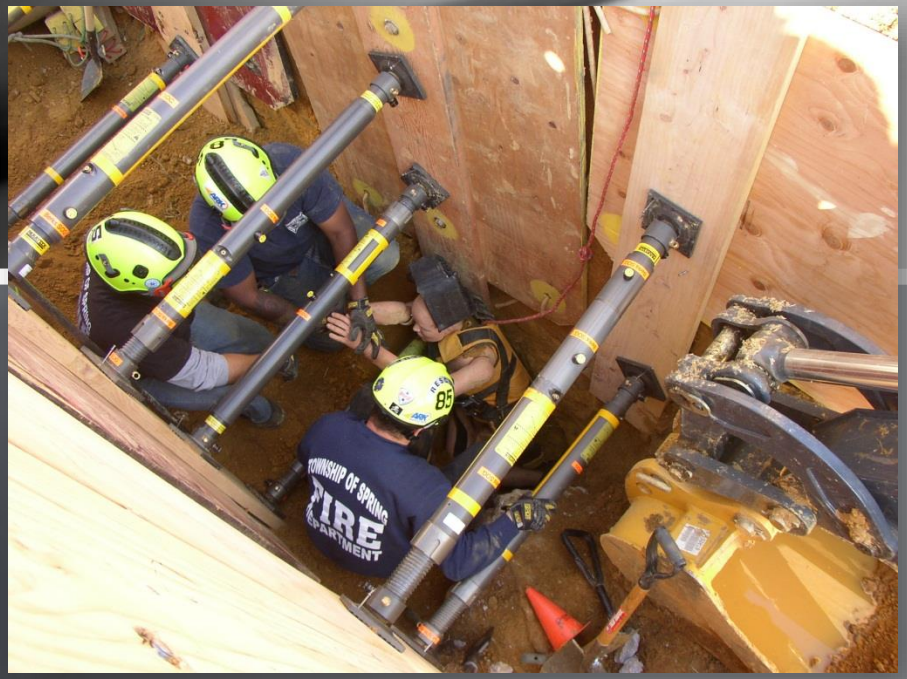
Rescue Operations for the Trench Rescuer

N.C Technical Rescuer; Trench Rescue



OSHA & You

- Trenching and excavation operations in N.C. are regulated by the N.C. Dept. of Labor, Occupational Safety and Health (OSHA).
- Fire and rescue agencies could be held accountable for inappropriate actions taken at a trench accident

Objectives

- Identify elements of pre-planning
- List factors rescuers must know to perform a scene size-up
- Create a written incident action plan (IAP) for trench rescue operations.
- List types of hazard assessment concerns.
- Identify various types of trenches, hazards associated of each.

Objectives

- Identify natural hazards present at a trench accident
- Discuss sheeting and shoring equipment used for supporting trench walls.
- Identify factors that contribute towards a trench collapse.

Terminology

Excavation

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

Terminology

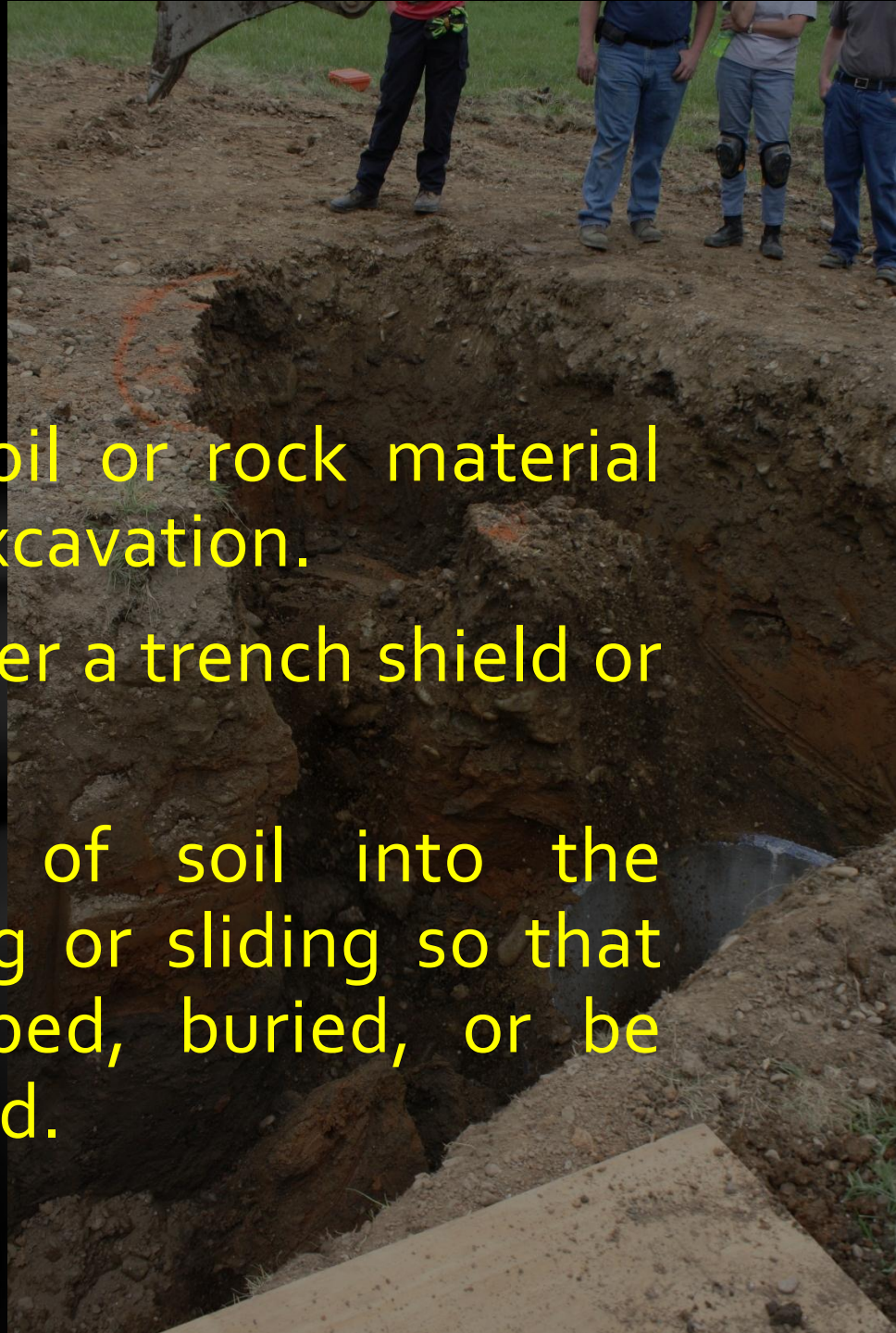
Trench:

"a narrow excavation whereas, the ***depth is greater than the width***, but the ***width of a trench*** (measured at the bottom) ***is not greater than 15 feet*** .

Terminology

Cave-in

- The separation of soil or rock material from the side of an excavation.
- Loss of soil from under a trench shield or support system
- Sudden movement of soil into the excavation, by falling or sliding so that one can be entrapped, buried, or be injured or immobilized.



Terminology

Competent Person:

- *Person certified by OSHA as the trained to identify existing and potential hazards of an excavation.*
- *Has the authority to take corrective measures to eliminate all hazards.*
- Who assumes a similar role with emergency service responders?

Terminology

Compact Soil:

Soil that is hard and appears stable can be indented by the thumb but difficult to penetrate.

Terminology

Distressed soil:

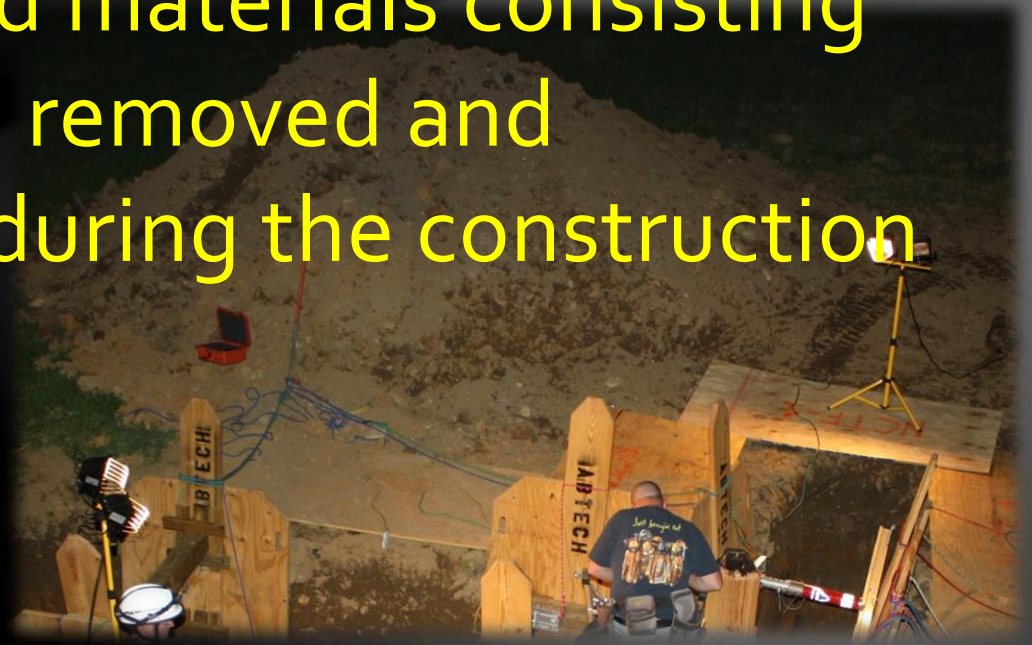
- Soil that is in a condition where a cave-in is imminent.
- Signs include;
  - Fissures (cracks) around the lip or wall of trench
  - Trench wall or floor bulging,
  - Running water in the trench.

Terminology:

Running soil – loose free flowing soil.

Surcharge: Additional weight in the trench area and lip.

Spoil Pile: Excavated materials consisting soils that have been removed and temporarily stored during the construction activity.



Terminology

Protective Isolation Systems

"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.

Includes:

- *Support Systems*
- *Sloping And Benching Systems*
- *Shield Systems*
- *Other Systems That Provide Protection*.

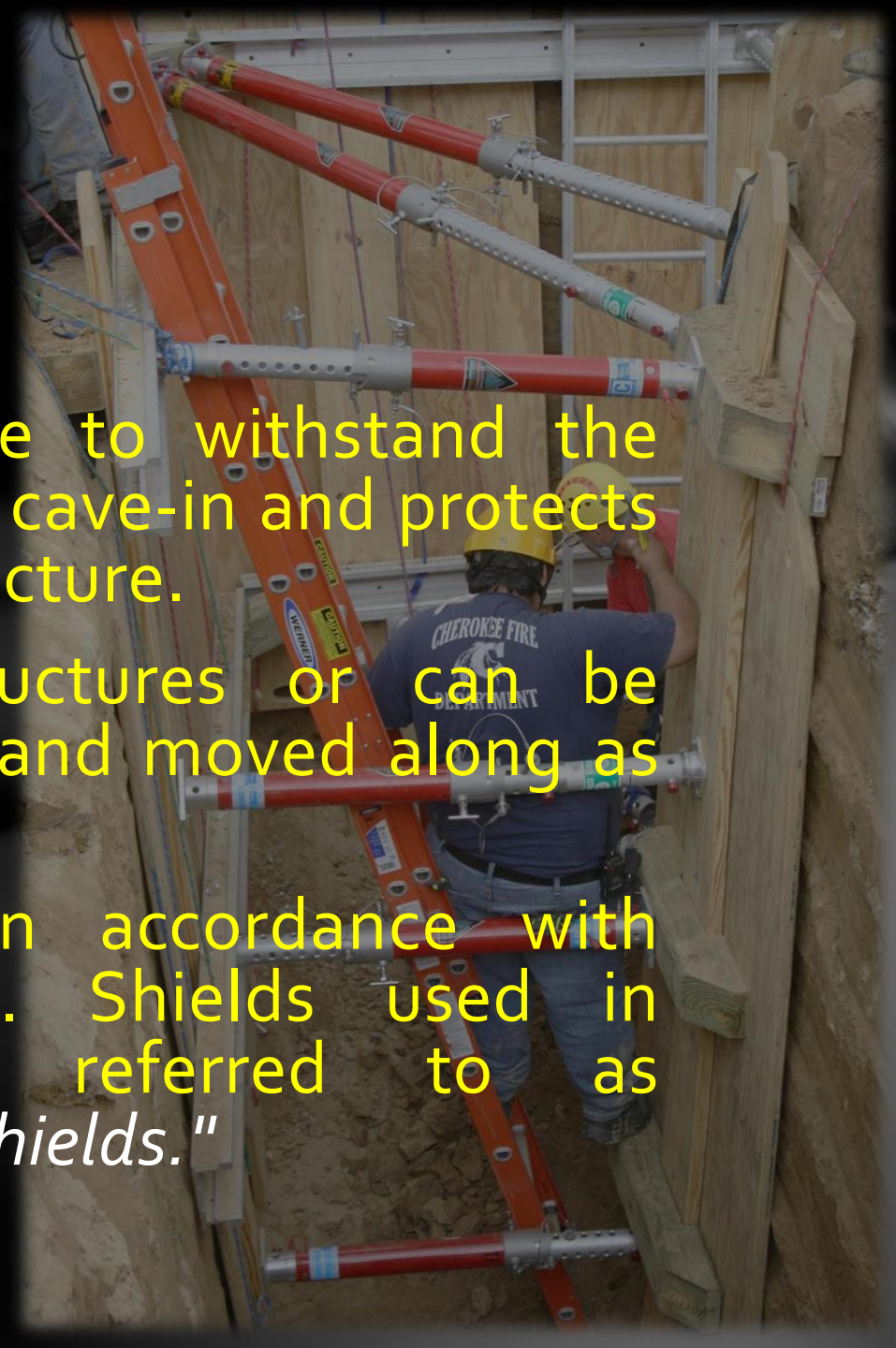
Terminology

Shielding:

"a structure that is able to withstand the forces imposed on it by a cave-in and protects employees within the structure.

Can be permanent structures or can be designed to be portable and moved along as work progresses.

Pre-built 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."*



Terminology

Shield or Trench box:

Pre-fabricated commercial protective system installed into the trench as a self-sufficient protective system.

Quickest and safest to use and usually made of steel or aluminum.

Can be used in Rescue Incidents

Terminology

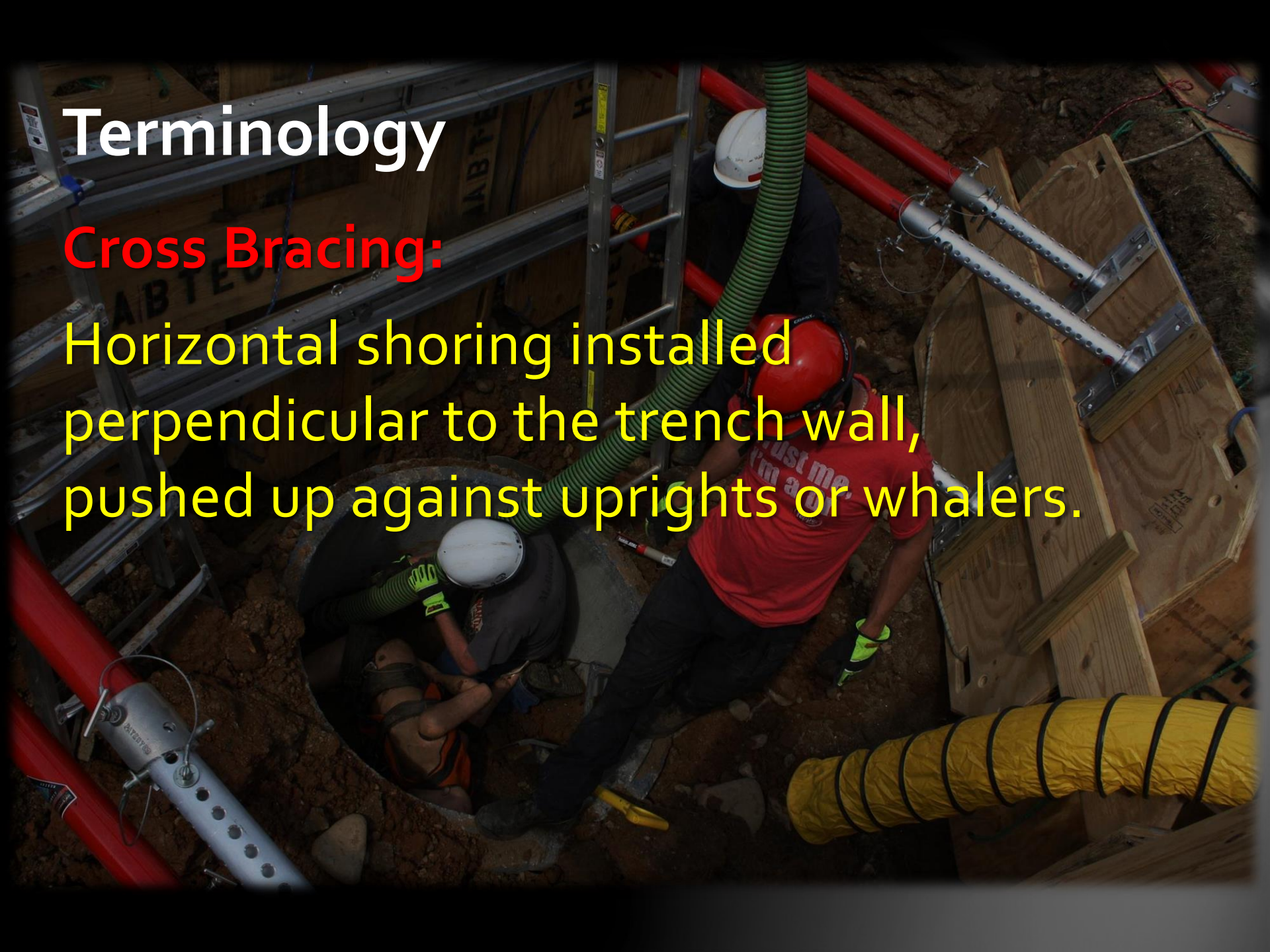
Sheeting:

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

Terminology

Shoring:

" 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."



Terminology

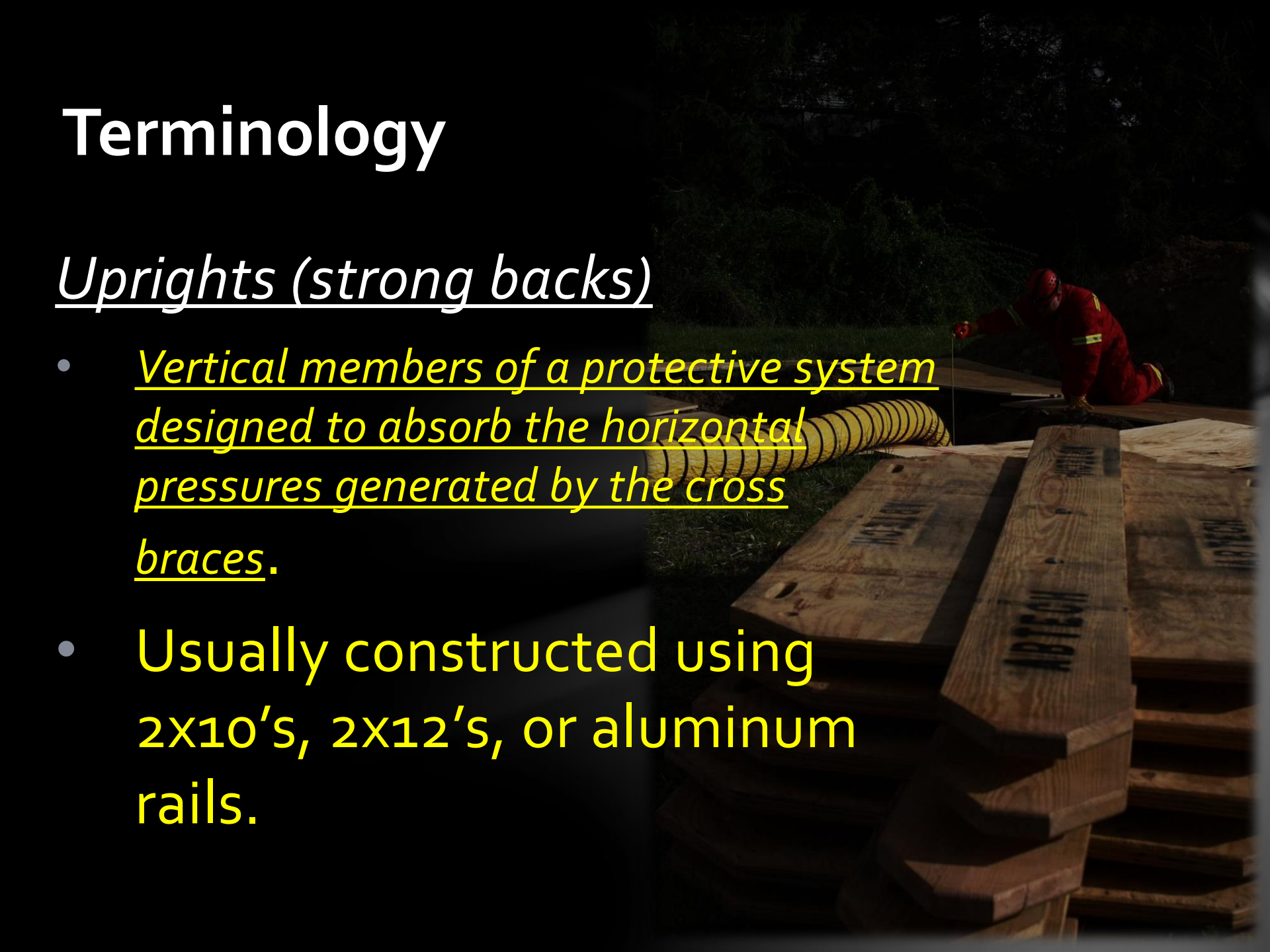
Cross Bracing:

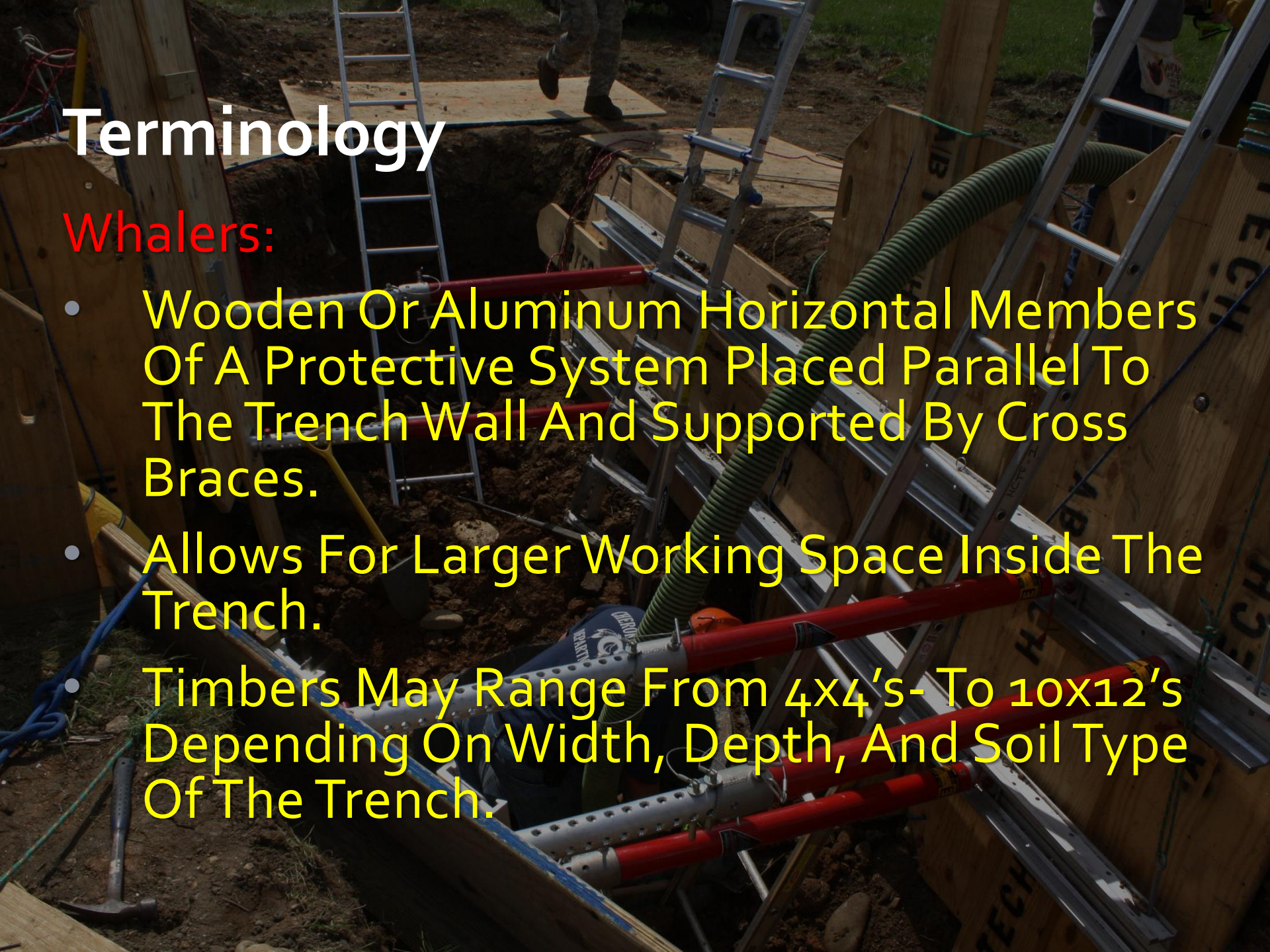
Horizontal shoring installed perpendicular to the trench wall, pushed up against uprights or whalers.

Terminology

Uprights (strong backs)

- *Vertical members of a protective system designed to absorb the horizontal pressures generated by the cross braces*.
- Usually constructed using 2x10's, 2x12's, or aluminum rails.





Terminology

Whalers:

- Wooden Or Aluminum Horizontal Members Of A Protective System Placed Parallel To The Trench Wall And Supported By Cross Braces.
- Allows For Larger Working Space Inside The Trench.
- Timbers May Range From 4x4's- To 10x12's Depending On Width, Depth, And Soil Type Of The Trench.

Terminology

Hazardous atmosphere:

" means an atmosphere that is potentially explosive, flammable, poisonous, corrosive, oxidizing, irritating, oxygen deficient, toxic, or otherwise harmful, may cause death, illness, or injury.

Terminology

Sloping Systems:

"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 varies with differences in soil type, environmental conditions of exposure, and application of surcharge loads.

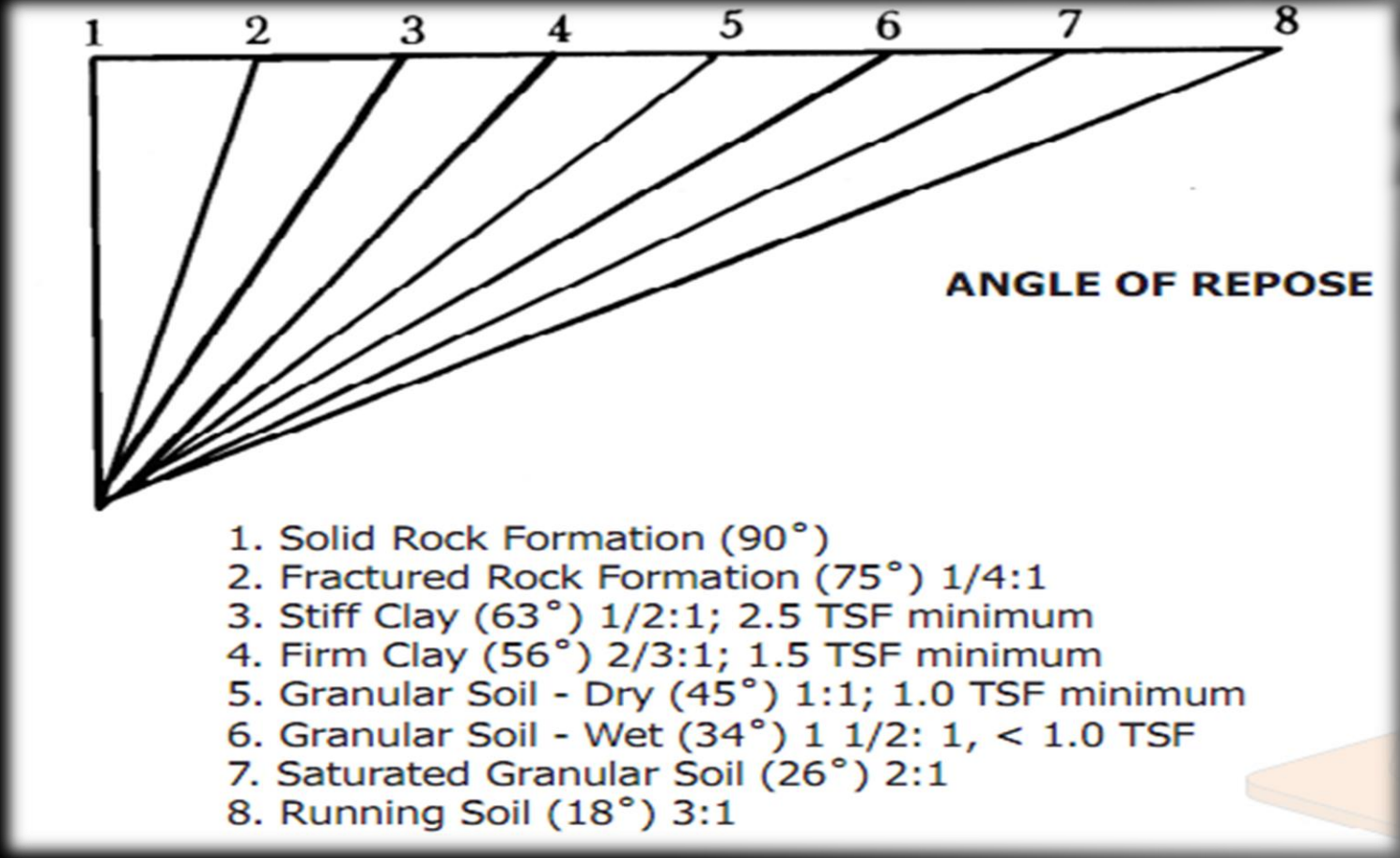
Trench Rescue Terminology

Angle Of Repose:

- **A**ngle trench walls should be cut back or sloped to reduce the chance of workers becoming buried in a collapse.
- *Recommended angle is 34° for every foot of vertical depth the trench should be cut back horizontally 1 ½ times the vertical depth.*

Trench Rescue Terminology

Angle Of Repose:



Terminology

Benching:

"a method of protecting employees 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. (Stair-stepping walls of trench)

Terminology

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 (wales). (*Speed Shores*)

Leading Causes For Cave-ins

- Failure to follow safety rules.
- Working in disturbed soil.
- Inadequate protective system.
- Absence of any protective system.
- Failure to recognize vibration sources.

Contributing Factors For Collapse

- Changes in weather.
- Surcharge weight
- Nearby Vibrations
- Water seepage.
- Mixed soil (soil stratification).
- Lack of sufficient moisture in the trench.

OSHA Statistics

- The average age of trench fatalities is 37 years old.
- 64% of fatalities occur in trenches less than 10’ deep.
- Collapsing trench walls moves at a rate of 55-66 fps or approximately 45 mph

Applicable OSHA Standards

- OSHA CFR 1926.650-652
  (Excavations)
- OSHA CFR 1910.146
  (Confined Space Entry)
- CFR 1910.147
  (Lock Out Tag Out Procedures)

Needs Assessment (Definition)

- The process of collecting information about an organizational need that could be met by conducting training & equipment.
- The need can be a desire to improve current performance or to correct a deficiency.
- A deficiency is a performance that does not meet the current standard.
- It means that there is a prescribed or best way of doing a task and that variance from it is creating a problem.

Needs Assessment

- *Is a part of the preplanning process (preparatory)*
- The purpose of a needs assessment is to evaluate the responding department's capacity to a given emergency incident.
- Questions in the Needs Assessment:
  - What is the frequency?
    - Time of day?
    - Particular day?
    - Day of week?
    - Time of month or year?

Preparatory Phase

Needs Assessment

- What is the duration of the incident?
  - Short Operation
  - Extended Operation
- Does the trench rescue problem involve natural hazards?
- Where in your region / jurisdiction are these types of incidents more likely to occur?
- What is the response time of "Specialized" rescue services, trained personnel, and equipment?

Pre-plan Issues (Preparatory Phase)

- What are the rescue capabilities (training & equipment) of responding mutual aid or private agencies?
- How many qualified trained responders can be anticipated?
- Tour your district; where are active trenching operations are being conducted?
  - Commercial & residential?

Pre-plan Issues (Preparatory Phase)

- Long-term operations;(Sustainability)
  - Sanitation needs?
  - Food and water
- Rehab and medical monitoring
- How will scene control be handled?
  - ***Managing bystanders and spectators is a high priority due to the importance of preventing a possible secondary collapse.***
    Environmental & Exposure protection of responders & patient.
  - Temperature (hot & cold)
  - Precipitation

Types of Response Plans

Self-Sufficient Response Option

- Is most efficient method for ensuring rapid response and high-level skill capability.
- Most expensive option.
- Requires a commitment of :
  - Many hours of specialized training and practice
  - Dedicated funds for specialized equipment and transport vehicle.
  - Large numbers of personnel from same agency.

Community Dependent Response

- Encompasses city/county-wide utility agencies to determine specific resource capabilities of each agency and personnel skill sets and specialized equipment.
- May also include private construction companies, lumber companies, and heavy equipment rental companies.
- Cranes and backhoes should not be used as manlifts.
- Requires the creation of a 24-hour resource list including:
  - Contact numbers and names of contact person.

Regional Response Option

- Spreads cost over several jurisdictions or state entities.
- Reduces the financial burden on an individual organization.
- Requires a commitment of each agency involved to maintain training proficiency and maintenance of assigned equipment.
- Difficult to organize and maintain because resources may be spread over a large area and will cause a significant response delay.
- Requires written mutual aid agreements and response guidelines with all agencies that have agreed to respond in the event of a trench rescue incident.

Creating A Trench Rescue Team.

- Selection Criteria:
  - Trench rescue is very strenuous requiring manipulation of heavy equipment under high stress conditions and various environmental situations.
  - Team members must be physically fit to meet the demands of the rescue operation and emotionally stable.
  - Personnel should have some basic construction skills, using a hammer, cutting with a skill or chainsaw.

Creating A Trench Rescue Team.

- Selection Criteria:
  - Identify the roles your team members will function in.
  - Everyone has a talent. Recognize those with special skill sets.
  - Medical personnel should versed in special trauma associated a trench entrapment, such as compartment syndrome or crush syndrome.

National Fire Protection Standards

NFPA 1670

Requires the AHJ to develop procedures for the procurement and use of resources for trench collapse rescue.

Option 1: Train and equip department personnel to meet all identified operational capabilities.

Option 2: Enter into mutual aid with neighboring entities.

Option 3: Contract with private providers.

Option 4: A combination of the above.

Awareness Level *(Level I)*

- Create procedures for :
  - Conducting a scene size-up.
  - Identification of the resources needed for implementing the emergency response system.
  - Implementing site control and scene management.
  - Identifying typical trench and excavation collapses and assessing potentials for secondary collapse.
  - Making a rapid *non-entry extrication* of a non-injured or minimally injured victim. *(Rescue trapped victim by rope)*

Operations Level *(Level I)*

- Develop and implement procedures for:
  - Making an entry into a trench or excavation.
  - Identifying probable victim location and survivability.
  - Making scene safe:
    - Identification
    - Construction
    - Application
    - Limitations
    - Removal of traditional sheeting and shoring using tabulated data and approved engineering practices.

Operations Level *(Level I)*

Members shall be capable of recognizing the hazards of using equipment and operating at trench and excavation emergencies that include the collapse or failure of individual, non-intersecting trenches with an initial depth of (8 ft) or less

i.e. Can only operate in Straight Wall Trenches Less than 8’

Operations Level *(Level I)*

- Develop and implement procedures for:
  - Initiating a one-call utility location service.
  - Ventilation of the trench.
  - Placing ground pads and protecting the lip of the trench.
  - Providing entry and egress paths.
    - *Maximum lateral travel distance to egress should not exceed 25 feet.*
  - Conducting a pre-entry briefing.
  - Recordkeeping and documentation during entry operations.

Operations Level *(Level I)*

- Develop and implement procedures for:
  - Implementing rapid intervention team.
  - Selection, utilization, and application of shield systems.
  - Selection, utilization, and application of sloping, and benching systems.
  - Defining the duties of panel team, entry team and shoring team.
  - Assessing the mechanism of entrapment and the method of victim removal.
  - Performing extrication.

Technician Level *(Level II)*

- All awareness & operations level capabilities.

- Implement procedures for:
  - The identification, application limitations and removal of manufactured protective systems using tabulated data and approved engineering practices.

Technician Level *(Level II)*

Members shall be capable of:

Recognizing hazards, using equipment, and operating at trench and excavation emergencies that include:

- The collapse or failure of *individual or intersecting trenches with an initial depth of more (8 ft)*
- *Where severe environmental conditions exist*
- *Digging operations involve supplemental sheeting and shoring, or manufactured trench boxes or isolation devices would be used*

Technician Level *(Level II)*

- Implement procedures for:
  - Monitor the atmosphere in all parts of the trench to be entered.
    - The monitoring shall be done in the following sequence:
      - ***Oxygen %***
      - ***Flammability (LEL & LFL)***
      - ***Toxicity (ppm).***

Technician Level *(Level II)*

- Implement procedures for:
  - Identification, construction application, limitations and removal of supplemental sheeting and shoring protective systems
  - Adjustments of protective systems based on digging operations and environmental conditions.
  - Rigging and placement of isolation systems

Training for the Collapse

Training

- Trench accidents require specialized training.
- Address OSHA 1926.650 -652 construction standard
- Agency Response guidelines established by NFPA 1670 and the Job Professional Qualification standard for trench rescue, NFPA 1006
- After initial training, periodic continuing education by a qualified instructor should be required to ensure that personnel retain their skill proficiency.

Training & Pre-planning

- Required periodic training of all agencies & personnel who may be involved in trench accidents.
- Gives those who would be involved in an incident an opportunity to see the plan in action and test their understanding of the plan.
- Use a written IAP for training and incidents.
- Provides an opportunity to address deficiencies that can be identified and remedied.

Training & OSHA Standards

- All command, training, and line officers (safety)should be very familiar with all regulations & actions taken during a trench rescue.
- Consider inviting an OSHA representative to your training session to seek input.
- OSHA representative on your call resource list.
  - Must be notified if any of the following occur;
    - A civilian or rescuer injury
    - Fatality as result of a collapse
    - Death of anyone as the result of a construction incident
    - Requested by the authority having jurisdiction.

Training & OSHA Standards

- When does OSHA require compliance with the standard?
  - When an employer/employee relationship exist.
  - When trench rescue operations are part of your job.
- Does your department train for, acquire equipment for, and prepare to participate in a trench rescue operation?

Training & OSHA Standards

Issue regarding paid versus volunteer.

- Most paid departments with a state run OSHA program must be compliant.
- Volunteers may be exempt from many OSHA regulations
- Do volunteers have to comply with NFPA?
- Do volunteers have to comply with OSHA?

Phase I Assessment

Phase I (Assessment)

- Primary assessment- performed by the first arriving unit.
- Begins with initial dispatch & continues during response and after arrival.
- The initial IC must begin formulating a mental picture of the of the scope of the problem based on dispatch information.
  - Dispatch info should ascertain while enroute:
    - Time of day
    - Weather
    - Traffic conditions during response to the scene.

Phase I (Assessment)

- On Arrival:
  - IC initiates an *information gathering process* to include;
    - Are All Workers Accounted For
    - Number Of Victims And Location(s)
    - Is Worker Partially Or Totally Buried
    - How Much Time Has Elapsed Since The Cave-in.
    - ***Risk Vs. Benefit Analysis***
      - Dead Is Dead

Phase I (Assessment)

On arrival: (cont'd)

- Do any workers speak english?
- *Positioning apparatus considerations:*
  - *Proximity to the trench hazard*
  - *Accessibility for later arriving specialty vehicles*
  - *Positioning for reducing Vibrations (300')*

Phase I (Assessment)

Once initial info is gathered the IC can initiates the decision-making process…

- Can the on-scene or responding units handle the rescue?
- If not, begin immediately requesting appropriate resources.
- Establish & announce command location

Phase I (Assessment)

- Establish Scene control;
  - Setting up (DANGER ZONES) hazard/ exclusion control zones ASAP
    - Hot
    - Warm
    - Cold

Phase I (Assessment)

- *Secondary Assessment* involves a closer evaluation of the scene to gather specific information about the trench characteristics, condition, and surcharge load.
  - Identify and document type of soil.
  - Condition of the trench
  - Type of cave-in
  - Type of shoring needed
  - Surrounding hazards
  - Isolate surrounding vibration sources.

Phase I (Assessment)

- *Secondary Assessment:*
- Mode of operation;
  - Rescue
  - Recovery
- The mode of operation will affect the development of the IAP.

Phase II Pre-Rescue Operations

Phase II (Pre-Rescue Operations)

- Begin developing and finalizing the Inicident Action Plan (IAP) with technical specialist, riggers, OSHA rep., Law Enforcement…
- *Document & Communicate & Update the IAP to all personnel.*
- Develop a back-up IAP.

Phase II (Pre-Rescue Operations)

- Conduct a SITSTAT & RESTAT
  - Situation status assessment
  - Resource status assessment.
  - Do the responding resources match the needs of my current and projected Incident Action Plan needs?
- Monitor atmosphere.
  - Create a Haz-Mat Group or branch w/supervisor
  - Document readings every 10 minutes
  - Haz-Mat group should ventilate the trench.
  - If ventilation is interrupted, evacuate trench.

Phase II (Pre-Rescue Operations)

- Mitigate other hazards.
  - Vibrations
    - Road traffic
    - Construction Equipment
    - Railroad
  - Utilities
    - Request representatives from utilities to respond
  - Storm Water
  - ***Support any exposed pipes (Utilities)***
    - Gas lines & Static Discharge

Phase II (Pre-Rescue Operations)

- Approach trench cautiously.
  - Look for fissures or cracks in trench lip
  - Place ground pads as your approach
  - Monitor surroundings and inside trench
  - Begin removing spoil pile surcharge
- Initiate shoring operations.
- Place ladders before any other operations so that a rescuer can self-extricate themselves.
  - *Should be within 25' but during rescues should be within rescuer's grasp in the work area.*

Phase III
Rescue Operations

Phase III (Rescue Operations)

- Implement personnel accountability system.
  - PAR Tags
  - Entry & egress control measures
- Only after initial shoring is in place, rescue operation can begin.
- *<u>After initial Sheeting & Shoring is in place…Begin backfilling behind sheeting…</u>*
  - May consist of freeing a partially buried victim and or physically removing soil to find a totally buried victim.

Phase IV Termination

Phase IV (Termination)

- Investigations initiated
  - Photos/video
  - Documentation of IAP
- Maintain accountability for personnel and equipment until the end of operations.
- Enforce PPE throughout termination.
- *ICS System should remain in place during termination phase.*
- *It is best to wait till morning to remove panels so they can be removed safely during daylight hours.*
- *If tools drop into the unprotected area rescuers should leave it and forget it.*

Phase IV (Termination)

- Dismantling of the shoring system.
  - This can be a very dangerous process if not done correctly.
  - *Swap out rescuers with fresh responders who are not fatigued.*
  - Safety brief rescuers often to avoid complacency.
  - Shoring system should be dismantled in reverse order of its construction.
  - *Personnel should always work within the safe zone*, just as they did during the construction phase.

Phase IV (Termination)

- Other issues to be addressed include
  - Investigating the cause of the incident
  - Releasing the scene back to those responsible
  - Providing psychological support via setting up a critical incident stress debriefing or defusing session.

Phase IV (Termination)

- *All equipment utilized should be inspected and serviced according to manufacturer's recommendations.*
- Conduct a critique and debrief the team on another date.

Scene Size-up

Size-up

- Initial size-up begins at the time of the alarm.
- Initial information is typically sketchy.
- Have the dispatcher to try to query the caller for additional information.

Size-up… *Things to ask?*

- What has happened? Who's in charge?
- What type of work was being done?
- Partial or complete burial?
- Trench collapse or other type of type emergency involving the trench?
- Will access to the site be a problem?
- What is the current & predicted weather?
- Where can I set up a staging area or *supply point of contro*l.

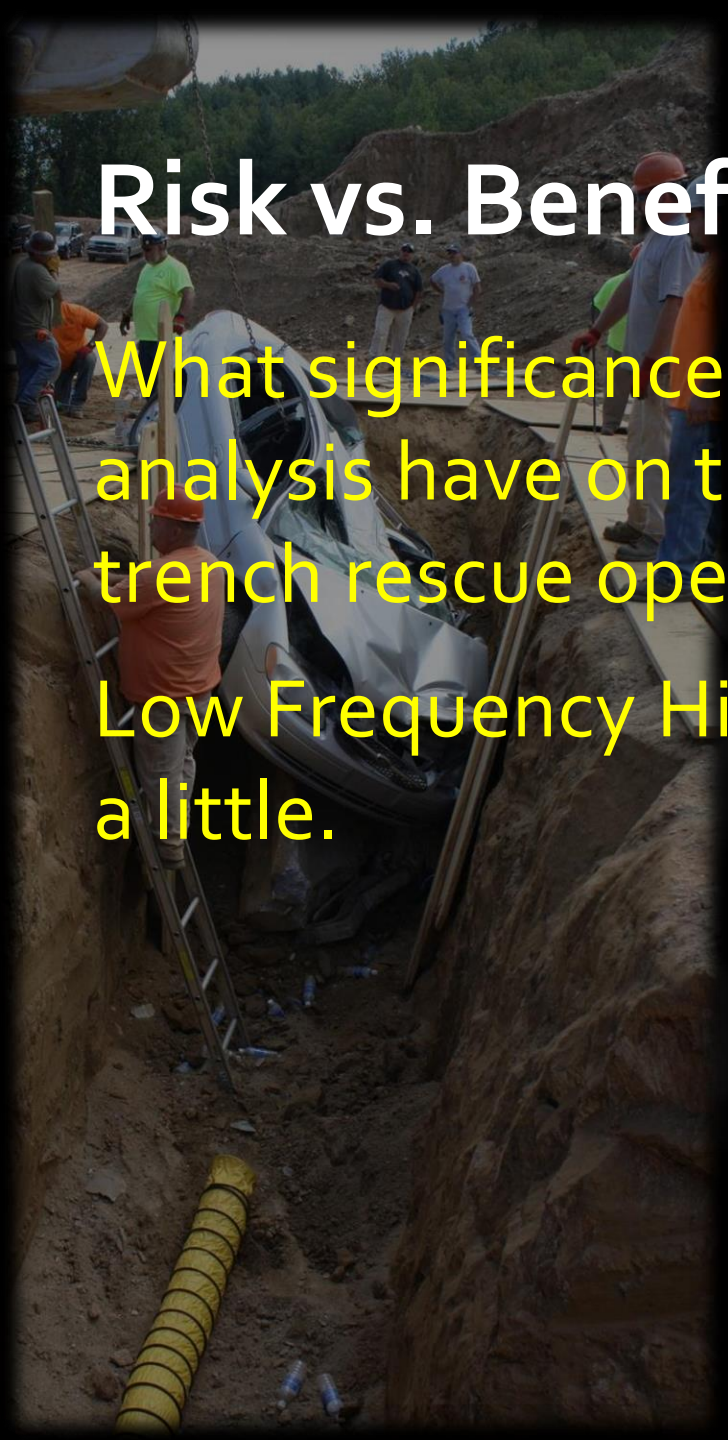
Size-up… *Primary Assessment*

- Who is in charge? Is everyone accounted for?
- How many victims? Their location?
- What has happened? What is likely to happen?
- Identify hazards to be mitigated.
- What current and future resource needs?
- Are responding resources sufficient?
- Establish scene control. (bystanders, vibrations, control zones…)

Size-up… *Secondary Assessment*

- Soil type. (A, B, or C?) Always shore for Type C!!!
- Condition of the trench?
- What type of cave-in?
- Single or multiple wall collapse?
- What type of shoring will be needed?
- What loads will have to be moved?
  - Spoil Pile
  - Equipment
- Are there hazards in and around the trench?
- Rescue or Recovery?

Risk vs. Benefit



Risk vs. Benefit

What significance does a risk/benefit analysis have on the success or failure of a trench rescue operation?

Low Frequency High Risk- Risk a lot to save a little.

Risk vs. Benefit

- Used to decide how much risk we are willing to assume in the performance of our duty?
- *Involves weighing all of the factors that deal with risk and compare them with all the factors that determine benefits.*
- *Can have a favorable outcome if the benefits heavily outweigh the risk*
- *If the risks appear to outweigh the benefits, there may be no advantage to continue the operation.*
- Purpose of conducting a risk/analysis is to prevent being put into a position that causes poor judgment calls resulting in catastrophic results.

Risk vs. Benefit

- Best two ways to reduce rescuer injuries and fatalities is through proper pre-planning and comprehensive training that will reduce problems.
  - Visit trench operation sites
  - Aware of rules and regulation pertaining to trench ops.
  - Developing a detailed response plan
  - Strategy & tactics
- Avoiding risk via identifying mode of ops. Rescue or recovery?

Risk vs. Benefit

- What is the risk to the rescuer?
- After addressing safety issues and neutralizing hazards… do rescuers stand a fair chance of succeeding without getting injured or killed?
- Is the risk to the rescuer proportional to the potential benefit of the attempted action?
- If questions arise regarding your judgement at this point in the operation, *you are getting ready to make a big mistake.*

Risk vs. Benefit

- What are the benefits to the situation?
- Can risks to the rescuer can be reduced and the benefit is a savable victim?
- No benefit in saving a dead person or their property if unnecessarily jeopardizes safety.
- 3 things that will enhance the potential for a successful operation.
  - Specialize people.
  - Specialized equipment.
  - Specialized training.

Incident Action Plans

Incident Action Plans

- An IAP is a battle plan
- Designed to establish goals and objectives based upon current & forecasted situation
- Is implemented to;
  - Provide A Safe & Stable Operation While Minimizing Risks.
  - Mitigate Hazards
  - Gain Access To Victims

Incident Action Plans

- Developed after a preliminary size-up.
- Should be simple, concise and flexible
- Hazards are identified
- Risk and benefits are addressed.
- Communicate IAP plan to on-scene personnel

Incident Action Plans

- Advised everyone when changes are made to the IAP.
- Develop a back up plan in the event something unforeseen occurs during the operations
- Provide a Rapid Intervention Team (RIT).

Collapse !!!

Common Types Of Trench Accidents

- Lip failure.
- Single wall/double wall slough-in. *(Most dangerous to rescuers at trench lip)*
- Single wall/double wall shear.
- Spoil pile collapse.
- Worker trapped by heavy equipment or pipe.
- Worker trapped by cave-in material.

Common Causes Of Trench Accidents

- Failure to follow safety rules.
- Working in previously disturbed soil.
- Careless or risky techniques
- Inadequate protective system.
- Absence of any protective systems.
- Complacency
- Cost /Time Savings Measures

Contributing Factors

- Narrow right of ways (*not enough room for spoil pile or other materials to be placed a safe distance from lip*).
- Vibrations (traffic, railways, nearby construction, equipment).
- Water seepage.
- Lack of sufficient moisture in trench walls
- Soil stratification (mixed soil layers).

Contributing Factors

- Rain, Melting Snow- excessive water.
- Changing Temperatures- affect stability of protective system.
- Heavy loads close to trench lips- increase pressure on trench walls.
- *Establish a vibration zone when necessary (recommend 300-500' radius).*
- *Deeper trenches create higher soil pressures*

Contributing Factors *(Water)*

- Water weighs 62.4 pounds per cubic foot.
- Contributes to a collapse since it can add tremendous weight to a total volume of soil.
- The absorption rate determines the total weight for any given volume of soil.
- The effect water has on the ability of the soil to maintain its strength when wet is critical.
- Beware of soil that looks solid but is actually wet and unstable.
- Soil that contains a high quantity of seeping water is considered saturated.

Contributing Factors
(Free-Standing Trench Dangers)

- Once a trench is cut, it is subjected to:
  - Changes in climatic hazards
    - Humidity
    - Storms
    - Temperature Fluctuations
    - Ground Frost
    - Wind
    - Dryness and water.

Contributing Factors

(Free-Standing Trench Dangers)

- Freestanding exposure time creates compressive forces of the exposed wall want to push the wall into the void.
- The longer the trench stays open without the support of a protective system, the greater risk for a collapse.

Contributing Factors

- Varying soil types *(layered compositions).*
- Multiple layers of soil have different friction coefficients *(cohesion)*
- Multiple layers make it difficult to establish a true soil classification.
- We ALWAYS construct for Type C Soil

Contributing Factors
(Heavy Equipment Hazards)

- On scene heavy equipment should not be used for dirt removal within the trench.
- Heavy equipment creates tremendous surcharge pressures along the trench lip and walls.
- *The deeper the trench; increases the lateral pressure and potential for collapse.*

Contributing Factors
(Heavy Equipment Hazards)

- Turn off equipment, give the keys to IC, leave the equipment in place.
  - Crib
  - Shore
  - Secure
  - Lockout/ Tagout

Contributing Factors
(Vibration Hazards)

- Operating equipment creates vibration hazards.
- *Create a vibration zone recommend 300 feet in any direction from the trench.*
- Any thing that is creating vibration within the vibration zone should be shut down or detoured.

Contributing Factors
(Vibration Hazards)

- Roadways
- Railroad
- Industrial Sites
- Construction sites
- Air traffic
- Emergency apparatus
- Responder movement
- Augers
- Drilling Equipment

Other Hazards

Man-made

- Lack of appropriate protective system.
- Spoil pile location
- Equipment location.
- Tripping hazards.

Electrical

- Control of electricity is best left to the electrical expert.
  - electrical pole
  - Cables
  - phone lines
  - transmission boxes.

Other Hazards

Chemical And Atmospheric Hazards

- Unearthed Drums Or Canisters.
- Gas For Saws, Cleaning Solvents For Pvc Pipe.
- Natural Gases:
  - Methane
  - Hydrogen Sulfide
- Provide Continuous Air Monitoring And Positive Pressure Ventilation During The Entire Operation.

Other Hazards (*Water)*

- Broken or sewer water main.
- Seeping or running water in the trench.
- Rain & storm water runoff
- Water must be evacuated from the trench and controlled as soon as possible.
- Consider digging run off drains or a canopy may have to be erected over the trench
- Dewatering & Well-Point Systems


Physical Forces &
Soil Pressures

There is a 500% increase in the likelihood of secondary cave-ins when one has already occurred within a trench.

With a cubic yard of earth weighing approximately 3,000 pounds, your rescue team needs protection!

Physical Forces

- 1 cubic foot of soil weighs approximately 100 pounds
  - Varies according to soil-moisture percentage content.
- 1 cubic foot equates to a 1'x 1' x 1'box of dirt.
- Dry soil is comprised of ½ soil and ½ air.
- Specific gravity of rock is 2.65 x heavier than water.
- Water weighing 62.4 pounds x 2.65, rock would weigh 113.88 pounds per cubic foot based on adding one half cubic foot of water (31.2 pounds pcf) and one half cubic foot of rock (82.68 pounds pcf).

Physical Forces

- *2'of average soil compressed on a victim's chest would weigh between 700 and 1000 pounds.*
- Normal soil weighing about 100 pounds pcf, a column of dirt 1' x 1' x 6' tall would have a total force of 600 pounds per square foot at the bottom.
- The amount of lateral force exerted on an unshored wall is about 33% of the total forces as measured on the bottom of any cubic foot.

Physical Forces

- The force at the four-foot level of a six-foot deep trench would be 400 pounds psf of vertical pressure; the lateral force would be about 132 pounds per square foot.
- Proper sheeting (panels) and shoring transmits the pressure of one side of the trench to the earth on the other side of the trench thus stabilizing the trench walls.

Collapses

Spoil Pile Collapses

- Spoil is dirt that has been excavated from the trench and placed somewhere at ground level near lip of trench.
- Collapse largely as the result of excavator operator negligence.
  - Placing dirt at the edge of the trench lip to expedite putting it back in the hole after the job is done.
  - Striking spoil pile with bucket
  - Surcharge of spoil pile
  - Spoil pile is too high and the angle repose is too steep

Spoil Pile Collapses

- The height of the spoil pile located on the edge becomes part of the overall depth of the trench on the spoil pile side collapse.
- *OSHA requires the spoil pile to be placed a minimum of 2 feet away from the lip of the trench*
- The angle of the pile cannot impose a threat of sliding into the trench.

Slough Failure

- The loss of a section of the trench wall.
- *Most dangerous to those responders at lip of trench.*
- The force associated with unconfined hydrostatic (water) pressure becomes greater than the soil's ability to stand.
- Can also occur as the result of excess surcharge bearing downward against the wall.
- Key Indicators:
  - Cracks along the trench walls
  - Cracks along the trench lip
  - Multiple layers of soil

Shear Wall Failure

- Occurs when a section of soil loses its ability to stand and collapses into the trench along a vertical plane.
- Caused by cracks exposed to weather over an extended period.
- As the cracks are exposed to the cycle of water and then drying out, the cracks get larger and deeper until the trench wall is no longer self-supporting.

Toe Failure

- A slough failure occurring at the bottom of the trench.
- As the soil falls into the trench it creates a void along the trench wall at floor level.
- It can be caused by a sand pocket or water seeping in at the bottom of the trench.

Rotational Failure

- Also known as “lip failure”.
- Crescent shaped starting back away from the lip and characteristically collapses in a half moon shape.
- Creates difficult challenges when designing protective systems

Wedge Failure

- Normally occurs with intersecting trenches.
- An angled section of earth will fall from the corner of an intersecting trench.
- Failure can be sudden and catastrophic.

Tension Cracks (Fissures)

- How are they caused?
  - Climatic changes
  - Expansion & Contraction
  - Moisture Content
  - Soil Type
  - Constantly evaluate
    - Identify, note time
    - Spray Paint
    - Time Increments

Soil Types

Stable Rock

- Is naturally solid and can remain standing after excavation.
- It is usually identified by a rock name such as granite or sandstone.
- Determining whether a deposit is of this type may be difficult unless it is known whether cracks exist and whether or not the cracks run into or away from the excavation

Type A Soil

- Soils that are cohesive materials with an unconfined compressive strength of 1.5 tons per square foot.
  - Examples include: clay, silty clay,clay loam, and sandy clay loam.
- Cannot be considered Type A if it is:
  - Fissured
  - Subject to vibration
  - Previously disturbed soil
  - Soil that is part of a sloped soil layer that is greater than 4 horizontal to 1 vertical.

Type B soil

- Soils that are cohesive materials with an unconfined compressive strength greater than 0.5 but less than 1.5 tons per square foot.
- Examples include:
  - Angular gravel
  - Silt
  - Silty loam
  - Sandy loam
  - Sandy clay loam.

Type C Soil

- *Soils that are cohesive materials with an unconfined compressive strength of. 0.5 tons per square foot or less.*
- Examples include:
  - Granular soil
  - Sand
  - Sandy loam
  - Submerged soil
  - Soil from which water is flowing or submerged unstable rock.
- *Correct slope for this type of soil is 34 degrees.*

Type C-6o Soil

- Created by *Speed Shore company* adopted by OSHA for soils that are moist and cohesive or mist dense granular soils that do not fit into Type A or B and is not flowing or submerged.
- Can be cut with near vertical walls and will stand unsupported long enough to allow shoring to be installed.

Soil Tests

POCKET PENETROMETER

Penetrometers are direct-reading, spring-operated instruments used to determine the unconfined compressive strength of saturated cohesive soils. Once pushed into the soil, an indicator sleeve displays the reading.

Visual Test

- Visualize the spoil pile dirt, fine grain dirt that remains in clumps is said to be cohesive.
- Examine trench walls for signs of layered soils, and indications of pre-disturbed soil
  - presence of underground utilities.
- Look for fissures on the trench wall and at ground level running away from the trench lip.
- Any standing, seeping, or running water?
- Relationship of soil types and slope

Visual Test

- Is a qualitative evaluation of conditions around the site.
- Assess entire excavation site, including soil adjacent to the site and the soil being excavated.
- If the soil remains in clumps, it is cohesive; if it appears to be coarse-grained sand or gravel, it is considered granular.
- The evaluator also checks for any signs of vibration.

Visual Test

- Look for signs of:
  - Bulging
  - Boiling
  - Sluffing
  - Surcharging and the spoil distance
  - Signs of surface water seeping from the sides of the excavation or from the water table
- In addition, the area adjacent to the excavation should be checked for signs of foundations or other intrusions into the failure zone.

Visual Test

- Evaluator should check for crack-line openings along the failure zone that would indicate tension cracks, look for existing utilities that indicate that the soil has previously been disturbed, and observe the open side of the excavation for indications of layered geologic structuring.

Plasticity Test

- Accomplished by molding a moist wet sample into a ball
- *Rolling it into a thread as thin as 1/8 inch diameter, and holding onto one end without it tearing.*
- *If a 2-inch long thread rolled 1/8" diameter can withstand tearing it is said to be cohesive.*

Ribbon Test

- Determines how much clay or silt the soil contains.
- Roll fine soil and fine sand between the palms of the hand forming a cylinder 6 inches long ¾ inch diameter.
- Lay the cylinder across one palm and using your thumb and forefinger press the cylinder to 1/8 inch flat.
- Hang the squeezed portion over the side of the hand.
- If the cylinder forms 6 or more ribbon sections in length the soil is said to be clay, less than 6 sections of ribbons the soil is said to contain silt.

Thumb Penetration Test

- Involves an attempt to press the thumb firmly into the soil in question.
- If the thumb makes an indentation in the soil only with great difficulty, the soil is probably Type A.
- If the thumb penetrates no further than the length of the thumb nail, it is probably Type B soil.
- If the thumb penetrates the full length of the thumb, it is Type C soil.
- The thumb test is subjective and is therefore the least accurate of the three methods.

Classifying the soil should be done regardless if the contractor will slope the excavation or not.

OSHA Confined Space Rules

- Large enough and configured for employee occupancy.
- Has limited means of egress.
- Not designed for continuous employee occupancy.
- Has an actual or potential hazardous atmosphere.
- May contain material that can engulf an entrant.
- Has an internal configuration that could trap or
- asphyxiate the entrant.
- Any other recognized serious safety hazard.

Responding to the Trench Collapse

Mantua Township, NJ Trench Collapse

Take Command !!!

Role Of Command

- Fixes responsibility of command on a specific person
- Ensures that a strong direct and visible command will be established from the
- Establishes an effective organization defining the objectives
- Provides a way to process information to support incident planning and decision-making.
- Provides a system for orderly transfer to arriving officers.
- NFPA 1561, defines the roles, responsibilities, and standard operating guidelines used to manage emergency operations.

Responsibilities of Command

- Establish Command on arrival with verbal size-up
- Remove endangered occupants and treat the injured.
- Provide for life safety and stabilize the incident.
- Conserve property and evidence.
- Provide for the safety, accountability, and welfare
- of personnel throughout the incident.
- Establish safety control zones that rescuers will work in.

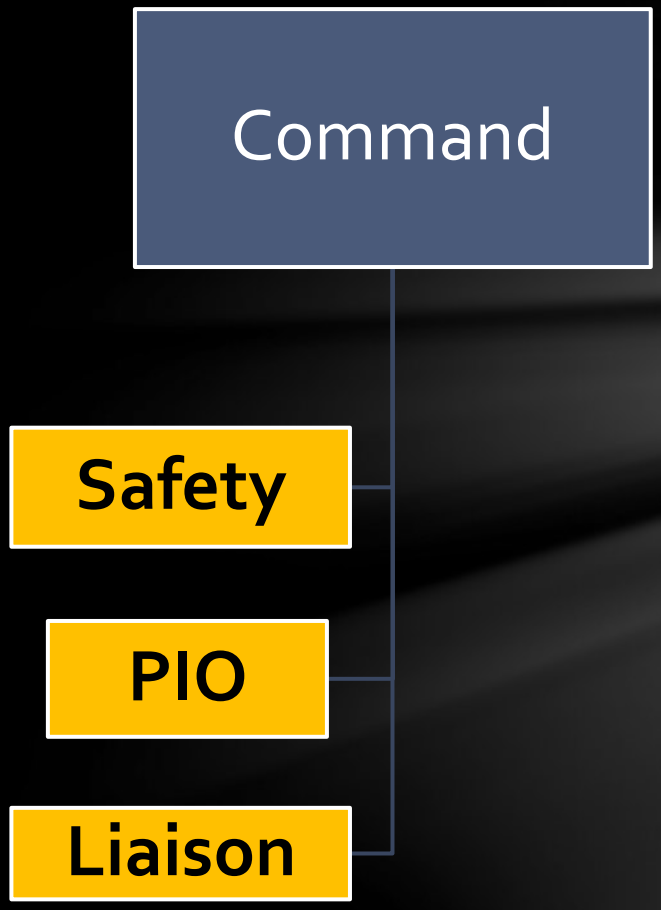
Responsibilities of Command

- Functions of Command
- Assumes and announce location of Command
- Rapid size-up
- Sets the goals & strategy of the incident
- Develops & updates IAP, initiates accountability
- Provide for the continuity, transfer, and termination of Command.

Unified Command

- Team concept;
- Incorporates all agencies having geographical, functional, or statutory responsibility for an incident to establish a common set of incident objectives and strategies.
- This accomplished without giving up agency authority, responsibility or accountability.

Command Staff



Command Staff

Safety Officer:

- Identifies, mitigates, and corrects unsafe acts.
- Must have a working knowledge of trench rescue, confined space, rope rescue, OSHA standards.
- Has full authority to halt any unsafe operation.

Command Staff

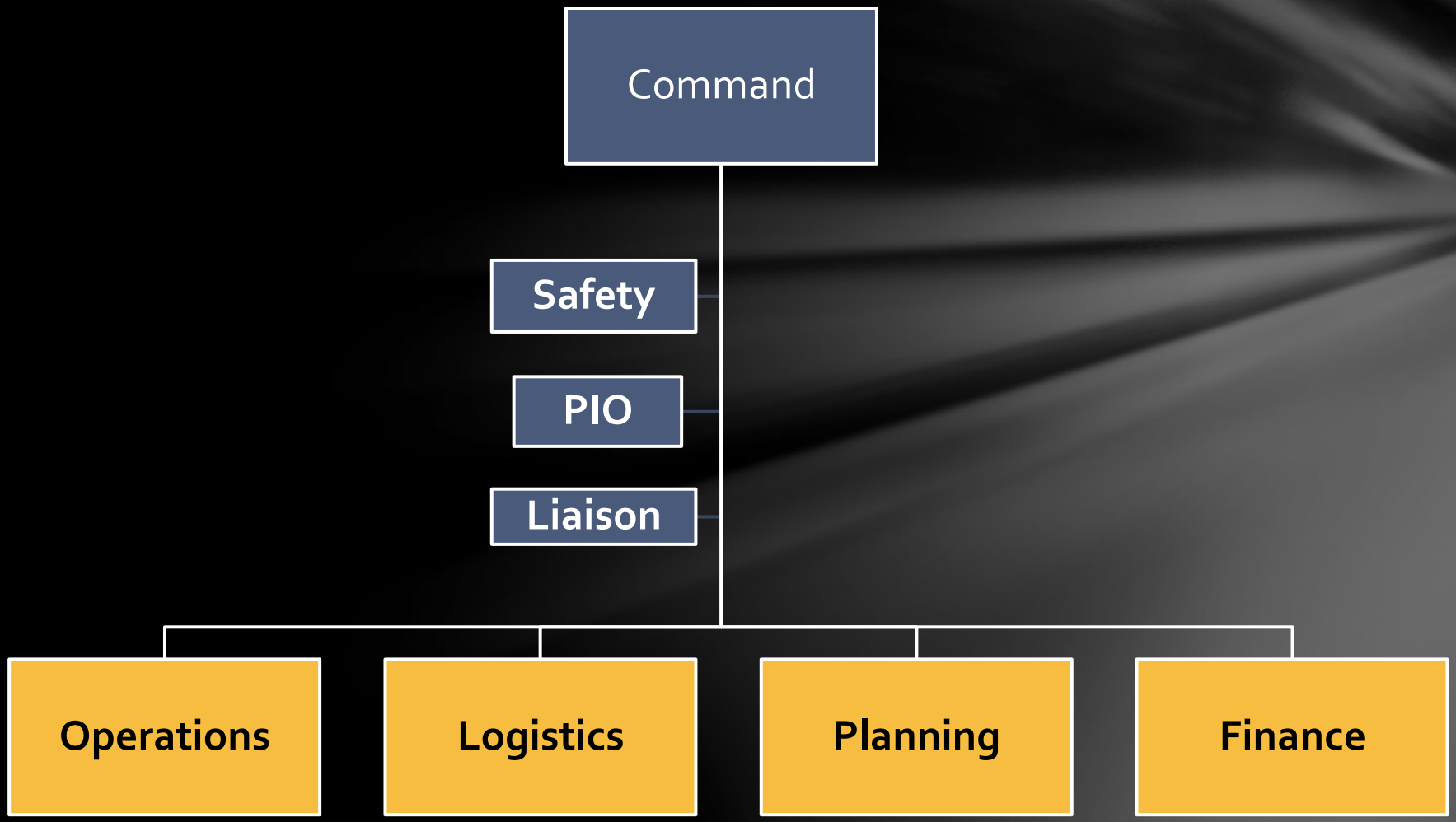
Liaison Officer:

- Communicates critical inter-agency information to & from all responding agencies.
- May interact with:
  - PD, EMS, utilities, Red Cross, & OSHA

Command Staff

- Public Information Officer:
- Responsible for communications with the media on the incident progress and educates the media on rescue methods.
- Only releases information ordered by command.
- Coordinates a media area, press releases, news conferences…

General Staff



Command Staff

Operations Section Chief:

- Responsible for overall coordination of the rescue effort.
- Directs tactical operations through divisions and groups
  - Extrication Group
  - Rescue Group
  - Medical Group
  - Haz-Mat Group

Staging Area works under Ops. Section chief

Command Staff

Logistics Section Chief:

- Procures equipment and personnel requested by the Operations or Command.
- Responsible for:
  - Rehab.
  - Ordering & maintaining adequate resources to handle additional any requests for equipment and specialized manpower.
  - Maintains and tracks inventory of all equipment
- Service Branch:
- Management of all service activities & supervises Communications, Medical, and Food Units.
- Support Branch:
  - Supply, Facilities and Ground Support Units.

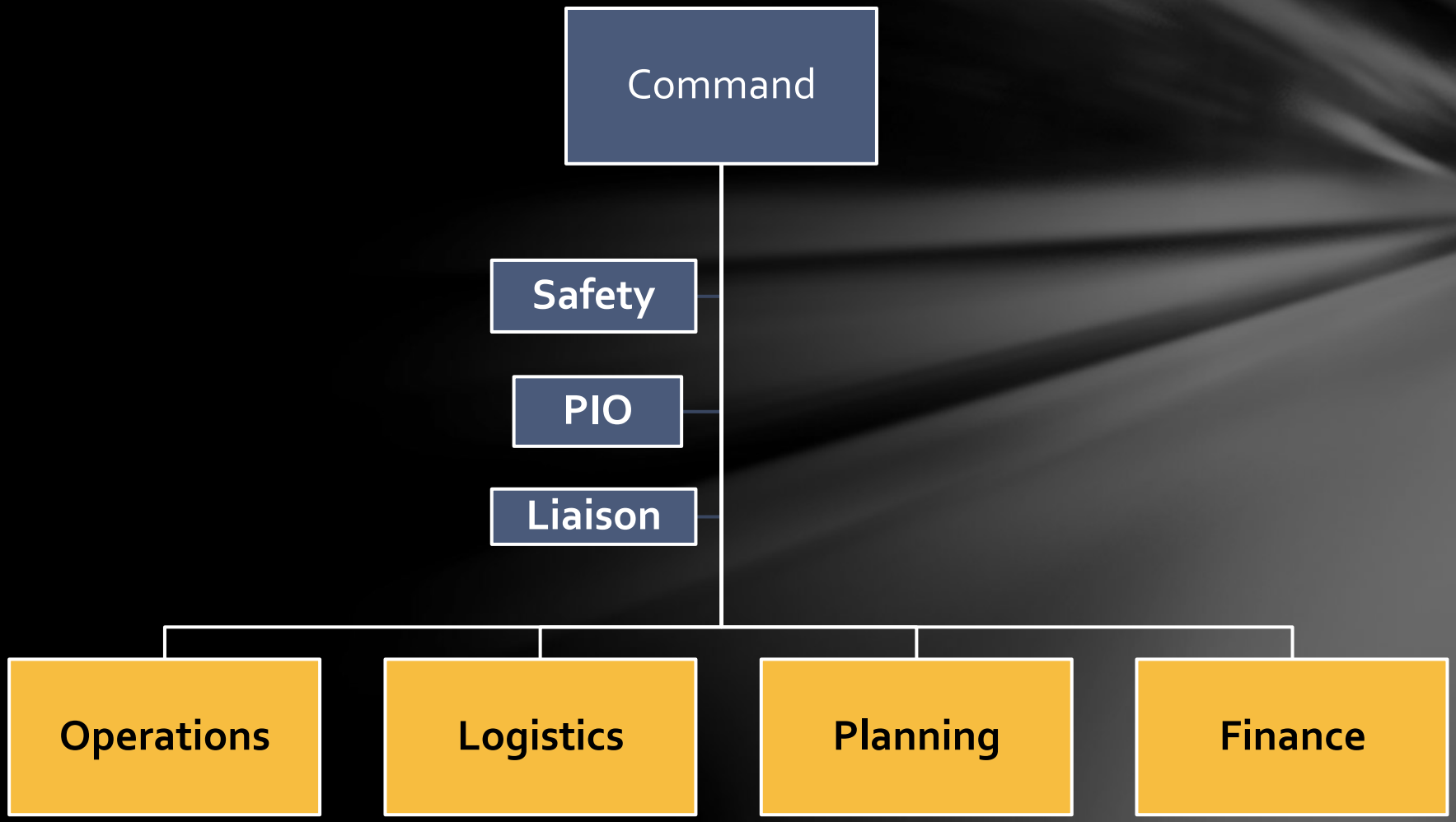
Command Staff

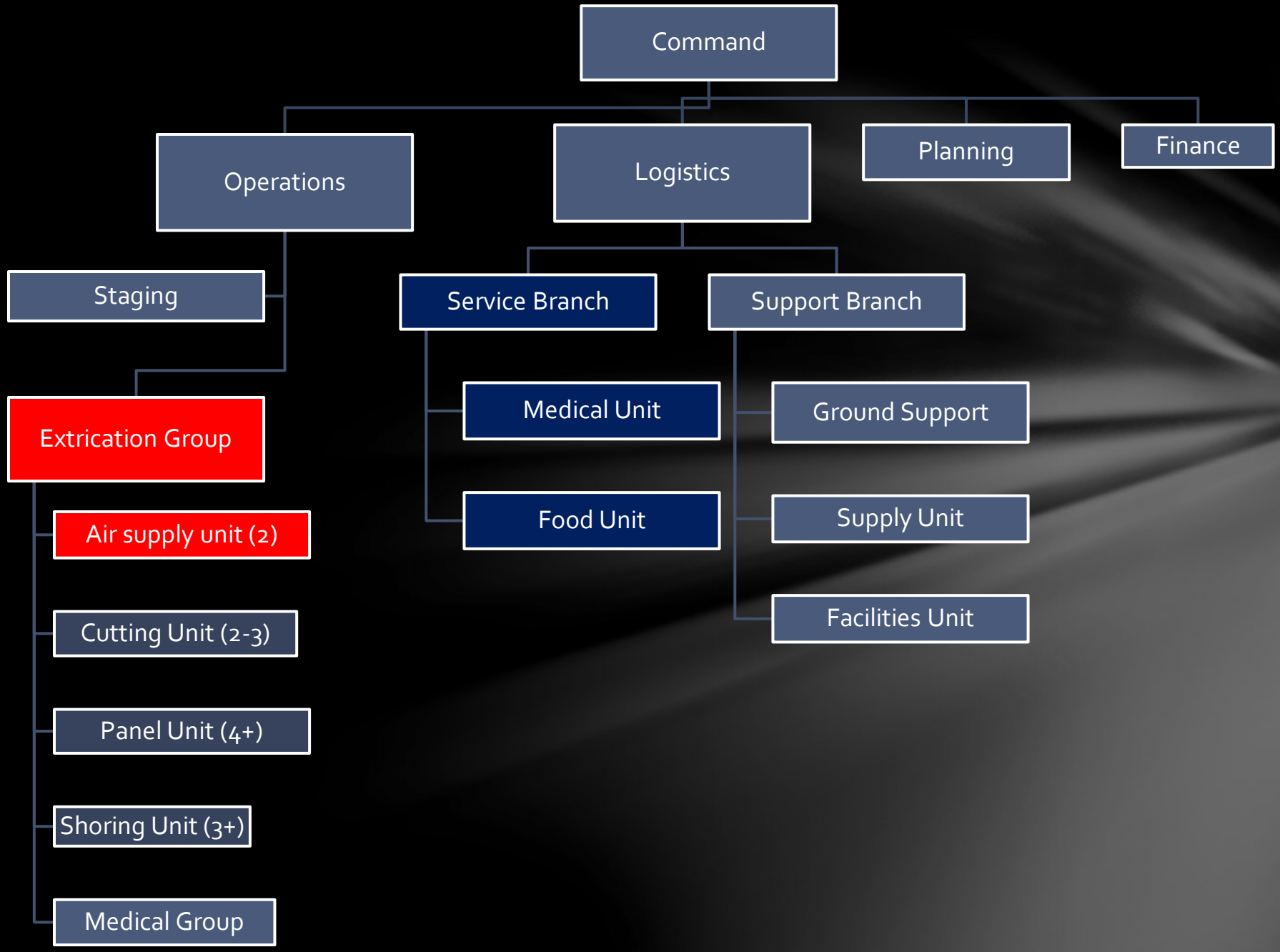
- Finance Section Chief:
  - Tracks cost of supplies, equipment, rentals, receipts, other financial matters.
  - Documents costs
  - Reimbursement

Command Staff

- Planning Section Chief:
- Responsible for assessment of the current & forecasted IAP and projects the situation and resource status needs.
- Forecasts future strategies & needs based upon soil changes, weather forecasts, resource availability….

General Staff

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Support Branch
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Medical Unit
Ground Support
Food Unit
Supply Unit
Facilities Unit
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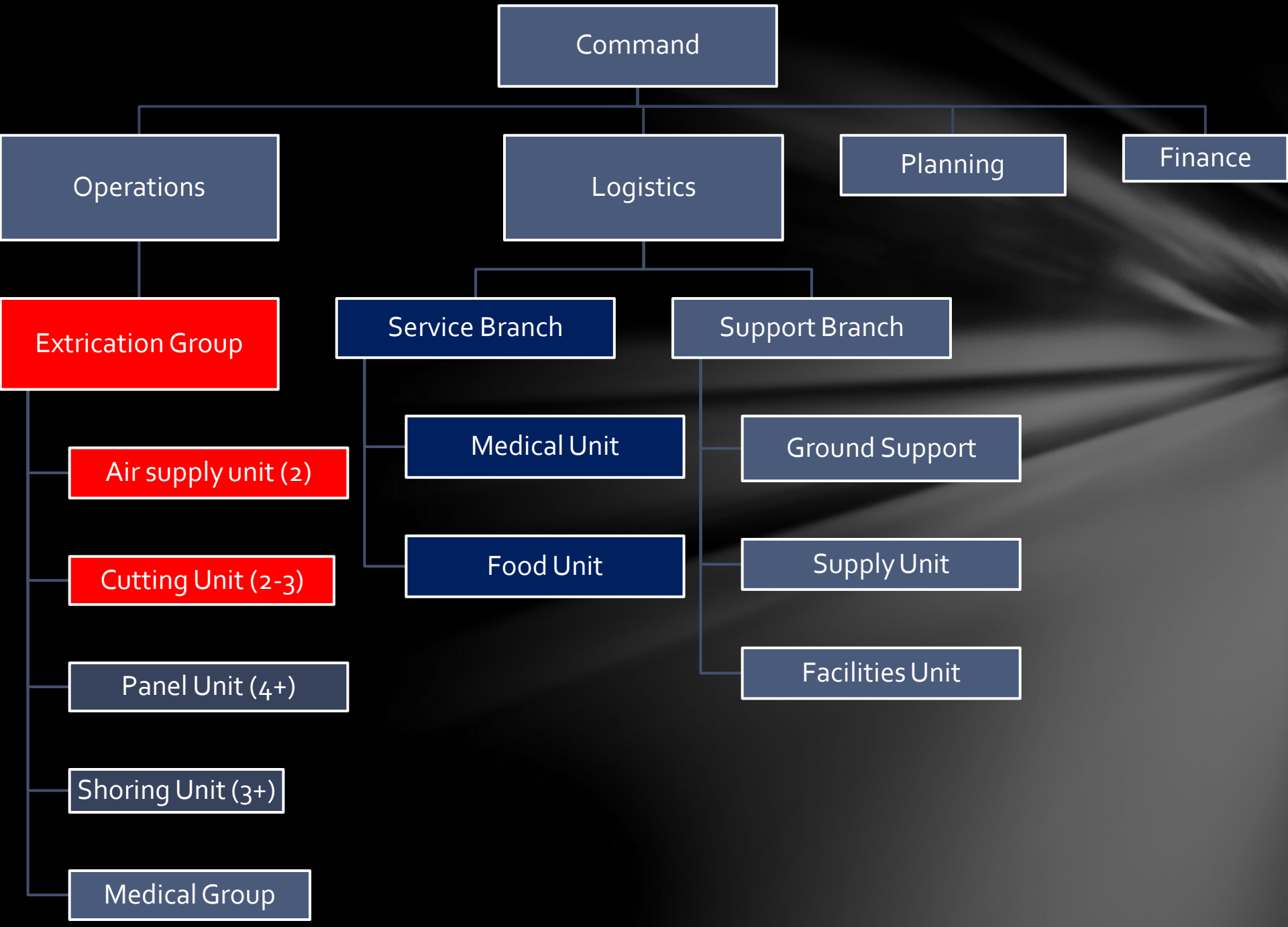
Cutting Unit (2-3)
Panel Unit (4+)
Shoring Unit (3+)
Medical Group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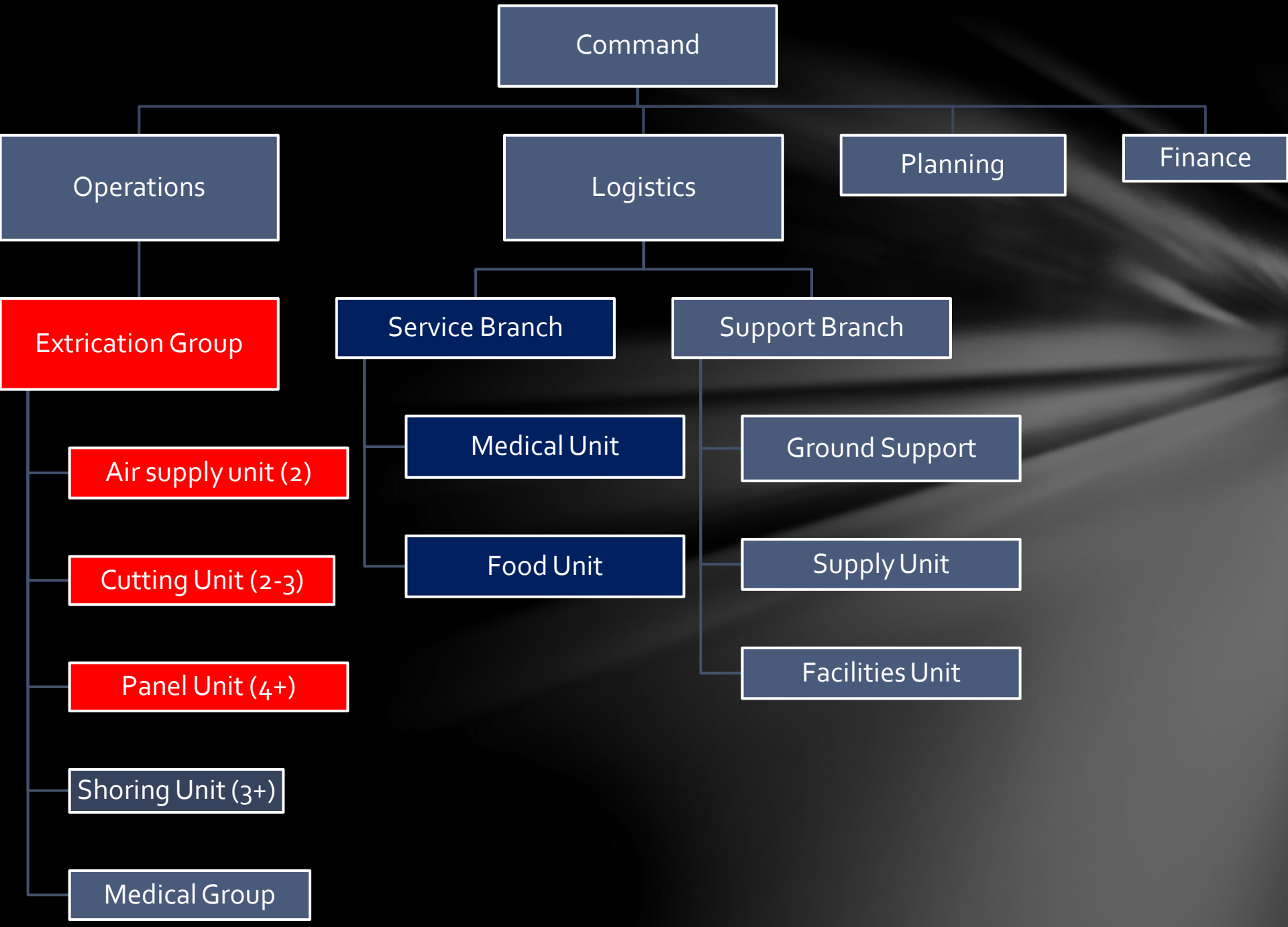
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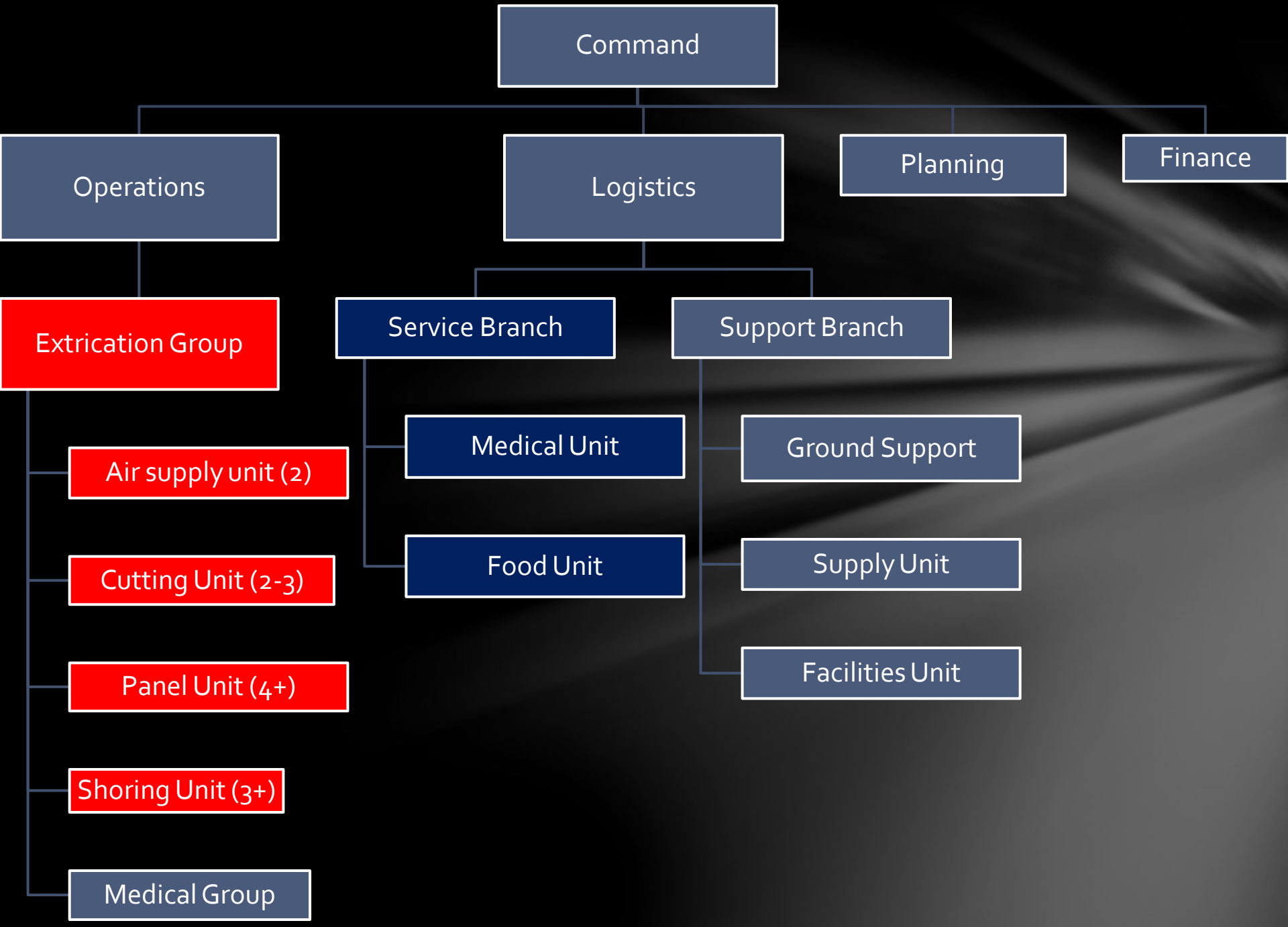
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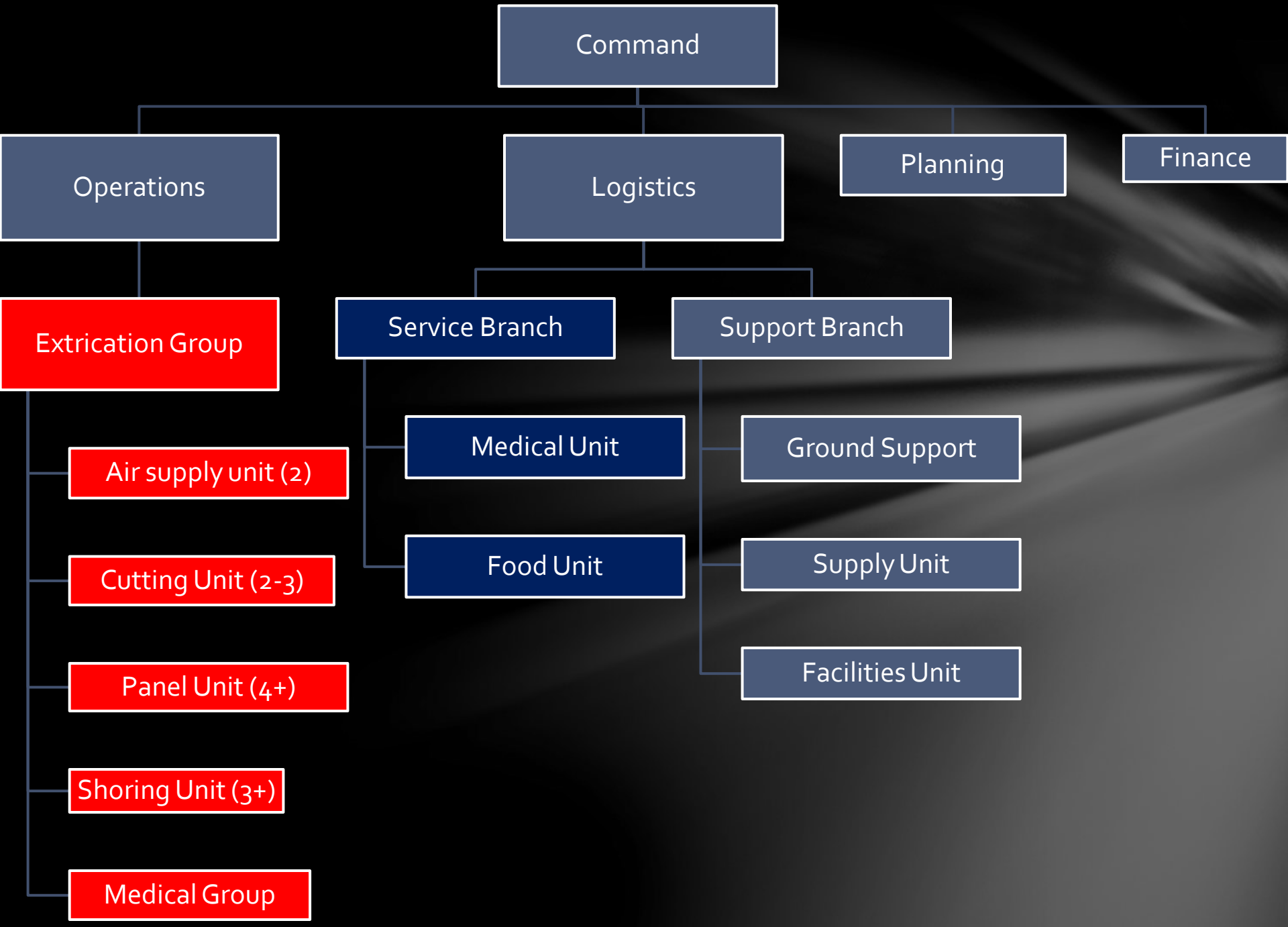
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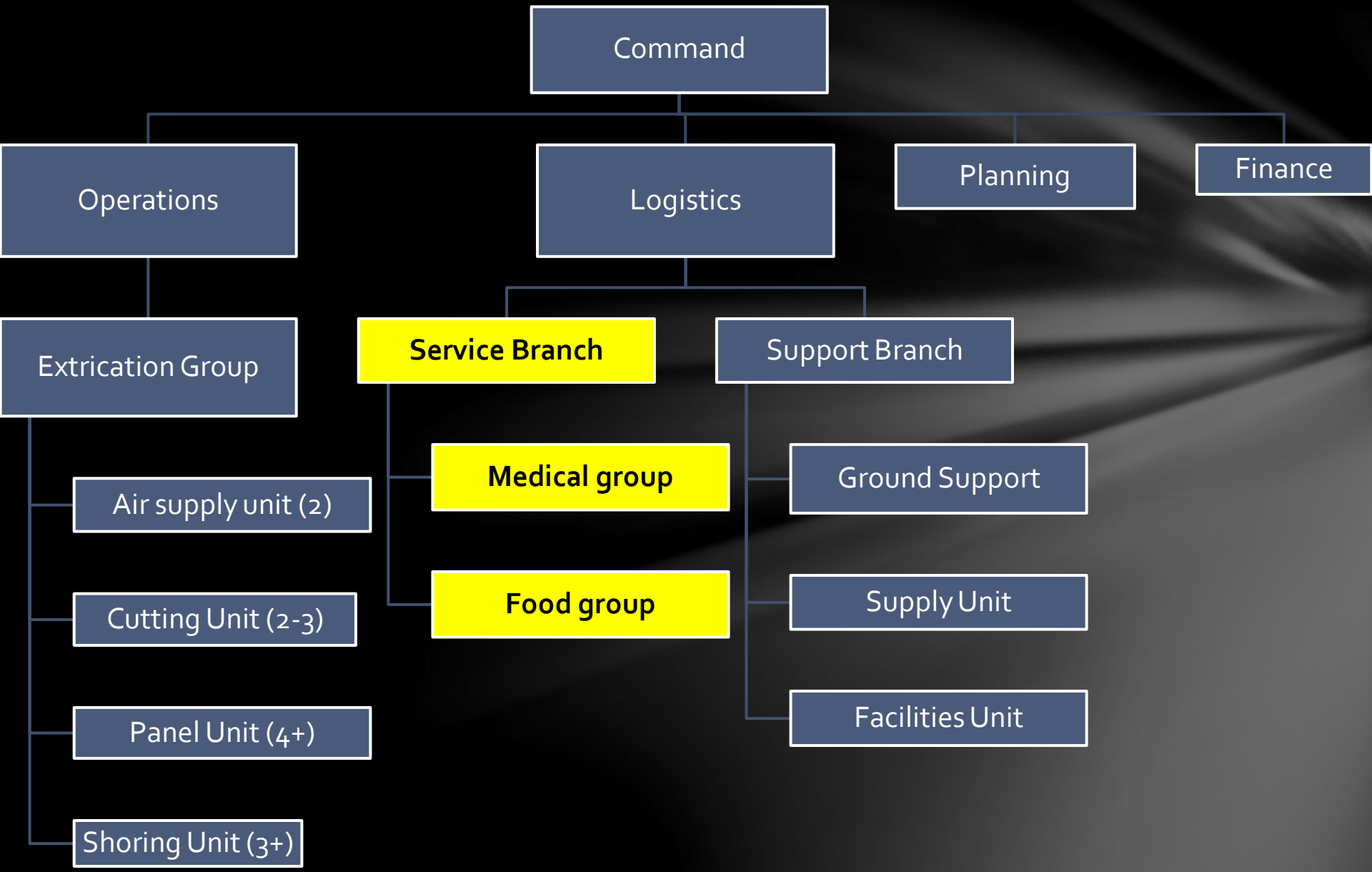
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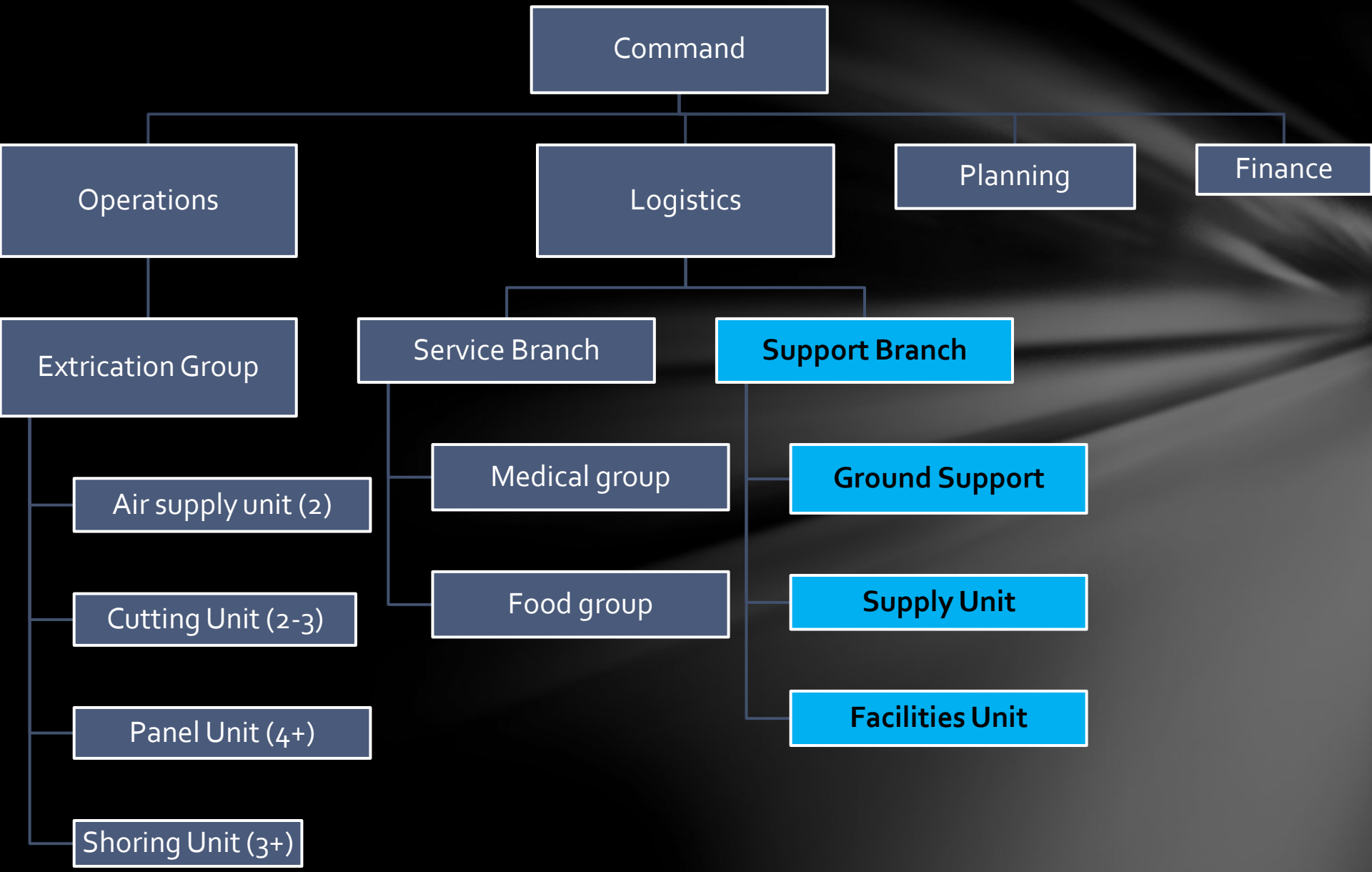
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Establish Control Zones

Control Zones

- **Hot Zone**- Area where the rescue takes place.
  - Allow only rescuers directly in the rescue or recovery are allowed in this zone.
  - One way in and one way out for accountability
- **Warm Zone**- adjacent to the hot zone and designated for support operations for rescuers in the Hot Zone.
- **Cold Zone**- outside the Warm Zone where the Command Staff, Logistics, Staging, Media, and family members will be staged.

Control Zones

- **Vibration Zone**- extends from the Hot Zone out to any distance that may encounter ground vibrations that may effect the stability of the trench
- Consider detours or stopping operation causing the vibration
- *A minimum of 300 feet is recommended initially but can be extended.*

Control Zones

- **Danger Zone**- The area surrounding an accident site that is proportional to the severity of the on the- scene hazard.
- **Rescue Area**- This should be an area directly around the rescue site.
  - 50 feet in all directions.
- **Safe Zone**- Area within the trench that is protected by a shoring system.

Equipment

Determining Equipment Resource Needs

- What is the scope of the problem?
  - Conduct a visual inspection of the spoil pile & trench walls for cohesiveness
  - Identify the depth & width
    - *OSHA requires that any trench with a depth of 5 feet or greater must have a protective system installed prior to workers entering the trench.*
      - **IFSTA manual that states 4 for Awareness/Ops.; 5' for Technician**
    - ***OSHA 1926.652(a) requires 5 feet as the starting point for the installation of a protective system*.**

Determining Equipment Resource Needs

- What is the scope of the problem?
  - If there is an existing or potential for a hazardous atmosphere in the trench protective shoring should be installed if the trench is 4 feet deep or greater.
  - Identify the type of collapse
  - Did the collapse involve more than one wall?
  - Will the surcharge loads need to be moved?
  - Is there water or exposed utilities within the trench?

Determining Equipment Resource Needs

- What type of shoring system will be need to be erected
- Timber, hydraulic, pneumatic shoring or sloping or benching?
- Consider the dimension of the material and spacing requirements for each of the soil classifications are found on tabulated data sheets in the OSHA standard 1926 Subpart Appendix C and D.
- *OSHA Tabulated Data sheet rates timber, pneumatic, and hydraulic shoring systems to a maximum depth of 20 feet.*
- *Depths greater than 20 feet require a Registered Professional Engineer (RPE) to design a protective shoring system*, along with, materials strong enough to support such pressures.

Determining Equipment Resource Needs

- Refer to manufacture's tabulated data sheet for proper installation if using commercial shoring equipment or trench boxes.
- *Based on the dimensions of the shoring panels, rescue teams can safely shore a trench to a maximum depth of approximately 15 feet before supplemental shoring has to be considered and an RPE should be consulted.*
- Recovery operation & Pt. location has been determined.
  - Consider the use of heavy equipment to slope the trench to an a safe depth & angle allowing rescuers to safely enter the trench for recovery.

How Deep is this Trench? Any other concerns?


BJM
PUMPS
DEWALT
DEWALT
JET


SPECIAL OPERATIONS
5-2-4

Equipment Needs

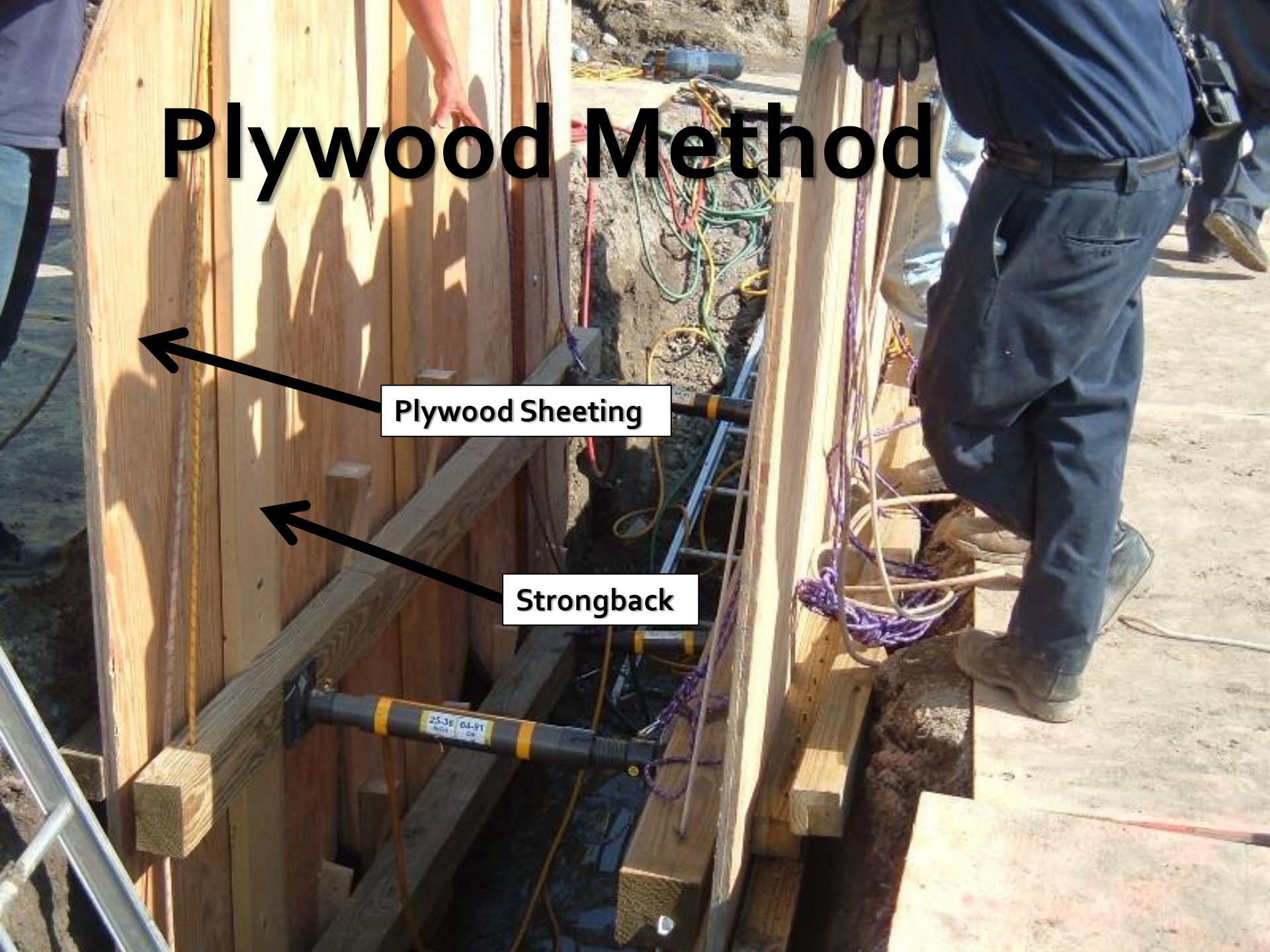
Quantity	Item
	Sheeting & Shoring Materials
6	**Cans Marking Paint** *(orange & yellow)*
8	**4' x 8' Ground Pads** *(minimum 3/4" plywood)*
8-12	**Shoring Panels** *(Arctic Birch may be used as rated by the manufacturer and/or OSHA; or if using plywood it must be a minimum of 1 1/8 glued and screwed together)*
16	**2" x 12" x 12' uprights** – *Preferred Yellow Pine or Douglas Fir*
4	**8" x 8" x 12'** – *Preferred Yellow Pine of Douglas Fir*
6	**6" x 6" x 12'** – *Preferred Yellow Pine or Douglas Fir*
8	**4" x 6" x 12'** – *Preferred Yellow Pine or Douglas Fir*
8	**2" x 4" x 8' Stub Grade** – *Preferred Yellow Pine or Douglas Fir*
24	**4" x 4" x 12'** – *Preferred Yellow Pine or Douglas Fir*
20	**4" x 4" x 18" Wedges**
80	**2" X 4" X 6"**
20	**2"X4" wedges**
4	**Swivels 15-20 degrees for air shores or screws jacks**
20	**2" diameter Steel pipe (cut to lengths)**
1	**Air Supply Cart w/attachments (hoses, gauges & regulators)if using Pneumatic Struts**
25	**25 Pneumatic Struts, Screw Jacks, and/or Timbers (17"-120") Air or Paratec pneumatic shore kit (25 struts)**
10	**SCBA bottles or Cascade air system**
	Fuel Powered Equipment
2	**OSHA Compliant Safety Fuel Cans**
1	**5 gallon gasoline can**
1	**Trash Pump - 80 GPM minimum w/3" inlet**
2	**Chain Saw with Spare Chain**
2	**Pair Chainsaw Chaps**
2	**4KW Portable Generators**
1	**Vacuum truck**
	Power Tools
1	**10 1/4" Circular Saw with extra blades**
1	**7 1/4 circular saw**
1	**Reciprocating saw (battery or elec)**
1	**Water Pump - 60 GPM minimum (May Be Submersible)**
	Hand Tools & Equipment
12	**5 gal Buckets**
6	**Framing Hammers 22 oz.**
4	**Folding Shovels (Military Type)**
2	**Shovels, Long Handle**

Sheeting & Shoring Materials

Trench Sheeting Panels *(plywood)*

- *When constructing panels using plywood the recommended grade is CDX and the required thickness is 1 and 1/8 inch per OSHA guidelines.*
- Can be accomplished by gluing and screwing
- Two (2) 5/8" or ¾" thick 4' x 8' sheets of plywood together.
- Provides for a thickness of 1 ¼" or 1½" panel.
- Improve durability by water proofing them and apply several coats of polyurethane.
- Prefabricated sheeting assemblies should be stored vertically and on their edges.

Plywood Method




TOWNSHIP OF SPRING
FIRE
DEPARTMENT
85

Trench Sheeting Panels *(Shor-form/Finn form)*

- Panels are made from Artic Birch *(exterior)* Nordic White Birch *(Interior)*
- One of the strongest hardwoods available
- Non-conductive and extremely strong.

Trench Sheeting Panels *(Shor-form/Finn form)*

- Tested to a 40-hour boil test without deformation.
- Panels are available in 4’ x 8’ sheets in;
  - ¾” (14 ply)
  - 1” (17 ply) (Rescue Use)
  - 1¼” (21 ply) (Rescue Use)

Trench Sheeting Panels

(Shor-form/Finn form)

- Attachment for strongbacks are identical for plywood & Finn-Form.
- Cut four ¾" holes in the corner panels to accommodate 7/16" ropes (*at least twice the depth of the trench*) for lowering panels into trench.*(should be secured at the bottom of the panel for control)*
- Cut a 45^{O} angle on each corner of the panels and the strongbacks to eliminate sharp edges.


O.R.F.D.
O.R.F.D.

Strongbacks or Uprights

- *"Strongbacks" are 2" x 12" x 12' long boards that are attached to the center line of the panels with 2 feet of the strongback extending from the top and bottom of the panel.*
- You can nail these strongbacks to the panels but it is recommended to bolt them using 3 ½ inch to ¾ inch carriage bolts and washers.

Strongbacks

- Act as bearing plates for all struts or cross-bracing.
- Lumber used in trench rescue should be Kiln dried with a moisture content of 20% or less and can be stored indefinitely due to the low moisture content.
- Question? Where can you get these materials on short notice? Or after hours? And assembled within an hour? Pre-planning is a must!

Screw Jacks

Screw Jacks

- Timber Screws & Pipe Screws
- Consist of a boot end that placed on one end of the timber or pipe and a threaded yoke assembly for tightening that is placed on the opposite end.
- Schedule 80 pipe, 2" in diameter, or timber must be cut on site to custom size of trench.
- Utilized for trenches 5'-7'
- Not designed to span large distances,
- Follow the manufacture's tabulated data for usage.

Hydraulic Shores

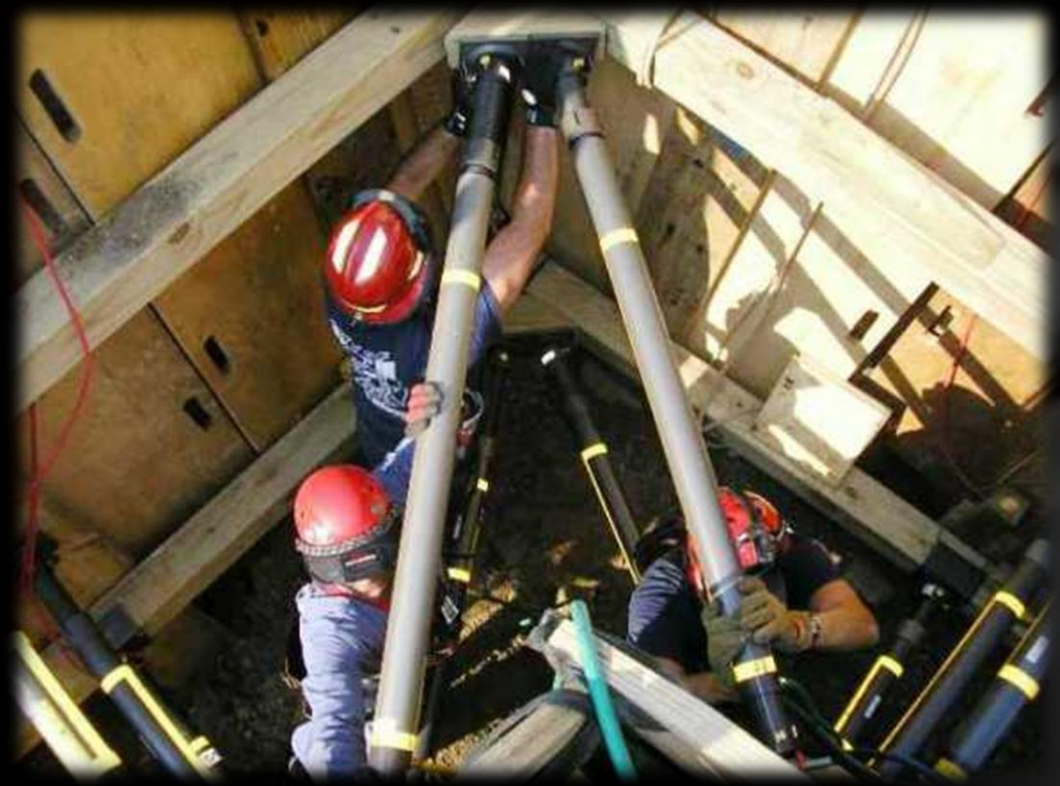
Hydraulic Shores *(Speed-Shore)*

- A pre-fabricated shoring system designed to be quickly deployed and taken down.
- Stored in the collapsed position and deployed as one unit after being is lowered into the trench.
- Expands using a 5-gallon reservoir of nonflammable and bio-degradable fluid.
- Uses a stopcock valve to maintain pressure.
- Does not work well when trench walls are not plum or vertical.

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)		
	VERTICAL SPACING (FEET)	SECTION MODULUS (IN^3)	UP TO 8		OVER 8 UP TO 12		OVER 12 UP TO 15		SOLID SHEET	2 FT.	3 FT.
			HORIZ. SPACING	CYLINDER DIAMETER	HORIZ. SPACING	CYLINDER DIAMETER	HORIZ. SPACING	CYLINDER DIAMETER			
OVER 5 UP TO 10		3.5	6.0	2 IN	6.0	2 IN NOTE(2)	6.0	3 IN	3x12	—	—
		7.0	6.5	2 IN	6.5	2 IN NOTE(2)	6.5	3 IN			
		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	3x12	—	—
		7.0	5.5	3 IN	5.5	3 IN	5.5	3 IN			
		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	3x12	—	—
		7.0	5.0	3 IN	5.0	3 IN	5.0	3 IN			
		14.0	6.0	3 IN	6.0	3 IN	6.0	3 IN			
OVER 20	NOTE (1)										

Pneumatic Shores



Pneumatic Shoring Attachments

Pneumatic Shores

- Air Shore and Paratech manufacture these air/gas operated devices.
- Can be operated using air, nitrogen, even CO_2.
- Constructed of lightweight tubular aluminum.
- Vary in lengths from 3'-12' with a variety of extensions, 150 swivels, whalers, and base plate attachments.
- The shore is extended by using compressed air at pressures recommended by the manufacturer.
- *Operating pressures ranges from 100 psi to 350 psi.*
- *The lateral force exerted by the pneumatic shores will vary from 400 pounds to 700 pounds.*

Always follow the specific manufacture's tabulated data sheets for correct installation of all shoring systems.

Assembly Of The Shores

- The disadvantage of the pneumatic shore is the considerable number of shores needed for the cache and the cost.

Other Equipment

- Gas Saws
  - Chainsaws best suited for cutting heavy timbers quickly
  - Starting procedures
    - Before using saw check fuel mix, bar oil, chain tightness, and the status of the chain brake.
    - Wear OSHA approved chaps, hearing protection, and eye protection when operating the chainsaw.
    - Field maintenance procedures for chains, spark plugs, and filters.
    - Be aware of noise near scene

Other Equipment

Atmospheric monitors & guidelines.

- Selection of an appropriate monitor.
- Calibration and bump test weekly.
- Monitoring in order
  - *Oxygen*
  - *Flammability / combustibility*
  - *Toxicity*

Atmospheric Monitoring & Ventilation

Other Equipment

ATMOSPHERIC MONITORS & GUIDELINES.

Alarm Settings-the preset level within a monitor at which the monitor will display a visual and audible alert signal.

- *Oxygen 19.5% -23.5%*
- Flammability / combustibility-10% of LEL
- Toxicity 26ppm for CO

ATMOSPHERIC MONITORS & GUIDELINES

- Detection-The act of discovering the presence of a contaminant.
- Detection range- expresses the unit of measure a monitor uses to detect the vapor for which it's programmed,
  - Combustible gas Indicators (CGI) usually display a % reading for the LEL and a PPM reading for toxicity.
- Explosive Limits- a display indicating the percentage of air to gas mixture known as LEL and UEL.
- Flammable range-the % of vapor in the air that must be present to sustain combustion should an ignition source be present.

ATMOSPHERIC MONITORS & GUIDELINES

- Flash point- the minimum temperature at which a combustible substance generates enough vapor to form an ignitable mixture with air in the vapor space above itself.
- Ignition temperature- the minimum temperature to which a liquid must be raised in order for combustion to be initiated and sustained.
- *Immediately dangerous to life and health (IDLH)- maximum concentration from which a person could escape without permanent or escape impairing effects within 30 minutes.*
- Permissible exposure limits(PEL)-the average concentration that must not be exceeded during an 8 hour work shift or 48 hour work week.

Monitoring The Trench *(Haz-Mat Group)*

- 1 person to monitor and record readings through the entire operation.
- Record on a tactical worksheet.
- All readings should be conveyed to the Extrication Group Supervisor or the Operations Section Chief 10-15 min. intervals.
- Any changes in readings or alarms should be immediately reported so life-saving actions can be taken
- Never leave the monitor unattended.
- Monitor at all levels of trench and all areas

Ventilation

- If a trench is has the potential for containing a hazardous atmosphere, ventilation should be implemented.
- If the hazardous atmosphere cannot be confirmed or denied by the on-scene competent person or contractor, rescue personnel near or in the trench should consider wearing appropriate breathing apparatus until the atmosphere is deemed safe through monitoring.
- Gasoline or electrical fans are acceptable. (beware of CO%)
- Electrical fans tend to be quieter than the gasoline powered fan and do not produce CO.

Ventilation

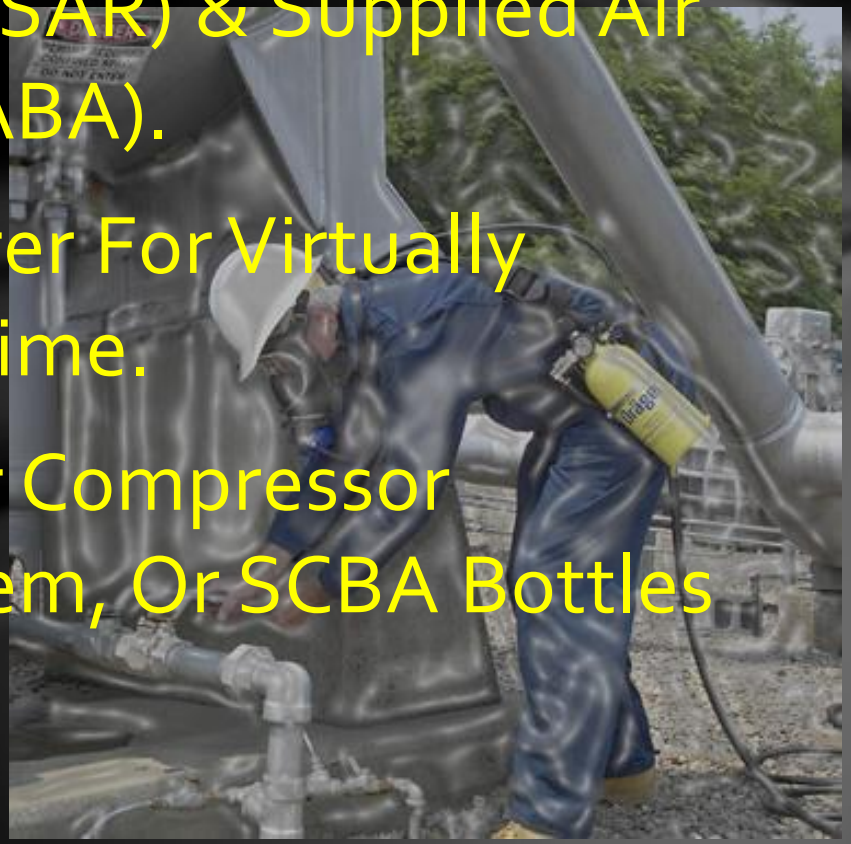
- All fans used for ventilation purposes must be able to produce a continuous minimum airflow of 1000 cubic feet per minute (CFM).
- Flexible trunk tubes attached to a ventilation fan stay relatively straight; a 90 degree bend in a trunk tube can reduce cfm air flow up to 50%.
- Air monitoring should be periodically conducted even with constant ventilation.
- Heaters should be attached for cold weather ops.

Supplied Air Systems

SAR & SABA

Supplied Air Systems

- Supplied Air Respirator (SAR) & Supplied Air Breathing Apparatus (SABA).
- Supplies Air To The Wearer For Virtually Unlimited Amounts Of Time.
- It Can Operate Off Of Air Compressor System, A Cascade System, Or SCBA Bottles Without Interruption.

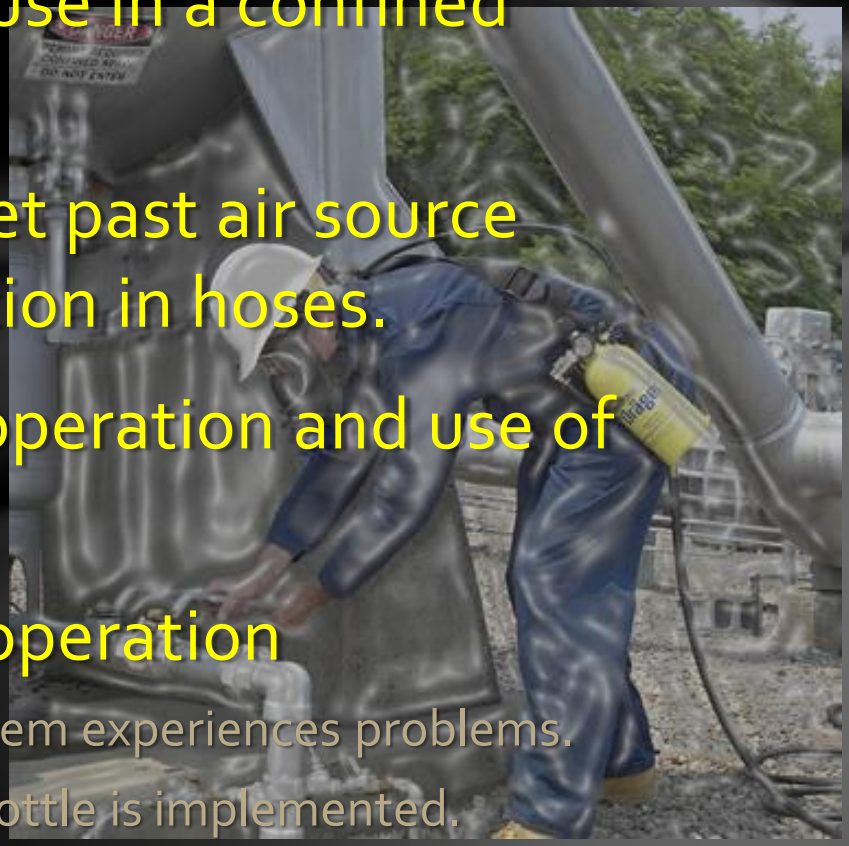


Supplied Air Systems

- OSHA CFR 1910.146 Mandates That The Wearer Also Carry An Escape Bottle System Providing At Least 10 Minutes Of Air.
- ***Varying Breathing Patterns And The Amount Of Physical Exertion, The Escape Bottle May Only Deliver 2-3 Minutes Of Emergency Air.***
- Rescuers Should Be Monitor Rescuers To Ensure That The Distance And Time Traveled In A Confined Space Does Not Exceed The Rescuer's Ability To Safely Escape.

Supplied Air Systems

- Low profile and is easier to use in a confined space.
- Can only travel up to 300 feet past air source using a SAR unit due to friction in hoses.
- Demonstration the proper operation and use of a SAR system.
- Emergency escape system operation
  - Go on escape bottle anytime SAR system experiences problems.
  - Wearer must evacuate when escape bottle is implemented.



Lifting And Moving Equipment & Operations

Lifting & Moving Equipment

- Ladders and timbers are used for lifting and moving operations.
- Ladders can be used for creating lifting, lowering, and moving platforms such as:
  - Ladder Jib
  - Ladder-as-a-Derrick
  - Ladder Hinge
  - Ladder Slide
  - Ladder A-Frame.
- Timbers are used for creating lifting, lowering & moving platforms such as:
  - A-frame
  - Tri-Pod
  - Timber Jib
  - Gin Pole

Lifting & Moving Equipment

Ladder Hinge

Ladder as a Derrick

Ladder A-Frame

Ladder Slide

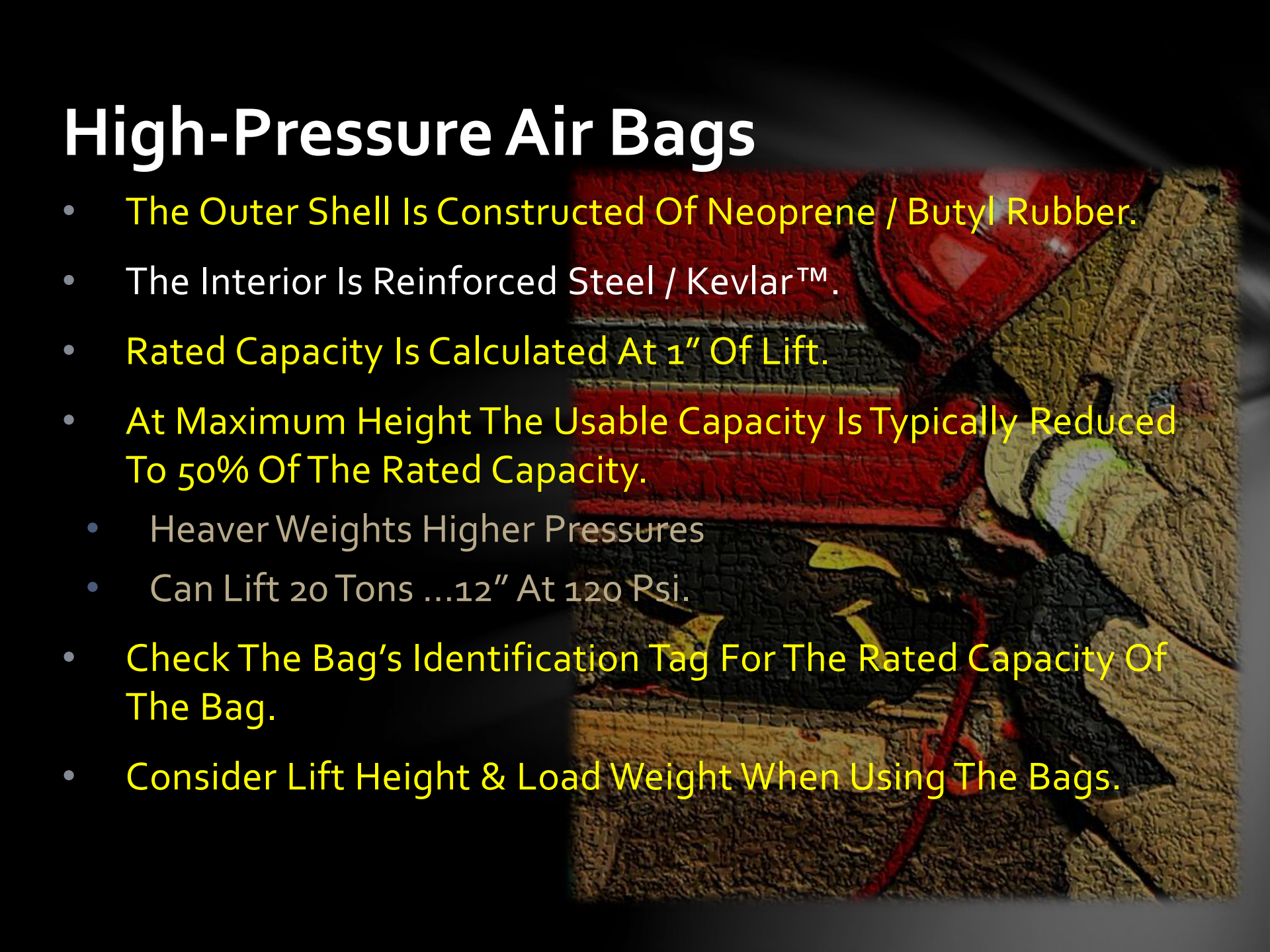
Lifting & Moving Equipment

Timber A-Frame

Timber Jib

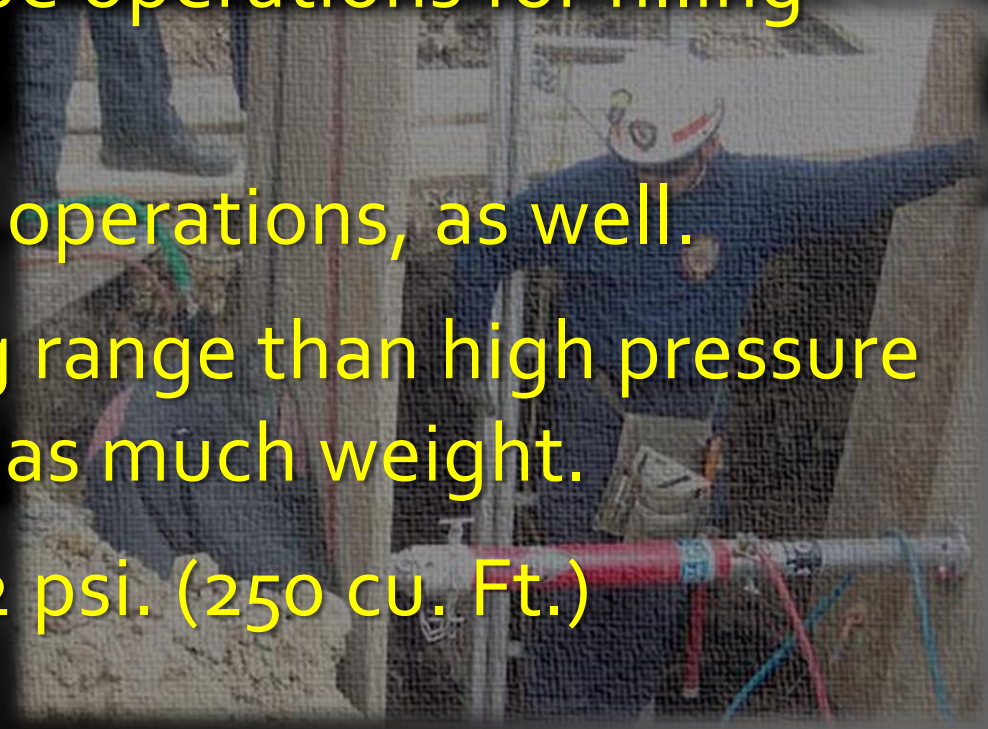
High-Pressure Air Bags

- The Outer Shell Is Constructed Of Neoprene / Butyl Rubber.
- The Interior Is Reinforced Steel / Kevlar™.
- Rated Capacity Is Calculated At 1" Of Lift.
- At Maximum Height The Usable Capacity Is Typically Reduced To 50% Of The Rated Capacity.
  - Heaver Weights Higher Pressures
  - Can Lift 20 Tons …12" At 120 Psi.
- Check The Bag's Identification Tag For The Rated Capacity Of The Bag.
- Consider Lift Height & Load Weight When Using The Bags.



Low-Pressure Air Bag

- Used in trench rescue operations for filling voids.
- Also used for lifting operations, as well.
- Have a higher lifting range than high pressure bags but cannot lift as much weight.
- 16 tons- 2’-5’ at 7-12 psi. (250 cu. Ft.)



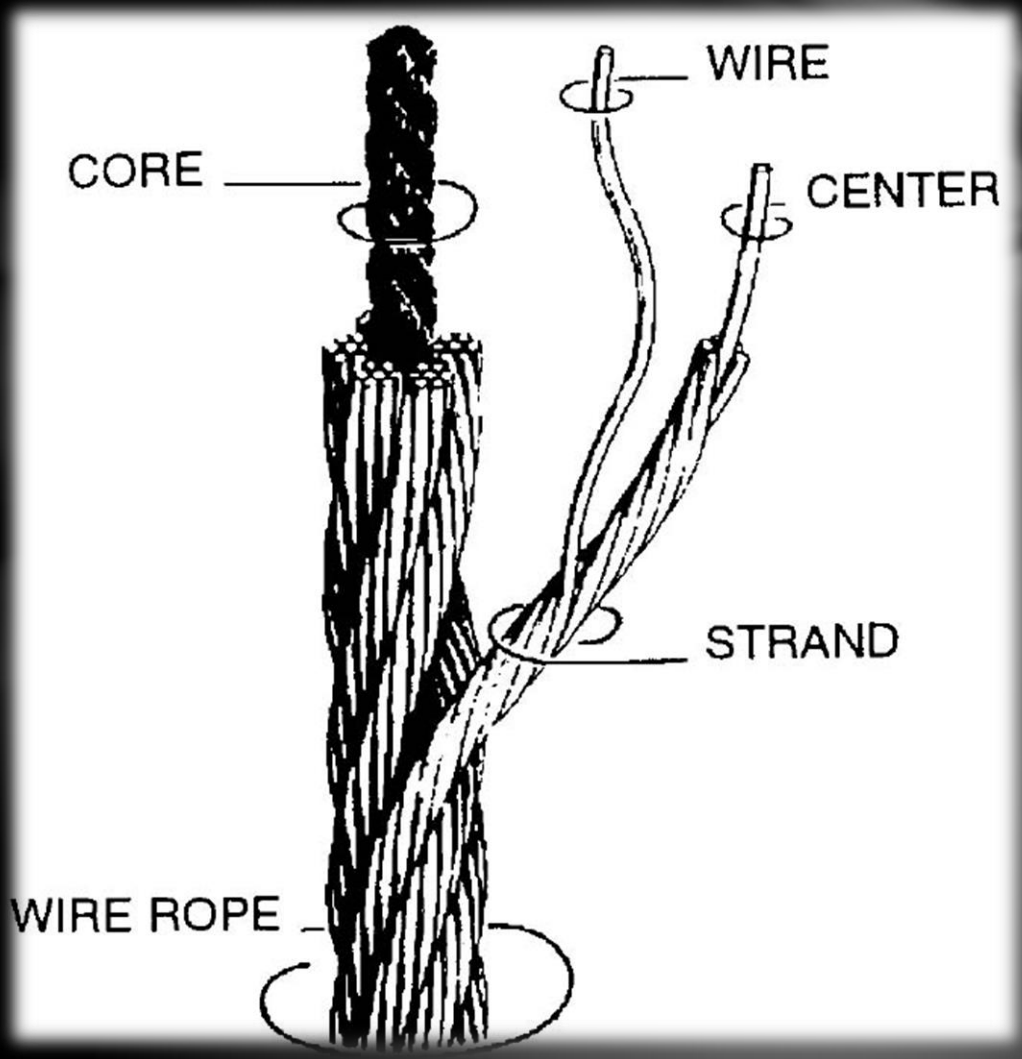
Heavy Rigging

Heavy Rigging

A length of rope, chain, or webbing attached to a load and to an anchor for the purpose of stabilizing, lifting, pulling, or moving objects.

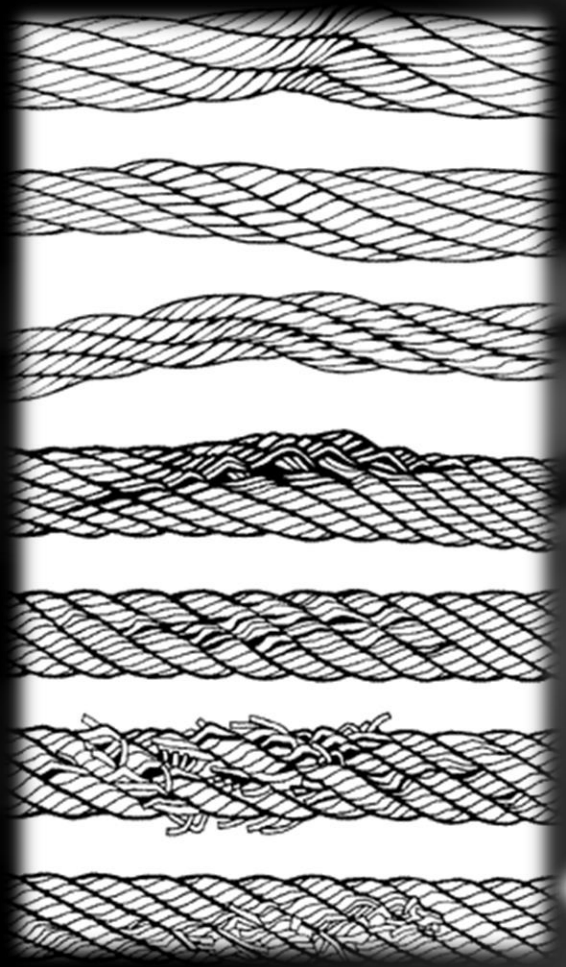
Heavy Rigging *Wire Rope*

- Core, strand, wire and center
- Four types:
  - Ordinary
  - Filler
  - Seale
  - Warrington.
- Strength depends on the size, grade and core.
- Slings are highly resistant to abrasion and crushing.



Heavy Rigging *Wire Rope*

- Inspection of wire rope should be done on a regular basis.
- Inspect for:
  - Broken wires
  - Crushed strands
  - Kinks
  - Bends
  - Protruding core, diameter reduction due to stretching
  - Abrasion
  - Corrosion and fatigue.



Heavy Rigging

Wire Rope Fittings & Terminations

- Flemish eye is the most reliable termination
  - does not reduce the load capacity.
- Fold Back eye is unreliable. Do not use!!
- Wedge Socket, will reduce load capacity by 10%.
- Cable clips reduce the load capacity by 20%.

Wedge Socket

Cable Clips

Fold Back Eye

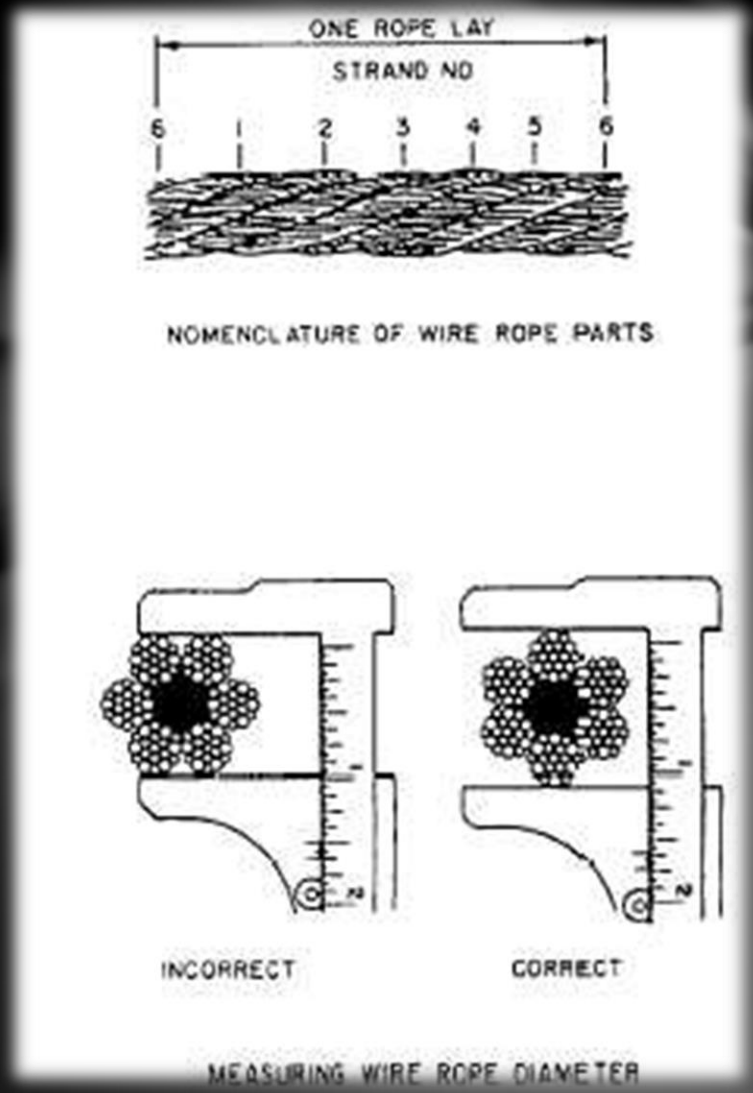
Flemish Eye

Heavy Rigging *Wire Rope Slings*

- when using slings, prevent bending or kinking.
- Safety factor of a wire rope sling is 5:1.
- Safety factor of wire rope used in lifts with personnel is 10:1.
- Safety factor of wire rope used in elevators is 20:1.
- Safety factor of wire rope in mobile cranes is 3:1 due to the potential for rough wear.

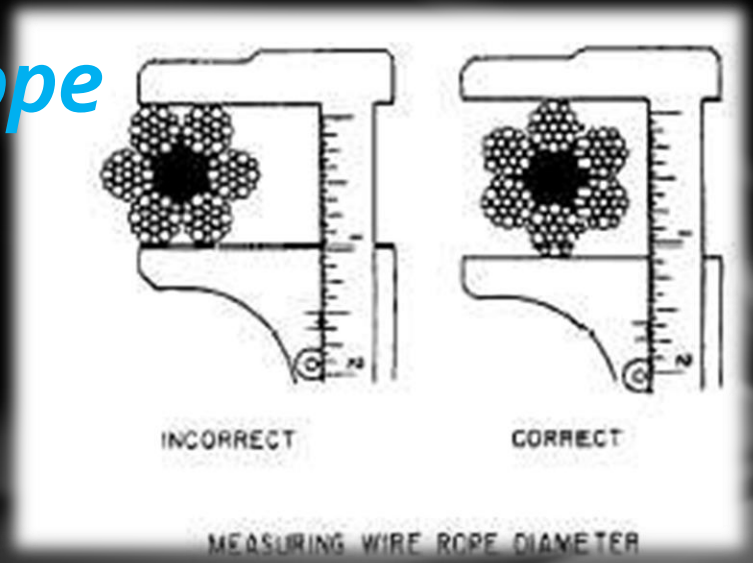
Heavy Rigging *Wire Rope Slings*

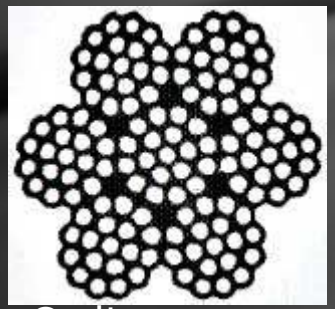
- To determine the diameter of a wire rope, measure across the crown not across the flat section.

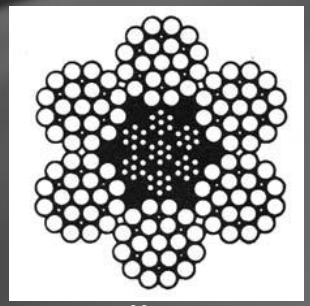


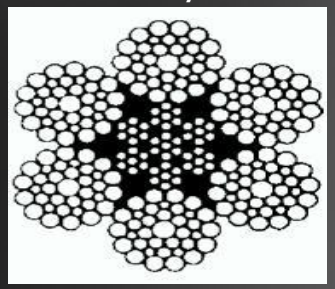
Heavy Rigging *Wire Rope*

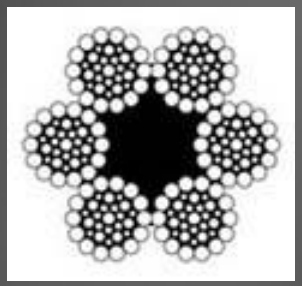
- To determine the diameter of a wire rope, measure across the crown not across the flat section.
- Wire rope configuration consists of four types:
  - Ordinary
  - Filler
  - Seale
  - Warrington.




Ordinary


Filler


Seale


Warrington

Chains And Chain Slings

- Applications are limited due to weight.
- Links can break without warning.
- Should not be exposed to cold temperatures for an extended period.
- Avoid kinking and twisting while under load.
- Use padding around sharp corners on the load to prevent the links from being cut.
- They cannot be used for overhead lifting unless tagged or rated by the manufacturer.
  (Grade 80, 90, 100 for overhead lifting)

Synthetic Slings

Made from materials such as:

- Nyon
- Polyester
- Aramid® fibers
- Kevlar®
- Dacron®,
- Nomex®
- High-density polyethylene.

Synthetic Slings

- Applications:
  - Mold around the load providing additional holding power.
  - Do not rust and are non-sparking.
  - Lightweight and easy to carry and rig.
  - More elastic than chain or wire rope.
  - Not effected by moisture and are resistant to many chemicals.
  - Are susceptible to abrasion and catastrophic failure.

Synthetic Web Slings

Triangle

Return Endless Eye

Reverse Eye

Double Eye

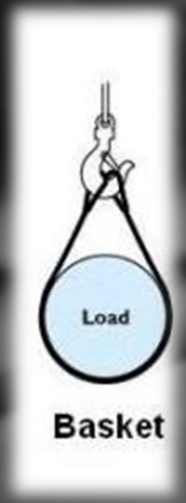
Choker

Sling Arrangements For Lifting Loads

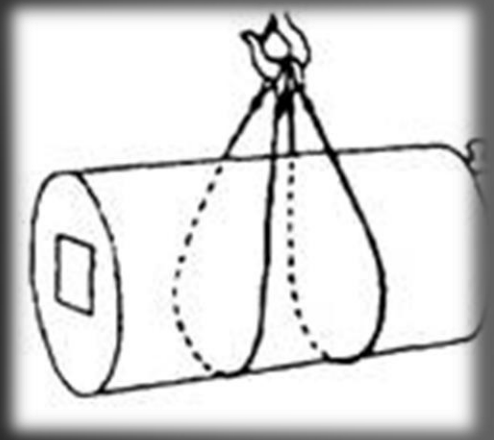
- Single vertical / horizontal hitches
  - Used to support a load using a single leg of rope, chain, or webbing.
  - Is not used when the load is hard to balance
  - Is difficult to find a center of gravity, the load is loose, or when the load extends past the point of attachment.

Sling Arrangements For Lifting Loads

- Basket hitches
  - Sling is passed under a load and both loops are attached to hooks or a master link.
  - It can be difficult to keep the load balanced or stabilized.

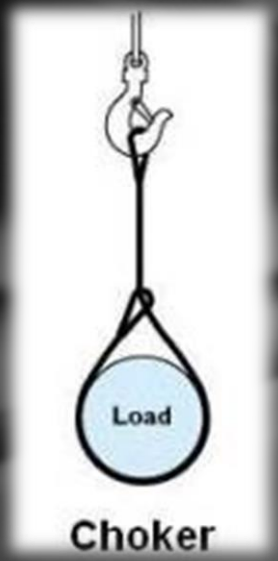


- Double basket hitches
  - Use two single slings wrapped in separate locations in the same manner as the basket hitch described above.

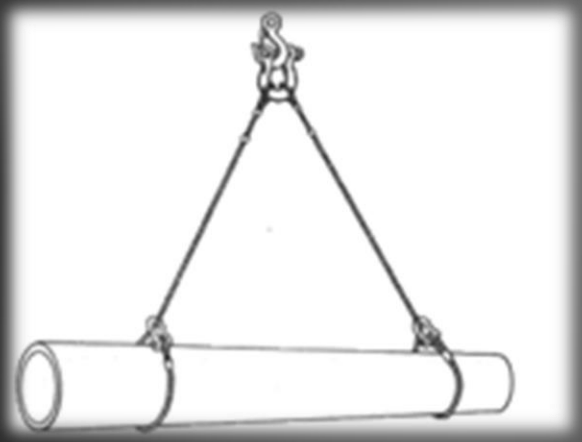


Sling Arrangements For Lifting Loads

- Single choker:
  - Configurations with one end of the sling passing under the load and through the other end of the sling.
  - This puts a vise-like grip on the load.

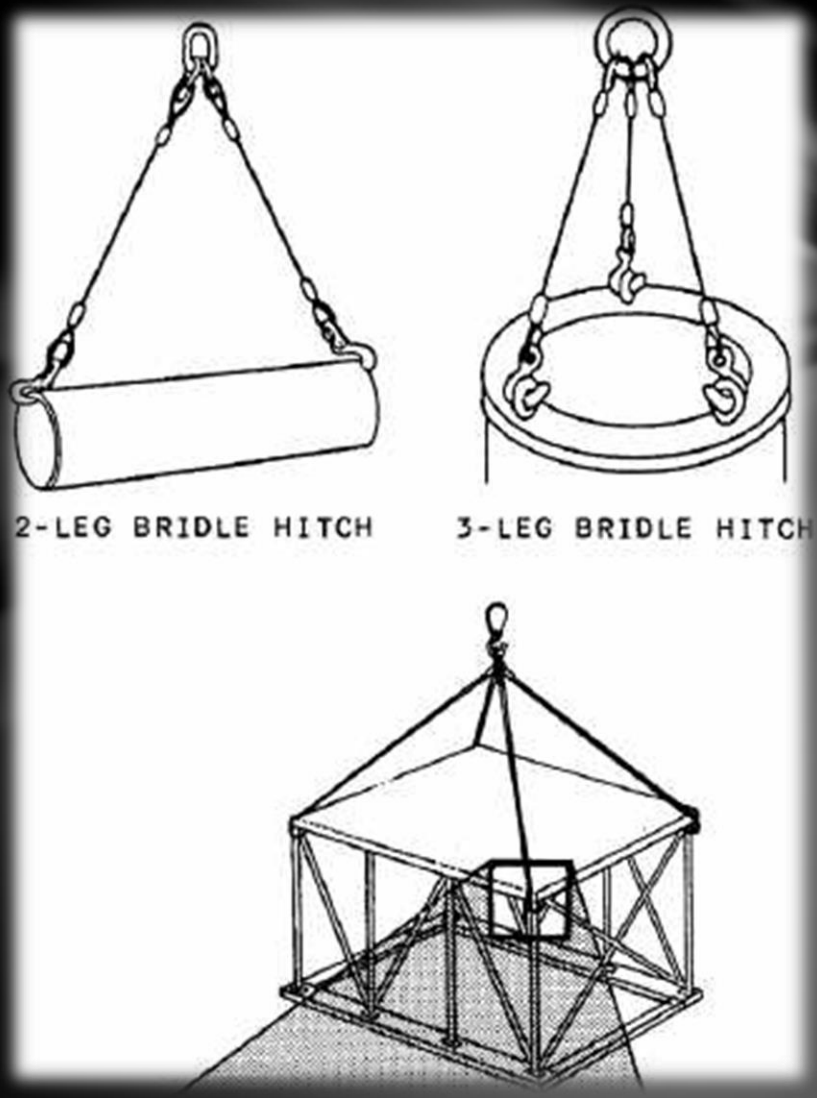


- Double choker hitches:
  - Two single slings spread apart around the load.
  - Does not make full contact with the load.



Sling Arrangements For Lifting Loads

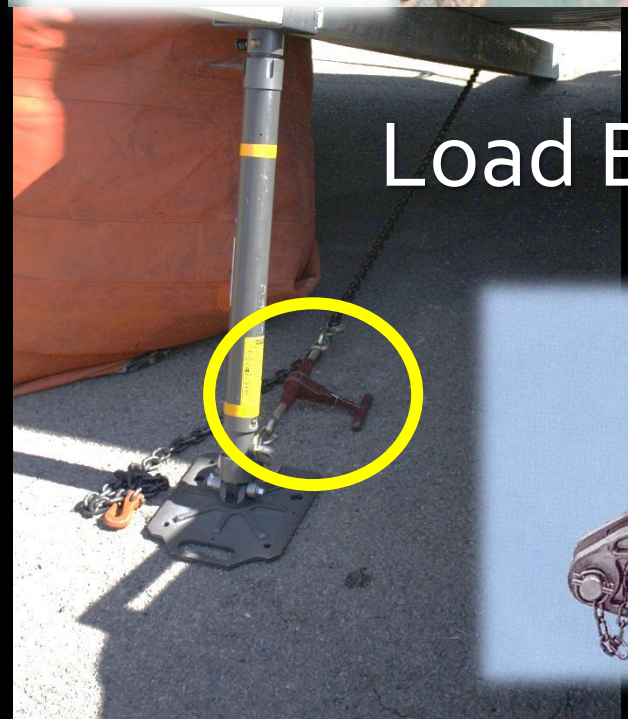
- Bridle hitches:
  - Consist of two or three legs attached to the load.
  - Slings are secured to a single point usually positioned in the center of gravity between the sling anchor points.



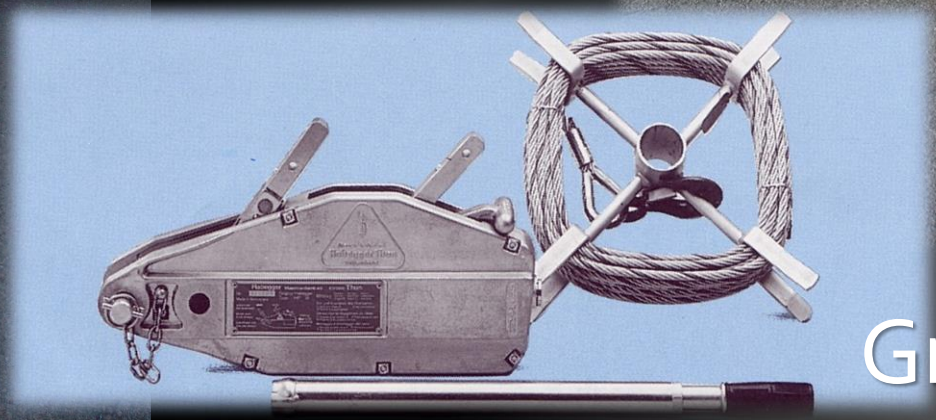
Load Tighteners

- Cable winches, load binders, chain hoists, and turnbuckles.
- Can be used to secure / stabilize heavy equipment
- Wire rope tighteners are used for light loads as well as tightening cable tiebacks and other rigging.
- Do not overload rope tighteners, and do not use cheater bars to gain extra leverage

Come-a-longs



Load Binder



Grip Hoist

Load Tighteners

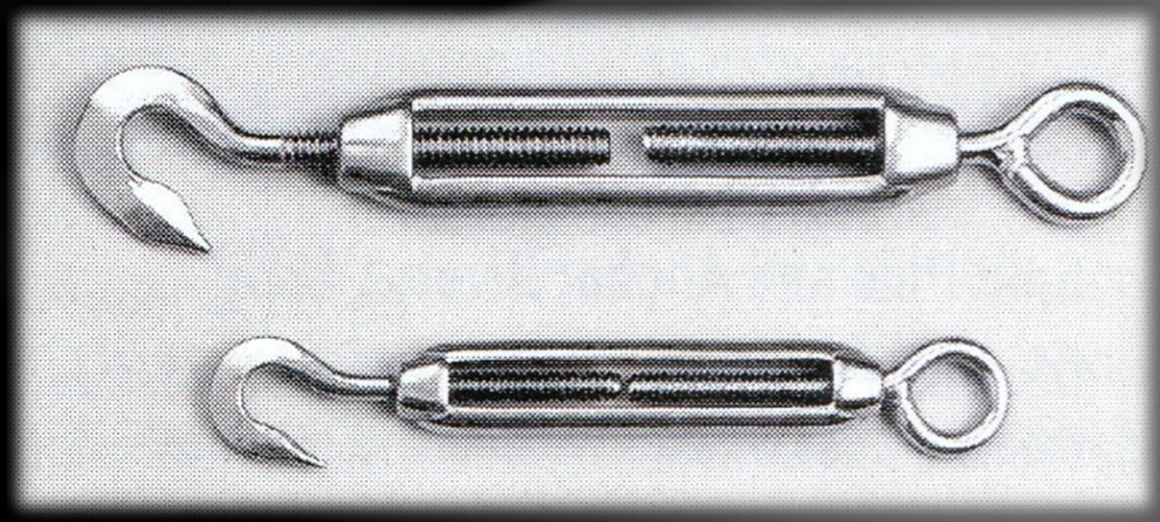
- Cable winches:
  - The length of the handle plus the strength of one person provides the overload limit
  - Must keep a minimum of one rope layer on the spool.
  - Take care in re-winding cable winches to prevent fouling.
  - Cable winches have limited use within confined spaces.

Load Tighteners

- Load binders:
  - Used in conjunction with chain use.
  - Use ratchet types for reliability and use wire ties on the handle for safety.
  - Always check manufacturer's specifications for maximum load limits.
  - Must take up as much slack in chains before attaching.

Chain Hoist

Turnbuckles



Load Tighteners

- Chain hoists
  - can lift up to 6 tons with just 100 pounds of pull.
  - They have up to 10 foot of take-up and only require 12 inches of clearance

Load Tighteners

- Turnbuckles:
  - Used in place of a cable winch to do final tightening of tiebacks.
  - Maximum take-up varies from 8 to 24 inches.
  - May be difficult to tighten under high loads.
  - Hook ends are only 2/3 as strong as the eye or jaw ends.
  - Use manufacturer's specifications for maximum load limits.

Rigging Fittings

- Components of slings (hook, shackle, pin, and eye) should be made from forged steel.
- Fittings provide a means of lifting a load without directly tying to the load.
- Hooks need to be latched or moused.
  - Mousing is a process of closing the open section of a hook to prevent slings from slipping off the hook.
  - Hooks can be moused using rope yarn, seizing wire, or shackle clips.

Rigging Fittings

- Check the rating stamp and working load rating on shackles.
- Pins are not interchangeable with other shackles.
- Screw the pin in all the way then back off ¼ turn before loading.

Heavy Equipment & Preplanning

- Developing and maintaining a listing of crane resources and heavy digging, and vacuum equipment.
- NCEM should develop a telephone call-up list or contract with resource.
- Establish a response times and confirm the on scene contact person and their location.
- Procedures for ordering a crane or digging equipment.

Heavy Equipment & Preplanning

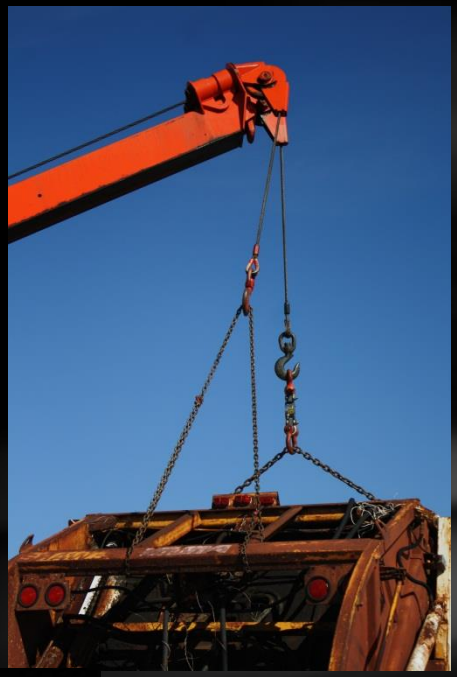
- Questions resources may asks:
  - *What are dimensions of Trench*
  - *What about access?*
  - *What is to be lifted or supported?*
  - Who are you, and what are you doing?
  - How quickly do you need the machines?
  - What do you intend for the machine to do?
  - Will multiple machines be needed?
  - What are the capabilities of the onsite rescuers?
  - Are they qualified to assist with set up?
  - What are the limits of room for operations?

Heavy Equipment & Preplanning

- Questions resources may asks:
  - Are there obstacles along the route, overhead clearances, tail-swing clearance?
  - Will work be performed on a 24 hour basis?
  - What areas of operation are anticipated?
  - Will radio communications be required?
  - Whistles? Hand Signals?
  - Who is the contact person, and who is the person in charge of the equipment

Cranes


XCMG QY50K
XCMG QY50K




P&H


Specializing in Customer Service
Brabus


HUNTER

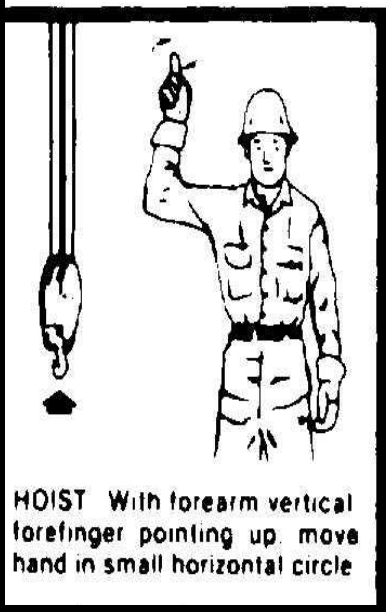

Moran Iron
ROMTWORKS

Cranes

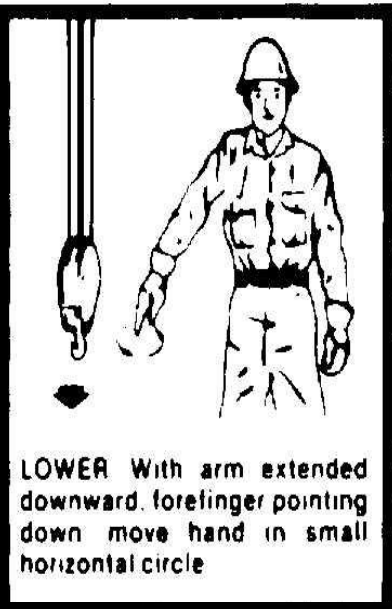
- Some have all wheel drive and all wheel steering.
- Outriggers need to be set on a firm surface.
- They are self-contained except for 120 tons and greater.
- Are rated by lifting capacity in tons at a distance of 10 feet from the center of the crane.
- Booms are variable length.

Cranes (Class I Levers)

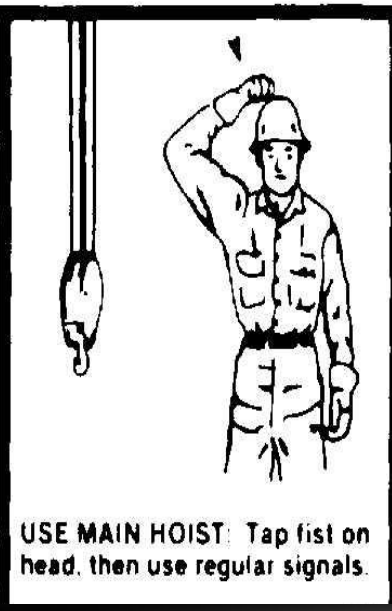
- Rough terrain cranes.
  - These cranes have pick and carry capability.
  - They are rated for "on rubber", or driving with aload.
  - They adapt to rough terrain but must be level to lift.
- Conventional cranes.
  - Require more than one load to haul the boom components, counter weights, and rigging.
  - Have a longer set-up time than a hydraulic crane.
  - Lifting capacity guidelines are the same as for hydraulic cranes.
  - Lifting capacity of all cranes is reduced the farther away the center of the crane is from the load.



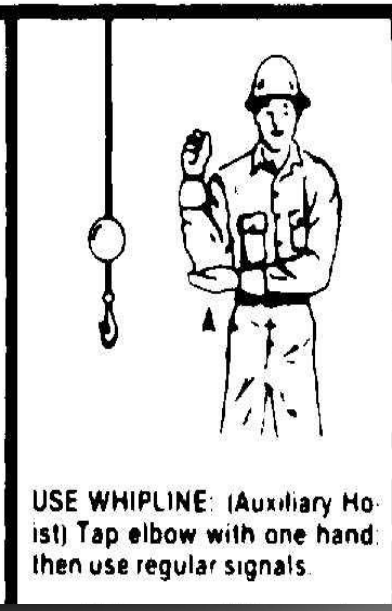
HOIST With forearm vertical forefinger pointing up, move hand in small horizontal circle



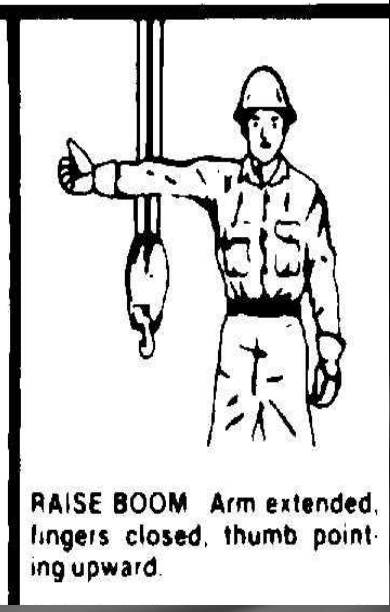
LOWER With arm extended downward, forefinger pointing down move hand in small horizontal circle



USE MAIN HOIST: Tap fist on head, then use regular signals.



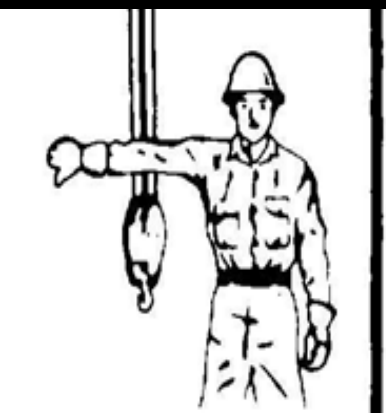
USE WHIPLINE: (Auxiliary Hoist) Tap elbow with one hand, then use regular signals.



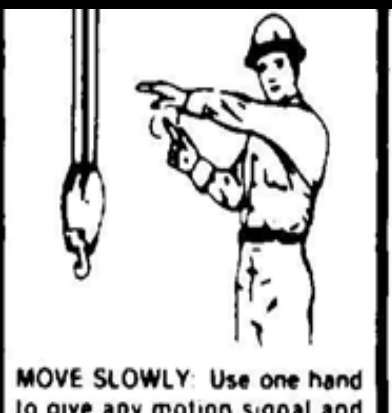
RAISE BOOM Arm extended, fingers closed, thumb pointing upward.

Stand in Clear View of Crane Operator

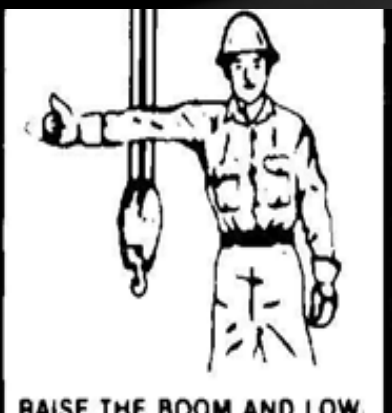
Use a whistle or air horn to indicate when hook is moving



LOWER BOOM Arm extended fingers closed, thumb pointing downward



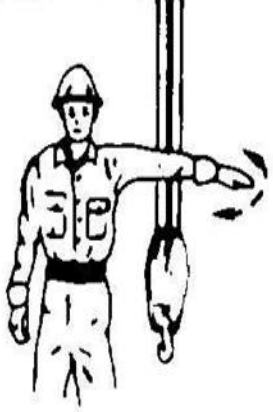
MOVE SLOWLY: Use one hand to give any motion signal and place other hand motionless in front of hand giving the motion signal (Hoist slowly shown as example)



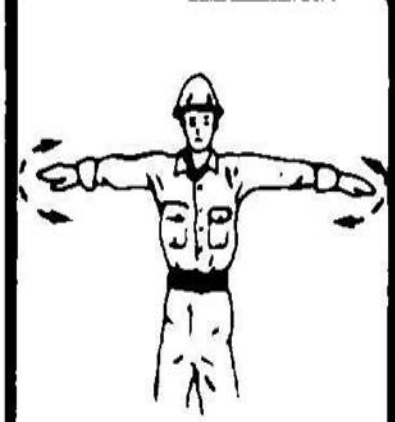
RAISE THE BOOM AND LOWER THE LOAD With arm extended, thumb pointing up, flex fingers in and out as long as load movement is desired.

LOWER THE BOOM AND RAISE THE LOAD With arm extended, thumb pointed down, flex fingers in and out as long as load movement is desired.

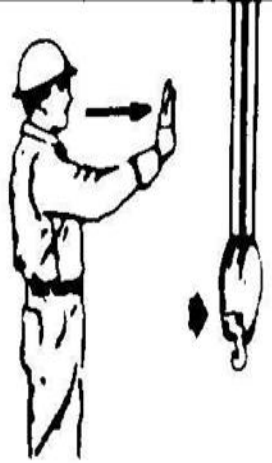
SWING Arm extended, point with finger in direction of swing of boom



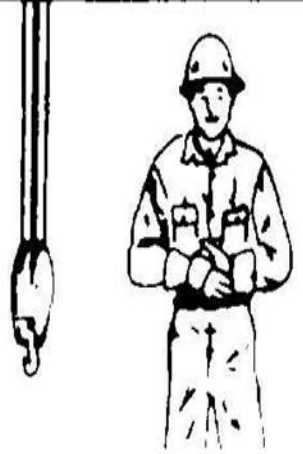
STOP: Arm extended, palm down, move arm back and forth horizontally.



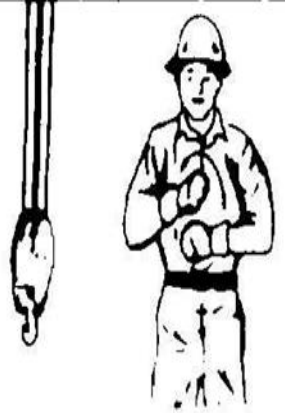
EMERGENCY STOP: Both arms extended palms down, move arms back and forth horizontally.



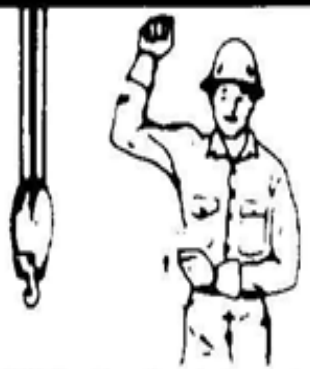
TRAVEL: Arm extended forward hand open and slightly raised make pushing motion in direction of travel.



DOG EVERYTHING Clasp hands in front of body

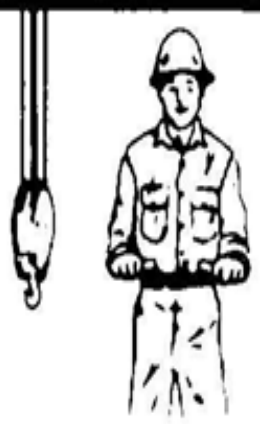


TRAVEL (Both Tracks) Use both fists in front of body, making a circular motion about each other indicating direction of travel forward or backward



TRAVEL (One Track) Lock the track on side indicated by raised fist. Travel opposite track in direction indicated by circular motion of other fist rotated vertically in front of body (For land cranes only)

EXTEND BOOM (Telescoping Booms) Both fists in front of body with thumbs pointing outward



RETRACT BOOM (Telescoping Booms) Both fists in front of body with thumbs pointing toward each other

EXTEND BOOM (Telescoping Boom—One Hand Signal) One fist in front of chest with thumb tapping chest.

RETRACT BOOM (Telescoping Boom—One Hand Signal) One fist in front of chest thumb pointing outward and heel of fist tapping chest

Protective Equipment

Apparel

- Recommended to use NFPA 1951 Standard on Apparel for Urban Technical Rescue Incidents
- *Least disable material is Cotton!! Cotton Kills!*
- The apparel list includes:
  - Helmet
  - Wrap around eye protection
  - Long pants and long sleeve shirt or jumpsuit/flightsuit
  - Steel-toed boots, and leather work gloves.
  - Knee and elbow protection
  - SCBA
  - Hearing protection
  - Safety vest
  - Dust masks /APR
  - Hydration system

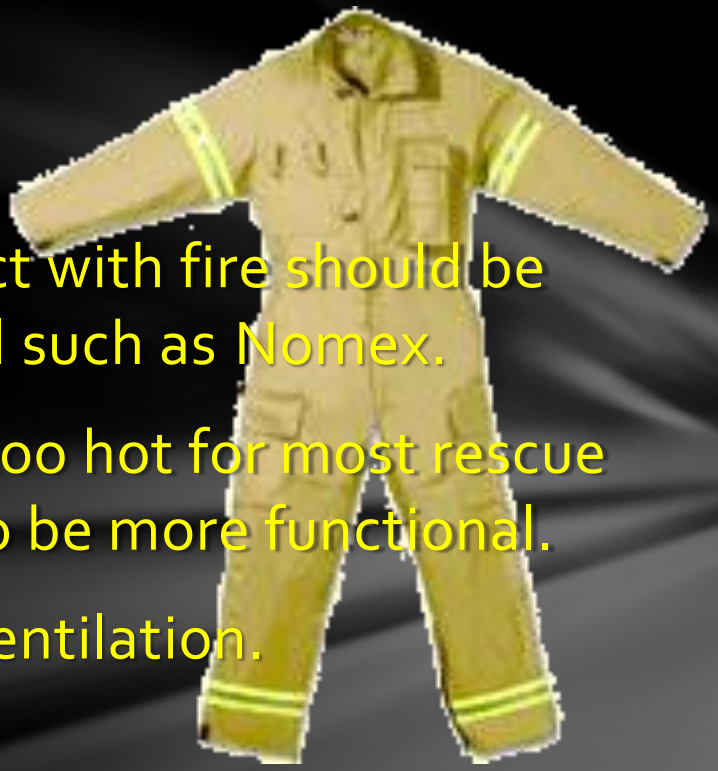
Helmets

- Only Rescue Helmets That Have A Three-point Suspension Type Chin Strap.
- A Single Chinstrap Is Inadequate For Rescue Activities.
- The Shell Of The Helmet Should Be Constructed Of Material That Will Resist Impacts And Penetration Of Sharp Objects.
  - Kevlar, Or Fiberglass Composites.

Helmets

- Should Protect The Head From Falling Objects And Side Impacts.
- Should Have A Narrow Profile With A Slight Brim.
- Inside Suspension System Of A Helmet Should Hold The Helmet Away From The Skull To Reduce The Shock Of Impact And Provide Comfort And Adequate Air Circulation.
- The Helmet Used Should Comply With ANSI Z87.1 Occupational And Educational Eye And Face Protection.

Garmets



- Any potential for coming into contact with fire should be constructed of fire resistant material such as Nomex.
- Turnout gear tends to be bulky and too hot for most rescue activities. Jumpsuits or BDUs tend to be more functional.
- Clothing having the ability for self-ventilation.
  - Gor-tex™
  - Polypropylenes
  - Thinsulate™
- Clothing should be sized so as not to bind
- *Cotton is the least desirable material for wet and cold environments..*

Garmets

- Layering clothing prepares the rescuer for various environmental conditions.
  - The first layer is underwear.
  - The second layer is for insulation.
  - The third layer is the outer shell

Footwear

- Boots should provide adequate support to the ankle, and protect the feet from impact loads, bruises, scrapes, and cuts.
- The soles of the boot should have a good adhesion surface, not slick like street shoes.
- Socks that provide good wicking capability that pulls moisture away from the feet to keep the feet dry and warm, reduce blisters.

Handwear

- Should provide comfort, protection from abrasions, cuts, and ease of use for rope handling activities.
- Should allow the hands to retain a sense of feeling so the fingers can operate equipment
- Leather work gloves provide good hand protection and are flexible enough to pick up tools objects easily and inexpensive.
- *Fire service gloves are often bulky NOT RECOMMENDED!!*
- Military flight gloves?

Eyewear

- Should prevent dust and flying debris from entering the eyes.
- Should be OSHA approved close fitting goggles or safety glasses
- Face shields alone on fire and rescue helmets do not give adequate protection from dust and flying debris.

Other equipment

- Elbow pads and kneepads to protect the rescuer's joints from abrasion and blunt trauma.
- Respiratory protection devices will depend on the atmospheric conditions of the environment the rescuer is working in.
- To filter dust and non-toxic particulates in an open clean atmosphere (19.5-23.5 % oxygen), a simple dust mask may be adequate but will not filter out toxins.