



# SANFORD UNDERGROUND RESEARCH FACILITY

**SOUTH DAKOTA SCIENCE AND TECHNOLOGY AUTHORITY**

## **Trenching and Excavation Standard**

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## **Revision History**

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## 1.0 Purpose

It is the purpose of the South Dakota Science and Technology Authority (SDSTA) that all excavating and trenching hazards shall be managed to protect personnel. This standard documents processes, systems and tools to mitigate associated risks.

SDSTA references the following to fulfill this standard:

- Occupational Safety and Health Administration (OSHA) 1926.650 to 1926.652, Trenching and Excavation
- American Conference of Governmental Industrial Hygienists (ACGIH)

## 2.0 Scope

This standard applies to personnel who work in and around trenches and excavations at Sanford Underground Research Facility (SURF).

## 3.0 Definitions

**Benching** – A method of protecting personnel from cave-ins by excavating the sides of an excavation to form one or a series of horizontal levels or steps, usually with vertical or near vertical surfaces between levels.

**Cave-in** – The separation of a mass of rock or soil material from the side of the excavation, or the loss of soil under a trench shield or support system, and its sudden movement into the excavation, either by falling or sliding, in sufficient quantity so that it could entrap, bury or otherwise and immobilize a person.

**Competent Person** – One who is capable of identifying existing and predictable hazards in the surroundings or working conditions which are unsanitary, hazardous, or dangerous to employees, and who has authorization to take prompt corrective measures to eliminate them.

**Excavation** – Any man-made cut, cavity, trench, or depression in an earth surface, that is formed by earth removal.

**Excavation Permit** – A permit issued for the purpose of excavation activities required on a SURF construction project.

**Means of egress** – A stairway, ladder, ramp or other safe means of egress shall be located in trench excavations that are 4 feet or more in depth so as to require no more than 25 feet of lateral travel for workers.

**Professional Engineer (PE)** – A person who is registered as a professional engineer in the state where the work is to be performed. However, an engineer registered in any state is deemed to be a registered engineer within the meaning of this Standard when approving designs for manufactured protective systems.

**Shield (Shield System)** – A structure that is able to withstand the forces imposed on it by a cave-in with the structure. Shields can be permanent structures or can be designed to be portable and moved along as work progresses. Also known as trench boxes or trench shields.

**Shoring (Shoring System)** – A structure such as a metal hydraulic, mechanical or timber shoring system that supports the sides of an excavation and which is designed to prevent cave-ins.

**Sloping (Sloping System)** – A method of cutting back the trench wall at an angle that is inclined away from the excavation to prevent cave-ins. The angle of incline varies with differences in such factors as the soil type, environmental exposure conditions, and applications of surcharge loads.

**Trench (Trench Excavation)** – A narrow excavation, in relation to its length, made below the surface of the ground. In general, the depth is greater than the width, but the width if the trench is not greater than fifteen feet. If forms or other structures are installed or constructed in an excavation as to reduce the dimension measured from the forms or structure to the side of the excavation to fifteen feet or less, the excavation is to be considered a trench.

## 4.0 Responsibilities

### 4.1. SDSTA Department Directors

- 4.1.1. Direct all supervisors to assess the hazards of each excavation and to identify the SDSTA personnel this may affect.
- 4.1.2. Provide all personnel with information, training, and the equipment they need to protect themselves and others from excavation hazards.
- 4.1.3. Ensure that all necessary equipment is available to comply with this Standard.
- 4.1.4. Enforce compliance with this Standard. All appropriate personnel must be trained and responsible as to the purpose and use of this excavation safety Standard.
- 4.1.5. Ensure a qualified individual with respect to trenching and excavation is on staff; this responsibility can be shared between the Facility Infrastructure and Engineering Departments.
- 4.1.6. Ensure that direct reports are trained to perform the assigned work.
- 4.1.7. Ensure accountability of the requirements of this document with direct reports.
- 4.1.8. Seek advice from the Environment Safety and Health (ESH) Department, as appropriate.

### 4.2. ESH Department

- 4.2.1. Provides guidance and maintains this standard.
- 4.2.2. Assists with the assessment and identification of excavation hazards.
- 4.2.3. Reviews contractor's qualifications with respect to trenching and excavation.
- 4.2.4. Issues and reviews ESH-(7000-P)-91681 Trenching and Excavation Permit.

### 4.3. Project Managers/Supervisors

- 4.3.1. Ensure that contractors have a competent person for excavation for all jobs under their supervision.
- 4.3.2. Ensure any trenching and excavation activities performed by the contractor under their supervision have been approved by the Surface Operations and Utilities Department.
- 4.3.3. Assure that all underground utility installations have been located and marked prior to excavation.
- 4.3.4. Notify Surface Operations and Utilities Department immediately in the event that a utility is damaged during the excavation process.
- 4.3.5. Ensure accountability of the requirements of this document with contractors/subcontractors.

- 4.3.6.** Ensure that contractors/subcontractors are trained to perform the assigned work, including all equipment and tools, and in the use of trenching and excavation.
- 4.3.7.** Ensure that the contractors/subcontractors retain the ESH-(7000-P)-91681 Trenching and Excavation Permit at the worksite until the project is complete.
- 4.3.8.** Identify WPC documents associated with work activities.
- 4.3.9.** Notify the ERT Supervisor prior to entering an excavation or trench. Information shall include the location of the entry, the number of entrants and the nature of the work.
- 4.3.10.** Seek advice from the ESH Department, as appropriate.

#### **4.4. Competent Person**

- 4.4.1.** Identifies and assesses the hazards of each excavation area.
- 4.4.2.** Ensures that personnel receive the appropriate training and equipment they need to protect them and others.
- 4.4.3.** Ensures that all personnel fully understand the requirements of the permit and their role in the operation.
- 4.4.4.** Ensures accountability of the requirements of this document.
- 4.4.5.** Ensures that all overhead and underground utilities have been located and marked prior to excavation.
- 4.4.6.** Completes all required testing and inspections and completes the ESH-(7000-P)-91681 Trenching and Excavation Permit. Must acquire all signatures on permit before work commences. (during normal administrative hours)
  - Ensure the ESH-(7000-P)-91681 Trenching and Excavation Permit is at the worksite until the project is complete.
- 4.4.7.** Ensures adequate precautions have been taken to protect against water accumulation or removal.
- 4.4.8.** Performs inspection of excavation protective systems. (e.g. trench box)

#### **4.5. Permit Holder**

- 4.5.1.** Makes appropriate inspections of the site conditions.
- 4.5.2.** Ensures that the information on the permit is in compliance with this standard.
- 4.5.3.** Ensure the ESH-(7000-P)-91681 Trenching and Excavation Permit is at the worksite until the project is complete.

#### **4.6. Workers and Users**

- 4.6.1.** Understand their assigned tasks relating to excavation safety.
- 4.6.2.** Assist with the assessment and identification of excavation hazards.
- 4.6.3.** Ensure accountability of the requirements of this document.
- 4.6.4.** Wear hi-visibility or other suitable PPE when exposed to vehicular traffic.
- 4.6.5.** Complete pre-shift/pre-use inspections as required.
- 4.6.6.** Participate in a pre-job briefing with co-workers who share in the work performance before work begins.
- 4.6.7.** Perform work in accordance with the Work Planning and Controls (WPC) documents.
- 4.6.8.** Contact your supervisor or ESH Department with any questions on documents or permits.
- 4.6.9.** Ensure training on applicable equipment and tools is complete and current prior to performing work.
- 4.6.10.** Safely stops work upon recognition of a condition that they feel poses undue risk to themselves, co-workers, or the environment. See ESH-(2000-S)-202124 Stop Work Standard for further information.

## 5.0 Instructions

### 5.1. Excavation Procedures

- Excavation Permitting and Inspection
  - All entities performing excavating and trenching activities at SURF must obtain an ESH-(7000-P)-97681 Trenching and Excavation Permit from the ESH department before the work begins and until the work is completed. The permit must be kept at the job site and be available upon request. When a permit is required, it should be requested at least 24 hours in advance.
  - **EXCEPTION:** Occasionally trenching and excavation work is identified during the course of other work activities or after normal administrative hours. When this occurs, notification to the ESH department is not required prior to starting trenching and excavation operations and posting the permit. The permit holder must assure all inspections, precautions, and reporting pertaining to trenching and excavation are performed and documented. Access to the permit is available on DocuShare, if required, outside of normal administrative hours. The ESH department will need to be contacted during normal administrative hours to finalize the permit.
- Project Development and Impact on Utilities
  - The Project Manager shall ensure that the project is coordinated with Surface Operations and Utilities Department early in the programming and development stages, so that conflicts with utilities can be resolved early. The SDSTA Buildings and Grounds Foreman shall contact utility and/or locating companies to perform underground utility locates prior to the start of excavation.
  - A risk assessment of critical safety equipment may need to be performed to determine if a Document-175959 Disablement or Impairment Permit is required.
- Utilities and Pre-work Inspection
  - A Competent Person shall inspect the site before the excavation is started to determine what safety measures are to be taken and shall follow the ESH Manual.
    - ◆ Verify proximity of nearby overhead utilities.
    - ◆ Verify the exact location of underground installations by safe and acceptable means when excavation operations approach the approximate location of the installations. The local procedures for clearly marking utilities before excavation shall be applied. Utilities left in place shall be protected by barricades, shoring, suspension, or other means as necessary.
      - ◇ Due to legacy underground utilities, area site maps (where available) should be reviewed for additional utilities that may not be identified during the locate.
- Stability of Adjacent Structures
  - A Competent Person shall take precautions as needed to protect workers, nearby buildings, or other structures. A registered PE should evaluate these structures and recommend precautions, when applicable.
- Protection of Personnel
  - Barricades, walkways, lighting, and signs shall be provided for the protection of pedestrians prior to the start of excavating operations.

- Guardrails, fences, or barricades shall be provided adjacent to walkways, driveways and other pedestrian or vehicle travel ways.
- Construction barricade lights shall be utilized at dusk on fences/barricades around perimeter of open trenches near travel ways.
- Protection of Workers in Excavations
  - A Competent Person shall inspect trenching and excavation operations, as well as provide protective systems for trenches 5-feet or deeper.
  - Stairs, ladders, or ramps shall be provided when workers enter excavations over 4-feet deep. Two or more means of egress shall be provided if the excavation is more than twenty feet in length. A means of egress shall be provided every twenty-five feet of trench length.
  - No one shall work under suspended or raised loads and materials handled by lifting or digging equipment.
  - A warning system (e.g. spotter) shall be used when mobile equipment is operated next to the edge of an excavation if the operator does not have a clear and direct view of the edge of the excavation.
  - Materials and equipment should be kept at least two feet from the edge of the excavation with the proper protective system if necessary.
  - Heavy equipment must remain a distance of at least 1 1/2 times depth of the trench away from the excavation, if not supported.

## **5.2. Hazardous Atmospheres and Confined Spaces**

- Workers shall not be permitted to work in hazardous and/or toxic atmospheres. A Competent Person shall test for hazardous atmospheres. Such atmospheres include those with the following:
  - Atmospheric oxygen concentration below 19.5% or above 23.5%.
  - A combustible gas concentration greater than 10% of the lower flammable limit.
  - Concentrations of hazardous substances that exceed those specified in the Permissible Exposure Limits (PELs) for airborne contaminants established by OSHA.
- If there is any possibility that the trench or excavation could contain a hazardous atmosphere, the Competent Person shall consider the space as a “Permit Required Confined Space”, and follow the requirement of Document-73369 SURF Confined Space Chapter.
  - Precautions shall be taken such as providing ventilation to prevent worker exposure to an atmosphere containing a concentration of a flammable gas in excess of 20% of the lower flammable limit of gas.
  - When controls are used that are intended to reduce the level of atmospheric contaminants to acceptable levels, testing shall be conducted as often as necessary to ensure that the atmosphere remains safe.

## **5.3. Walkways and Guardrails**

- Walkways shall be provided where workers or equipment are allowed to cross over excavations. Guardrails shall be provided on walkways used only by workers if the walkway is



four feet or more above the lower level. If workers pass below a walkway, then guardrails and toeboards shall be provided.

- o Guardrails shall be provided on walkways used by pedestrians regardless of the height above the excavation.

#### **5.4. Hazards Associated with Water Accumulation**

- Workers shall not work in excavations with excessive water or where water is collecting unless adequate precautions have been taken to protect against the hazards posed. Methods for controlling water accumulation must be provided and should consist of the following if work is necessary in the excavation:
  - o Trenches shall be free of excessive water and atmospheric hazards as well as have a safe entrance and egress before work begins.
  - o Use of special support or shield systems approved by a PE.
  - o Water removal equipment when used shall be monitored by a Competent Person.
  - o Use of safety harnesses and lifelines.
  - o Trenches shall be inspected by the Competent Person after each rain and before anyone is permitted to re-enter the excavation.

#### **5.5. Protection of Workers from Falling Objects**

- Workers shall be protected from loose rock or soil that could fall or roll from the excavation face. Such protection shall consist of:
  - o Scaling to remove loose material.
  - o Installation of barricades such as wire mesh or timber as needed to stop and contain the falling material; Or
  - o Sloping may be used instead of barricades when practical.
- Workers shall be protected from excavated materials, equipment or other objects that could pose a hazard by falling or rolling into the excavation. These materials or equipment shall be kept at least two feet from the edge of the excavation or otherwise restrained. Material piled, grouped, or stacked near the edge of the excavation must be stable and self-supporting.
- Provide a warning system (such as barricades, hand or mechanical signals, or stop logs) when mobile equipment is operated adjacent to an excavation, or when such equipment must approach the edge of an excavation, and the operator does not have a clear and direct view of the edge.

#### **5.6. Inspections**

- A Competent Person shall conduct visual daily inspections of excavations, adjacent areas, and protective systems for evidence of a hazardous condition. Inspections shall be conducted prior to the start of work, and after every rainstorm. These inspections are only required when the trench will be or is occupied. Inspections shall be documented on the ESH-(7000-P)-91681 Trenching and Excavation Permit or an equivalent contractor form approved by an ESH personnel.

## 5.7. Requirements for Protective Systems

- Protection of Workers in Excavations
  - Personnel working in excavations shall be protected from cave-ins by using either an adequate sloping and benching system or an adequate support and protective system. The only exceptions are when the excavation is made in stable rock or the excavation is less than five feet in depth and an inspection by the Competent Person provides no indication for a potential cave-in.
  - Support systems shall be installed and removed in a manner that protects workers from cave-ins, structural collapses, or from being struck by members of the support system.
  - Backfilling shall progress together with the removal of support systems from excavations.
  - Soil or other material must be kept at least two feet away from the edge of a trench.
- Soil Classification
  - In order to design the most appropriate protective system, a Competent Person shall determine the soil type (see below) using a visual test with one or more manual tests. Testing shall be performed in accordance with the OSHA Excavation Standard 1926.650 to 1926.652. The results of these tests are to be recorded in the ESH-(7000-P)-91681 Trenching and Excavation Permit.
    - ◆ Stable rock – Natural solid mineral matter that can be excavated with vertical sides and remain intact while exposed.
    - ◆ Soil Type A – The most stable: clay, silty clay, and hardpan. No soil is Type A if it is fissured, is subject to vibration of any type, has previously been disturbed, or is seeping water.
    - ◆ Soil Type B – Medium stability: silt, sandy loam, medium clay and unstable dry rock; previously disturbed soils unless otherwise classified as Type C.
    - ◆ Soil Type C – Least stable: gravel, loamy sand, soft clay, submerged soil or dense, heavy unstable rock, and soil from which water is seeping.
  - Soil Mixed Types (Layered Geological Strata) – The soil must be classified on the basis of the soil classification of the weakest soil layer. Each layer may be classified individually if a more stable layer lies below the less stable layer.

## 5.8. Types of Protective Systems

- Sloping, Benching, Shoring, and Shielding are systems that may be used to protect workers from cave-ins in trenches of more than five feet deep. A Competent Person should select the method of protection that is most suitable for the site conditions, taking into account the soil type and surrounding structures.
  - If the soil type is not classified, then the excavation must be sloped at an angle not steeper than 1.5 horizontal to 1.0 vertical.
  - Protective Systems shall conform with the OSHA Excavation Standard 1926.650 to 1926.652.
- Design Requirements
  - Sloping, and benching systems may be designed by either a Competent Person or a PE.

- o Shoring and shielding systems must be designed by a PE. The design shall include the following:
  - ◆ A plan indicating the sizes, types, and configurations of the materials to be used in the protective system.
  - ◆ The identity of the PE approving the design.
- o All excavations over twenty feet in depth must be approved by a PE.
- o Add soft fill dirt when reworking utility trenching to minimize and reduce the chance of a trench settling, shifting, or eroding.

## **6.0 Documented Information/Related Document**

- 6.1.** ESH-(7000-P)-97681 Trenching and Excavation Permit
- 6.2.** ESH-(2000-S)-202124 Stop Work Standard
- 6.3.** Document-73369 Confined Space Chapter
- 6.4.** Document-175959 Disablement or Impairment Permit
- 6.5.** Occupational Safety and Health Administration (OSHA) 1926.650 to 1926.652, Trenching and Excavation
- 6.6.** American Conference of Governmental Industrial Hygienists (ACGIH)