WORK PLAN
UNION PACIFIC RAILROAD
REMOVAL OF UNDERGROUND STORAGE TANKS

I. INTRODUCTION

This work plan details the methods that will be used to remove and permanently close underground storage tanks owned and operated by Union Pacific Railroad at various locations throughout the UPRR System. All work will be accomplished in accordance with federal, state, and local regulations including API bulletin 1604, 40 CFR 280 and 281, and OSHA. Due to the potential hazardous conditions which may be associated with the removal of petroleum storage systems a Health and Safety Plan (HASP) is attached. It provides written procedures to deal with those hazardous conditions. Prior to mobilization the necessary notification will be made by the Consulting Group staff to the appropriate state regulatory agency, and proper permits will be obtained from the local fire department by the advance person. The Project Supervisor will have the final responsibility to assure that all proper permits are obtained.

II. PROJECT ORGANIZATION

The project team is made up of two groups within USPCI's Remedial Services Division, the Geoscience Group within Consulting Group and the Englewood office of the Operations group. The field crew consists of members from both groups. The geologist on the crew is an EA employee and reports to the Consulting Group's LUST/UST Project Manager while the remainder of the crew are Operations employees reporting to the Project Manager. Figure One shows the reporting requirements.

III. SITE PREPARATION

A USPCI employee will work in advance of the tank removal crew to facilitate site preparation. Tasks will include locating tanks to be removed, transferring liquids from the tanks to other onsite storage, disposal, or to recyclers, locating underground obstructions, and securing a backfill source. The advance person will begin the input of site information on the Preliminary Site Evaluation form (see attached) and sign and date that portion that deals with his work. The advance person will also complete the daily report form. Both forms will be mailed on a timely basis (no less than weekly) to the Project Management Team (the Consulting Group Project Manager and the Operations Project Manager). This advance man will coordinate with the appropriate UPRR liaison (usually the Manager of Environmental Field Operations for the region) for assistance in locating tanks, locating underground obstructions, recycler and water treatment plant information, and obtaining any as-built drawings. The advance person will determine the contents of the tank based on UPRR records, verbal information from onsite UPRR users of the tank, and his own observations of the tank contents. All tanks that are identified as having or may of had contained waste oil by any of the sources listed above or any other source will not be emptied until the contents have been analyzed. The advance person will submit a representative sample from each waste oil tank for a laboratory analyses of PCBs and halogenated and aromatic hydrocarbons by EPA Methods 8080 and 8010 & 8020 respectively. A copy of the sample chain-of-custody documentation will sent to the Operations Project Manager when the samples are submitted to the laboratory. Laboratory results will be sent directly to the Operations Project Manager. If results indicate the presence of hazardous substances the Operations Project Manager will contact the appropriate Director (or his designate) in the

UPRR Environmental Management Group for disposal instructions. Disposal of this material will be at the direction of UPRR. USPCI's role will be to carry out the wishes of UPRR while maintaining compliance with the appropriate environmental regulations.

Liquid removal will be accomplished with two men, the advance man and the vacuum truck driver. The UPRR liaison will be consulted for recycling or disposal information. Whenever possible and with UPRR's approval liquids will be transported to the nearest UPRR water treatment plant. When this is not possible the UPRR liaison will be contacted for direction in choosing a recycler or a disposal option. Figure two is a decision tree for the handling of these liquids. USPCI will carry out UPRR recycling instructions <u>while maintaining compliance with appropriate environmental regulations.</u> All disposal or recycling decisions will be made by UPRR and a UPRR representative must sign all accompanying disposal or recycling documentation. The advance person must know the regulations and confirm the disposal or recycling practice with the Project Manager. In all cases the Project Manager will have the authority to change the disposal or recycling options after conferring with UPRR.

Once the product has been identified the removal will take place. Removal is usually accomplished with a vacuum truck although an air diaphragm pump might also be used. In either case, all the following precautions will be taken:

1) The truck or pump will be securely grounded to the tank,
2) A flat bottom hose of 1-1/4 inch diameter will be used at the intake. The hose will be checked by a USPCI employee prior to each use to assure there are no holes or leaks,
3) The workers, truck or pump will be upwind during the entire pumping operation, and

4) The hose will be of sufficient length to allow the truck or pump to be at least 30 feet from the tank.

The advance person is responsible for the transmittal of the Preliminary Site Evaluation form to both the Project Supervisor and the Project Management Team. The tank removal crew will mobilize to site after the advance work is completed and the preliminary site evaluation transmitted to the Project Supervisor. Upon arrival, site control zones will be delineated. The control zones will include an exclusion zone, a contamination reduction zone, and a support zone. The exclusion zone includes the immediate area of the tank where the excavation will take place. The contamination reduction zone will be immediately adjacent to the exclusion zone and is the exit/entry point where any needed decontamination will be accomplished. The support zone will be the remainder of the site where all other activities will take place.

IV. EXCAVATION AND REMOVAL

After all liquids have been identified and removed from the tank, and piping and underground utilities have been located, excavation will begin. If utilities were not located by the advance person then the Project Supervisor is responsible for locating utilities. The top of the tank will be exposed. Excavated soil will be stockpiled at least two feet from the edge of the excavation to lessen the potential for cave-in. As much work as possible will be performed from outside the excavation. In the event that workers must enter excavations greater than four (4) feet in depth, then the sides of the excavation will be cut to the angle of repose or shoring will be installed per OSHA 1926.650 and a USPCI confined space entry permit obtained. Throughout the work

the atmosphere in and around the excavation will be monitored by an USPCI instrument trained employee or contractor for the presence of organic vapors using a combustible gas/oxygen monitor, colorimetric tubes, and a photoionization detector (PID). All workers will wear the proper personal protective equipment as described in the Health and Safety Plan.

Once the top of the tank is exposed all tank fixtures, fill pipe, gauge pipe, pumps, etc. will be removed. All the lines running into or out of the UST will be removed. The vent line will remain connected until the tank is purged. All other openings in the tank will be temporarily plugged. After the tank has been properly sealed the atmosphere within it will be monitored using the combustible gas meter. Reading will be taken at one foot intervals from the bottom of the tank up (care must be taken to keep the probe out of any fluids).

A. <u>Testing</u>

Testing of the tank and work area atmosphere for flammable or combustible vapors will be accomplished with a Gastech Model 1214s combustible gas/oxygen meter with a tank attachment. This instrument will be calibrated with hexane on a minimum weekly basis and after any physical abuse or environmental change (altitude, humidity, etc.). The extension hose of the meter will be marked in one-foot increments to allow ease of measuring the tank atmosphere at one-foot intervals beginning six inches from the bottom of the tank. A non-sparking rod will be used to insure that the actual tank atmosphere and not a fill pipe is being tested. The instrument will be operated by personnel thoroughly trained in its operation by the USPCI Health and Safety.

The tank and excavation atmospheres will be tested (at a minimum) immediately prior to any action and immediately

after any change in conditions such as an environmental change (temperature, humidity, etc.), a physical change in the tank (excavation, solar heating, movement), a personnel change, or any significant time period (2 hours or more after icing). When readings are 10% or less of the lower explosion limit (LEL) (relative to the hexane calibration gas) or a combination of below 20% LEL and 3% oxygen the tank will be considered safe for removal from the ground. All readings of both the combustible gas meter and PID will be recorded on the Preliminary Site Evaluation form, and duly signed and dated by the instrument trained personnel.

B. **Purging**

All tanks will be purged prior to their removal from the ground. Purging may be accomplished by a variety of methods to include: dry ice, water, nitrogen, or liquid CO_2. These purging methods remove flammable vapors from the tank atmosphere only temporarily. Additional purging will be required for additional work on the tank (transportation, etc.). All vapors will be vented through the vent line in the tank and additional piping as necessary so that vapors are vented at least 12 feet above grade and 3 feet above any adjacent roof lines.

Water may be used for cleaning when the following criteria are met:

1) A method for removing any free product is available,

2) Tank capacity is 500 gallons or less, and

3) Water removal is followed by dry ice purging,

Water may be used on small tanks that have considerable sludge or scale that may be removed with the water. All water must be properly handled (according to UPRR direction) at an appropriate facility.

Dry ice may be used when the following criteria are met:

1) Tanks up to 500 gallons have a single centered fill pipe, or
2) For tanks larger than 500 gallons the ice can be adequately distributed over the tank by either a manway or a minimum of 2 access pipes spread over the tank;

Dry ice will be added to the tank at the rate of 3 pounds of dry ice per 100 gallons of tank capacity. The dry ice will be crushed to quarter size or smaller and distributed as evenly as possible over the tank to promote rapid evaporation. Care will be taken to prevent skin contact with the dry ice. Monitoring shall begin one hour after adding the ice, and the tank and work area must be below 10% LEL or a combination of below 20% LEL and 3% oxygen before continuing with the removal.

Nitrogen may be used for purging when the following criteria are met:

1) An access point at the bottom of the tank is available for introduction of the nitrogen.

2) The inflow device must be grounded to the tank, and

3) Inflow pressure must not exceed 5 psi.

Nitrogen may be used on any tank that meets all of the above criteria. A minimum of one and one-half of the tank's volume of nitrogen must be added.

C. **Removal**

After vapors have been purged all access holes will be plugged with the exception of a 1/8-inch vent hole to prevent excess differential pressure. The tank will then be exposed by excavating around it while monitoring the soil being removed with the PID. The tank will then be removed by placing nylon straps around the tank and lifting it out with an excavator or a crane. The use of chains for lifting the tank will not be done under any circumstances.

The tank will be blocked in place on the surface to prevent movement. The following steps are required for tank extraction:

1) Straps will be inspected prior to each usage to assure the strength ratings are adequate, there are no signs of wear, and proper clevis-type attachments are used (hooks are not to be used). Color coded straps will be used that clearly show a color change when significant wear has occurred,

2) Straps are placed completely around the tank and snubbed to prevent slippage. Straps will be placed after over-excavating the ends of the tanks by a man on either bank working the straps under the ends of the tank,

3) All attachments on both the tank and the lifting machine are secured,

4) Free lifts are preferred. A smooth ramp and dragging is a last resort,

5) The USPCI 416 Backhoe or equivalent cannot be used for tanks larger than 3000 gallons,

6) A connecting strap will be used to provide a single lifting point. A spreader bar will not be used, and

7) Tanks are not to be lifted by pipes, lift hooks, manways, etc.

Once the tank is secured on the surface, it will be clearly labeled stating the former contents and current vapor state including removal date. The lettering will be two inches high and the label will include the following:

TANK HAS CONTAINED LEADED GASOLINE*
NOT VAPOR FREE
NOT SUITABLE FOR STORAGE OF FOOD OR LIQUIDS
INTENDED FOR HUMAN OR ANIMAL CONSUMPTION
DATE OF REMOVAL: MONTH/DAY/YEAR
*Or other flammable/combustible liquid

Tanks that contained leaded fuels or unknowns will also have the following label:

TANK HAS CONTAINED LEADED GASOLINE
LEAD VAPORS MAY BE RELEASED IF HEAT IS APPLIED TO THE SHELL

After removal the tank will be transported to a USPCI approved tank destruction facility for recycling. Prior to transport the tank atmosphere will be purged as described above, and it will not be moved until it is below 10% of the LEL. This purge will be considered to be effective from the time a 10% reading is obtained through a four(4)-hour haul. If transportation takes longer than four(4) hours, then

additional purging will be required.

V. SAMPLING AND ANALYSIS

Excavation of the tank will be monitored continuously with a photoionization detector this along with visual inspection of the soil will be used to detect the presence of contamination. If contamination is observed the appropriate state agency will be notified. This notification will be the initial responsibility of the Project Supervisor in the field. In the event that the release is detected by laboratory analyses only the Consulting Group Project Manager or his designate will be responsible for the release notification. All visually stained soil will be excavated, segregated in a separate stockpile on visqueen. Once the excavation of contaminated soil is complete as indicated by the on-site monitoring instruments, a minimum of four samples will be collected in the excavation for off-site laboratory analysis. Samples will be collected from the backhoe bucket when the excavation is greater than four feet deep. The samples will be collected in such a manner that the soil sample will not have been in contact with the bucket of the backhoe. All samples will be collected with a decontaminated stainless steel trowel and placed directly into laboratory supplied bottles. The samples will be immediately placed on ice and maintained at 4 degrees centigrade. These samples will be analyzed for Total Petroleum Hydrocarbons (TPH), Toxic Characteristic Leaching Procedure (TCLP) for lead (if the tank contained leaded fuel), and benzene, toluene, ethylbenzene, and xylene to determine if all contaminated soil has been removed and to allow the proper disposal option to be chosen. Specific analytical methods will be dependent on the individual state requirements for the material the tank contained. The sampler will complete the appropriate chain-of-custody documentation and ship the samples to the

laboratory via overnight service. In no case will samples be held in the field greater than two days during which time their integrity and custody must be maintained.

The sampler and the Project Supervisor are responsible for assuring that all sample documentation is included with the Preliminary Site Evaluation form. The sampler (geologist) shall report directly to the Consulting Group in Boulder and the Project Supervisor shall report to the Operations Project Manager in the Englewood Office.

VI. BACKFILL

When on-site instrument analysis indicates the excavation is complete the hole will be backfilled with borrow material obtained either off-site or from an UPRR borrow area. Prior to being placed in the excavation the borrow material will be sampled and sent to the laboratory for the same analyses as the tank samples. Only "clean" borrow material will be placed in the excavation. Borrow material will be placed in one-foot lifts and compacted with the backhoe.

VII. DISPOSAL

The tank will be cleaned, prepared for scrap, and transported directly to the USPCI approved disposal/scrap site as appropriate. The methods used will be consistent with API guidelines 2015 and 2015A, Cleaning Petroleum Storage Tanks and Guide for Controlling the Lead Hazard Associated with Tank Entry and Cleaning, respectively. All sludge and loose material will be removed and drummed. The Project Supervisor will assure that sludge will be shoveled out and the tank washed down or steam cleaned if necessary. The sludge will be tested for TCLP toxicity for lead and ignitability. If it is classified as a hazardous waste, it will be transported to USPCI's Lone Mountain or Grassy Mountain facilities for proper

disposal.

The appropriate state agency will be consulted to determine the proper disposal options for contaminated soil and nonhazardous tank sludge. The disposal information available directly from the disposal facilities along with any supplied by the agencies will be transmitted to the appropriate Director (or his designate) in the UPRR Environmental Management Group. The UPRR will choose the disposal option for use at each site. USPCI will only take direction or instructions from the appropriate Director (or his designate) in the UPRR Environmental Management Group while maintaining compliance with all appropriate environmental regulations.

VIII. REGULATORY NOTIFICATION

The Consulting Group shall make the 30-day notice of the intent to remove in advance of the crew mobilization. Prior to removal of the tank, the Project Supervisor will assure that all permits have been obtained from the local fire department. In the event that contaminated soil or free product is encountered the Project Supervisor shall notify the Project Management Team immediately and the appropriate state agency within 24 hours. All additional contaminated soil will be excavated if possible, and a site closure report will be prepared by the Consulting Group and submitted to the state. There are situations where there is more contamination than can be easily and quickly removed and/or there is a threat of groundwater contamination. In those cases the excavation will be lined with visqueen and backfilled. An initial abatement report will be submitted within 20 days of the initial notification. If free product is discovered, a free product removal report will be submitted within 45 days of the initial notification. The Consulting Group will then perform an investigation as appropriate to determine the nature and

extent of contamination. In the event that no soil contamination is detected a site closure report will be submitted to the appropriate state agency.

IX. RECORD KEEPING

The Project Supervisor will fill out Daily Report forms (attached) with a listing of manpower and equipment as well as a brief description of the work performed that day. The advance person will also complete the Daily Report Form. The Project Supervisor is responsible for assuring that the Preliminary Site Evaluation Forms and Daily Report Forms (attached) are completed signed and dated and that all the pertinent data including: maps, photographs, descriptions, sample locations, chain-of-custody, all instrument readings and all observations are included with the Preliminary Site Evaluation forms.

FORMS

UST REMOVAL CHECKLIST
PRELIMINARY SITE EVALUATION

Inspected by _____

Date: State:

Site Location:

Service Unit:

Site Address:

Tank Designation #: No. of Tanks This Location:

Facility ID Notification #:

Map: YES ____ NO ____

Notification: In Service ____ Out of Service ____

Verbal OK ____ Needed ____

TANK INFORMATION

	Dimensions	Size	Material	Contents	Age	Comments
Reported:						
Actual:						

Current Contents: No. of Openings:

Markings/Identification:

Above Ground Structures:

Overhead Structures:

Buried Utilities:

Sprint/MCI:

Any Sign of Leakage: YES ____ NO ____

Special Hazards or Conditions:

Date Located Date Excavated Date Shipped

No. of Samples Taken: Sample Designations:

Address for Notifying Utilities:

Comments/Instructions:

All supervisors are to call every morning to either Steve Beck, Curt Hull, or Jerry Dorn and provide their location and how they can be contacted.

Supervisor's Signature: _____

Date: _____ UPRR Service Unit: _____

State: _____ UPRR Contact: _____

Tank #: _____ UPRR Phone #: _____

Check when completed or insert value.

____ 1. Inform UPRR of your work schedule.

____ 2. Locate tank.

____ 3. Check LEL/O_2 levels in work area. _____

____ 4. Stick tank. total liquid level: _____

fuel level: _____

water level: _____

____ 5. Determine if fill pipe is present.

____ 6. Sample product.

Determination in field:

Gasoline___ Diesel___ Oil___ Other___

Analyze off-site as required:

PCB ___ Chlorinated Solvents ___

Waste Oils ___

Lab: Results sent to: _____

____ 7. Remove product: Ground to tank _____

Truck upwind _____

LEL in work area _____

____ 8. Amount of product removed: _____

____ 9. Vacuum truck company and driver.

____ 10. UPRR contacted for liquids handling (recycling/disposal) instructions.

UPRR representative: _____

_____

_____

_____

____ 11. Where and how were the liquids disposed of:

_____

_____

_____

All supervisors are to call every morning to either Steve Beck, Curt Hull, or Jerry Dorn and provide their location and how they can be contacted.

Supervisor's Signature: _____

Date: _____

Check when completed or insert value.

____ 1. Inform UPRR of work schedule.

____ 2. Ascertain if state removal notification and permits exist. YES____ NO____

____ 3. Inform State and/or local regulators, including health & fire departments, of work schedule.

____ 4. Check tank LEL. _____ O_2 _____
These readings should be taken at one foot intervals and recorded in a table.

____ 5. Expose vents.

____ 6. Check work area LEL _____ PID _____

____ 7. Excavate around tank.

____ 8. Take notes and make a sketch showing all piping associated with the tank.
TAKE PHOTOGRAPHS

____ 9. Add dry ice. Amount _____

____ 10. Check tank LEL. _____ O_2 _____

____ 11. If LEL is <20% and O_2 is < 3% then pull tank.
If LEL is >20% or O_2 is >3% then repeat steps 9, 10, 11.

____ 12. What is the condition of the tank? Show holes in tank on sketch made for step 7.
TAKE PHOTOGRAPHS

____ 13. Block and label tank.

____ 14. Measure soil sample head space. PID _____
Use table to record all PID readings.

____ 15. Remove contaminated soil.

____ 16. Resample for head space analysis as necessary.

____ 17. Collect soil samples **as directed by Boulder staff** and send to laboratory for analysis.
TAKE PHOTOGRAPHS of SAMPLE LOCATIONS

____ 18. Fill out chain-of-custody and include with samples.

____ 19. Ship cooled samples to the laboratory by Federal Express. **Do not hold samples in the field over 2 days.**
Date shipped: _____

____ 20. Samples sent to: _____
Results to be reported to: _____

____ 21. Prepare a map showing locations of the excavation, soil samples, buildings, utilities, and all other permanent objects within 100 feet of the excavation, or greater if necessary to show pertinent features. The map should be to scale.

____ 22. Sample backfill material and send to laboratory for analysis.

____ 23. Prepare cross section sketches of excavation walls.
TAKE PHOTOGRAPHS

____ 24. Backfill excavation after getting approval from Boulder.

____ 25. Prepare tank for transport if required.

____ 26. Check tank LEL. _____

____ 27. If LEL is <10% load tank on truck or trailer.
If LEL is >10% repeat add dry ice and repeat step 22.

____ 28. Secure tank.

____ 29. Haul tank. If more than 4 hours - check tank LEL _____ and repurge with dry ice if necessary.

____ 30. What is the amount and disposition of the contaminated soils?
No disposal without approval from Englewood.

_____

____ 31. COMMENTS _____

_____

_____

_____

_____

_____

_____

____ 32. Include all maps and tables to made. Make copies for your files and send originals to Boulder.

DAILY REPORT FOR UST REMOVAL

USPCI
A Subsidiary of Union Pacific Corporation

Remedial Services Division
303/938-5500
5665 Flatiron Parkway
Boulder, Colorado 80301

Client:
Day:
Date:
Location:
Tank #:
Job #:

EQUIPMENT	QTY (DYS,HRS)	UNIT PRICE	TOTAL
Dump/Haul Truck			
Backhoe			
Extra Backhoe			
Triple Axle Trailer			
Steel Trailer			
Utility Truck			
Crane			
Laptop Computer			
Tools			
Skimmer			
Foxboro GC			
Gastech GX-86			
Photovac Tip II			
Line Locator			
Fax			
Cutting Torch			
Sensidyne Pump			
SCBA			
Other			

LABOR	QTY (HRS)	UNIT PRICE	TOTAL
Program Manager			
Project Manager			
Project Supervisor			
Chemist			
Geologist			
Equipment Operator			
Other			
Data Clerk			
Secretary			

EXPENDABLES	QTY	UNIT PRICE	TOTAL
Analysis TPH			
BTX			
EPTOX Pb			
Ignitability			
Expenses			
Meals			
Lodging			
Travel			
Dry Ice			
Sensidyne Tubes			
Temp. Fence			
Visqueen			
Backfill			
Drums(55G)			
Tyvek(standard)			
Tyvek(coated)			
Respirators			
Half Face			
Full Face			
Cartridges			
Boots			
Gloves			
Gloves			
Samples sent to:			

USPCI Representative_____ Client Representative_____

POLYESTER ROPE SLINGS
Spliced Eyes in Both Ends

MAXIMUM SAFE WORKING LOADS — POUNDS (Safety Factor = 5)

Rope Diameter (inches)	Single Vertical Hitch	Single Choker Hitch	Single Basket Hitch (Vertical Legs)	2-Leg Bridle Hitch & Single Basket Hitch With Legs Inclined 60°	45°	30°
5/16	200	150	400	350	280	200
3/8	300	225	600	520	420	300
7/16	500	375	1,000	870	700	500
1/2	700	525	1,400	1,200	1,000	700
9/16	1,200	900	2,400	2,100	1,700	1,200
5/8	1,500	1,125	3,000	2,600	2,100	1,500
3/4	1,900	1,425	3,800	3,300	2,700	1,900
7/8	2,400	1,800	4,800	4,150	3,400	2,400
15/16	2,950	2,200	5,900	5,100	4,200	2,950
1	3,400	2,550	6,800	5,900	4,800	3,400
1 1/16	4,200	3,150	8,400	7,300	5,900	4,200
1 1/8	4,900	3,675	9,800	8,500	6,900	4,900
1 3/16	5,600	4,200	11,200	9,700	7,900	5,600
1 1/4	6,300	4,725	12,600	10,900	8,900	6,300
1 5/16	7,100	5,325	14,200	12,300	10,000	7,100
1 3/8	8,900	6,675	17,800	15,400	12,600	8,900
1 1/2	10,600	8,100	21,600	18,700	15,300	10,800
1 5/8	12,900	9,675	25,800	22,300	18,200	12,900
2	15,200	11,400	30,400	26,300	21,500	15,200
2 1/8	17,400	13,050	34,800	30,100	24,600	17,400
2 1/4	20,400	15,300	40,800	35,300	28,800	20,400
2 3/8	23,200	17,400	46,400	40,200	32,800	23,200
2 1/2	26,000	19,500	52,000	45,000	36,800	26,000

If used with Choker Hitch multiply above values by 4/5.

For Double Basket Hitch multiply above values by 2.

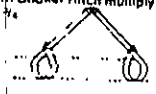
Note: For Safe Working Loads of Endless or Grommet Slings, Multiply Above Values by 2.

NYLON WEB SLINGS
(8000 lb/in Material)

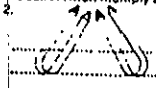
MAXIMUM SAFE WORKING LOADS — POUNDS (SAFETY FACTOR* = 5)
(Eye & Eye, Twisted Eye Triangle Fittings, Choker Fittings)

Web Width (inches)	Single Vertical Hitch	Single Choker Hitch	Single Basket Hitch (Vertical Legs)	2-Leg Bridle Hitch & Single Basket Hitch With Legs Inclined 60°	45°	30°
1	1,600	1,200	3,200	2,770	2,260	1,600
2	3,200	2,400	6,400	5,550	4,520	3,200
3	4,800	3,600	9,600	8,300	6,800	4,800
4	6,400	4,800	12,800	11,100	9,050	6,400
5	8,000	6,000	16,000	13,850	11,300	8,000
6	9,600	7,200	19,200	16,600	13,500	9,600
7	11,200	8,400	22,400	19,400	15,800	11,200
8	12,800	9,600	25,600	22,200	18,100	12,800
9	14,400	10,800	28,800	25,000	20,400	14,400
10	16,000	12,000	32,000	27,700	22,600	16,000
11	17,600	13,200	35,200	30,500	24,900	17,600
12	19,200	14,400	38,400	33,300	27,200	19,200

If used with Choker Hitch multiply above values by 4/5.



For Double Basket Hitch multiply above values by 2.



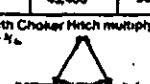
Note: For Safe Working Loads of Endless or Grommet Slings, Multiply Above Values by 2.

NYLON ROPE SLINGS
Spliced Eyes in Both Ends

MAXIMUM SAFE WORKING LOADS — POUNDS (Safety Factor = 5)

Rope Diameter (inches)	Single Vertical Hitch	Single Choker Hitch	Single Basket Hitch (Vertical Legs)	2-Leg Bridle Hitch & Single Basket Hitch With Legs Inclined 60°	45°	30°
5/16	200	150	400	350	280	200
3/8	300	225	600	520	420	300
7/16	500	375	1,000	870	700	500
1/2	700	525	1,400	1,200	1,000	700
5/8	1,250	940	2,500	2,200	1,770	1,250
3/4	1,500	1,125	3,000	2,600	2,100	1,500
7/8	2,000	1,500	4,000	3,500	2,800	2,000
1	2,800	2,100	5,600	4,850	4,000	2,800
1 1/8	3,200	2,400	6,600	5,500	4,500	3,200
1 1/4	3,800	2,850	7,600	6,600	5,400	3,800
1 3/8	4,800	3,600	9,600	8,300	6,800	4,800
1 1/2	5,500	4,125	11,000	9,500	7,800	5,500
1 5/8	6,300	4,725	12,600	10,900	8,900	6,300
1 3/4	7,200	5,400	14,400	12,500	10,200	7,200
1 7/8	8,200	6,150	16,400	14,200	11,600	8,200
1 1/2	10,200	7,650	20,400	17,700	14,400	10,200
1 5/8	12,400	9,300	24,800	21,500	17,500	12,400
1 3/4	15,000	11,250	30,000	26,000	21,200	15,000
2	17,900	13,400	35,800	31,000	25,300	17,900
2 1/8	20,200	15,150	40,400	35,000	28,600	20,200
2 1/4	23,800	17,850	47,600	41,200	33,700	23,800
2 1/2	26,600	20,000	53,200	46,100	37,600	26,600
2 3/4	30,700	23,000	61,400	53,200	43,400	30,700

If used with Choker Hitch multiply above values by 4/5.



For Double Basket Hitch multiply above values by 2.

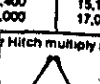
Note: For Safe Working Loads of Endless or Grommet Slings, Multiply Above Values by 2.

POLYPROPYLENE ROPE SLINGS
Spliced Eyes in Both Ends

MAXIMUM SAFE WORKING LOADS — POUNDS (Safety Factor = 5)

Rope Diameter (inches)	Single Vertical Hitch	Single Choker Hitch	Single Basket Hitch (Vertical Legs)	2-Leg Bridle Hitch & Single Basket Hitch With Legs Inclined 60°	45°	30°
5/16	150	110	300	260	210	150
3/8	250	180	500	430	350	250
7/16	400	300	800	700	560	400
1/2	500	375	1,000	860	700	500
5/8	830	620	1,660	1,400	1,200	830
3/4	960	720	1,920	1,700	1,350	960
7/8	1,300	975	2,600	2,250	1,800	1,300
1	1,700	1,275	3,400	2,900	2,400	1,700
1 1/8	1,900	1,425	3,800	3,300	2,700	1,900
1 1/4	2,200	1,650	4,400	3,800	3,100	2,200
1 3/8	2,900	2,175	5,800	5,000	4,100	2,900
1 1/2	3,000	2,250	6,000	5,200	4,200	3,000
1 5/8	3,750	2,800	7,500	6,500	5,300	3,750
1 3/4	4,200	3,150	8,400	7,300	5,900	4,200
1 7/8	4,400	3,300	8,800	7,600	6,200	4,400
1 1/2	6,000	4,500	12,000	10,400	8,500	6,000
1 5/8	7,300	5,500	14,600	12,600	10,300	7,300
1 3/4	8,700	6,500	17,400	15,100	12,300	8,700
2	10,400	7,800	20,800	18,000	14,700	10,400
2 1/8	11,500	8,600	23,000	19,800	16,300	11,500
2 1/4	13,200	9,900	26,400	22,900	18,700	13,200
2 3/8	15,100	11,300	30,200	26,200	21,400	15,100
2 1/2	17,000	12,750	34,000	29,400	24,000	17,000

If used with Choker Hitch multiply above values by 4/5.



For Double Basket Hitch multiply above values by 2.

Note: For Safe Working Loads of Endless or Grommet Slings, Multiply Above Values by 2.

POLYESTER ROPE SLINGS
Spliced Eyes in Both Ends

Rope Diameter (Inches)	MAXIMUM SAFE WORKING LOADS — POUNDS (Safety Factor = 5)					
	Single Vertical Hitch	Single Choker Hitch	Single Basket Hitch (Vertical Legs)	2-Leg Bridle Hitch & Single Basket Hitch With Legs Inclined		
				60°	45°	30°
5/16	200	150	400	350	280	200
3/8	300	225	600	520	420	300
7/16	500	375	1,000	870	700	500
1/2	700	525	1,400	1,200	1,000	700
5/8	1,200	900	2,400	2,100	1,700	1,200
3/4	1,500	1,125	3,000	2,600	2,100	1,500
7/8	1,900	1,425	3,800	3,300	2,700	1,900
1	2,400	1,800	4,800	4,150	3,400	2,400
1 1/8	2,950	2,200	5,900	5,100	4,200	2,950
1 1/4	3,400	2,550	6,800	5,900	4,800	3,400
1 3/8	4,200	3,150	8,400	7,300	5,900	4,200
1 1/2	4,900	3,675	9,800	8,500	6,900	4,900
1 5/8	5,600	4,200	11,200	9,700	7,900	5,600
1 3/4	6,300	4,725	12,600	10,900	8,900	6,300
1 7/8	7,100	5,325	14,200	12,300	10,000	7,100
2	8,900	6,675	17,800	15,400	12,600	8,900
2 1/8	10,800	8,100	21,600	18,700	15,300	10,800
2 1/4	12,900	9,675	25,800	22,300	18,200	12,900
2	15,200	11,400	30,400	26,300	21,500	15,200
2 1/2	17,400	13,050	34,800	30,100	24,600	17,400
2 1/4	20,400	15,300	40,800	35,300	28,800	20,400
2 1/2	23,200	17,400	46,400	40,200	32,800	23,200
2 3/4	26,000	19,500	52,000	45,000	36,800	26,000

If used with Choker Hitch multiply above values by 3/4.

For Double Basket Hitch multiply above values by 2.

Note: For Safe Working Loads of Endless or Grommet Slings, Multiply Above Values by 2.

NYLON WEB SLINGS
(8000 lb/in Material)

Web Width (Inches)	MAXIMUM SAFE WORKING LOADS — POUNDS (SAFETY FACTOR* = 5) (Eye & Eye, Twisted Eye, Triangle Fittings, Choker Fittings)					
	Single Vertical Hitch	Single Choker Hitch	Single Basket Hitch (Vertical Legs)	2-Leg Bridle Hitch & Single Basket Hitch With Legs Inclined		
				60°	45°	30°
1	1 600	1,200	3 200	2,770	2 260	1 600
2	3 200	2,400	6 400	5,550	4 520	3 200
3	4 800	3 600	9 600	8 300	6,800	4 800
4	6 400	4 800	12 800	11 100	9 050	6 400
5	8 000	6 000	16 000	13 850	11 300	8 000
6	9 600	7 200	19 200	16,600	13 600	9 600
7	11,200	8,400	22,400	19 400	15 800	11 200
8	12 800	9,600	25 600	22 200	18 100	12 800
9	14 400	10 800	28 800	25 000	20,400	14,400
10	16 000	12 000	32 000	27,700	22,600	16 000
11	17 600	13,200	35,200	30 500	24,900	17 600
12	19,200	14 400	38 400	33 300	27,200	19 200

If used with Choker Hitch multiply above values by 3/4.

For Double Basket Hitch multiply above values by 2

Note: For Safe Working Loads of Endless or Grommet Slings, Multiply Above Values by 2.

NYLON ROPE SLINGS
Spliced Eyes in Both Ends

Rope Diameter (Inches)	MAXIMUM SAFE WORKING LOADS — POUNDS (Safety Factor = 5)					
	Single Vertical Hitch	Single Choker Hitch	Single Basket Hitch (Vertical Legs)	2-Leg Bridle Hitch & Single Basket Hitch With Legs Inclined		
				60°	45°	30°
5/16	200	150	400	350	280	200
3/8	300	225	600	520	420	300
7/16	500	375	1,000	870	700	500
1/2	700	525	1,400	1,200	1,000	700
5/8	1,250	940	2,500	2,200	1,770	1,250
3/4	1,500	1,125	3,000	2,600	2,100	1,500
7/8	2,000	1,500	4,000	3,500	2,800	2,000
1	2,800	2,100	5,600	4,850	4,000	2,800
1 1/8	3,200	2,400	6,600	5,500	4,500	3,200
1 1/4	3,800	2,850	7,600	6,600	5,400	3,900
1 3/8	4,800	3,600	9,600	8,300	6,800	4,600
1 1/2	5,500	4,125	11,000	9,500	7,800	5,500
1 5/8	8,300	4,725	12,600	10,900	8,900	6,300
1 3/4	7,200	5,400	14,400	12,500	10,200	7,200
1 7/8	8,200	6,150	16,400	14,200	11,600	8,200
2 1/8	10,200	7,650	20,400	17,700	14,400	10,200
2 1/4	12,400	9,300	24,800	21,500	17,500	12,400
2 1/2	15,000	11,250	30,000	26,000	21,200	15,000
2	17,900	13,400	35,800	31,000	25,300	17,900
2 1/8	20 200	15,150	40 400	35,000	28,600	20,200
2 1/4	23 800	17,850	47,600	41,200	33,700	23,800
2 1/2	26,600	20 000	53,200	46,100	37,600	26,600
2 3/4	30,700	23,000	61,400	53,200	43,400	30,700

If used with Choker Hitch multiply above values by 3/4.

For Double Basket Hitch multiply above values by 2.

Note: For Safe Working Loads of Endless or Grommet Slings, Multiply Above Values by 2.

POLYPROPYLENE ROPE SLINGS
Spliced Eyes in Both Ends

Rope Diameter (Inches)	MAXIMUM SAFE WORKING LOADS — POUNDS (Safety Factor = 5)					
	Single Vertical Hitch	Single Choker Hitch	Single Basket Hitch (Vertical Legs)	2-Leg Bridle Hitch & Single Basket Hitch With Legs Inclined		
				60°	45°	30°
5/16	150	110	300	260	210	150
3/8	250	190	500	430	350	250
7/16	400	300	800	700	560	400
1/2	500	375	1,000	860	700	500
5/8	830	620	1,660	1,400	1,200	830
3/4	960	720	1,920	1,700	1,350	960
7/8	1,300	975	2,600	2,250	1,800	1,300
1	1,700	1,275	3,400	2,900	2,400	1,700
1 1/8	1,900	1,425	3,800	3,300	2,700	1,900
1 1/4	2,200	1,650	4,400	3,800	3,100	2,200
1 3/8	2,900	2,175	5,800	5,000	4,100	2,900
1 1/2	3,000	2,250	6,000	5,200	4,200	3,000
1 5/8	3,750	2 800	7,500	6,500	5,300	3,750
1 3/4	4,200	3,150	8,400	7,300	5,900	4,200
1 7/8	4,400	3,300	8,800	7,600	6,200	4,400
2 1/8	6,000	4,500	12,000	10,400	8,500	6,000
2 1/4	7,300	5,500	14,600	12,600	10,300	7,300
2 1/2	8,700	6,500	17,400	15,100	12,300	8,700
2	10,400	7,800	20,800	18,000	14,700	10,400
2 1/8	11,500	8,600	23,000	19,900	16,300	11,500
2 1/4	13,200	8,900	26,400	22,900	10,700	13,200
2 1/2	15,100	11,300	30,200	26,200	21,400	15,100
2 3/4	17,000	12,750	34,000	29,400	24,000	17,000

If used with Choker Hitch multiply above values by 3/4.

For Double Basket Hitch multiply above values by 2.

Note: For Safe Working Loads of Endless or Grommet Slings, Multiply Above Values by 2.

APPENDIX-C

USPCI EXCAVATION POLICY

INTRODUCTION

Excavations and trenches are encountered daily by USPCI personnel. Modern heavy equipment allows us to dig deeper, faster, and safer than ever before. However, despite improvements in equipment, working in an excavation can be one of the most hazardous tasks our employees perform.

There are many hazards associated with excavations. They include:

1) Collapse or failure of excavation walls burying workers and equipment.
2) Materials, tools, and equipment falling into holes and striking workers below.
3) Hazards involving public utilities such as gas, water, and electric lines.
4) Hazards associated with a confined space such as oxygen deficient or toxic atmospheres.
5) Wet and muddy conditions, causing slips trips or falls, complicated by limited spaces in which to work.
6) Falling hazards when climbing into or out of the excavation.
7) Employees working too close together.
8) Stumbling over equipment, excavated material or falling into the excavation.

Collapsing of the side walls presents the greatest danger. Most common causes are:

1) Inadequate sloping or shoring in an attempt to reduce costs, or save time.
2) Misjudging of soil stability.
3) Failure of apparently adequate shoring due to unexpected lateral forces caused by vibration from trains or traffic.
4) Superimposed loads on the ground surface adjacent to the cuts, including the spoil (excavated soil), from the hole itself, or heavy equipment.

5) Use of nonengineered trench boxes.

6) Failure to recognize changes in soil conditions after rain storms, freezes, or dry periods.

7) Under cutting of trench walls by trenching machines not properly leveled.

Recognizing and preventing these hazards can save lives and property. This policy addresses these hazards and sets a standard which, when properly followed, can help prevent unsafe working conditions.

GENERAL REQUIREMENTS

1. An effort will be made to eliminate the need for employees to enter excavations. Sampling, monitoring, and other work processes can be done from outside the excavation. (i.e., attaching a GasTech probe to the bucket of the backhoe to check for oxygen content.)

2. All surface encumbrances shall be removed from or supported in the area of the excavation which could create a hazard to employees. (i.e., an excavation removes some of the soil supporting a utility pole--this pole would have to be resupported.)

3. The location of utility installations such as power, water, and gas lines will be determined prior to opening an excavation. The appropriate utility company will be notified at least 48 hours prior to starting. If the utility company can not or will not respond to our request, then all efforts will be made to locate utility installations. Utility location will be accomplished by qualified operators using approved detection equipment. While the excavation is open all utility installations will be supported and protected from damage.

4. When working in an excavation 4 feet or more in depth, a means of egress will be provided. This can either be a ladder, stair way, or ramp. If a ladder is used, it must extend a minimum of 3 feet above the edge of the excavation and be secured. Stairways will be of proper rise and size and will have a hand rail if it has four or more risers. Ramps will be designed by the Engineering Department and be of non-slip design without tripping hazards. The ramp will be capable of supporting the intended load.

5. Employees exposed to vehicular and/or equipment traffic will wear a fluorescent traffic vest. Safety cones and other traffic control devices such as a flagger will be used to divert traffic away from the excavation. An outside contractor should be used for traffic control, because of OSHA requirements.

6. No employee will be allowed to work under an overhead load. (i.e., the bucket of the backhoe.) When vehicles and gondolas are loaded, employees will stand clear to avoid being struck by material.

7. To prevent cave-ins and equipment damage, a means of warning equipment operators when working near the edge of the excavation will be provided. This can take the form of curb stops, barricades, or having a spotter with an pre-established communication system assist the operator.

8. All excavations around hazardous materials, or processes should be treated as a confined space. The atmosphere in the excavation needs to be tested for flammability, toxicity, and oxygen deficiency. If a hazard is determined to exist then the company policy for confined spaces will be followed. This includes proper PPE, respiratory protection, monitoring and rescue equipment, and an observer.

9. Work will not be performed in an excavation which is accumulating water. Water accumulation can be minimized by the use of pumps. The pumps will be of sufficient size to minimize water accumulation. If pumps are used a specific employee will be responsible for monitoring the pumps and their effectiveness.

Because of the changes which take place whenever water enters an excavation a complete inspection of the excavation will be performed before anyone is allowed to enter the excavation.

10. Prior to working in or around an excavation, a visual inspection of the excavation will be made to ensure that all potential causes of sidewall collapse have been identified and eliminated. Signs of instability are:

    1) Tension cracks in soil;
    2) Bottom sloughing away, embankment undercut, or cracks in the embankment;
    3) Excess water eroding sidewalls;
    4) Bulging of sidewalls;
    5) Lateral movement of soils;
    6) Sloughing of sidewalls;
    7) Changes in soil color; and
    8) Cracking of timbers, bowing or bending of braces or sheeting, cracks in soil behind sheeting, and boils in bottom of excavation.

Work will stop if the inspection indicates an unsafe condition and will not resume until the hazard is corrected.

11. If a bridge or walkway is used which allows employees to cross over or walk parallel with an excavation, standard guard rails will be in place.

12. When left unattended, barriers will be erected around the excavation to secure it from unauthorized personnel.

13. Excavations will be back filled as soon as the operation is completed.

14. Spoil piles will be no closer than 2 feet from the edge of the excavation. Wet soil will have to be piled further from the edge because of the extra weight (3 feet for type B soil, 4 feet for type C soil) or removed from the site.

15. In addition to hard hats, safety glasses, and steel toed boots, employees will use the proper respiratory protection and PPE as warranted.

CAVE-IN PROTECTION

A specific protection system for cave-ins will be used before any employee enters an excavation. The protective system may be one of the following:

1) Trench box
2) Shoring (wood or metal)
3) Sloping or benching

An engineered trench box is the preferred method of protection. The following precautions must be taken when using a trench box. The box must be the proper size to assure total protection.

1) Its design must be capable of withstanding anticipated loads.
2) Employees will be protected from cave-in when entering or exiting a trench box.
3) Trench boxes shall be secured to prevent sudden movement from sudden loads.
4) Employees will not be allowed in trench box when it is being moved or installed.

Shoring is another alternative. Shoring can be of either wood or metal construction, with premanufactured shoring systems being the preferred method. When using wood for shoring material refer to the attached timber shoring charts. These charts give you the type of

wood, size of timbers and spacing for the various types of soils and the size of the excavation.

Premanufactured shoring is more cost effective and easier to install. Manufacturer's instructions and recommendations for the use of their shoring system must be followed. Copies of the instructions will be kept at the job site. No alteration to the shoring system will be allowed.

Regardless of which type of shoring system is used the following practices must be following:

1) Shoring materials must be sound, free of defects or damage.
2) Shoring members will be secured together to prevent sliding, falling, kickouts, or other predictable failure.
3) Load capacity of members will not be exceeded.
4) During installation and removal of the system employees will be protected against cave-ins.
5) Shoring member removal will begin and progress from the bottom up with the employees out of the excavation.
6) Backfilling will be done with the removal of the support system.

Sloping and benching is the third choice. This method is widely used because of cost and ease. It is also the system of protection most likely to fail. Problems which lead to failure are:

1) Improper angle of side wall slope
2) Failure to allow for changing or unrecognized conditions
3) Lack of inspection of the excavation before entry

OSHA is very specific as to sloping requirements, and has published a set of guidelines, of which copies are attached.

The shoring and sloping standard refers to specific soil types (A,B,C). An understanding of the different types is important, since the shoring and sloping requirements are designed for use with a specific soil condition. It is USPCI's policy that all soils will be classified as either type B or C.

Type B soil characteristics:

1) Cohesive in nature (sticks together)
2) Moist samples can be molded and shaped
3) Dry samples break up in clumps

4) Your thumb cannot penetrate a type B soil

5) Fine grained

Type B protection requirements:

1) Trench box must extend 18 inches above excavation

2) Angle of sidewall slope is 1:1

3) Shoring use soil B chart

Type C soil characteristics:

1) Non-cohesive

2) Granular (i.e., sand gravel)

3) Moist samples may be pliable but will not hold their shape

4) Dry samples crumble easily into granular pieces

5) Layered soil types are considered to be type C

6) Soils with freely seeping water are type C

7) Predisturbed soil is type C

Type C protection requirements:

1) Trench box must extend 18 inches above edge of excavation

2) Angle of sidewall slope is 1.5:1

3) Shoring use type C chart

In addition to manual testing of the soil to determine type, a visual analysis will also be performed. The best time for a visual analysis is during the actual digging.

Things to observe are:

1) Particle size of the soil

2) Whether the soil stays in clods breaks up

3) Presence of cracks or fissures

4) Sources of vibration

5) Sources of water

6) Layering of soil types

7) Compare the angle of repose of the spoil pile to the angle of the excavation slope. The slope angle should equal or be less than the spoil's angle of repose.

Some jobs may not conform to the conditions specified in this policy or the excavation may exceed 20 feet in depth. When this occurs, the Engineering Department must be consulted and approve or design the appropriate protection system. Copies of the design signed by the engineer must be kept at the job site.

In order to protect lives and property, it is USPCI's policy that only company trained and certified employees can supervise an excavation project. This person will be deemed the competent individual and will have the authority to see that this policy is followed.

Even with these safeguards, accidents can occur. The chief causes of accidents are:

1) Failure or inadequate job planning
2) Disregard of soil behavior
3) Disregard of safety standards
4) Improper use of equipment
5) Willingness to take gambles or short cuts

These are all human factors for which no policy can account. Eliminating these causative factors from the job site requires everyone's cooperation. In addition, we must <u>think</u> when involved in an excavation project.

PART 1926—[AMENDED]

Subpart M—[Amended]

1. By revising the authority citation for subpart M of part 1926 to read as follows:

Authority: Sec. 107, Contract Work Hours and Safety Standards Act (Construction Safety Act) (40 U.S.C. 333); Secs. 4, 6, 8, Occupational Safety and Health Act of 1970 (29 U.S.C. 653, 655, 657); Secretary of Labor's Order No. 12–71 (36 FR 8754), 8–76 (41 FR 25059), or 9–83 (48 FR 35736), as applicable, and 29 CFR part 1911.

2. By revising subpart P of part 1926 to read as follows:

Subpart P—Excavations

Subpart P—Excavations

Authority: Sec. 107, Contract Worker Hours and Safety Standards Act (Construction Safety Act) (40 U.S.C. 333); Secs. 4, 6, 8, Occupational Safety and Health Act of 1970 (29 U.S.C. 653, 655, 657); Secretary of Labor's Order No. 12–71 (36 FR 8754), 8–76 (41 FR 25059), or 9–83 (48 FR 35736), as applicable, and 29 CFR part 1911.

§ 1926.650 Scope, application, and definitions applicable to this subpart.

(a) *Scope and application.* This subpart applies to all open excavations made in the earth's surface. Excavations are defined to include trenches.

(b) *Definitions applicable to this subpart.*

Accepted engineering practices means those requirements which are compatible with standards of practice required by a registered professional engineer.

Aluminum Hydraulic Shoring means a pre-engineered shoring system comprised of aluminum hydraulic cylinders (crossbraces) used in conjunction with vertical rails (uprights) or horizontal rails (walers). Such system is designed, specifically to support the sidewalls of an excavation and prevent cave-ins.

Bell-bottom pier hole means a type of shaft or footing excavation, the bottom of which is made larger than the cross section above to form a belled shape.

Benching (Benching system) means a method of protecting employees 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 means the separation of a mass of soil or rock material from the side of an excavation, or the loss of soil from 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 injure and immobilize a person.

Competent person means 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.

Cross braces mean the horizontal members of a shoring system installed perpendicular to the sides of the excavation, the ends of which bear against either uprights or wales.

Excavation means any man-made cut, cavity, trench, or depression in an earth surface, formed by earth removal.

Faces or *sides* means the vertical or inclined earth surfaces formed as a result of excavation work.

Failure means the breakage, displacement, or permanent deformation of a structural member or connection so as to reduce its structural integrity and its supportive capabilities.

Hazardous atmosphere means an atmosphere which by reason of being explosive, flammable, poisonous, corrosive, oxidizing, irritating, oxygen deficient, toxic, or otherwise harmful, may cause death, illness, or injury.

Kickout means the accidental release or failure of a cross brace.

Protective system means a method of protecting employees from cave-ins, from material that could fall or roll from an excavation face or into an excavation, or from the collapse of adjacent structures. Protective systems include support systems, sloping and benching systems, shield systems, and other systems that provide the necessary protection.

Ramp means an inclined walking or working surface that is used to gain access to one point from another, and is constructed from earth or from structural materials such as steel or wood.

Registered Professional Engineer means a person who is registered as a professional engineer in the state where the work is to be performed. However, a professional engineer, registered in any state is deemed to be a "registered professional engineer" within the meaning of this standard when approving designs for "manufactured protective systems" or "tabulated data" to be used in interstate commerce.

Sheeting means the members of a shoring system that retain the earth in position and in turn are supported by other members of the shoring system.

Shield (Shield system) means a structure that is able to withstand the forces imposed on it by a cave-in and thereby protect employees within the structure. Shields can be permanent structures or can be designed to be portable and moved along as work progresses. Additionally, shields can be either premanufactured or job-built in accordance with § 1926.652 (c)(3) or (c)(4). Shields used in trenches are usually referred to as "trench boxes" or "trench shields."

Shoring (Shoring system) means 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.

Sides. See "Faces."

Sloping (Sloping system) means a method of protecting employees from cave-ins by excavating to form sides of an excavation that are inclined away from the excavation so as to prevent cave-ins. The angle of incline required to prevent a cave-in varies with differences in such factors as the soil type, environmental conditions of exposure, and application of surcharge loads.

Stable rock means natural solid mineral material that can be excavated with vertical sides and will remain intact while exposed. Unstable rock is considered to be stable when the rock material on the side or sides of the excavation is secured against caving-in or movement by rock bolts or by another protective system that has been designed by a registered professional engineer.

Structural ramp means a ramp built of steel or wood, usually used for vehicle access. Ramps made of soil or rock are not considered structural ramps.

Support system means a structure such as underpinning, bracing, or shoring, which provides support to an adjacent structure, underground

installation, or the sides of an excavation.

Tabulated data means tables and charts approved by a registered professional engineer and used to design and construct a protective system.

Trench (Trench excavation) means 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 of a trench (measured at the bottom) is not greater than 15 feet (4.6 m). If forms or other structures are installed or constructed in an excavation so as to reduce the dimension measured from the forms or structure to the side of the excavation to 15 feet (4.6 m) or less (measured at the bottom of the excavation), the excavation is also considered to be a trench.

Trench box. See "Shield."

Trench shield. See "Shield."

Uprights means the vertical members of a trench shoring system placed in contact with the earth and usually positioned so that individual members do not contact each other. Uprights placed so that individual members are closely spaced, in contact with or interconnected to each other, are often called "sheeting."

Wales means horizontal members of a shoring system placed parallel to the excavation face whose sides bear against the vertical members of the shoring system or earth.

§ 1926.651 General requirements.

(a) *Surface encumbrances.* All surface encumbrances that are located so as to create a hazard to employees shall be removed or supported, as necessary, to safeguard employees.

(b) *Underground installations.* (1) The estimated location of utility installations, such as sewer, telephone, fuel, electric, water lines, or any other underground installations that reasonably may be expected to be encountered during excavation work, shall be determined prior to opening an excavation.

(2) Utility companies or owners shall be contacted within established or customary local response times, advised of the proposed work, and asked to establish the location of the utility underground installations prior to the start of actual excavation. When utility companies or owners cannot respond to a request to locate underground utility installations within 24 hours (unless a longer period is required by state or local law), or cannot establish the exact location of these installations, the employer may proceed, provided the employer does so with caution, and provided detection equipment or other acceptable means to locate utility installations are used.

(3) When excavation operations approach the estimated location of underground installations, the exact location of the installations shall be determined by safe and acceptable means.

(4) While the excavation is open, underground installations shall be protected, supported or removed as necessary to safeguard employees.

(c) *Access and egress*—(1) *Structural ramps.* (i) Structural ramps that are used solely by employees as a means of access or egress from excavations shall be designed by a competent person. Structural ramps used for access or egress of equipment shall be designed by a competent person qualified in structural design, and shall be constructed in accordance with the design.

(ii) Ramps and runways constructed of two or more structural members shall have the structural members connected together to prevent displacement.

(iii) Structural members used for ramps and runways shall be of uniform thickness.

(iv) Cleats or other appropriate means used to connect runway structural members shall be attached to the bottom of the runway or shall be attached in a manner to prevent tripping.

(v) Structural ramps used in lieu of steps shall be provided with cleats or other surface treatments on the top surface to prevent slipping.

(2) *Means of egress from trench excavations.* A stairway, ladder, ramp or other safe means of egress shall be located in trench excavations that are 4 feet (1.22 m) or more in depth so as to require no more than 25 feet (7.62 m) of lateral travel for employees.

(d) *Exposure to vehicular traffic.* Employees exposed to public vehicular traffic shall be provided with, and shall wear, warning vests or other suitable garments marked with or made of reflectorized or high-visibility material.

(e) *Exposure to falling loads.* No employee shall be permitted underneath loads handled by lifting or digging equipment. Employees shall be required to stand away from any vehicle being loaded or unloaded to avoid being struck by any spillage or falling materials. Operators may remain in the cabs of vehicles being loaded or unloaded when the vehicles are equipped, in accordance with § 1926.601(b)(6), to provide adequate protection for the operator during loading and unloading operations.

(f) *Warning system for mobile equipment.* When mobile equipment is operated adjacent to an excavation, or when such equipment is required to approach the edge of an excavation, and the operator does not have a clear and direct view of the edge of the excavation, a warning system shall be utilized such as barricades, hand or mechanical signals, or stop logs. If possible, the grade should be away from the excavation.

(g) *Hazardous atmospheres*—(1) *Testing and controls.* In addition to the requirements set forth in subparts D and E of this part (29 CFR 1926.50–1926.107) to prevent exposure to harmful levels of atmospheric contaminants and to assure acceptable atmospheric conditions, the following requirements shall apply:

(i) Where oxygen deficiency (atmospheres containing less than 19.5 percent oxygen) or a hazardous atmosphere exists or could reasonably be expected to exist, such as in excavations in landfill areas or excavations in areas where hazardous substances are stored nearby, the atmospheres in the excavation shall be tested before employees enter excavations greater than 4 feet (1.22 m) in depth.

(ii) Adequate precautions shall be taken to prevent employee exposure to atmospheres containing less than 19.5 percent oxygen and other hazardous atmospheres. These precautions include providing proper respiratory protection or ventilation in accordance with subparts D and E of this part respectively.

(iii) Adequate precaution shall be taken such as providing ventilation, to prevent employee exposure to an atmosphere containing a concentration of a flammable gas in excess of 20 percent of the lower flammable limit of the gas.

(iv) 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.

(2) *Emergency rescue equipment.* (i) Emergency rescue equipment, such as breathing apparatus, a safety harness and line, or a basket stretcher, shall be readily available where hazardous atmospheric conditions exist or may reasonably be expected to develop during work in an excavation. This equipment shall be attended when in use.

(ii) Employees entering bell-bottom pier holes, or other similar deep and confined footing excavations, shall wear a harness with a life-line securely attached to it. The lifeline shall be separate from any line used to handle materials, and shall be individually

shall be conducted by a competent person using tests described in paragraph (d) below, or in other recognized methods of soil classification and testing such as those adopted by the America Society for Testing Materials, or the U.S. Department of Agriculture textural classification system.

(3) *Visual and manual analyses.* The visual and manual analyses, such as those noted as being acceptable in paragraph (d) of this appendix, shall be designed and conducted to provide sufficient quantitative and qualitative information as may be necessary to identify properly the properties, factors, and conditions affecting the classification of the deposits.

(4) *Layered systems.* In a layered system, the system shall be classified in accordance with its weakest layer. However, each layer may be classified individually where a more stable layer lies under a less stable layer.

(5) *Reclassification.* If, after classifying a deposit, the properties, factors, or conditions affecting its classification change in any way, the changes shall be evaluated by a competent person. The deposit shall be reclassified as necessary to reflect the changed circumstances.

(d) *Acceptable visual and manual tests.*—(1) *Visual tests.* Visual analysis is conducted to determine qualitative information regarding the excavation site in general, the soil adjacent to the excavation, the soil forming the sides of the open excavation, and the soil taken as samples from excavated material.

(i) Observe samples of soil that are excavated and soil in the sides of the excavation. Estimate the range of particle sizes and the relative amounts of the particle sizes. Soil that is primarily composed of fine-grained material is cohesive material. Soil composed primarily of coarse-grained sand or gravel is granular material.

(ii) Observe soil as it is excavated. Soil that remains in clumps when excavated is cohesive. Soil that breaks up easily and does not stay in clumps is granular.

(iii) Observe the side of the opened excavation and the surface area adjacent to the excavation. Crack-like openings such as tension cracks could indicate fissured material. If chunks of soil spall off a vertical side, the soil could be fissured. Small spalls are evidence of moving ground and are indications of potentially hazardous situations.

(iv) Observe the area adjacent to the excavation and the excavation itself for evidence of existing utility and other underground structures, and to identify previously disturbed soil.

(v) Observe the opened side of the excavation to identify layered systems. Examine layered systems to identify if the layers slope toward the excavation. Estimate the degree of slope of the layers.

(vi) Observe the area adjacent to the excavation and the sides of the opened excavation for evidence of surface water, water seeping from the sides of the excavation, or the location of the level of the water table.

(vii) Observe the area adjacent to the excavation and the area within the excavation for sources of vibration that may affect the stability of the excavation face.

(2) *Manual tests.* Manual analysis of soil samples is conducted to determine quantitative as well as qualitative properties of soil and to provide more information in order to classify soil properly.

(i) *Plasticity.* Mold a moist or wet sample of soil into a ball and attempt to roll it into threads as thin as ⅛-inch in diameter. Cohesive material can be successfully rolled into threads without crumbling. For example, if at least a two inch (50 mm) length of ⅛-inch thread can be held on one end without tearing, the soil is cohesive.

(ii) *Dry strength.* If the soil is dry and crumbles on its own or with moderate pressure into individual grains or fine powder, it is granular (any combination of gravel, sand, or silt). If the soil is dry and falls into clumps which break up into smaller clumps, but the smaller clumps can only be broken up with difficulty, it may be clay in any combination with gravel, sand or silt. If the dry soil breaks into clumps which do not break up into small clumps and which can only be broken with difficulty, and there is no visual indication the soil is fissured, the soil may be considered unfissured.

(iii) *Thumb penetration.* The thumb penetration test can be used to estimate the unconfined compressive strength of cohesive soils. (This test is based on the thumb penetration test described in American Society for Testing and Materials (ASTM) Standard designation D2488—"Standard Recommended Practice for Description of Soils (Visual—Manual Procedure).") Type A soils with an unconfined compressive strength of 1.5 tsf can be readily indented by the thumb; however, they can be penetrated by the thumb only with very great effort. Type C soils with an unconfined compressive strength of 0.5 tsf can be easily penetrated several inches by the thumb, and can be molded by light finger pressure. This test should be conducted on an undisturbed soil sample, such as a large clump of spoil, as soon as practicable after excavation to keep to a minimum the effects of exposure to drying influences. If the excavation is later exposed to wetting influences (rain, flooding), the classification of the soil must be changed accordingly.

(iv) *Other strength tests.* Estimates of unconfined compressive strength of soils can also be obtained by use of a pocket penetrometer or by using a hand-operated shearvane.

(v) *Drying test.* The basic purpose of the drying test is to differentiate between cohesive material with fissures, unfissured cohesive material, and granular material. The procedure for the drying test involves drying a sample of soil that is approximately one inch thick (2.54 cm) and six inches (15.24 cm) in diameter until it is thoroughly dry:

(A) If the sample develops cracks as it dries, significant fissures are indicated.

(B) Samples that dry without cracking are to be broken by hand. If considerable force is necessary to break a sample, the soil has significant cohesive material content. The soil can be classified as a unfissured cohesive material and the unconfined compressive strength should be determined.

(C) If a sample breaks easily by hand, it is either a fissured cohesive material or a granular material. To distinguish between the two, pulverize the dried clumps of the sample by hand or by stepping on them. If the clumps do not pulverize easily, the material is cohesive with fissures. If they pulverize easily into very small fragments, the material is granular.

Appendix B to Subpart P

Sloping and Benching

(a) *Scope and application.* This appendix contains specifications for sloping and benching when used as methods of protecting employees working in excavations from cave-ins. The requirements of this appendix apply when the design of sloping and benching protective systems is to be performed in accordance with the requirements set forth in § 1926.652(b)(2).

(b) *Definitions.*

Actual slope means the slope to which an excavation face is excavated.

Distress means that the soil is in a condition where a cave-in is imminent or is likely to occur. Distress is evidenced by such phenomena as the development of fissures in the face of or adjacent to an open excavation; the subsidence of the edge of an excavation; the slumping of material from the face or the bulging or heaving of material from the bottom of an excavation; the spalling of material from the face of an excavation; and ravelling, i.e., small amounts of material such as pebbles or little clumps of material suddenly separating from the face of an excavation and trickling or rolling down into the excavation.

Maximum allowable slope means the steepest incline of an excavation face that is acceptable for the most favorable site conditions as protection against cave-ins, and is expressed as the ratio of horizontal distance to vertical rise (H:V).

Short term exposure means a period of time less than or equal to 24 hours that an excavation is open.

(c) *Requirements.*—(1) *Soil classification.* Soil and rock deposits shall be classified in accordance with appendix A to subpart P of part 1926.

(2) *Maximum allowable slope.* The maximum allowable slope for a soil or rock deposit shall be determined from Table B–1 of this appendix.

(3) *Actual slope.* (i) The actual slope shall not be steeper than the maximum allowable slope.

(ii) The actual slope shall be less steep than the maximum allowable slope, when there are signs of distress. If that situation occurs, the slope shall be cut back to an actual slope which is at least ½ horizontal to one vertical (½H:1V) less steep than the maximum allowable slope.

(iii) When surcharge loads from stored material or equipment, operating equipment, or traffic are present, a competent person shall determine the degree to which the actual slope must be reduced below the maximum allowable slope, and shall assure that such reduction is achieved. Surcharge loads from adjacent structures shall be evaluated in accordance with § 1926.651(i).

(4) *Configurations.* Configurations of sloping and benching systems shall be in accordance with Figure B–1.

TABLE B-1

MAXIMUM ALLOWABLE SLOPES

SOIL OR ROCK TYPE	MAXIMUM ALLOWABLE SLOPES (H:V) [1] FOR EXCAVATIONS LESS THAN 20 FEET DEEP [3]
STABLE ROCK TYPE A [2] TYPE B TYPE C	VERTICAL (90°) 3/4 : 1 (53°) 1:1 (45°) 1½: 1 (34°)

NOTES:

1. Numbers shown in parentheses next to maximum allowable slopes are angles expressed in degrees from the horizontal. Angles have been rounded off.
2. A short-term maximum allowable slope of 1/2H:1V (63°) is allowed in excavations in Type A soil that are 12 feet (3.67 m) or less in depth. Short-term maximum allowable slopes for excavations greater than 12 feet (3.67 m) in depth shall be 3/4H:1V (53°).
3. Sloping or benching for excavations greater than 20 feet deep shall be designed by a registered professional engineer.

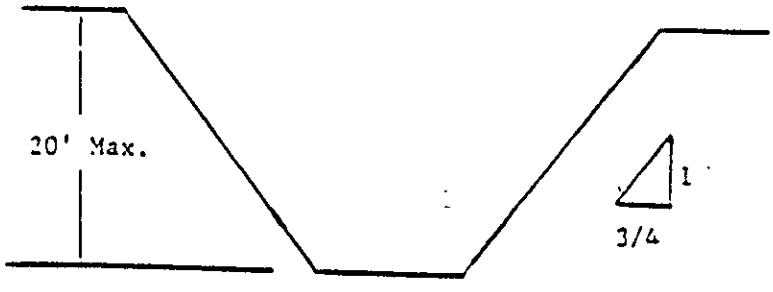
Figure B-.

Slope Configurations

(All slopes stated below are in the horizontal to vertical ratio)

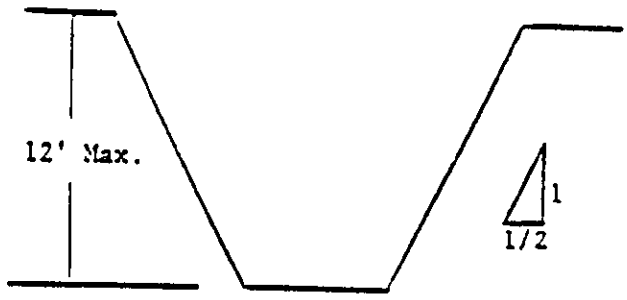
B-1.1 Excavations made in Type A soil.

1. All simple slope excavation 20 feet or less in depth shall have a maximum allowable slope of ¾:1.



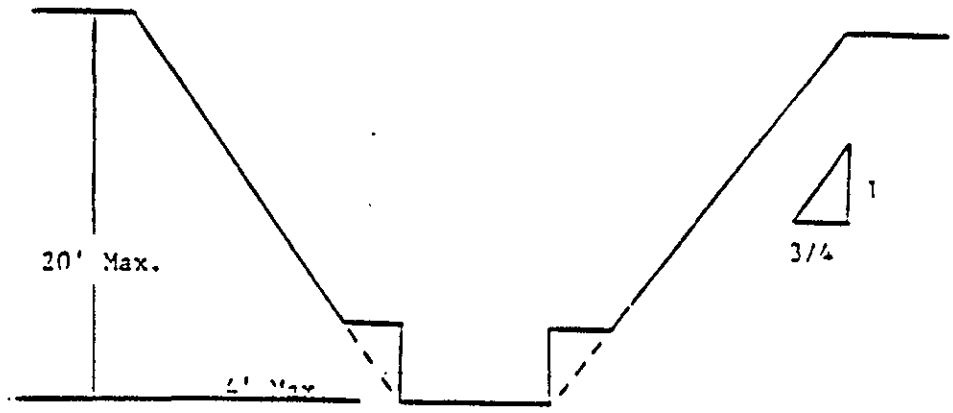
Simple Slope—General

Exception: Simple slope excavations which are open 24 hours or less (short term) and which are 12 feet or less in depth shall have a maximum allowable slope of ½:1.

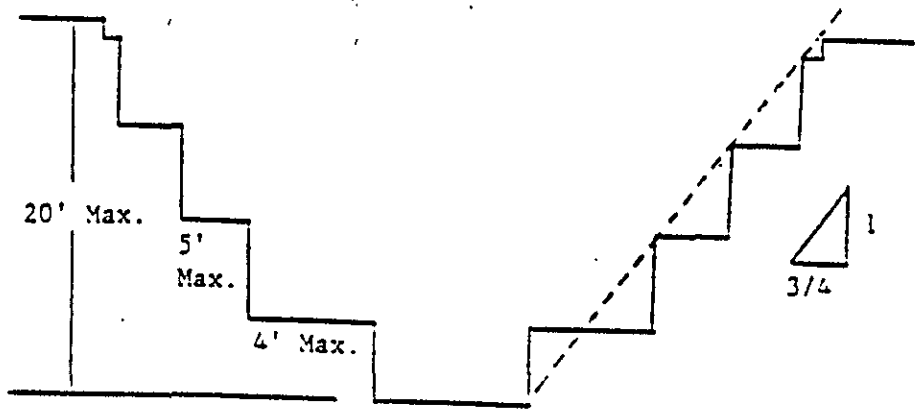


Simple Slope—Short Term

2. All benched excavations 20 feet or less in depth shall have a maximum allowable slope of ¾ to 1 and maximum bench dimensions as follows:

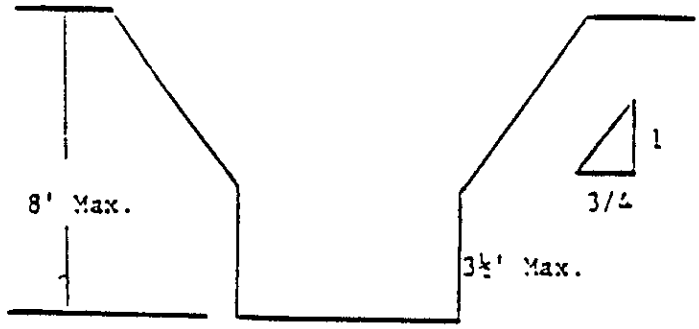


Simple Bench



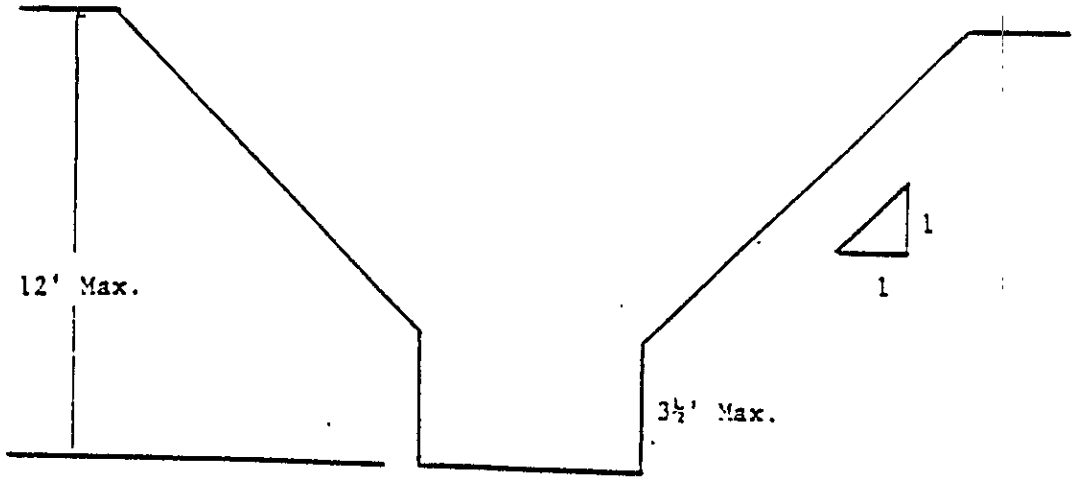
Multiple Bench

3. All excavations 8 feet or less in depth which have unsupported vertically sided lower portions shall have a maximum vertical side of 3½ feet.



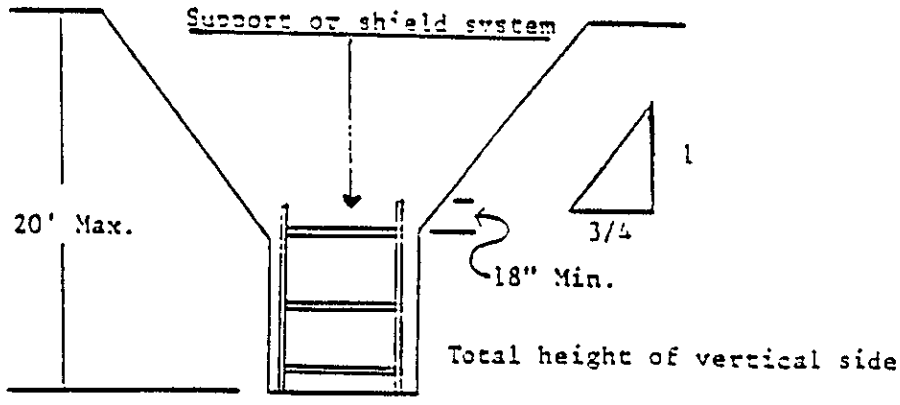
Unsupported Vertically Sided Lower Portion—Maximum 8 Feet in Depth

All excavations more than 8 feet but not more than 12 feet in depth which unsupported vertically sided lower portions shall have a maximum allowable slope of 1:1 and a maximum vertical side of 3½ feet.



Unsupported Vertically Sided Lower Portion—Maximum 12 Feet in Depth

All excavations 20 feet or less in depth which have vertically sided lower portions that are supported or shielded shall have a maximum allowable slope of ¾:1. The support or shield system must extend at least 18 inches above the top of the vertical side.

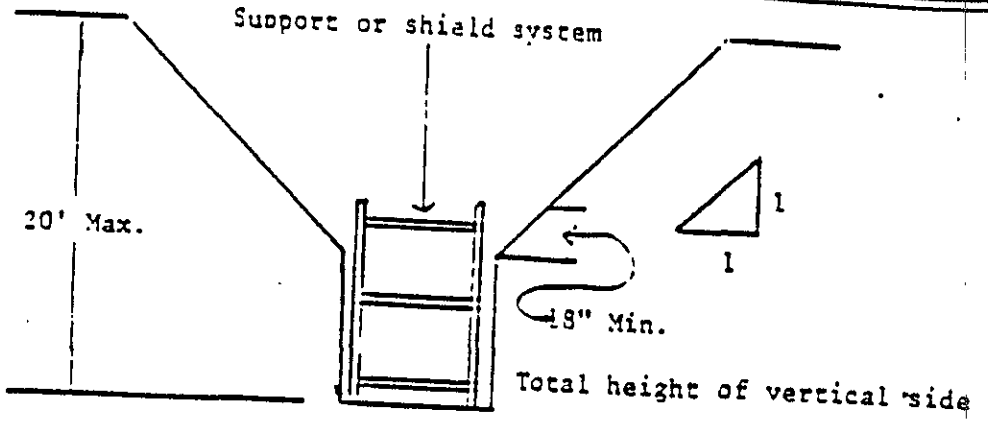


Suported or Shielded Vertically Sided Lower Portion

4. All other simple slope, compound slope, and vertically sided lower portion excavations shall be in accordance with the other options permitted under § 1926.652(b).

B–1.2 Excavations Made in Type B Soil

1. All simple slope excavations 20 feet or less in depth shall have a maximum allowable slope of 1:1.

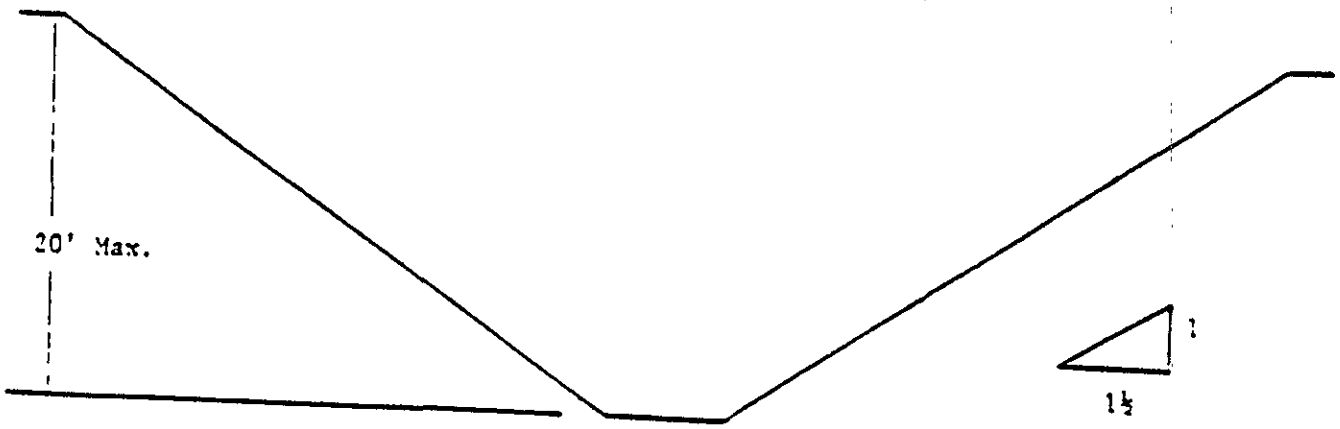


Vertically Sided Lower Portion

4. All other sloped excavations shall be in accordance with the other options permitted in § 1926.652(b).

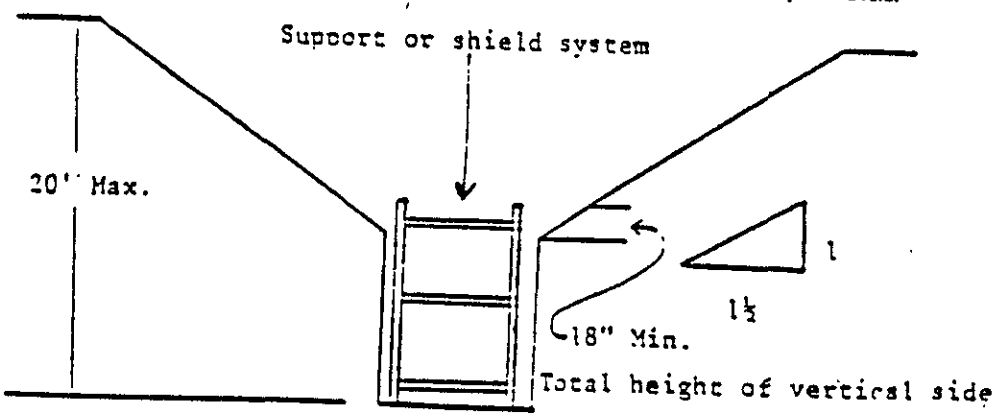
B–1.3 Excavations Made in Type C Soil

1. All simple slope excavations 20 feet or less in depth shall have a maximum allowable slope of 1½:1.



Simple Slope

2. All excavations 20 feet or less in depth which have vertically sided lower portions shall be shielded or supported to a height at least 18 inches above the top of the vertical side. All such excavations shall have a maximum allowable slope of 1½:1.

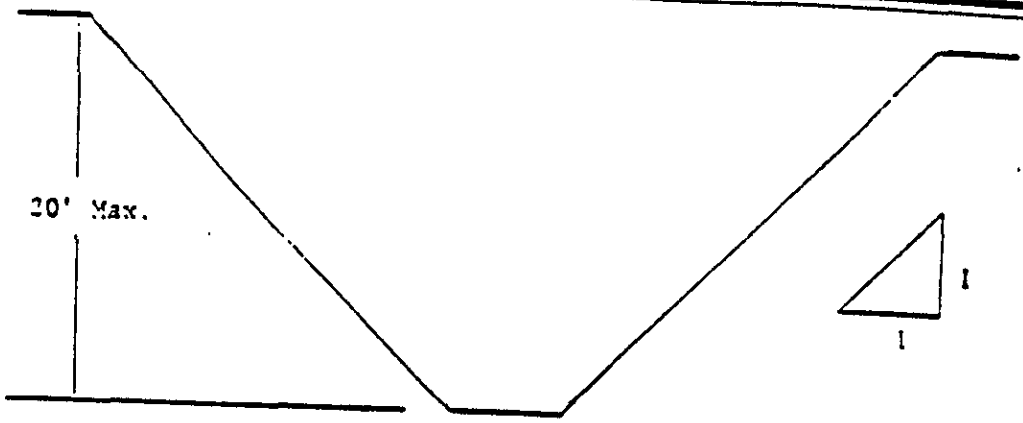


Vertical Sided Lower Portion

3. Al. other sloped excavations shall be in accordance with the other options permitted in § 1926.652(b).

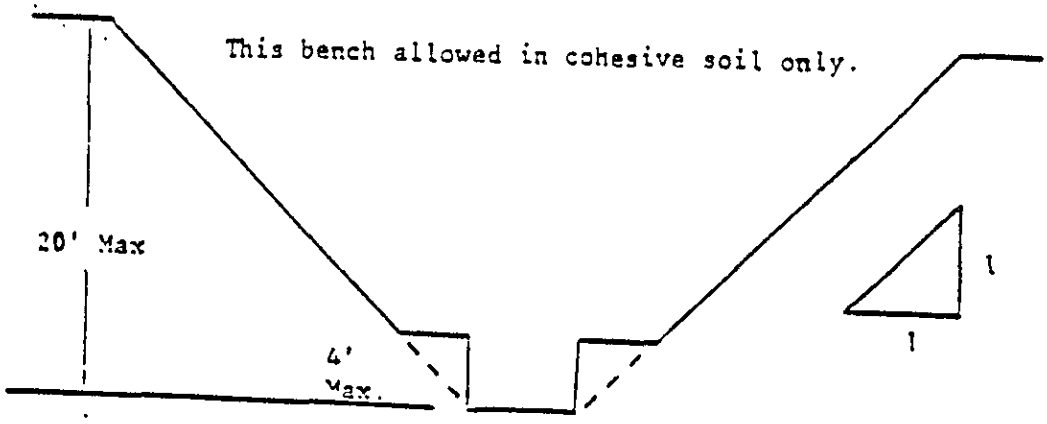
B–1.4 Excavations Made in Layered Soils

1. All excavations 20 feet or less in depth made in layered soils shall have a maximum allowable slope for each layer as set forth below.

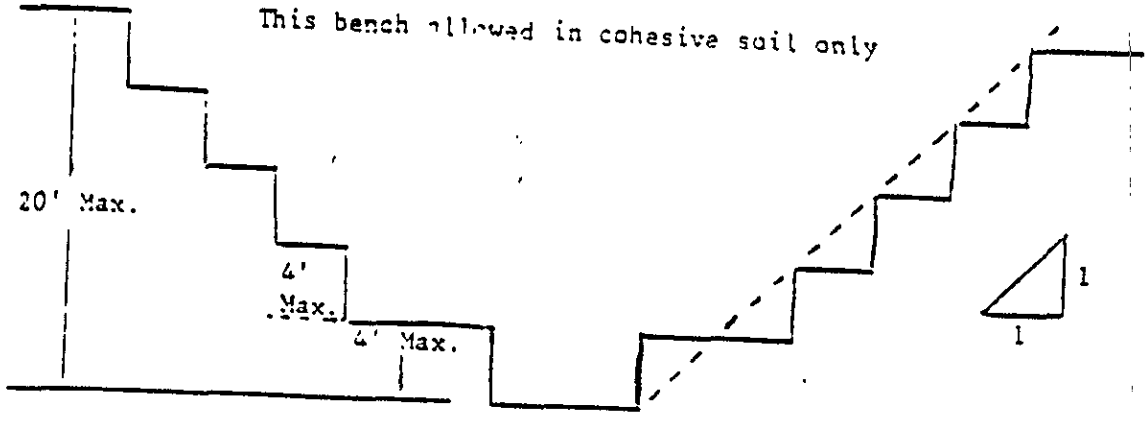


Simple Slope

2. All benched excavations 20 feet or less in depth shall have a maximum allowable slope of 1:1 and maximum bench dimensions as follows:

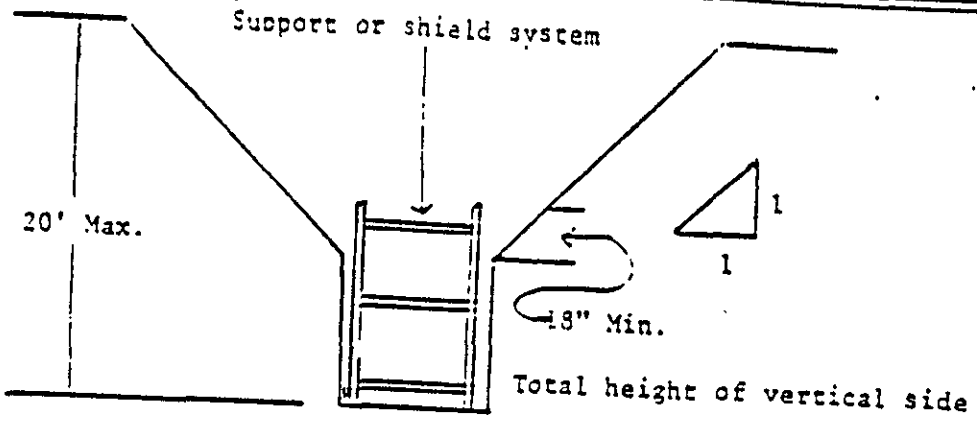


Single Bench



Multiple Bench

3. All excavations 20 feet or less in depth which have vertically sided lower portions shall be shielded or supported to a height at least 18 inches above the top of the vertical side. All such excavations shall have a maximum allowable slope of 1:1.

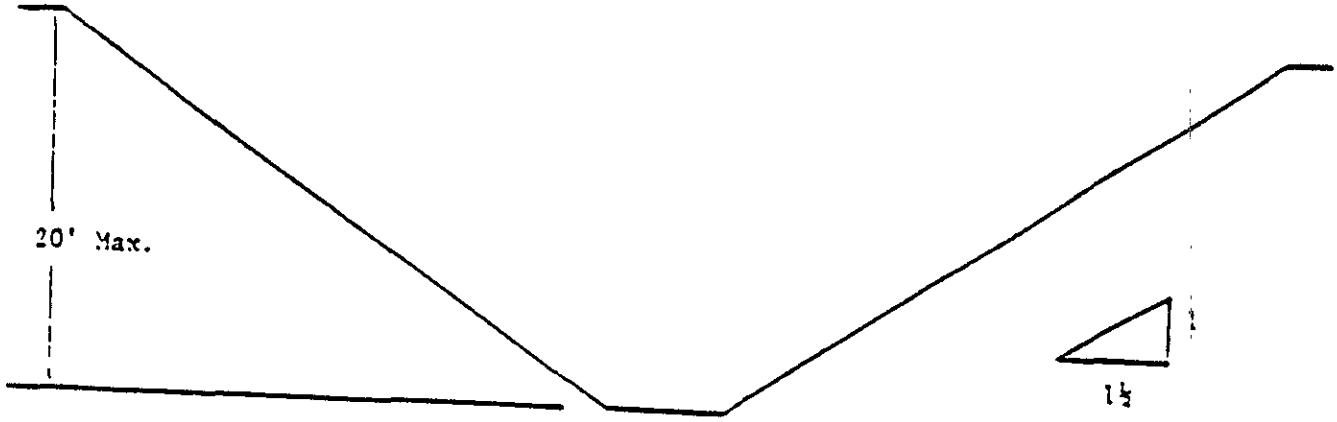


Vertically Sided Lower Portion

4. All other sloped excavations shall be in accordance with the other options permitted in § 1926.652(b).

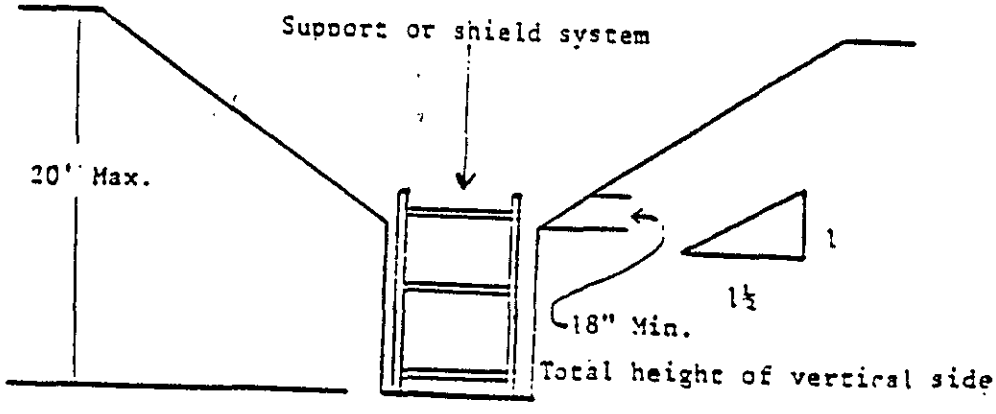
B–1.3 Excavations Made in Type C Soil

1. All simple slope excavations 20 feet or less in depth shall have a maximum allowable slope of 1½:1.



Simple Slope

2. All excavations 20 feet or less in depth which have vertically sided lower portions shall be shielded or supported to a height at least 18 inches above the top of the vertical side. All such excavations shall have a maximum allowable slope of 1½:1.

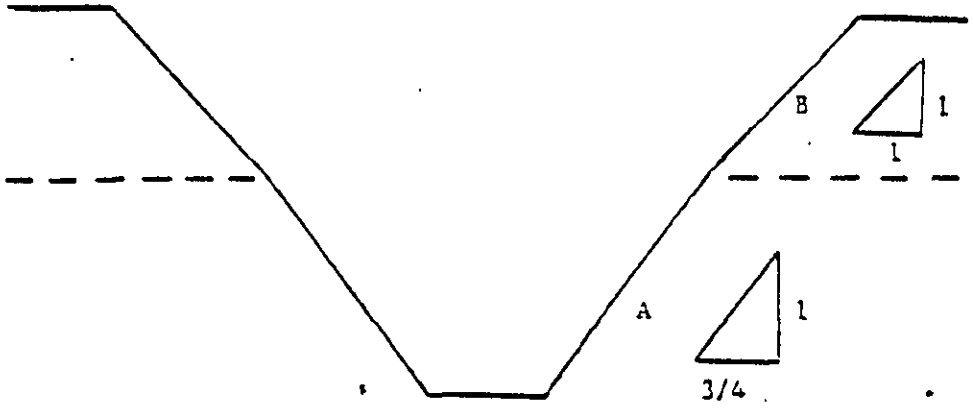


Vertical Sided Lower Portion

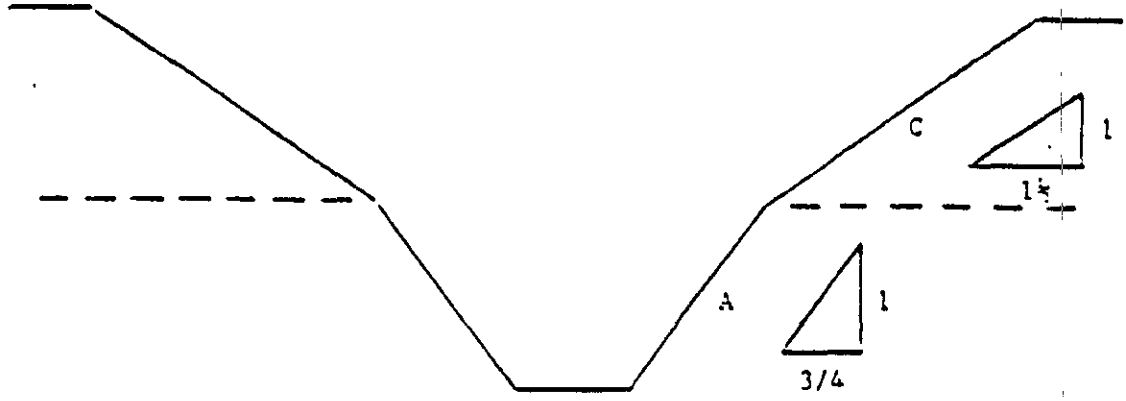
3. Al. other sloped excavations shall be in accordance with the other options permitted in § 1926.652(b).

B–1.4 Excavations Made in Layered Soils

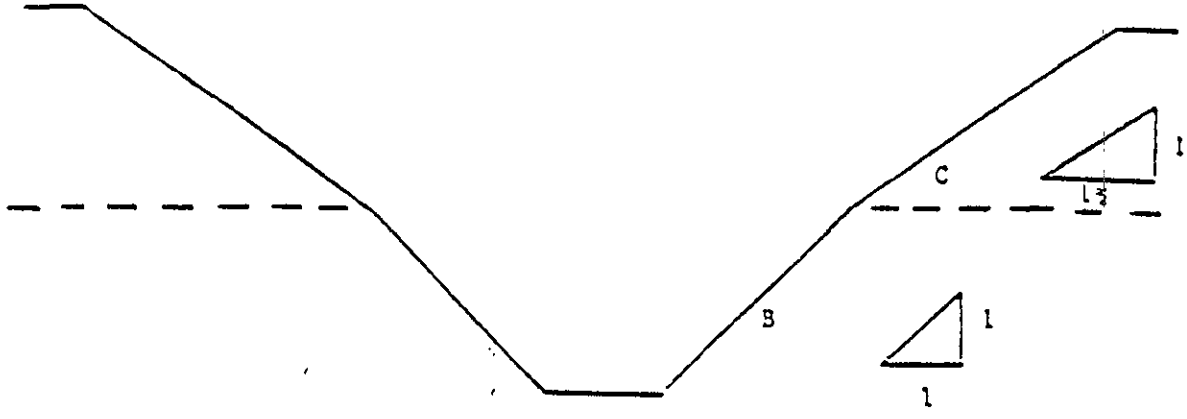
1. All excavations 20 feet or less in depth made in layered soils shall have a maximum allowable slope for each layer as set forth below.



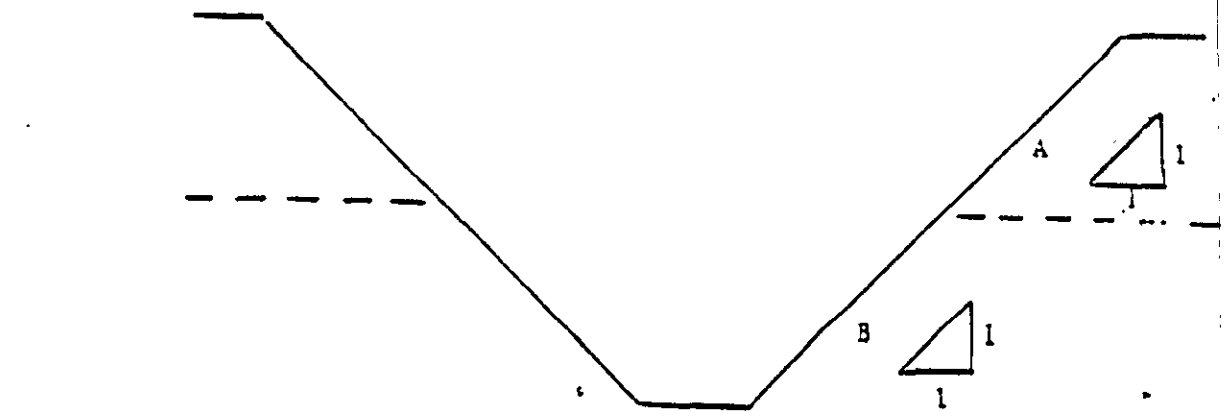
B OVER A



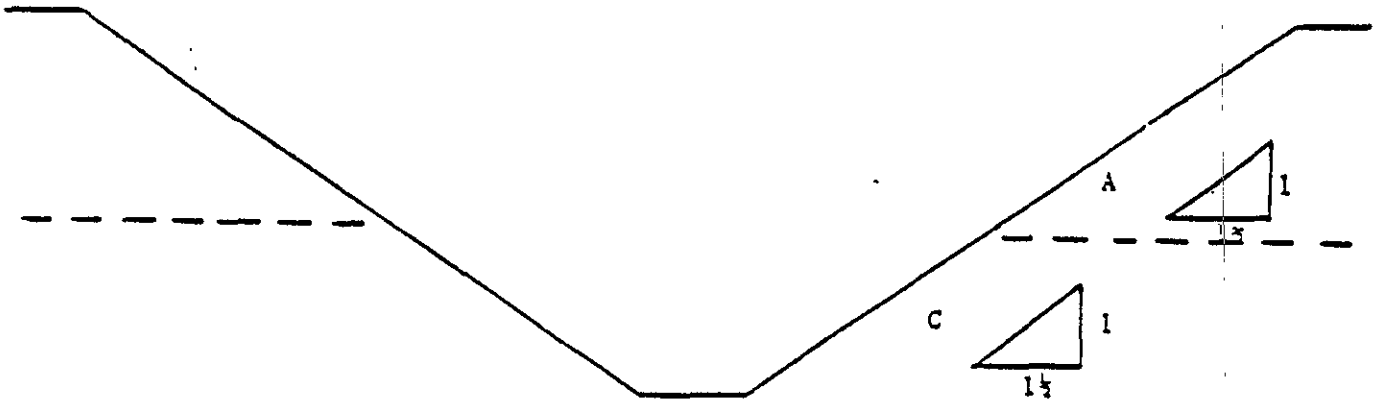
C OVER A



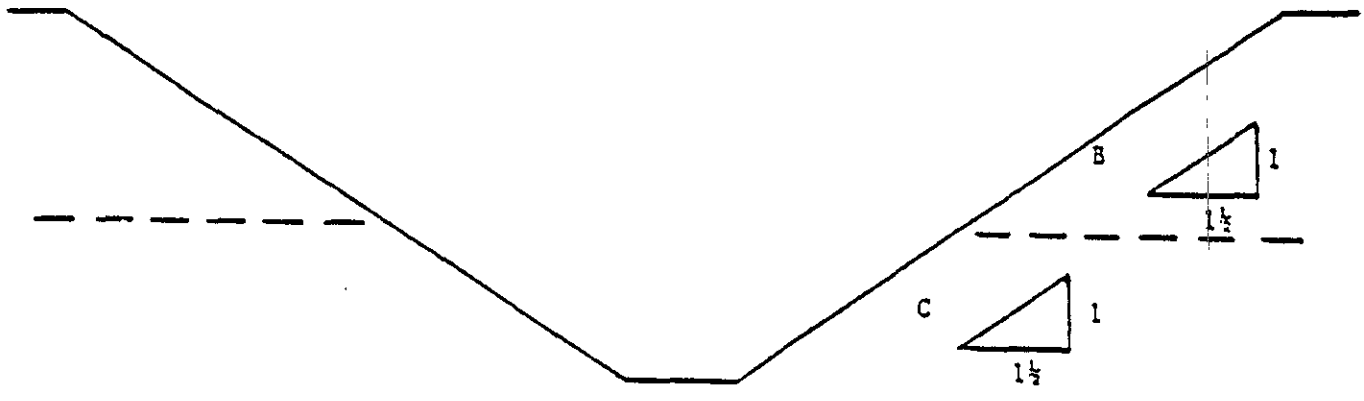
C OVER B



A OVER B



A OVER C



B OVER C

2. All other sloped excavations shall be in accordance with the other options permitted in § 1926.652(b).

Appendix C to Subpart P

Timber Shoring for Trenches

(a) *Scope.* This appendix contains information that can be used timber shoring is provided as a method of protection from cave-ins in trenches that do not exceed 20 feet (6.1 m) in depth. This appendix must be used when design of timber shoring protective systems is to be performed in accordance with § 1926.652(c)(1). Other timber shoring configurations: other systems of support such as hydraulic and pneumatic systems; and other protective systems such as sloping, benching, shielding, and freezing systems must be designed in accordance with the requirements set forth in § 1926.652(b) and § 1926.652(c).

(b) *Soil Classification.* In order to use the data presented in this appendix, the soil type or types in which the excavation is made must first be determined using the soil

classification method set forth in appendix A of subpart P of this part.

(c) *Presentation of information.* Information is presented in several forms as follows:

(1) Information is presented in tabular form in Tables C–1.1, C–1.2, and C–1.3, and Tables C–2.1, C–2.2 and C–2.3 following paragraph (g) of the appendix. Each table presents the minimum sizes of timber members to use in a shoring system, and each table contains data only for the particular soil type in which the excavation or portion of the excavation is made. The data are arranged to allow the user the flexibility to select from among several acceptable configurations of members based on varying the horizontal spacing of the crossbraces. Stable rock is exempt from shoring requirements and therefore, no data are presented for this condition.

(2) Information concerning the basis of the tabular data and the limitations of the data is presented in paragraph (d) of this appendix, and on the tables themselves.

(3) Information explaining the use of the tabular data is presented in paragraph (e) of this appendix.

(4) Information illustrating the use of the tabular data is presented in paragraph (f) of this appendix.

(5) Miscellaneous notations regarding Tables C–1.1 through C–1.3 and Tables C–2.1 through C–2.3 are presented in paragraph (g) of this Appendix.

(d) *Basis and limitations of the data.*—(1) *Dimensions of timber members.* (i) The sizes of the timber members listed in Tables C–1.1 through C–1.3 are taken from the National Bureau of Standards (NBS) report, "Recommended Technical Provisions for Construction Practice in Shoring and Sloping of Trenches and Excavations." In addition, where NBS did not recommend specific sizes of members, member sizes are based on an analysis of the sizes required for use by existing codes and on empirical practice.

(ii) The required dimensions of the members listed in Tables C–1.1 through C–1.3 refer to actual dimensions and not nominal dimensions of the timber. Employers wanting to use nominal size shoring are directed to Tables C–2.1 through C–2.3, or have this choice under § 1926.652(c)(3), and are referred to The Corps of Engineers, The Bureau of Reclamation or data from other acceptable sources.

(2) *Limitation of application.* (i) It is not intended that the timber shoring specification apply to every situation that may be experienced in the field. These data were developed to apply to the situations that are most commonly experienced in current trenching practice. Shoring systems for use in situations that are not covered by the data in this appendix must be designed as specified in § 1926.652(c).

(ii) When any of the following conditions are present, the members specified in the tables are not considered adequate. Either an alternate timber shoring system must be designed or another type of protective system designed in accordance with § 1926.652.

(A) When loads imposed by structures or by stored material adjacent to the trench weigh in excess of the load imposed by a two-foot soil surcharge. The term "adjacent" as used here means the area within a horizontal distance from the edge of the trench equal to the depth of the trench.

(B) When vertical loads imposed on cross braces exceed a 240-pound gravity load distributed on a one-foot section of the center of the crossbrace.

(C) When surcharge loads are present from equipment weighing in excess of 20,000 pounds.

(D) When only the lower portion of a trench is shored and the remaining portion of the trench is sloped or benched unless: The sloped portion is sloped at an angle less steep than three horizontal to one vertical; or the members are selected from the tables for use at a depth which is determined from the top of the overall trench, and not from the toe of the sloped portion.

(e) *Use of Tables.* The members of the shoring system that are to be selected using this information are the cross braces, the uprights, and the wales, where wales are required. Minimum sizes of members are specified for use in different types of soil. There are six tables of information, two for each soil type. The soil type must first be determined in accordance with the soil classification system described in appendix A to subpart P of part 1926. Using the appropriate table, the selection of the size and spacing of the members is then made. The selection is based on the depth and width of the trench where the members are to be installed and, in most instances, the selection is also based on the horizontal spacing of the crossbraces. Instances where a choice of horizontal spacing of crossbracing is available, the horizontal spacing of the crossbraces must be chosen by the user before the size of any member can be determined. When the soil type, the width and depth of the trench, and the horizontal spacing of the crossbraces are known, the size and vertical spacing of the crossbraces, the size and vertical spacing of the wales, and the size and horizontal spacing of the uprights can be read from the appropriate table.

(f) *Examples to Illustrate the Use of Tables C–1.1 through C–1.3.*

(1) *Example 1.*

A trench dug in Type A soil is 13 feet deep and five feet wide.

From *Table C–1.1*, for acceptable arrangements of timber can be used.

Arrangement #1

Space 4×4 crossbraces at six feet horizontally and four feet vertically.

Wales are not required.

Space 3×8 uprights at six feet horizontally. This arrangement is commonly called "skip shoring."

Arrangement #2

Space 4×6 crossbraces at eight feet horizontally and four feet vertically.

Space 6×8 wales at four feet vertically.

Space 2×6 uprights at four feet horizontally.

Arrangement #3

Space 6×6 crossbraces at 10 feet horizontally and four feet vertically.

Space 8×10 wales at four feet vertically.

Space 2×6 uprights at five feet horizontally.

Arrangement #4

Space 6×8 crossbraces at 12 feet horizontally and four feet vertically.

Space 10×10 wales at four feet vertically.

Spaces 3×8 uprights at six feet horizontally.

(2) *Example 2.*

A trench dug in Type B soil in 13 feet deep and five feet wide. From Table C–1.2 three acceptable arrangements of members are listed.

Arrangement #1

Space 6×6 crossbraces at six feet horizontally and five feet vertically.

Space 8×8 wales at five feet vertically.

Space 2×6 uprights at two feet horizontally.

Arrangement #2

Space 6×8 crossbraces at eight feet horizontally and five feet vertically.

Space 10×10 wales at five feet vertically.

Space 2×6 uprights at two feet horizontally.

Arrangement #3

Space 8×8 crossbraces at 10 feet horizontally and five feet vertically.

Space 10×12 wales at five feet vertically.

Space 2×6 uprights at two feet vertically.

(3) *Example 3.*

A trench dug in Type C soil is 13 feet deep and five feet wide.

From Table C–1.3 two acceptable arrangements of members can be used.

Arrangement #1

Space 8×8 crossbraces at six feet horizontally and five feet vertically.

Space 10×12 wales at five feet vertically.

Position 2×6 uprights as closely together as possible.

If water must be retained use special tongue and groove uprights to form tight sheeting.

Arrangement #2

Space 8×10 crossbraces at eight feet horizontally and five feet vertically.

Space 12×12 wales at five feet vertically.

Position 2×6 uprights in a close sheeting configuration unless water pressure must be resisted. Tight sheeting must be used where water must be retained.

(4) *Example 4.*

A trench dug in Type C soil is 20 feet deep and 11 feet wide. The size and spacing of members for the section of trench that is over 15 feet in depth is determined using Table C–1.3. Only one arrangement of members is provided.

Space 8×10 crossbraces at six feet horizontally and five feet vertically.

Space 12×12 wales at five feet vertically.

Use 3×8 tight sheeting.

Use of Tables C–2.1 through C–2.3 would follow the same procedures.

(g) *Notes for all Tables.*

1. Member sizes at spacings other than indicated are to be determined as specified in § 1926.652(c), "Design of Protective Systems."

2. When conditions are saturated or submerged use Tight Sheeting. Tight Sheeting refers to the use of specially-edged timber planks (e.g., tongue and groove) at least three inches thick, steel sheet piling, or similar construction that when driven or placed in position provide a tight wall to resist the lateral pressure of water and to prevent the loss of backfill material. Close Sheeting refers to the placement of planks side-by-side allowing as little space as possible between them.

3. All spacing indicated is measured center to center.

4. Wales to be installed with greater dimension horizontal.

5. If the vertical distance from the center of the lowest crossbrace to the bottom of the trench exceeds two and one-half feet, uprights shall be firmly embedded or a mudsill shall be used. Where uprights are embedded, the vertical distance from the center of the lowest crossbrace to the bottom of the trench shall not exceed 30 inches. When mudsills are used, the vertical distance shall not exceed 42 inches. Mudsills are wales that are installed at the toe of the trench side.

6. Trench jacks may be used in lieu of or in combination with timber crossbraces.

7. Placement of crossbraces. When the vertical spacing of crossbraces is four feet, place the top crossbrace no more than two feet below the top of the trench. When the vertical spacing of crossbraces is five feet, place the top crossbrace no more than 2.5 feet below the top of the trench.

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TABLE C-1.2

TIMBER TRENCH SHORING -- MINIMUM TIMBER REQUIREMENTS *

SOIL TYPE B P_a = 45 X H + 72 psf (2 ft. Surcharge)

DEPTH OF TRENCH (FEET)	SIZE (ACTUAL) AND SPACING OF MEMBERS**													
	CROSS BRACES							WALES		UPRIGHTS				
	HORIZ. SPACING (FEET)	WIDTH OF TRENCH (FEET)					VERT. SPACING (FEET)	SIZE (IN)	VERT. SPACING (FEET)	MAXIMUM ALLOWABLE HORIZONTAL SPACING (FEET)				
		UP TO 4	UP TO 6	UP TO 9	UP TO 12	UP TO 15				CLOSE	2	3		
5 TO 10	UP TO 6	4X6	4X6	6X6	6X6	6X6	5	6X8	5			2X6		
	UP TO 8	6X6	6X6	6X6	6X8	6X8	5	8X10	5			2X6		
	UP TO 10	6X6	6X6	6X6	6X8	6X8	5	10X10	5			2X6		
	See Note 1													
10 TO 15	UP TO 6	6X6	6X6	6X6	6X8	6X8	5	8X8	5		2X6			
	UP TO 8	6X8	6X8	6X8	8X8	8X8	5	10X10	5		2X6			
	UP TO 10	8X8	8X8	8X8	8X8	8X10	5	10X12	5		2X6			
	See Note 1													
15 TO 20	UP TO 6	6X8	6X8	6X8	8X8	8X8	5	8X10	5	3X6				
	UP TO 8	8X8	8X8	8X8	8X8	8X10	5	10X12	5	3X6				
	UP TO 10	8X10	8X10	8X10	8X10	10X10	5	12X12	5	3X6				
	See Note 1													
OVER 20	SEE NOTE 1													

* Mixed oak or equivalent with a bending strength not less than 850 psi.
** Manufactured members of equivalent strength may by substituted for wood.

TABLE C-2.1

TIMBER TRENCH SHORING -- MINIMUM TIMBER REQUIREMENTS *
SOIL TYPE A P_a = 25 X H + 72 psf (2 ft. Surcharge)

DEPTH OF TRENCH (FEET)	SIZE (S4S) AND SPACING OF MEMBERS **													
	CROSS BRACES							WALES		UPRIGHTS				
	HORIZ. SPACING (FEET)	WIDTH OF TRENCH (FEET)					VERT. SPACING (FEET)	SIZE (IN)	VERT. SPACING (FEET)	MAXIMUM ALLOWABLE HORIZONTAL SPACING (FEET)				
		UP TO 4	UP TO 6	UP TO 9	UP TO 12	UP TO 15				CLOSE	4	5	6	8
5 TO 10	UP TO 6	4X4	4X4	4X4	4X4	4X6	4	Not Req'd	Not Req'd				4X6	
	UP TO 8	4X4	4X4	4X4	4X6	4X6	4	Not Req'd	Not Req'd					4X8
	UP TO 10	4X6	4X6	4X6	6X6	6X6	4	8X8	4			4X6		
	UP TO 12	4X6	4X6	4X6	6X6	6X6	4	8X8	4				4X6	
10 TO 15	UP TO 6	4X4	4X4	4X4	6X6	6X6	4	Not Req'd	Not Req'd				4X10	
	UP TO 8	4X6	4X6	4X6	6X6	6X6	4	6X8	4		4X6			
	UP TO 10	6X6	6X6	6X6	6X6	6X6	4	8X8	4			4X8		
	UP TO 12	6X6	6X6	6X6	6X6	6X6	4	8X10	4		4X6		4X10	
15 TO 20	UP TO 6	6X6	6X6	6X6	6X6	6X6	4	6X8	4	3X6				
	UP TO 8	6X6	6X6	6X6	6X6	6X6	4	8X8	4	3X6	4X12			
	UP TO 10	6X6	6X6	6X6	6X6	6X8	4	8X10	4	3X6				
	UP TO 12	6X6	6X6	6X6	6X8	6X8	4	8X12	4	3X6	4X12			
OVER 20	SEE NOTE 1													

* Douglas fir or equivalent with a bending strength not less than 1500 psi.
** Manufactured members of equivalent strength may be substituted for wood.

TABLE C-2.2

TIMBER TRENCH SHORING -- MINIMUM TIMBER REQUIREMENTS *

SOIL TYPE B P_a = 45 X H + 72 psf (2 ft. Surcharge)

DEPTH OF TRENCH (FEET)	SIZE (S4S) AND SPACING OF MEMBERS **													
	CROSS BRACES						WALES		UPRIGHTS					
	HORIZ. SPACING (FEET)	WIDTH OF TRENCH (FEET)					VERT. SPACING (FEET)	SIZE (IN)	VERT. SPACING (FEET)	MAXIMUM ALLOWABLE HORIZONTAL SPACING (FEET)				
		UP TO 4	UP TO 6	UP TO 9	UP TO 12	UP TO 15				CLOSE	2	3	4	6
5 TO 10	UP TO 6	4X6	4X6	4X6	6X6	6X6	5	6X8	5			3X12 4X8		4X12
	UP TO 8	4X6	4X6	6X6	6X6	6X6	5	8X8	5		3X8		4X8	
	UP TO 10	4X6	4X6	6X6	6X6	6X8	5	8X10	5			4X8		
	See Note 1													
10 TO 15	UP TO 6	6X6	6X6	6X6	6X8	6X8	5	8X8	5	3X6	4X10			
	UP TO 8	6X8	6X8	6X8	8X8	8X8	5	10X10	5	3X6	4X10			
	UP TO 10	6X8	6X8	8X8	8X8	8X8	5	10X12	5	3X6	4X10			
	See Note 1													
15 TO 20	UP TO 6	6X8	6X8	6X8	6X8	8X8	5	8X10	5	4X6				
	UP TO 8	6X8	6X8	6X8	8X8	8X8	5	10X12	5	4X6				
	UP TO 10	8X8	8X8	8X8	8X8	8X8	5	12X12	5	4X6				
	See Note 1													
OVER 20	SEE NOTE 1													

* Douglas fir or equivalent with a bending strength not less than 1500 psi.

** Manufactured members of equivalent strength may be substituted for wood.

TABLE C-2.1

TIMBER TRENCH SHORING -- MINIMUM TIMBER REQUIREMENTS *

SOIL TYPE C P_a = 80 X H + 72 psf (2 ft. Surcharge)

DEPTH OF TRENCH (FEET)	SIZE (S4S) AND SPACING OF MEMBERS **													
	CROSS BRACES						WALES		UPRIGHTS					
	HORIZ. SPACING (FEET)	WIDTH OF TRENCH (FEET)					VERT. SPACING (FEET)	SIZE (IN.)	VERT. SPACING (FEET)	MAXIMUM ALLOWABLE HORIZONTAL SPACING (FEET)				
		UP TO 4	UP TO 6	UP TO 9	UP TO 12	UP TO 15				CLOSE				
5 TO 10	UP TO 6	6X6	6X6	6X6	6X6	8X8	5	8X8	5	3X6				
	UP TO 8	6X6	6X6	6X6	8X8	8X8	5	10X10	5	3X6				
	UP TO 10	6X6	6X6	8X8	8X8	8X8	5	10X12	5	3X6				
	See Note 1													
10 TO 15	UP TO 6	6X8	6X8	6X8	8X8	8X8	5	10X10	5	4X6				
	UP TO 8	8X8	8X8	8X8	8X8	8X8	5	12X12	5	4X6				
	See Note 1													
	See Note 1													
15 TO 20	UP TO 6	8X8	8X8	8X8	8X10	8X10	5	10X12	5	4X6				
	See Note 1													
	See Note 1													
	See Note 1													
OVER 20	SEE NOTE 1													

* Douglas fir or equivalent with a bending strength not less than 1500 psi.

** Manufactured members of equivalent strength may be substituted for wood.

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Appendix D to Subpart P

Aluminum Hydraulic Shoring for Trenches

(a) *Scope.* This appendix contains information that can be used when aluminum hydraulic shoring is provided as a method of protection against cave-ins in trenches that do not exceed 20 feet (6.1m) in depth. This appendix must be used when design of the aluminum hydraulic protective system cannot be performed in accordance with § 1926.652(c)(2).

(b) *Soil Classification.* In order to use data presented in this appendix, the soil type or types in which the excavation is made must first be determined using the soil classification method set forth in appendix A of subpart P of part 1926.

(c) *Presentation of Information.* Information is presented in several forms as follows:

(1) Information is presented in tabular form in Tables D–1.1, D–1.2, D–1.3 and E–1.4. Each table presents the maximum vertical and horizontal spacings that may be used with various aluminum member sizes and various hydraulic cylinder sizes. Each table contains data only for the particular soil type in which the excavation or portion of the excavation is made. Tables D–1.1 and D–1.2 are for vertical shores in Types A and B soil. Tables D–1.3 and D1.4 are for horizontal waler systems in Types B and C soil.

(2) Information concerning the basis of the tabular data and the limitations of the data is presented in paragraph (d) of this appendix.

(3) Information explaining the use of the tabular data is presented in paragraph (e) of this appendix.

(4) Information illustrating the use of the tabular data is presented in paragraph (f) of this appendix.

(5) Miscellaneous notations (footnotes) regarding Table D–1.1 through D–1.4 are presented in paragraph (g) of this appendix.

(6) Figures, illustrating typical installations of hydraulic shoring, are included just prior to the Tables. The illustrations page is entitled "Aluminum Hydraulic Shoring; Typical Installations."

(d) *Basis and limitations of the data.*

(1) Vertical shore rails and horizontal wales are those that meet the Section Modulus requirements in the D–1 Tables. Aluminum material is 6061–T6 or material of equivalent strength and properties.

(2) Hydraulic cylinders specifications. (i) 2-inch cylinders shall be a minimum 2-inch inside diameter with a minimum safe working capacity of no less than 18,000 pounds axial compressive load at maximum extension. Maximum extension is to include full range of cylinder extensions as recommended by product manufacturer.

(ii) 3-inch cylinders shall be a minimum 3-inch inside diameter with a safe working capacity of not less than 30,000 pounds axial compressive load at extensions as recommended by product manufacturer.

(3) Limitation of application.

(i) It is not intended that the aluminum hydraulic specification apply to every situation that may be experienced in the field. These data were developed to apply to the situations that are most commonly experienced in current trenching practice. Shoring systems for use in situations that are not covered by the data in this appendix must be otherwise designed as specified in § 1926.652(c).

(ii) When any of the following conditions are present, the members specified in the Tables are not considered adequate. In this case, an alternative aluminum hydraulic shoring system or other type of protective system must be designed in accordance with § 1926.652.

(A) When vertical loads imposed on cross braces exceed a 100 Pound gravity load distributed on a one foot section of the center of the hydraulic cylinder.

(B) When surcharge loads are present from equipment weighing in excess of 20,000 pounds.

(C) When only the lower portion of a trench is shored and the remaining portion of the trench is sloped or benched unless: The sloped portion is sloped at an angle less steep than three horizontal to one vertical; or the members are selected from the tables for use at a depth which is determined from the top of the overall trench, and not from the toe of the sloped portion.

(e) *Use of Tables D–1.1, D–1.2, D–1.3 and D–1.4.* The members of the shoring system that are to be selected using this information are the hydraulic cylinders, and either the vertical shores or the horizontal wales. When a waler system is used the vertical timber sheeting to be used is also selected from these tables. The Tables D–1.1 and D–1.2 for vertical shores are used in Type A and B soils that do not require sheeting. Type B soils that may require sheeting, and Type C soils that always require sheeting are found in the horizontal wale Tables D–1.3 and D–1.4. The soil type must first be determined in accordance with the soil classification system described in appendix A to subpart P of part 1926. Using the appropriate table, the selection of the size and spacing of the members is made. The selection is based on the depth and width of the trench where the members are to be installed. In these tables the vertical spacing is held constant at four feet on center. The tables show the maximum horizontal spacing of cylinders allowed for each size of wale in the waler system tables, and in the vertical shore tables, the hydraulic cylinder horizontal spacing is the same as the vertical shore spacing.

(f) *Example to Illustrate the Use of the Tables:*

(1) Example 1:

A trench dug in Type A soil is 8 feet deep and 3 feet wide. From Table D–1.1: Find vertical shores and 2 inch diameter cylinders spaced 8 feet on center (o.c.) horizontally and 4 feet on center (o.c.) vertically. (See Figures 1 & 3 for typical installations.)

(2) Example 2:

A trench is dug in Type B soil that does not require sheeting, 13 feet deep and 5 feet wide. From Table D–1.2: Find vertical shores and 2 inch diameter cylinders spaced 6.5 feet o.c. horizontally and 4 feet o.c. vertically. (See Figures 1 & 3 for typical installations.)

(3) A trench is dug in Type B soil that does not require sheeting, but does experience some minor raveling of the trench face. The trench is 16 feet deep and 9 feet wide. From Table D–1.2: Find vertical shores and 2 inch diameter cylinder (with special oversleeves as designated by footnote #2) spaced 5.5 feet o.c. horizontally and 4 feet o.c. vertically, plywood (per footnote (g)(7) to the D–1 Table) should be used behind the shores. (See Figures 2 & 3 for typical installations.)

(4) Example 4: A trench is dug in previously disturbed Type B soil, with characteristics of a Type C soil, and will require sheeting. The trench is 18 feet deep and 12 feet wide. 6 foot horizontal spacing between cylinders is desired for working space. From Table D–1.3: Find horizontal wale with a section modulus of 14.0 spaced at 4 feet o.c. vertically and 3 inch diameter cylinder spaced at 9 feet maximum o.c. horizontally. 3×12 timber sheeting is required at close spacing vertically. (See Figure 4 for typical installation.)

(5) Example 5: A trench is dug in Type C soil, 9 feet deep and 4 feet wide. Horizontal cylinder spacing in excess of 6 feet is desired for working space. From Table D–1.4: Find horizontal wale with a section modulus of 7.0 and 2 inch diameter cylinders spaced at 6.5 feet o.c. horizontally. Or, find horizontal wale with a 14.0 section modulus and 3 inch diameter cylinder spaced at 10 feet o.c. horizontally. Both wales are spaced 4 feet o.c. vertically. 3×12 timber sheeting is required at close spacing vertically. (See Figure 4 for typical installation.)

(g) *Footnotes, and general notes, for Tables D–1.1, D–1.2, D–1.3, and D–1.4.*

(1) For applications other than those listed in the tables, refer to § 1926.652(c)(2) for use of manufacturer's tabulated data. For trench depths in excess of 20 feet, refer to § 1926.652(c)(2) and § 1926.652(c)(3).

(2) 2 inch diameter cylinders, at this width, shall have structural steel tube (3.5×3.5×0.1875) oversleeves, or structural oversleeves of manufacturer's specification, extending the full, collapsed length.

(3) Hydraulic cylinders capacities. (i) 2 inch cylinders shall be a minimum 2-inch inside diameter with a safe working capacity of not less than 18,000 pounds axial compressive load at maximum extension. Maximum extension is to include full range of cylinder extensions as recommended by product manufacturer.

(ii) 3-inch cylinders shall be a minimum 3-inch inside diameter with a safe work capacity of not less than 30,000 pounds axial compressive load at maximum extension. Maximum extension is to include full range of cylinder extensions as recommended by product manufacturer.

(4) All spacing indicated is measured center to center.

(5) Vertical shoring rails shall have a minimum section modulus of 0.40 inch.

(6) When vertical shores are used, there must be a minimum of three shores spaced equally, horizontally, in a group.

(7) Plywood shall be 1.125 in. thick softwood or 0.75 inch thick, 14 ply, arctic white birch (Finland form). Please note that plywood is not intended as a structural member, but only for prevention of local raveling (sloughing of the trench face) between shores.

(8) See appendix C for timber specifications.

(9) Wales are calculated for simple span conditions.

(10) See appendix D, item (d), for basis and limitations of the data.

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ALUMINUM HYDRAULIC SHORING
TYPICAL INSTALLATIONS

FIGURE NO. 1
VERTICAL ALUMINUM HYDRAULIC SHORING (SPOT BRACING)

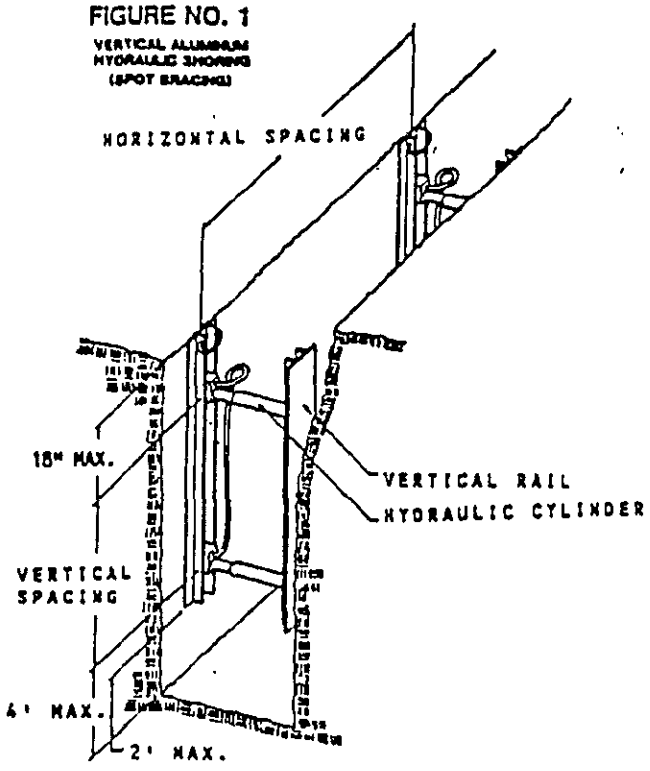


FIGURE NO. 2
VERTICAL ALUMINUM HYDRAULIC SHORING (WITH PLYWOOD)

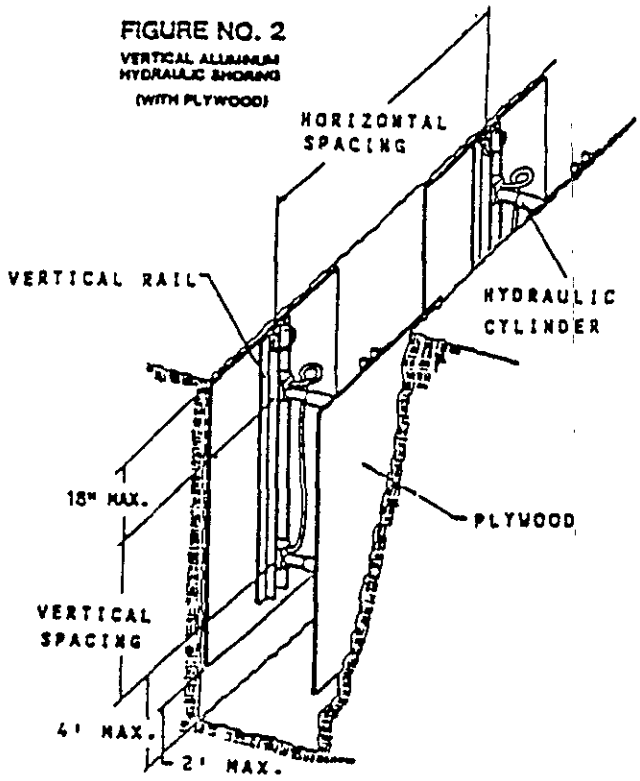


FIGURE NO. 3
VERTICAL ALUMINUM HYDRAULIC SHORING (STACKED)

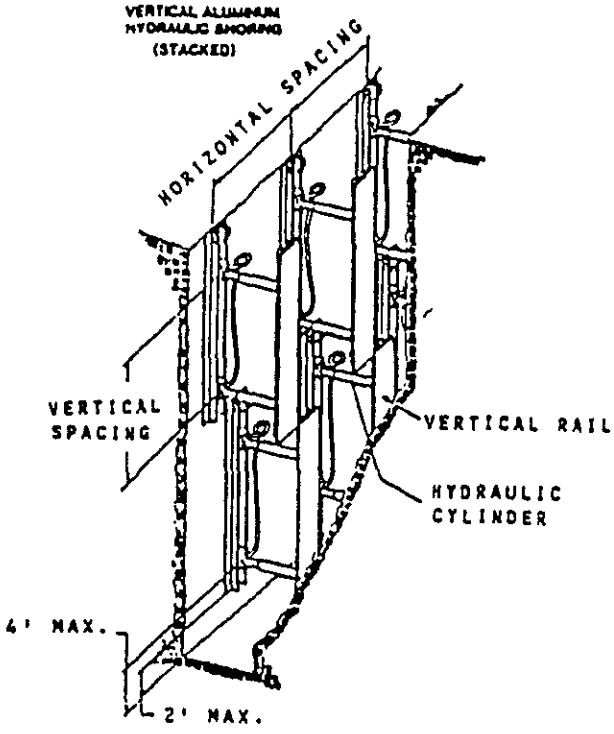


FIGURE NO. 4
ALUMINUM HYDRAULIC SHORING WALER SYSTEM (TYPICAL)

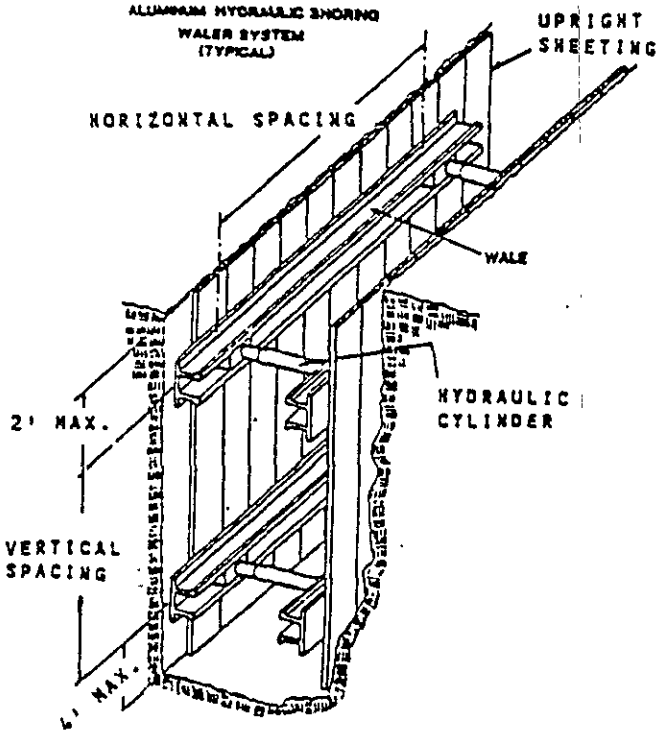


TABLE D - 1.1
ALUMINUM HYDRAULIC SHORING
VERTICAL SHORES
FOR SOIL TYPE A

DEPTH OF TRENCH (FEET)	HYDRAULIC CYLINDERS				
	MAXIMUM HORIZONTAL SPACING (FEET)	MAXIMUM VERTICAL SPACING (FEET)	WIDTH OF TRENCH (FEET)		
			UP TO 8	OVER 8 UP TO 12	OVER 12 UP TO 15
OVER 5 UP TO 10	8	4	2 INCH DIAMETER	2 INCH DIAMETER NOTE (2)	3 INCH DIAMETER
OVER 10 UP TO 15	8				
OVER 15 UP TO 20	7				
OVER 20	NOTE (1)				

Footnotes to tables, and general notes on hydraulic shoring, are found in Appendix D, Item (g)
Note (1): See Appendix D, Item (g) (1)
Note (2): See Appendix D, Item (g) (2)

TABLE D - 1.2
ALUMINUM HYDRAULIC SHORING
VERTICAL SHORES
FOR SOIL TYPE B

DEPTH OF TRENCH (FEET)	HYDRAULIC CYLINDERS				
	MAXIMUM HORIZONTAL SPACING (FEET)	MAXIMUM VERTICAL SPACING (FEET)	WIDTH OF TRENCH (FEET)		
			UP TO 8	OVER 8 UP TO 12	OVER 12 UP TO 15
OVER 5 UP TO 10	8	4	2 INCH DIAMETER	2 INCH DIAMETER NOTE (2)	3 INCH DIAMETER
OVER 10 UP TO 15	6.5				
OVER 15 UP TO 20	5.5				
OVER 20	NOTE (1)				

Footnotes to tables, and general notes on hydraulic shoring, are found in Appendix D, Item (g)
Note (1): See Appendix D, Item (g) (1)
Note (2): See Appendix D, Item (g) (2)

TABLE D - 1.3
ALUMINUM HYDRAULIC SHORING
WALER SYSTEMS
FOR SOIL TYPE B

DEPTH OF TRENCH (FEET)	WALES		HYDRAULIC CYLINDERS						TIMBER UPRIGHTS		
			WIDTH OF TRENCH (FEET)						MAX.HORIZ.SPACING (ON CENTER)		
	VERTICAL SPACING (FEET)	SECTION MODULUS* (IN^3)	UP TO 8		OVER 8 UP TO 12		OVER 12 UP TO15		SOLID SHEET	2 FT.	3 FT.
			HORIZ. SPACING	CYLINDER DIAMETER	HORIZ. SPACING	CYLINDER DIAMETER	HORIZ. SPACING	CYLINDER DIAMETER			
OVER 5 UP TO 10	4	3.5	8.0	2 IN	8.0	2 IN NOTE(2)	8.0	3 IN	—	—	3x12
		7.0	9.0	2 IN	9.0	2 IN NOTE(2)	9.0	3 IN			
		14.0	12.0	3 IN	12.0	3 IN	12.0	3 IN			
OVER 10 UP TO 15	4	3.5	6.0	2 IN	6.0	2 IN NOTE(2)	6.0	3 IN	—	3x12	—
		7.0	8.0	3 IN	8.0	3 IN	8.0	3 IN			
		14.0	10.0	3 IN	10.0	3 IN	10.0	3 IN			
OVER 15 UP TO 20	4	3.5	5.5	2 IN	5.5	2 IN NOTE(2)	5.5	3 IN	3x12	—	—
		7.0	6.0	3 IN	6.0	3 IN	6.0	3 IN			
		14.0	9.0	3 IN	9.0	3 IN	9.0	3 IN			
OVER 20	NOTE (1)										

Footnotes to tables, and general notes on hydraulic shoring, are found in Appendix D, Item (g)

Notes (1): See Appendix D, item (g) (1)

Notes (2): See Appendix D, Item (g) (2)

* Consult product manufacturer and/or qualified engineer for Section Modulus of available wales.

TABLE D - 1.4
ALUMINUM HYDRAULIC SHORING
WALER SYSTEMS
FOR SOIL TYPE C

DEPTH OF TRENCH (FEET)	WALES		HYDRAULIC CYLINDERS						TIMBER UPRIGHTS		
			WIDTH OF TRENCH (FEET)						MAX.HORIZ SPACING (ON CENTER)		
			UP TO 8		OVER 8 UP TO 12		OVER 12 UP TO 15				
	VERTICAL SPACING (FEET)	SECTION MODULUS (IN³)	HORIZ. SPACING	CYLINDER DIAMETER	HORIZ. SPACING	CYLINDER DIAMETER	HORIZ. SPACING	CYLINDER DIAMETER	SOLID SHEET	2 FT.	3 FT.
OVER 5 UP TO 10		3.5	6.0	2 IN	6.0	2 IN NOTE(2)	6.0	3 IN			
		7.0	6.5	2 IN	6.5	2 IN NOTE(2)	6.5	3 IN	3x12	——	——
		14.0	10.0	3 IN	10.0	3 IN	10.0	3 IN			
OVER 10 UP TO 15	4	3.5	4.0	2 IN	4.0	2 IN NOTE(2)	4.0	3 IN			
		7.0	5.5	3 IN	5.5	3 IN	5.5	3 IN	3x12	——	——
		14.0	8.0	3 IN	8.0	3 IN	8.0	3 IN			
OVER 15 UP TO 20	4	3.5	3.5	2 IN	3.5	2 IN NOTE(2)	3.5	3 IN			
		7.0	5.0	3 IN	5.0	3 IN	5.0	3 IN	3x12	——	——
		14.0	6.0	3 IN	6.0	3 IN	6.0	3 IN			
OVER 20	NOTE (1)										

Footnotes to tables, and general notes on hydraulic shoring, are found in Appendix D, Item (g)

Notes (1): See Appendix D, item (g) (1)

Notes (2): See Appendix D, Item (g) (2)

* Consult product manufacturer and/or qualified engineer for Section Modulus of available wales.

BILLING CODE 4510-26-C

Appendix E to Subpart P—Alternatives to Timber Shoring

Figure 1. Aluminum Hydraulic Shoring

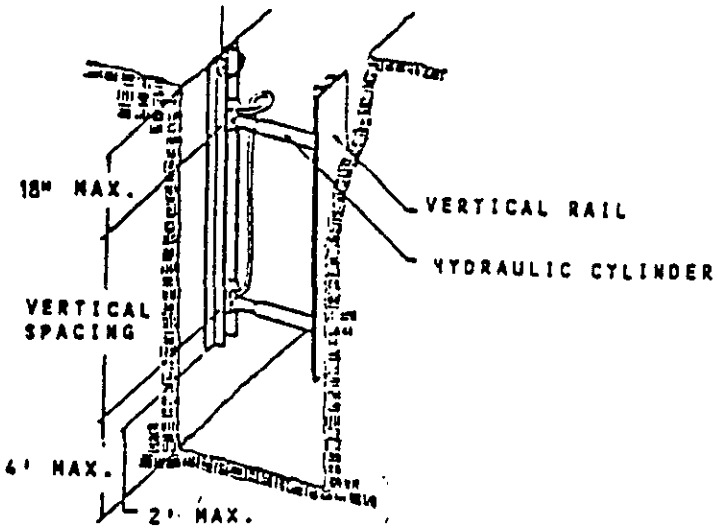
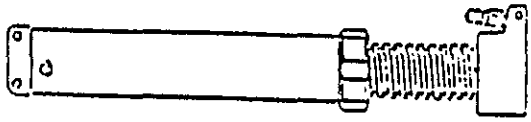
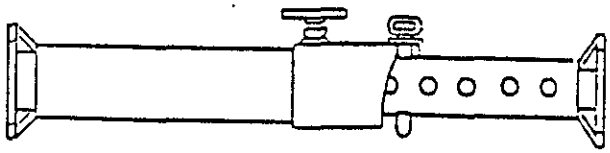


Figure 2. Pneumatic/hydraulic Shoring





BILLING CODE 4510-26-M

Figure 3. Trench Jacks (Screw Jacks)

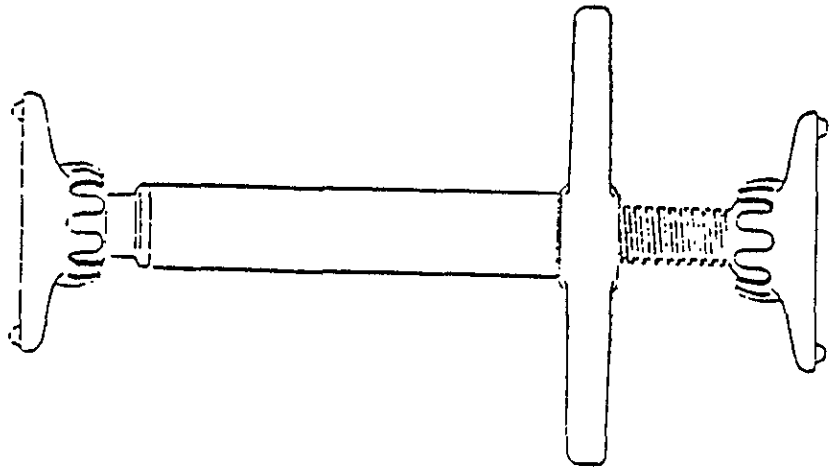
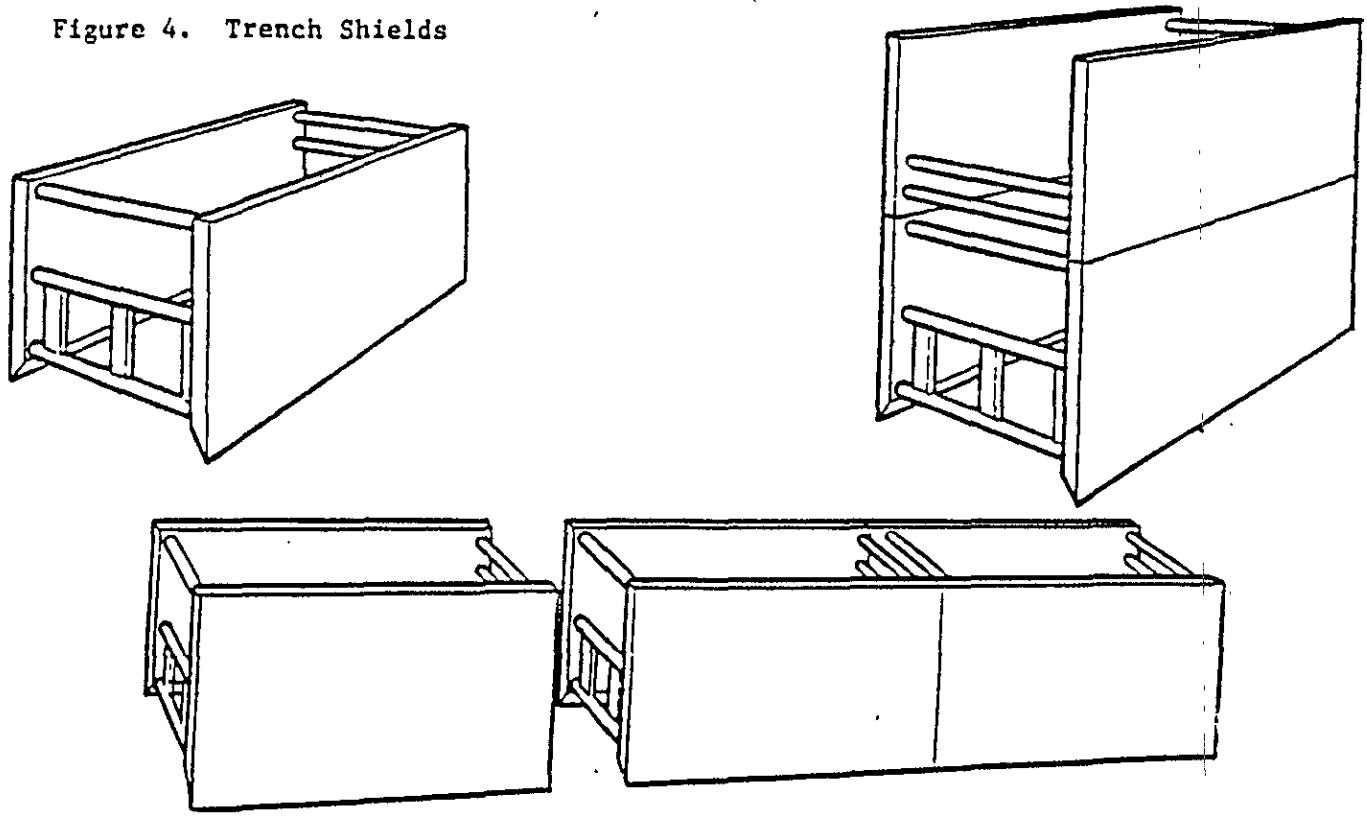


Figure 4. Trench Shields



BILLING CODE 4510-26-C

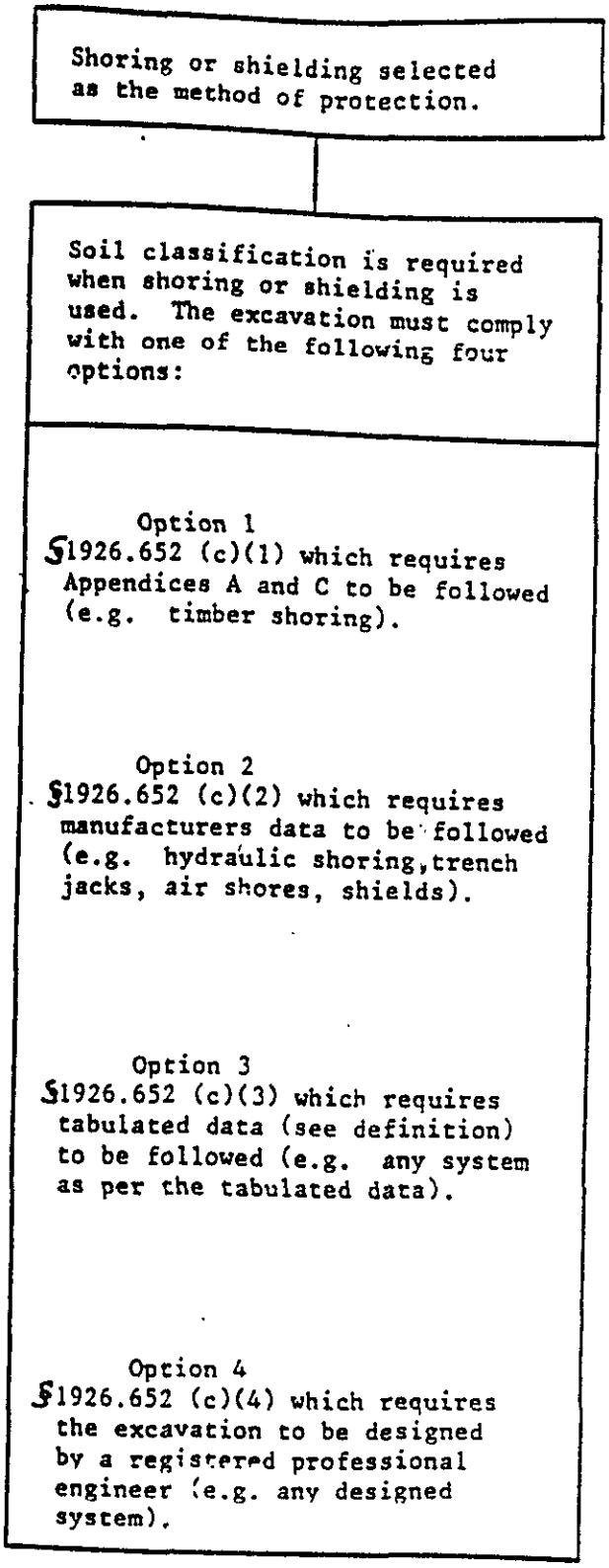


FIGURE 3 - SHORING AND SHIELDING OPTIONS

[FR Doc. 89-25217 Filed 10-30-89; 8:45 am]
BILLING CODE 4510-26-C

Appendix F to Subpart P—Selection of Protective Systems

The following figures are a graphic summary of the requirements contained in subpart P for excavations 20 feet or less in depth. Protective systems for use in excavations more than 20 feet in depth must be designed by a registered professional engineer in accordance with § 1926.652 (b) and (c).

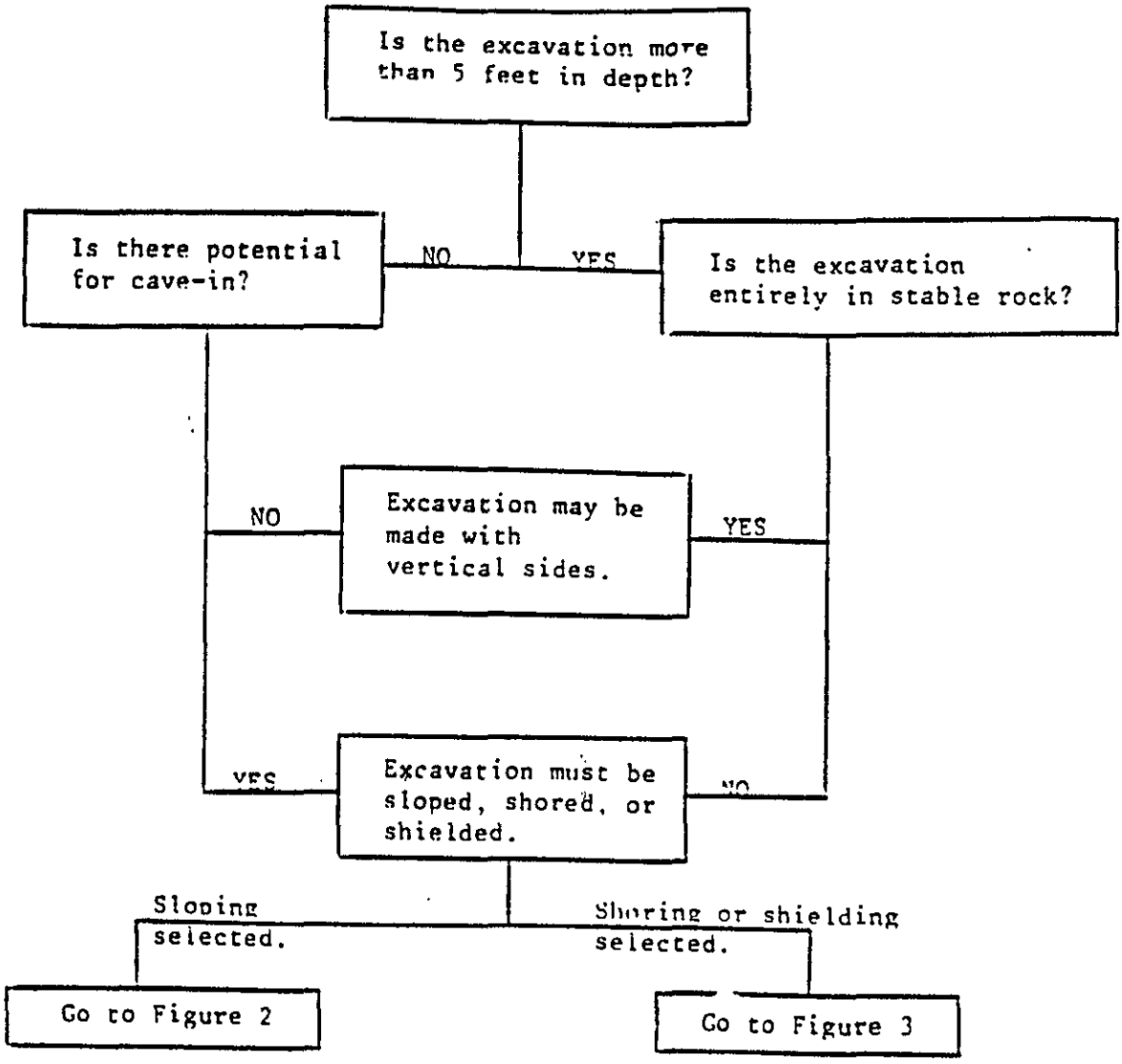


FIGURE 1 - PRELIMINARY DECISIONS

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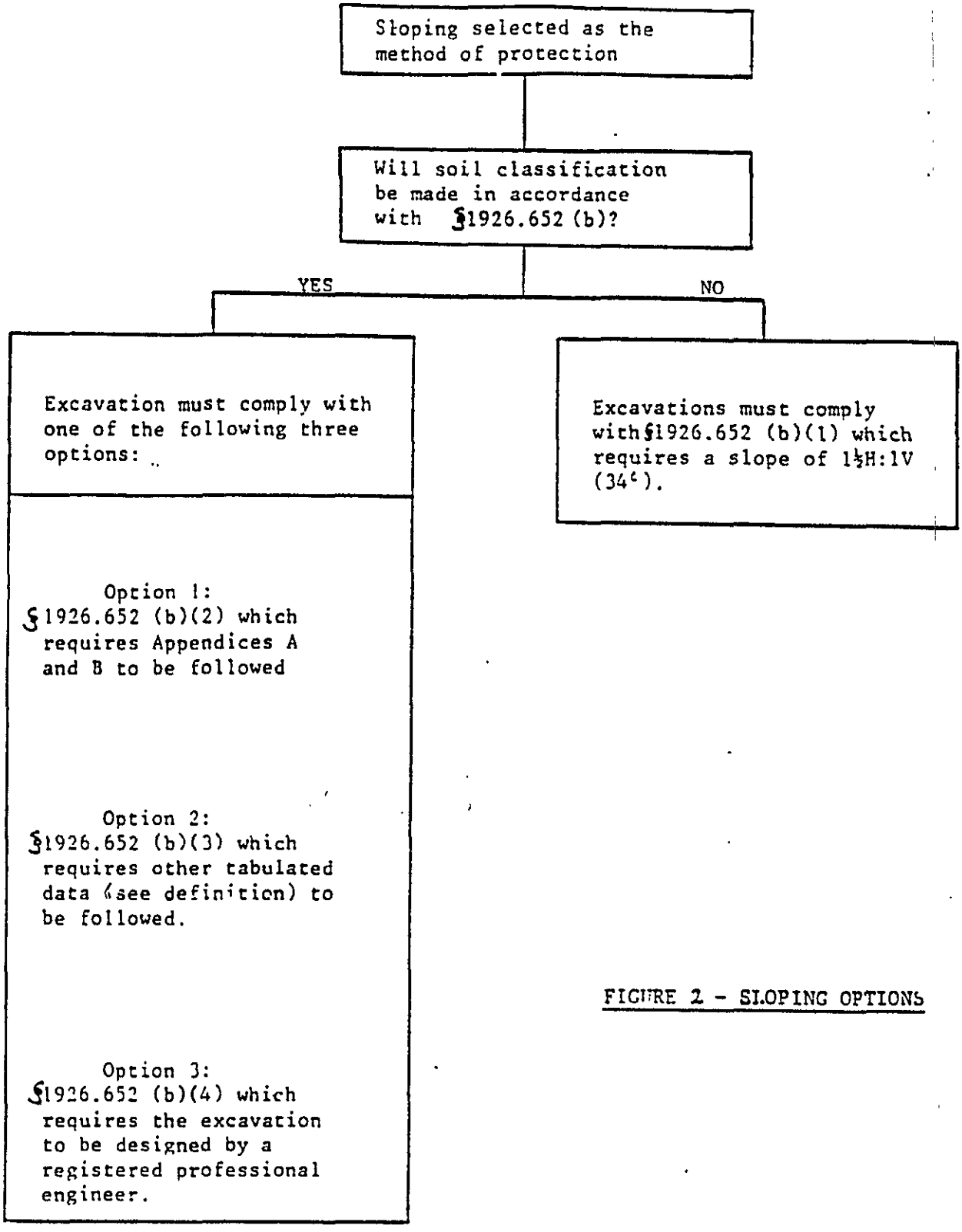

FIGURE 2 - SLOPING OPTIONS

nearest hospital + route?

HEALTH & SAFETY PLAN - 1991
UNION PACIFIC RAILROAD -
Y.A.T./PROJECT No. 94808
VARIOUS LOCATIONS THROUGHOUT CALIFORNIA

TABLE OF CONTENTS

1.0 INTRODUCTION

The personal health and safety of all individuals directly involved in the Union Pacific Railroad (UPRR) Yank A Tank (YAT) Project and the general public who may be in the vicinity of the site is of particular concern to USPCI. Therefore, all prudent and reasonable measures will be taken to establish and maintain safe healthy working environmental conditions.

This Health and Safety Plan identifies the potential hazards associated with the project and the actions that will be taken to minimize or eliminate those hazards; e.g., engineering controls, use of personal protective equipment, training, etc. Although every effort was made to develop a plan that is as comprehensive and detailed as possible, conditions may change once the project is initiated which warrant modification of this plan. Throughout each stage of the project, the plan will be reviewed and changed or modified as necessary.

Modification of the plan will be the responsibility of the USPCI Project Manager. Substantial changes will be reviewed and approved by a member of USPCI's Health and Safety staff. All on-site workers will be trained from this or any modified Health and Safety Plans.

Although it is hoped that the UPRR YAT Project will not require it, an Emergency Response Plan is provided in this document.

2.0 SCOPE OF WORK

2.1 Client's Business

Union Pacific operates over 25,000 miles of railroad track throughout the United States.

2.2 History of Site

All tanks are in different states but generally the same type of conditions exist. Primary use of underground storage tanks were used to fuel engines along the rail line.

2.3 General Scope of Work

This project consists of the removal of petroleum underground storage tanks (UST's) along the UPRR line in the state of California. The following is a brief description of how a tank removal will proceed.

Most tanks will be well away from any active tracks. In the event that any tanks are within 20 feet of active tracks UPRR will provide a flagman to maintain safe working conditions around the tracks.

A lead crew consisting of a USPCI representative, vacuum truck, and vacuum truck operator will arrive on site first. They will remove all fluids from the tanks prior to any excavation. Hydrocarbon reactive putty will be used to

determine liquid tank contents. If tank contents cannot be determined then activity at the site will halt. A sample if existing material will be analyzed to determine the contents of the tank. If the tank contents indicate material other than gasoline, diesel fuel, or hydraulic fluid, analysis for PCB's and chlorinated solvents will be performed at an approved laboratory. Reports of this analysis will be forwarded to USPCI's Project Supervisor or Sr. Project Manager. Only after approval from USPCI's Project supervisor and/or Sr. Project Manager shall product removal begin. If hazardous materials are found to exist, the Project Supervisor or Sr. Project Manager shall notify Union Pacific Environmental personnel and determine proper disposal methods. Under NO circumstances shall unknown material be removed from any underground storage tank. A Gastech 1314 or PID will be used to determine proper respiratory protective equipment to be worn by the lead crew. (Refer to section 5.0)

Prior to excavation underground lines and tanks will be located using site maps, as well as utility and generator information. The top of the tank will be exposed with soil stockpiled at least two feet from the excavation. Throughout the work, the atmosphere in and around the excavation will be monitored for the presence of hydrocarbon vapor using a combustible gas meter, and/or an PID for PEL levels. Once the tank is exposed all tank fixtures and pipes will be removed. Flammable vapors will be temporarily purged from the tank by adding dry ice (see section 3.0). The tank will be tested continuously (6 inches from the bottom to the top) with the combustible gas meter. When readings do not exceed 10% of the LEL and 3% O_2 the tank will be considered safe for removal from the ground. All lines will be plugged with concrete or removed as appropriate. All tanks will be purged regardless of LEL levels.

The tanks will be lifted out of the excavation with nylon straps or spark proof covered cables with high strength ratings. A 1/8" vent hole will remain open to prevent excess differential pressure. The tank will be lifted with the excavator or a crane. During all lifting, personnel shall stay well away from the tank. The tank will be secured on the surface with blocks and clearly labeled as described in section 2.4.1. The excavation will be sampled using the excavator bucket. No one will enter the excavation unless absolutely necessary and the proper cave in protection is in place. Once the excavation is clean it will be backfilled using the excavator. If the excavation must remain open and ~~cannot be~~ continuously attended by USPCI employees then a temporary fence will be erected around the excavation.

with clean fill?

Depending on County Regulation in California The tank will be transported to a Recycling Facility to be cut up for disposal and scrap or will be transproted to USPCI Grassy Mtn. for disposal. No hot work is to be allowed by any USPCI employee, hot work includes any activity which may generate heat; welding, cutting, brazing, drilling, using saws, etc.

If contaminated soil is found it will be removed and stockpiled separately from clean soil. The Gastech or PID will be used to monitor the atmosphere in the breathing zone. A consistent reading of 100 ppm over a 15 minute period

will be the action level at which PPE will be upgraded to Level "C". A consistent reading of 1000 ppm over a 15 minute period will be the action level at which PPE will be upgraded to Level "B".

County Regulations verry from county to county. the above statement is only a USPCI standard. Ammendment for each county must be addressed and approved by the USPCI H&S Staff.

2.4 Specific Tasks

Removal of fluids from tank, locate any underground lines, purge tank using dry ice, expose tank and remove all tank fixtures & pipes, plug lines, remove tank, sample excavation, recheck LEL Ø add more dry ice, load tank for transportation.

2.4.1 Inspections Before Shipping Tanks

Prior to transporting the tank the atmosphere will be checked. The tank will be not be moved until it is below 10% of the LEL and 3% of the O
2
, all free liquids are removed and labels are applied to the tank. Labels will state the former contents and current vapor state including removal date. The labels will be two inches high and will include the following:

DANGER
KEEP FIRE AND SPARKS AWAY
DO NOT CUT OR PUNCTURE
- AND -
TANK HAS CONTAINED LEADED GASOLINE*
NOT VAPOR FREE
NOT SUITABLE FOR STORAGE OF FOOD OR LIQUIDS INTENDED FOR HUMAN OR ANIMAL CONSUMPTION
DATE OF REMOVAL: MONTH/DAY/YEAR
* Or other flammable/combustible liquid

2.5 Personnel

Four (2) technicians, two (1) equipment operators, and two (1) supervisors will be required for this project. Key personnel are:

who?

Project Manager
Responsibilities include overall responsibility for all activities, personnel, and health and safety.

Specific responsibilities include: client interface; acquisition, dispersal and maintenance of all supplies and equipment; maintenance of all project records; compliance with all legal standards, policies and procedures; receipt and complete documentation for all contractors and subcontractors such as training, insurance, supplies and other services; writing health and safety plans, communicating the hazards of the site to all; maintaining communication with all parties involved with the site.

Project Supervisor
Responsibilities include on-site supervision of all activities and personnel.

Specific responsibilities include: observing all policies and procedures and complying with all applicable laws; receiving and acting on reports of injury and/or illness; observing a timely, safe progression of the project; recommending proper PPE and ensuring its use; using or managing the use of monitoring equipment; oversee maintenance of equipment; ensure adequate supplies, tools and equipment are available on site; ensuring that the integrity of the various zones is observed and maintained; conduct daily health and safety meetings.

Health and Safety Designee
Responsibilities include: revising the health and safety plan when there are changes in the scope, duration or activity of the job; identifying actual and potential risks to health and safety; communicating all risk assessment results to the Project Manager and Supervisor(s); maintaining supplies of PPE; providing "stand-by" status when an observer is needed (tank entry, etc.); maintaining and managing the decontamination area; monitoring environmental conditions that pose risk (i.e. temperature, airborne contaminants, etc.); acquiring and organizing health and safety information (MSDS's, analytical results, emergency information, etc.)

who?

Instrumentation Qualified Person
Responsible for PID, Gastech, and Sensidyne operation, maintenance, calibration, results interpretation and documentation.

Equipment Operators
Responsible for operating track hoe, overseeing the decon of equipment, maintenance.

Excavation Qualified Person
Responsible for decisions regarding shoring, sloping, conducting daily inspection etc.

2.6 Equipment

1. Trucks
2. Hand Tools & Non Sparking Hand Tools
3. Track Hoe
4. PID
5. Sensidyne
6. Gastech
7. Nylon Straps
9. Placards
10. Level D PPE
11. Crane
12. Barrier Fence & Tape
13. Sampling Equipment
14. Vent Pipe
15. Traffic Cones
16. Emergency Equipment as specified in Section 10.0
17. Copper Grounding Rod

3.0 CHEMICAL HAZARDS

Gasoline (leaded and unleaded)
Diesel
Oil

WARNING: This project involves the handling of material which are, or which contain chemical known to the State of California to cause cancer, or birth defects, or other reproductive harm.

4.0 POTENTIAL PHYSICAL HAZARDS/CONTROLS

Task	Potential Hazards	Controls
Removal of Fluids from Tank	Spills	Absorbent pads will be on hand in event of spill.
	Traffic-Auto & Train	Orange traffic cones will be placed in heavy traffic areas. Flagmen wearing orange vests will be employed on all active rail lines, all other lines will require installation of derail lockout.
	Ignition of Vapors	The vacuum tanker used to remove tanks' contents will be bonded to the tank by the use of a bonding cable. Good metal to metal contact will be maintained. The tanker or tank will be grounded by using a grounding rod which is driven into the ground a minimum of three feet.
	Noise from the Vacuum Truck	Hearing protection as described in the PPE section (section 5.0) will be used.
	Contact with Free Liquids	Use of proper PPE (see section 5.0)
	Inhalation of Vapors	Use of proper respiratory protection (see section 5.0)

4.0 POTENTIAL PHYSICAL HAZARDS/CONTROLS - CONT.

Task	Potential Hazards	Controls
Purging Tank	Product Vapor Ignition	Tank will be grounded using a separate grounding rod to prevent static discharge. Flammable vapors will be temporarily removed from the tank atmosphere by purging with dry ice. All tanks will be purged regardless of LEL levels. No open flames, live circuits, or running engines will be allowed in the EZ. A 12' vent pipe made of PVC will be used as an extension to the existing vent. Dry ice will be added to the tank at the rate of three pounds of dry ice per one hundred gallons of tank capacity. The dry ice will be crushed into quarter size pieces and distributed as evenly as possible over the tank to promote rapid evaporation. LEL monitoring will be continuous after one hour of dry ice evaporation. The tank and work area must have an LEL level not exceeding 10% and 3% Oxygen. Only non-sparking tools will be used in the EZ.
	Frost Bite from Dry Ice	Leather or insulated gloves will be used to prevent frost-bite. Actual handling of dry ice will be

kept to a minimum.

4.0 POTENTIAL PHYSICAL HAZARDS/CONTROLS - CONT.

Task	Potential Hazards	Controls
Purging Tank Cont.	Muscle Strain	Proper lifting techniques will be used while lifting heavy objects.
	Slips, Trips, Falls	Any loose material which could create a tripping hazard will be removed. Any wet or slick surfaces will be cleaned up or avoided.
	Stinging Plants & Animals	The EZ will be inspected for the presence of plants and animals which could be a hazard.
Expose Tank/Remove All Fixtures and Pipes	Ignition of Flammable Vapors	Task will not start until the tank has been properly purged by the addition of dry ice. Monitoring must confirm that the atmosphere in the tank does not exceed 10% of the LEL for the last known contaminant and the O content does not exceed 3%.
	Contacting Energized Utilities	All utilities will be identified and deenergized prior to starting work. Contact with underground structures will be reason to proceed with caution and cease operations if necessary.
	Contact with Free Liquids	If free product is present PPE as specified in Section 5.0 will be utilized.

4.0 POTENTIAL PHYSICAL HAZARDS/CONTROLS - CONT.

Task	Potential Hazards	Controls
Expose Tank/Remove All Fixtures and Pipes Cont.	Inhalation of Vapors	If a consistent reading of 100 ppm on the OVM above background is noted all employees in the EZ will move to Level "C" PPE as defined in section 6.0.
Tank Extraction	Ignition of Flammable Vapors	Proper purging of the tank, use of non-sparking tools, removal of ignition sources, identify and deenergize underground utilities, utilization of vent pipes.
	Employees Being Struck By Tank	Guidelines attached to the tank will be used to assist in moving the tank during extraction, all personnel will stay a safe distance away.
	Dropping The Tank	Tank lifting equipment will be inspected prior to each use. No straps will be used with wear indicator showing. Tanks over 1000 gallons will be lifted with a steel cable with spark proof non-conductive coating

4.0 POTENTIAL PHYSICAL HAZARDS/CONTROLS - CONT.

Task	Potential Hazards	Controls
Tank Extraction-Cont.	Heavy Equipment Operation	All personnel will stay in eye contact with operator and will stand clear of machinery work area. One person with knowledge of hand signals will be designated to communicate information to the operator.
	Cave-In Of Excavation	Spoil piles will be located at least two feet from the excavation. No individuals will be allowed into the excavation unless sides are properly laid back or shoring is in place (Appendix C). Qualified personnel trained in excavation techniques will be present during tank removals. Any excavation left unattended will be surrounded by temporary fencing.
	Contact with Overhead Utilities	All overhead utilities will be noted, observed and, if possible, deenergized. Caution will be exercised while working around overhead utilities or structures. Only qualified equipment operators will be allowed to operate heavy equipment.

4.0 POTENTIAL PHYSICAL HAZARDS/CONTROLS - CONT.

Task	Potential Hazards	Controls
Sample Excavation	Inhalation of Vapors	The bucket of the backhoe will be employed as a sample tool. Monitoring will be performed during sampling activities (See Section 6.0) proper PPE will be worn while occupying the EZ. (Section 5.0)
	Cave-In of Excavation	No individuals will be allowed into the excavation unless sides are properly sloped or shoring is in place. Qualified personnel trained in excavation techniques will be present during sampling events. (Appendix C)
	Contact with Hazardous Materials	Contact with Hazardous Materials is extremely unlikely. In the event that hazardous materials are encountered, proper PPE will be worn while in the EZ (see section 5.0). Proper decontamination procedures will be enforced (see section 7.0)
Loading Tank for Transport	Dropping Tank	Tank lifting equipment will be inspected prior to each use. No straps will be used when wear indicator is showing. Tanks over 1000 gallons will be lifted with steel cable with spark proof non-conductive protective coating.

4.0 POTENTIAL PHYSICAL HAZARDS/CONTROLS - CONT.

Task	Potential Hazards	Controls
Loading Tank for Transport Cont.	Employee Being Struck By Tank	Guidelines attached to the tank will be used to help move tank. All personnel will maintain a safe distance from the tank.
	Dislodging Other Tanks Loaded on Flat Cars	Proper cribbing techniques will be utilized when preparing tanks for transport. Tanks prepared for transport will be inspected by U.P.R.R. personnel prior to shipment.

5.0 PERSONAL PROTECTIVE EQUIPMENT (PPE)

Area	Task	PPE Required
1. Exclusion Zone (EZ) 30 feet directly adjacent to the excavation	Removal of Liquid	Level C PPE full face respirator with OV cartridges, chemrell coveralls, steel toed rubber boots, nitrile gloves, hard hat, hearing protection (if required).
	Removal of Sludge	Level C PPE full face respirator with OV/HEPA filters, poly coated tyvek, Beta Poly Max steel toed rubber boots, nitrile gloves and hard hat.
	Removal of Tank	Steel toed boots, leather gloves, hard hat, and safety glasses unless upgrading is required. If upgrading is required then Level C PPE will be needed: full face respirator with HEPA filters, poly coated tyvek, Beta Poly Max steel toed rubber boots, hard hat and nitrile gloves.
2. Contaminant Reduction Zone (CRZ) 25 Feet directly around the area where the tank will be placed	Marking Tanks	Beta Poly Max steel toed rubber boots, leather gloves, hard hat, and safety glasses.
3. Support Zone (SZ) all other areas	Administrative and support activities	Hard hat, steel toed leather boots, safety glasses with side shields.

6.0 INSTRUMENTATION/MONITORING

Calibration will be performed in accordance with the manufacturer's specifications, using the procedures detailed by the manufacturer. Calibrations will be done only by those USPCI employees qualified by education and training. Calibration will be done in a clean environment which is similar to the actual work environment in terms of temperature, pressure, and humidity. Prior to actual use each instrument will be allowed sufficient warm-up time and will be "zeroed", as applicable. Calibration and maintenance log book will be maintained on-site for each instrument.

All readings will be recorded in the project's general log book or the project's instrumentation log book. Results, sample locations, environmental conditions, dates, times and the instrument operator's initials shall be logged.

Colormetric tubes will be used to help determine concentrations of contamination in highly contaminated sites or as the project manager deems necessary. tubes used will be those designed to detect the contaminates thought to be present in the highest concentrations and/or are potentially the most toxic;i.e.benzene toluene or xylene.

Instrument	Location of Sampling	Frequency	Action Level/Action
Gastech Combustible Gas/O Detector	In The Tank	Before digging excavation, once tank is exposed, before moving tank, whenever environmental conditions change, no greater than every 12 hours.	10% of LEL and 3% of Oxygen content/ addition of more dry ice.
Colorimetric Tube	Around tank	Before and during work in highly contaminated sites	1/2 of the target concentration/ work stoppage or upgrade PPE.

Instrument	Location of Sampling	Frequency	Action Level/Action
PID/Gastech Monitor	Around tank and excavation	Before and frequently during all activities	A consistent reading of 100 ppm above background or greater for 15 minutes in the breathing zone of nearest employee/ upgrading to Level C PPE. A consistent reading of 1000 ppm or greater will be cause for upgrading to Level B PPE.

7.0 SITE CONTROL MEASURES

1. Exclusion Zone (EZ) - The area of excavation, and 30 feet directly adjacent to the excavation, only key personnel shall be allowed in this area.

   No one may enter the EZ who is not properly protected, using the required PPE, and who has not: 1) completed the required training; 2) completed the field supervised training; and 3) been medically evaluated and found to be "medically fit" to work at a hazardous waste site.

   Smoking, drinking, and eating are prohibited in the EZ.

2. Contaminant Reduction Zone (CRZ) - The area where the tanks will be placed and 25 feet surrounding it. The CRZ will have limited access and no contamination.

   All materials and personnel leaving the EZ contaminated or potentially contaminated will pass through this zone in order to be decontaminated. Wastes generated by the decontamination process will remain in this area until proper disposal can be accomplished.

   Smoking and eating are prohibited in the CRZ.

3. Support Zone (SZ) -, All other areas shall be considered the SZ this is where all administrative and support facilities are located.

   This zone will not be restricted and will function as the area in which all non-hazardous activities can be located, such as storage of supplies, rest areas, office space, etc.

8.0 DECONTAMINATION PROCEDURES

During UST removal personnel and equipment do not come in contact with regulated material therefore no decontamination is necessary. If personnel do come in contact with material in UST (diesel fuel, unleaded gas) disposable PPE will be thrown away in a plastic bag designated for contaminated PPE and any clothing will be washed. In the event that hazardous wastes are encountered decontamination procedures will consist of the following: contaminated surfaces (typically back hoe/front end loader buckets) will be thoroughly cleaned with diesel fuel. Contaminated diesel fuel and rags will be properly disposed of with material destined for landfill or incineration.

Respirators will be cleaned after each use. This can be done with non alcohol wipes. If used , respirator must be cleaned with soap and water at least once a week.

9.0 TRAINING

Each USPCI employee entering the UPRR-YAT site has successfully completed a 40 hour health and safety training course, has completed three days of supervised field work, and has been trained in first aid and CPR.

Supervisory personnel have completed 8 additional hours of training.

The individual operating monitoring instruments has successfully completed an 8 hour instrumentation course, the equipment operator has or is participating in USPCI's equipment operating training program and the individual supervising the excavation has been qualified through a USPCI excavation course.

Contractors, subcontractors, clients, and any other persons present at the site are required to document the required training as is relevant to their activities.

A pre-job conference and daily site safety meeting will be held.

10.0 MEDICAL MONITORING

All USPCI employees involved on-site at the UPRR-Yat sites will have received a pre-employment and annual physical and are certified to be capable of working on a hazardous waste site, wear respiratory protection, and operate equipment (as applicable).

All subcontractors, clients and any other site visitors will be required to provide documentation of medial certification prior to being allowed in the exclusion zone.

This project does not warrant special medical monitoring of any kind.

11.0 EMERGENCY PLAN

Two 10 lb. ABC fire extinguishers, an eye wash, first aid kit, sorbent pads, non sparking shovels, whisk brooms, and dust pans will be available on-site.

In case of any emergency, the on-site project supervisor is responsible for verbally alerting all personnel and providing instructions for response evacuation.

In case of small spills, sorbent pads will be used to contain and clean up liquids. The whisk broom and dust pan will be used to cleanup spills of dry materials.

Employees who become minimally contaminated will immediately flush the affected area with soap and water in the tub located in the CRZ or with the portable eye wash.

Emergency phone numbers are provided in Attachment D. Reportable spills will be the responsibility of the project supervisor.

12.0 SIGN-OFF

All persons, entering the work area (USPCI employees, subcontractors, visitors, clients, regulatory agency personnel, etc.) must read the health and safety plan and acknowledge by their signature that they have understood the plan and will abide by the requirements.

"I acknowledge that I have read and understood the above health and safety plan and will abide by the requirements specified in it."

Name (Print)	Signature	Representing	Date/Time
Craig V. Malcomb	CRAIG HALCOMB	USPCI	11-25-91
ORIN RHODIUS	Orin Rhodius	USPCI	11/25/91 11:00 am
Donald K. Ostrand	Donald K. Ostrand	USPCI	11-25-91 11:00
TIM ALBRIGHT		USPCI	11-25-91 - 11:00 AM
RON MUSTACA		SSF	11-26-91 10:30 a.m.
Mark T. Fill		SJI	11-26-91 10:30 AM
Jim Gustafson		HAZMAT INC	11-27-91 8:30 AM.
Jack Bean		Jakes	11-27-91 9:00 a.m.
Nick DiFranco		Jakes	11-27-91 9:00 AM
MARION Christian, Jr		F.P.B	12/06/91 Noon
Dennis Byrne		Alameda county	12/06/91 11:30
Bruce Zike		Dynamac	12/14/92
Mark Van Scyoc		Dynamac	12/14/92
Robert McSHOW		dero tech	9/14/92
GARY Ritchie		SES	9-17-92
Lonnie Ritchie			9-17-92

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Name (Print)	Signature	Representing	Date/Time
STEVE D SATHRIAGE		SES	1-6-92
MARCEL BRILLA		SES	1-6-92
Don Skaggs		SES	1-6-92
ED EPPLE		Milestone EA	1-14-92
WILLIAM K. THOMAS		USPCI	01/20/92
JAMES HENDERSON		USPCI	01/22/92
SEAN WILSON		USPCI	1/22/92
BRIAN MYRDAHL		USPCI	1/22/92
SCOTT DEROCA		USPCI	1-22-92
JAMES BENNETT		USPCI	2-5-92
Malo T Fiu		Solvent Servic	5/26/92.
A. Mardirosian		USPCI	8/18/92
C. CHRISTIE		ADAMS ENV.	8/20/92
Francisco		ADAMS ENV.	8/20/92
	Brian G. Leonard	USPCI	9-4-92
Kerry Lefever	Kerry Lefever	ESE	9/4/92
Ben Castaneda		AGROTECH	9/10/92
	DON HUANG	ALAMEDA COUNTY	9/11/92

APPENDIX "D"

EMERGENCY PHONE NUMBERS

USPCI Contacts:

Tim Albright Sr. Project Supervisor	Work # (714) 467-3733 Home # (714) 428-8231
Curt Hull - Environmental Assessments P.M.	Work # (303) 938-5569 Home # (303) 420-7808
Agnes Templeman - Medical Monitoring Coordinator	Work # (303) 938-5515
USPCI Incident Number	1 (800) 877-0454

U.P.R.R. Contacts:

Roger Fitch -	Work # (402) 271-3031
Bob Kuhn -	Work # (402) 271-2261

Most Emergency if not different on Amendments 911

APPENDIX-E

SUBSTANCE	ANTICIPAT CONC/ VOL	PEL	IDLH	INCOMPAT UNUS PROP	SYMPTOMS OF EXPOSURE	FLASH POINT	LEL	VAPOR PRESSURE	SPECIFIC GRAVITY	pH	TARGET ORGANS
Toluene	*	200ppm 300ppm ceil	2000ppm	strong oxidizers	ftg, weakness, conf, dizz;head; dil pup, musc ftg, insom, pares	40 f	1.3%	22mm	92		CNS, liver, kidneys, skin
1,1,1 Trichloroethane	*	350ppm 1900 mg/m3	1000ppm	strong oxidizers, strong caustics, chemically active metals	head, lass, CNS, depress, poor equi, irrit eyes, derm		16%	100mm	133		skin, CNS, CVS, eyes
Trichloroethene	*	100ppm 200ppm ceil	Ca	strong caustics, chemically active metals	head, vertigo, vis dist, tremors, somnolence, nau, vomit, irrit eyes		11%	58mm	131		resp sys, heart, liver, kidneys, CNS, skin
Xylene	*	100ppm 435 mg/m3	1000ppm	strong oxidizers	dizz, excitement, drows, staggering gait, irrit eyes, nose, throat, vomit, abdom pain	81 f	1.1%		106		CNS;eyes, GI tract, blood, liver, kidneys, skin
Hydrogen Sulfide	*	200ppm ceil	300ppm	strong oxidizers, metals	apnea, coma, convuls; irrit eyes, irrit resp sys; dizz; ftg		46%	20 atm	34		resp sys, eyes
Naphthalene	*	10ppm 50mg/m3	500ppm	strong oxidizers	irrit eyes, conf; excitement, nau, vomit, abdn pain, irrit bladder, sweat, jaun	174 f	0.9%	.05mm	128		eyes, blood, liver, kidneys, skin, RBC, CNS
Total Hydro Carbons											

SUBSTANCE	ANTICIPAT CONC/ VOL	PEL	IDLH	INCOMPAT UNUS PROP	SYMPTOMS OF EXPOSURE	FLASH POINT	LEL	VAPOR PRESSURE	SPECIFIC GRAVITY	pH	TARGET ORGANS
2-Hexanone	*	100ppm 435mg/m3	5000ppm	strong oxidizers	irrit eyes, nose, weak,pares; derm; head; drow	77 f	1.2%	5mm	100		CNS;skin, resp sys
Methylene Chloride	*	500ppm 1000ppm ceil	Ca	strong oxidizers and caustics, chemically active metals	irrit eyes,nose, chest oppression, dysp vis dist, CNS depress	?	12%	350mm	85		skin, CVS,eyes, CNS
Methyl Ethyl Ketone	*	200ppm 590mg/m3	3000ppm	very strong oxidizers,	irrit nose,eyes, head;dizz,vomit	21 f	2%	70mm	72		CNS,lungs
4-Methyl-2-Pentanone	*	100ppm 410mg/m3	3000ppm	strong oxidizers	irrit eyes, muc memb; head; narcosis, coma	73 f	1.4%	15mm	100		Resp sys, eyes, skin, CNS
Styrene	*	100ppm 200ppm ceil	5000ppm	oxidizers, catalysts for vinyl polymers, strong acids, aluminum chloride	irrit eyes, nose; drow, weak, unsteady gait, defatting derm	90 f	1.17%	4.5mm	104		CNS, resp sys, eyes, skin
Tetrachloro-ethene	*	100ppm 200ppm ceil	Ca	strong oxidizers, chemically active metals	irrit eyes,nose, throat; nau;flush face, vertigo, dizz			14mm	166		liver, kidneys, eyes, upper resp sys, CNS
Total Hydro Carbons											

SUBSTANCE	ANTICIPAT CONC/ VOL	PEL	IDLH	INCOMPAT UNUS PROP	SYMPTONS OF EXPOSURE	FLASH POINT	LEL	VAPOR PRESSURE	SPECIFIC GRAVITY	pH	TARGET ORGANS
2-Methyl-naphthalene	*				Irritant						
2-Ethylhexyl	*										
Phenanthrene	*										
Chrysene	*		Ca							—	—
2-Methylphenol	*	5ppm	250ppm	strong oxidizers	CNS effects; conf, depress; resp fail; dysp, irreg rapid resp, weak pulse	187 f			108		CNS, resp sys, liver, kidneys, skin, eyes
4-Methylphenol	*	5ppm	250ppm	strong oxidizers	CNS effects; conf, depress; resp fail; dysp, irreg rapid resp, weak pulse	187 f			108		CNS, resp sys, liver, kidneys, skin, eyes
Total Hydro Carbons											

SUBSTANCE	ANTICIPAT CONC/ VOL	PEL	IDLH	INCOMPAT UNUS PROP	SYMPTOMS OF EXPOSURE	FLASH POINT	LEL	VAPOR PRESSURE	SPECIFIC GRAVITY	pH	TARGET ORGANS
Acetone	*	1000ppm 2400 mg/m3	2000ppm	oxidizing materials,acids	irrit eyes, nose, throat, dizz	1.4f	2.6 %	266mm	58		Resp sys, skin
Benzene	*	1 ppm	Ca	strong oxidizers chlorine, bromine with iron	irrit eyes,nose,resp sys;giddy;neu,ftg, anor,bone marrow, abdm pain	12.0f	1.3 %	75mm	78		Blood,CNS, skin,bone marrow,eyes, resp sys
Carbon Disulfide	*	20ppm 50ppm ceil	500ppm	strong oxidizers, chemically active metals	dizz,head,poor sleep,ftg,ner;anor, low wght,ocular changes, GI;burns	-22.0f	1.3 %	300mm	76		CNS,eyes, lungs,liver, kidneys, skin
Carbon Tetrachloride	*	10ppm 30ppm ceil	Ca	chemically active metals	CNS depres;skin irrit drow,liver, kidney damage			91mm	154		CNS;eyes,lungs,liver, kidneys,skin
1,1 Dichloroethane	*	100ppm 400 mg/m3	4000ppm	strong oxidizers and caustics	CNS depres;skin irrit;drow; unconsciousness, liver,kidney,damage	17f	6%	182mm	99		skin,liver, kidneys
Ethyl Benzene	*	100ppm 435 mg/m3	2000ppm	strong oxidizers	irrit eyes,muc memb; head;derm;narco, coma	59f	1%	7.1mm	106		eyes,upper resp sys,skin CNS
Total Hydro Carbons											

* AMOUNT OF SUBSTANCE UNKNOWN

SUBSTANCE	ANTICIPAT CONC/VOL	PEL	IDLH	INCOMPAT UNUS PROP	SYMPTOMS OF EXPOSURE	FLASH POINT	LEL	VAPOR PRESS	SPEC GRAV	pH	TARGET ORGANS
Carbon Dioxide (dry ice)	o-1000 pds	5000 ppm	50000 ppm	Dusts of various metals such as magnesium, zirconium, titanium, aluminum, chromium & manganese are ignitable when suspended in carbon dioxide	Head, dizz restless pares, dysp, sweat, mal, inc heart rate, pulse press, elevated BP, coma, asphy,convu luls a hegh concentrati ons,FROST BITE	NA	NA	>1 atm			lungs, skin, CVS

IN ADDITION THE WASTE OILS ENCOUNTERED MAY OR MAY NOT CONTAIN THE FOLLOWING SUBSTANCES:

SUBSTANCE	ANTICPAT CONC/VOL	PEL	IDLH	INCOMPAT UNUS PROP	SYMPTOMS OF EXPOSRE	FLASH POINT	LEL	VAPOR PRESS	SPEC GRAV	pH	TARGET ORGANS
PCB Polychlorin ated biphenyl	unknown	0.001 mg/m3	Ca	Strong oxidizers	Irrt eyes, chloracne, liver damage (carc)	?	?	0.00006	1.38		Skin, eyes, liver

USPCI

HEALTH AND SAFETY PLAN

REVIEW APPROVAL FORM

CLIENT: UPRR

PROJECT: Yank Tank Blanket (Master)

LOCATION: Various. Specific Loc. by addendum

SUBMITTED BY: Tim Albright

DATE RECEIVED: 18 Nov 91

✓	APPROVED (please note comments)
	APPROVED WITH CHANGES INDICATED*
	RESUBMIT WITH CHANGES INDICATED

*Changes must be made before plan can be considered approved and before job begins (ATTACH REVIEW SHEETS).

REVIEWED BY: Edward C Tilton

DATE: 18 Nov 91

THE SIGNED REVIEW APPROVAL FORM MUST ACCOMPANY THE ONSITE HEALTH AND SAFETY PLAN