



R0085913



# ENGINEERING REQUIREMENTS

## SAVANNAH RIVER SITE

EXCAVATION AND BACKFILL (U)

DOCUMENT NO.:

02224-01-R

DATE: 08/19/94

REVISION: 1

PAGE 1 OF 10

### 1.0 PURPOSE AND SCOPE

#### 1.1 Purpose

This document provides technical requirements for excavation and backfill required for structures and facilities located at the Savannah River Site (SRS). These requirements may be augmented by detailed requirements shown on the drawings.

#### 1.2 Scope

The Scope of information contained herein is applicable for the excavation, hauling, stockpiling, disposal, and backfilling of all materials necessary for the construction of foundations for structures and other facilities at SRS. This document replaces Engineering and Project Division Generic Specification X-0003 (C-SPC-G-00056) and DuPont Standards SC3E and SC5E in their entirety.

1.2.1 Except as noted, the technical requirements described herein are applicable for the excavation backfill operations for all structures/facilities. These technical requirements are to be augmented further by the appropriate level of Quality Assurance requirements as stated on design drawings.

1.2.2 The Constructor shall control the quality of items and services to meet the requirements of this document, the appropriate Quality Assessment Report requirements, and the requirements of other Codes and Standards as applicable.

### 2.0 DOE ORDER APPLICABILITY

Department of Energy (DOE) Order 6430.1A is applicable to the work described herein. Technical requirements, as specified, meet or exceed the minimum standards set by the above described Order.

### 3.0 NATIONAL CODES AND STANDARDS APPLICABILITY

#### 3.1 General

3.1.1 The applicability of the following Codes and Standards is limited to the extent of the reference in the text.

Sponsor	Number	Subject
ASTM	C 39-86	Standard Method of Test for Compressive Strength of Molded Concrete Cylinders
ASTM	D 422-90	Standard Test Method for Particle-Size Analysis of Soils
ASTM	D 1556-90	Standard Test Method for Density of Soil In-Place by Sand-Cone Method

EXCAVATION AND BACKFILL	DOCUMENT NO: 02224-01-R	
	DATE: 08/19/94	REVISION: 1
	PAGE 2 OF 10	

ASTM	D1557-78	Standard Test Method for Moisture-Density Relations of Soils and Soil-Aggregate Mixture Using 10 lb Rammer and 18 in. Drop	<p>3.1.2 Later editions of the Codes and Standards may be used provided the minimum requirements as specified herein are fully satisfied.</p> <p>3.1.3 In case of conflicts between the various Codes and Standards, the more restrictive requirement shall apply. When conflict exists between the Codes and Standards and engineering drawings, the latter shall prevail.</p>
ASTM	D 2216-90	Standard Test Method for Laboratory Determination of Moisture Content of Soil	<p style="text-align: center;"><b>4.0 DEFINITIONS</b></p> <p>Abbreviations used in the document shall have the following meanings:</p>
ASTM	D 2922-81	Standard Test Methods for Density of Soil and Soil Aggregate In-Place by Nuclear Method (Shallow Depth)	<p>ASTM American Society of Testing and Materials</p> <p>CLSM Controlled Low Strength Material</p> <p>DE Design Engineering</p> <p>E&amp;PD Engineering and Projects Division</p>
ASTM	D 3017-88	Standard Test Method for Water Content of Soil and Rock by Nuclear Methods (Shallow Depth)	<p>PESC Project Engineering Services Contractor</p> <p style="text-align: center;"><b>5.0 REQUIREMENTS</b></p> <p><b>5.1 General</b></p>
ASTM	D 4318-84	Standard Test Method for Liquid Limit, Plastic Limit and Plasticity Index of Soils	<p>5.1.1 The responsibility for all design functions including the production of engineering drawings, procurement and project documents lies with E&amp;PD-DE and/or designated PESC. The appropriate individual representing these entities is referred to herein as the "Engineer".</p>
ASTM	D 4643-87	Standard Test Method for Determination of Water Content by the Microwave Oven Method	<p>5.1.2 The responsibility for all construction activities including the installation of vendor supplied and field procured items lies with E&amp;PD and/or selected subcontractors. The appropriate individual representing these entities is referred herein as the "Constructor".</p>

**EXCAVATION AND BACKFILL**

DOCUMENT NO:

02224-01-R

DATE: 08/19/94

REVISION: 1

PAGE 3 OF 10

5.1.3 Based on the appropriate project documents, such as QAR, design drawings will establish the Quality Class of construction for various structures, systems and components. Unless noted otherwise, field inspection activities for "NS & CP" classifications shall be independently inspected by the quality control organization and for "PS & GS" classifications, such inspections shall be peer verified by the constructor's line organization.

5.1.4 The agency responsible for all soil testing is referred to herein as the "Testing Agency".

**5.2 Excavation**

5.2.1 The Constructor will determine the suitability of excavation material for backfill. Suitable material shall consist of material meeting the requirements for structural or common fill. All material shall be removed within the limits of excavation as shown on the design drawings.

5.2.2 Any material which, is determined by the Constructor, to be suitable for reuse shall be placed or stockpiled in designated areas. Excess material, unsuitable material and excavated CLSM shall be disposed of in areas designated by SRS.

5.2.3 The final excavation to the soil bearing surface shall be made using either smooth blade equipment or hand excavation for the final 6 inches. The bearing surface for footings, mats, grade beams, sumps, floor slabs and other load carrying members shall be undisturbed naturally deposited inorganic soil or compacted structural fill. Bearing surfaces shall be approved by the engineer for all NS and CP projects. PS and GS projects shall also be inspected if so stated on the drawings. All inspections will take place prior to the

placement of reinforcing steel and concrete forms. The Engineer reserves the right to disapprove a bearing surface after initial approval was given if the bearing surface has deteriorated or softened. The bearing surface shall then be reapproved after additional preparation is executed by the Constructor.

5.2.4 If unsuitable material is encountered at the elevation shown, Engineer will be notified. Where excavation is performed to elevations below those shown on the design drawings, the planned elevation shall be reestablished. Elevations may be reestablished by filling the space with concrete of a minimum 28 day strength of 2000 psi, CLSM Material (if appropriate), or by backfilling and compacting with suitable fill.

5.2.5 All excavations shall conform to the line, grades, and tolerances shown on the drawings. Where no tolerances are specified a tolerance of  $\pm 6$  inches may be utilized.

5.2.6 The method of excavation shall not weaken surrounding areas or damage structures or parts thereof that are completed or under construction. Existing structures and utilities adjacent to excavations shall be protected and supported to prevent settlement. When required, shoring shall be provided by the Constructor unless otherwise shown on the design drawings.

5.2.7 Areas being excavated and areas to be filled shall be maintained in a clean condition free from leaves, brush, sticks, trash, and other debris.

**EXCAVATION AND BACKFILL**

DOCUMENT NO:

02224-01-R

DATE: 08/19/94

REVISION: 1

PAGE 4 OF 10

5.2.8 Different classes of material, based on gradation and plasticity, as determined by the Constructor shall be stockpiled separately and shall be placed to provide natural drainage and a stable embankment. Stockpiles shall be constructed with a maximum height not exceeding 40 ft.

5.2.9 Temporary roads shall be constructed by the Constructor as required to complete the work. At the completion of the project, these construction roads shall be removed and the land returned to the original condition unless otherwise specified.

5.2.10 Construction roadside slopes and spoil area slopes shall be graded to meet existing contours to prevent water accumulation and erosion.

**5.3 Drainage**

Excavation shall be performed so that the area of the site and the area immediately surrounding the site will be continually and effectively drained. Water shall not be permitted to accumulate in the excavation. The excavation shall be drained by pumping or other satisfactory methods to prevent softening of the foundation bottom, undercutting of footings, or other action detrimental to proper construction procedures.

**5.4 Materials**

5.4.1 Unless otherwise approved or designated, materials for earthwork construction shall be obtained from the excavation, stockpiles located near the work, or designated borrow areas. Material containing brush, roots, peat, sod, or other organic material, rock greater than 3 inches in diameter or frozen material shall not be placed in the backfill.

5.4.2 Borrow material shall be obtained from the excavation, indicated borrow areas or from other sources that meet the requirements of structural and common fill or as approved in writing by the Engineer.

5.4.3 Borrow sources and stockpiles shall be excavated and maintained to provide satisfactory drainage.

5.4.4 Structural fill used for backfilling shall consist of sands or silty sands free of organic material, loam, trash, snow, ice, frozen soil, rock greater than 3 inches in diameter and other objectionable material and should be well graded within the following limits as determined in accordance with ASTM D 422 and shall have a plastic index less than 8.

Sieve Size	Percent Passing By Weight
No. 3/8"	100
NO. 4	95-100
No. 10	85-100
No. 20	70-100
No. 40	35-95
No. 60	15-70
No. 140	5-30
No. 200	0-25

The site approved CLSM may be used as common or structural fill.

5.4.5 Common fill shall consist of any sand that can be readily placed, spread, and compacted to a minimum in place dry density of 100 pounds per cubic foot. Maximum liquid limit and maximum plasticity index, as determined per ASTM D 4318 shall be respectively 40 and 10. Gradation tests per ASTM D 422 shall be performed as necessary for establishing soil classification. Unsuitable excavated material shall be

**EXCAVATION AND BACKFILL**

DOCUMENT NO:

02224-01-R

DATE: 08/19/94

REVISION: 1

PAGE 5 OF 10

disposed of as directed by the Constructor.

5.4.6 The CLSM shall have a 28 day compressive strength of 30 to 150 psi. In place wet density shall be in a range of 115 to 145 #/cf. after material has set, density may be obtained by ASTM C 2922 or ASTM C 1556.

The water content of CLSM as placed shall be between 60 and 66 gallons per cubic yard unless noted otherwise by the engineer. Water addition if required, shall be added to the CLSM batch upon receipt at the jobsite, prior to any discharge and shall be mixed by a minimum of 30 revolution of the drum. Any water added to the batch at the jobsite shall be recorded on the batch ticket by the receiving organization.

**5.5 Fill - Structural**

5.5.1 After the completion of footings and walls, and prior to the placement of backfill, all forms will be removed and the excavation shall be cleaned of all trash, debris and unsuitable material. Structural fill placed beneath foundations on approved subgrade is subject to the provisions of this section.

5.5.2 No backfill shall be placed on the foundation soils or around foundation concrete until the area has been approved by Constructor. Before placing backfill material, the subgrade shall be scarified to a minimum depth of at least 2 inches, moisture conditioned, if necessary, and compacted to the requirements as given in the sections below. Fill material with a substantial clay content and other materials as noted within the design documents are required to be scarified to a minimum depth of 2" of compacted lift to ensure proper bonding between lifts or as directed by the engineer. Granular materials need not be scarified between

lifts unless noted otherwise. When CLSM is used, scarification is not required.

5.5.3 Backfill shall be placed in successive uniform loose layers and to a depth at which densities can be obtained. In no case shall any layer of loose material placed for compaction exceed 9" when hand operated mechanical equipment is used and 12" when self propelled or towed mechanical equipment is used. No backfilling against concrete shall be done until the concrete has attained a strength equal to 80 percent of the design strength, or as directed by the Engineer. If the subgrade concrete has been waterproofed, the backfilling shall be done so as not to damage the waterproofing or its protective materials. CLSM may be used against concrete immediately after form removal.

5.5.4 To ensure proper bonding between lifts the constructor may direct that compacted surfaces be lightly scarified to break up stratification before the succeeding layer is placed there-on.

5.5.5 In freezing weather, a layer of fill shall not be left in an uncompacted state at the close of a day's operations. Prior to terminating work for the day, the final layer of compacted fill, after compaction, shall be rolled with a smooth-wheeled roller to eliminate ridges of soil left by tractors, trucks, and other compaction equipment. Do not place a layer of compacted fill on snow, ice or soil that was permitted to freeze prior to compaction. Removal of these unsatisfactory materials will be required.

5.5.6 If the top of contact surfaces of the previous fill layer or subgrade have become too dry to permit a suitable bond between those surfaces or the surface has become disturbed, such surfaces shall be scarified to a depth of 6 inches, the loosened material dampened to the

**EXCAVATION AND BACKFILL**

DOCUMENT NO:

02224-01-R

DATE: 08/19/94

REVISION: 1

PAGE 6 OF 10

required moisture content and then compacted to the specified density.

5.5.7 Before placing additional fill, material that is soft and yielding as a result of excess water shall be replaced with suitable material or scarified and allowed to dry out to the specified moisture content and recompact.

5.5.8 Oversize material as defined in Section 5.4.4 shall be removed from the backfill and disposed of in designated areas in accordance with Reference 3.

5.5.9 Fill shall be compacted to a minimum density of 95 percent of the maximum dry density determined in accordance with ASTM D 1557.

5.5.10 Sloped ground surfaces steeper than one vertical to four horizontal on which fill is to be placed shall be plowed, stepped or benched, or broken up as required, so that the fill material will bond with the existing surface. Prepared surfaces on which compacted fill is to be placed shall be wetted or dried as may be required to obtain the moisture/compaction specified.

**5.6 Fill - Common**

Unless noted otherwise within the design documents, areas to receive fill shall be "common fill" areas.

Areas to receive common backfill shall be free of all trash, debris, and unsuitable materials. Placement and compaction procedures shall be the same as for Structural Fill described in Section 5.5, except for compaction criteria. Common backfill shall be compacted to a minimum of 90 percent of the maximum density determined in accordance with ASTM D 1557.

**5.7 Moisture Control**

5.7.1 Material to be compacted shall be moisture conditioned, as far as practicable, in the stockpiles or borrow sources. If the material does not have the required moisture content uniformly distributed throughout, such material shall be conditioned by flooding, sprinkling, aerating, harrowing, disking, draining, or other means approved by the Constructor. Natural moisture content of the fill material shall be determined by the Testing Agency in accordance with ASTM D 2216 or D 4643.

5.7.2 Except or as otherwise designated or approved, for materials where a definable moisture-density curve can be established by Test Method ASTM D 1557, the moisture content during compaction shall not be more than 2 percent below or 2 percent above the optimum. For very clean sands where a definable moisture-density curve cannot be established, the material shall be saturated. Optimum moisture content will be determined by the Testing Agency per ASTM D 1557. Moisture content is only an acceptance criteria for structural fill.

5.7.3 After placement of loose material in the fill, the moisture content shall be adjusted as necessary to bring the material within required moisture content limits. The Testing Agency will verify moisture content limits. Testing Agency will verify moisture content per ASTM D 2216, D 3017, or D 4643, as necessary. Material placed in the fill too wet for compaction shall be left to drain, or be aerated and dried by disking and harrowing or otherwise mixed until the moisture content of the entire layer is uniform and within the specified limits. Sprinkling shall be by sprinkler trucks (or other suitable means for congested areas) equipped with pressure spray bars and valves to give a uniform and even application of water to the dry

areas and a positive control of the rate of water application at all times. Any section of the fill containing material which is too wet or too dry shall not be compacted until the moisture content of the material is brought within the specified limits or the material shall be removed and replaced with material having a moisture content within the specified limits.

5.7.4 Placement of fill for which moisture conditioning is required shall be suspended when the ambient temperature is 32° and falling.

#### 5.8 Compaction

5.8.1 Material satisfactorily placed and spread and having a moisture content within the specified limits shall be compacted by vibratory or static rolling. Rolling shall be performed systematically on all portions of each area being rolled. The vibratory roller, if used, shall be a self propelled unit having a minimum dynamic force of 30,000 pounds per drum.

5.8.2 Unless otherwise approved, all roller trips shall be made in parallel paths. To ensure complete coverage of the area rolled, each trip of the roller shall overlap the adjacent trip by not less than 2 feet. If there is sufficient area, the dumping, spreading, sprinkling, mixing, and compacting may be performed at the same time at different points on the backfill surface.

5.8.3 Unless otherwise specified, all backfill not accessible to roller compaction shall be compacted by power tampers or vibratory compactors or other approved means to the same degree of compaction achieved by roller-compaction.

5.8.4 Material satisfactorily placed and spread in the fill, and having a moisture content uniformly distributed through the

fill within the specified limits, shall be compacted by rolling to attain the satisfactory compaction of not less than 95% for structural fill, and 90% for common fill of the maximum dry density determined in accordance with ASTM D 1557. Compliance shall be verified per ASTM D 1556 or D 2922.

#### 5.9 Test Fill

5.9.1 Existing test fill data from previous work at SRS should be utilized for guidance on construction methodology for placement and compaction of backfill. When required to evaluate specific compaction equipment or backfill materials not previously evaluated, an additional test fill shall be constructed. The methods of handling, spreading, and moisture conditioning of the material shall be the same for the test fill as for the earthwork operations.

5.9.2 The test fill, using approved materials and specific methods, shall be constructed to include as a minimum the following variables for the evaluation of equipment to produce the required compaction: moisture content, number of equipment passes per lift, lift thickness.

5.9.3 If more than one type of soil material is approved for backfill or fill, each material shall be tested separately in the test fill.

5.9.4 The Constructor shall monitor the test fill. The Testing Agency shall take test samples as often as required for evaluation of the equipment and compacting effort. Based on the evaluation, the Engineer may direct modification of the variables listed above.

**EXCAVATION AND BACKFILL**

DOCUMENT NO:

02224-01-R

DATE: 08/19/94

REVISION: 1

PAGE 8 OF 10

**5.10 Grading**

All areas of this work shall be uniformly graded. The finished surface shall be reasonably smooth, compacted, and free from irregular surface changes. The degree of finish shall be that ordinarily obtainable from blade-grader operations, unless otherwise specified. Any temporary ditches shall be installed to permit adequate drainage. Prior to placement of foundation material, the following shall be accomplished as required: (1) Soft or otherwise unsuitable material shall be replaced with suitable material. (2) Low areas resulting from removal of unsuitable materials shall be brought up to required grade with suitable material, and the entire subgrade shaped to line grade, and cross section, and compacted as specified. The surface of excavated or filled areas on which foundations are to be placed shall vary not more than  $\pm 0.1$  ft from the established grade or approved cross section.

**5.11 Testing**

The Testing Agency will perform all specified tests on the fill material to assure compliance with this document. The Testing Agency will conduct field density and other tests in the compacted fill and the related laboratory compaction testing to determine the relative degree of compaction and other properties. Field density tests will be taken as required with at least one test each day for each area in which compaction is being carried out or at least one test for each 250/500 cubic yards of fill per Table 7.1. Testing shall be performed at a greater frequency, as determined by the Engineer, at the start of compaction for every new structure/facility/project and in congested areas of small placement volumes.

In addition, concurrent with construction, the Testing Agency will take samples of the material from the borrow areas and fill and test these samples for moisture content, compaction, plasticity and gradation, and carry out any other control or record tests which may be required.

Testing will be performed by the Testing Agency as frequently as is deemed necessary by the Constructor.

If the nuclear method is used for density and moisture determination, field calibration shall be performed in accordance with ASTM D 2922 and ASTM D 3017.

Testing of CLSM shall be as required by design documents, or as requested by Engineering or the Constructor.

If CLSM testing is requested, the following physical tests are applicable and depending upon the attributes required, the testing performed shall follow the guidelines listed below.

**Compressive Strength** - Compressive strength specimens shall be fabricated in accordance with the manufacturer's recommendations. Compressive strength tests shall be prepared in accordance with ASTM C 39 and be used for information only. Testing cannot completely comply with ASTM C 39. Recommend tests be performed at 14 and 28 days, (2) cylinders each.

**Density** - Wet densities shall be obtained either by ASTM D 1556 or ASTM D 2922 on the day following the placement.

**5.12 Erosion Control**

Requirements for erosion control shall be as described on the design drawings. Erosion and sediment control 02270-03-R or as directed by the Constructor.

### 5.13 Inspection

Prior to final acceptance, all work shall be inspected (by the Engineer, if so specifically stated on design drawings) for conformance to drawings and document requirements. A graded approach for inspection of excavation and backfill activities as specified in Table 1, which may include some or all of the attributes stated below.

5.13.1 Proper selection of the fill or backfill material

5.13.2 In place density and moisture content of the compacted material (moisture content shall only be used as an acceptance criteria for structural fill)

5.13.3 Excavation and grading to be within specified tolerance

5.13.4 Frequency of testing and the adequacy of test results

5.13.5 Results of inspections on natural subgrades or compacted fill surface prior to placement of foundation concrete or additional backfill

### 6.0 REFERENCES

6.1 Site Clearing and Grubbing, Document No. 02111-01-R

6.2 Site Grading, Document No. 02210-01-R

6.3 Erosion and Sediment Control Document No. 02270-03-R

### 7.0 TABLES AND FIGURES

7.1 Table 1, Graded Approach for Inspection of Excavation and Backfill

**EXCAVATION AND BACKFILL**

DOCUMENT NO: 02224-01-R

DATE: 08/19/94

REVISION: 1

PAGE 10 OF 10

Table 1 Graded Approach For  
Inspection Of Excavation And Backfill

INSPECTION ACTIVITY	NS	CP	PS	GS
Excavation within specified tolerances	X			
Subgrade inspection prior to backfill or concrete placement	X	X	X	
Proper selection of fill material	X	X		
In place density of compacted material	X	X	X	X
In place moisture content of structural fill material	X	X	X	X
Frequency of testing (minimum of once per specified yardage)	250	250	500 <sup>1</sup>	500 <sup>2</sup>
Grading within specified tolerances	X	X	X	X
DOCUMENTATION RESPONSIBILITY	QC	QC	CE	CE

1. No testing required for individual fills of less than 2 CY
2. No testing required for individual fills of less than 5 CY