test run, contain the contaminants of concern at high enough concentrations to adequately test the system. Additional testing may be warranted to verify that the physical properties of the materials are also representative of site conditions.

****

Obtain contaminated material used for the field demonstration from [_____]. Prior to performing the field demonstration, test contaminated material to be used for the field demonstration to verify it contains the following minimum levels of contamination: [_____].

3.3.3 Testing

****

NOTE: Consideration should be given to the need for monitoring off-gas, dust, and noise generation during the field demonstration to ensure compliance with local, state, and federal regulations.

****

Perform testing to verify that the treated material from the field demonstration meets the specified physical and chemical criteria. If the treated material produced during the field demonstration does not pass the testing requirements, treat an equal quantity of the same type of material

which failed using a new mix design or procedure.

3.3.4 Volume Increase

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NOTE: The excessive addition of reagents during treatment can result in a greater than anticipated volume increase. Limiting volume increase is important if the treated material is to be placed in an onsite landfill with limited storage space. For this reason, monitoring of volume increase is often done during the treatability study, field demonstration, and/or full-scale treatment.

The excessive addition of reagents can also result in higher treatment and off-site disposal costs.

****

Determine and report the estimated increase in volume resulting from treatment with the field demonstration test results. Determine the volume increase by comparing the volume of in situ contaminated material to be treated to the volume of treated material using the following formula:

B= 100 x [(1+R) x (D in situ/D treated) - 1], where

B= Volume increase in percent.
R= Dry weight ratio of solidifying agent to waste.
D in situ = Dry unit weight of in situ waste.
D treated = Dry unit weight of compacted treated material.

3.3.5 Field Demonstration Test Results

****

NOTE: While two options of the field demonstration test results paragraph are provided, it is preferable to force the Contractor to stop processing contaminated material until results from the field demonstration indicate that the Contractor's proposed mix design can successfully treat the contaminated material.

****

After completion of the field demonstration, [do not process additional contaminated material until test results from the field demonstration verify that the treated material meets the physical and chemical criteria listed in Table 1] [contaminated material may continue to be processed. However, if test results from the field demonstration do not pass the criteria listed in Table 1, reprocess the contaminated material treated with the failing mix design with a working mix design at no additional cost to the Government].

3.4 QUALITY CONTROL PROCEDURES

****

NOTE: Leaching and hydraulic conductivity tests are not amenable to real time quality control because of the time required to perform the tests; therefore, it is preferable to minimize the number of leaching and hydraulic conductivity tests performed and to

maintain quality control of the S/S process by verifying that the mix design works during the field demonstration and maintaining quality control by monitoring batch proportions and mixing time. Real time indicator tests such as pH, specific conductance, mix temperature, and water content can also be used as quality control tools.

****

3.4.1 Batch Proportions

Record the mixing time, mixing speed, and amounts of contaminated material, reagents, and water added to each batch. Maintain mixing time, mixing speed, and batch proportions within the limits specified in the approved Work Plan and as modified during the field demonstration.

3.4.2 Segregation

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NOTE: To prevent double handling, it is preferable to place treated material directly into the permanent storage area rather than stockpiling it until post-treatment testing is completed.

****

[Separate treated material into units (stockpiles) for post-treatment testing. Perform post-treatment testing at the frequency listed in Table 2. Unit size greater than the quantity pertaining to the most frequent quality control test is prohibited.] [Place treated material directly into the permanent storage site after treatment. Place treated material such that the material from specific batches/runs can be defined and removed if it fails post-treatment testing.]

3.4.3 Quality Control Tests

****

NOTE: Samples for post-treatment testing should generally be collected immediately after treatment. This eliminates the need to remove samples from the treated mass after it has cured.

If the treated material exhibits soil-like properties, moisture content and density criteria may also need to be specified for the post-treatment test samples.

The values shown in Table 2 for frequency of testing are only examples and need to be determined on a site specific basis. If required, site specific testing requirements for off-gas emissions, dust, and noise should also be included in the table.

****

Perform the tests listed in Table 2 on representative samples of treated material. Collect samples for quality control and quality assurance testing immediately after treatment and allowed to cure as specified in ASTM D4832 or by another approved method. Samples must meet the post-treatment testing criteria listed in Table 1.

Table 2 - POST-TREATMENT QUALITY CONTROL TESTING FREQUENCY	
Standard Test Procedure	Frequency/Cubic Meters Yards
TCLP EPA SW-846.3-3	1 per [500][_____]
Unconfined Compressive Strength ASTM D1633	1 per [500][_____]
Permeability ASTM D5084	1 per [500][_____]
Volume Increase ASTM D1556/D1556M	1 per [500][_____]

3.4.4 Retesting and Reprocessing

Perform retesting and reprocessing , at no additional cost to the Government, for treated material that does not meet the physical and chemical requirements listed in Table 1.

3.4.4.1 Retesting

Retest or reprocess any unit that fails post-treatment quality control or quality assurance testing. If the Contractor elects to retest the unit, collect and test two additional samples for the failed parameter. If both tests pass, reprocessing of the unit will not be required. If either sample fails, reprocess the unit.

3.4.4.2 Reprocessing

If the Contractor reprocesses a unit of material, sample and test the unit as described in paragraph Quality Control Tests after reprocessing.

3.4.5 Adjustments to Mix Design

Subject to approval, the mix design may be changed based on the characteristics of the material being treated. An additional field demonstration may be required by the Contracting Officer prior to implementation of the new mix design.

3.4.6 Quality Assurance Testing

Submit duplicate samples to the Government's quality assurance laboratory at a frequency of one set of samples per [10] [_____] sets of quality control tests performed. Quality assurance samples will be tested for the parameters listed in Table 2. The Contracting Officer may require additional quality assurance tests as a result of failed quality assurance or quality control tests. The Contracting Officer may also require additional quality assurance tests due to changes in the mix design or physical appearance of the contaminated material.

-- End of Section --