

IDENTIFY BEST PRACTICES FOR EXCAVATION AND D&D RELATED TO ELECTRICAL SAFETY

EFCOG Initiative # 6

July 16-20, 2007

Albuquerque, NM





Figure 2-1. Road grader engulfed in flames

Intrusions Continue

The ESTG initiative #6 Subteam Evaluated 21 ORPS Events from January 2006 to April 2007

■ Imperfect Tools

- Technologies for subsurface investigations have inherent limitations
- Drawing inaccuracies/availability

■ LTA Controls

- Administrative barriers (Buffer zones, etc.)
- Errors/poor work planning and execution

Who

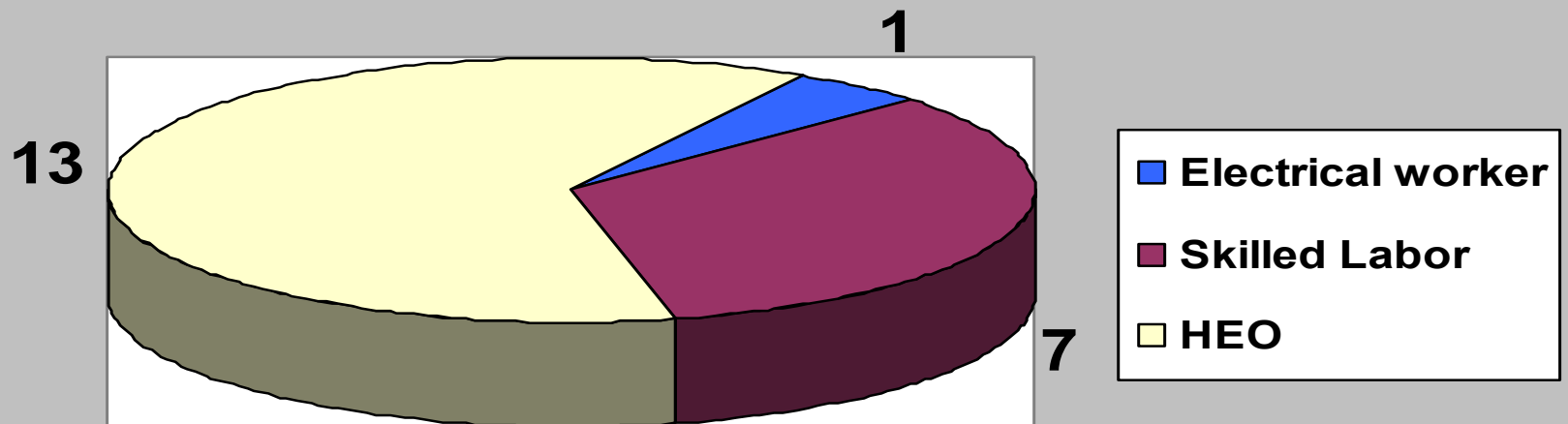


Figure 1. Who

Contractor Vs Sub

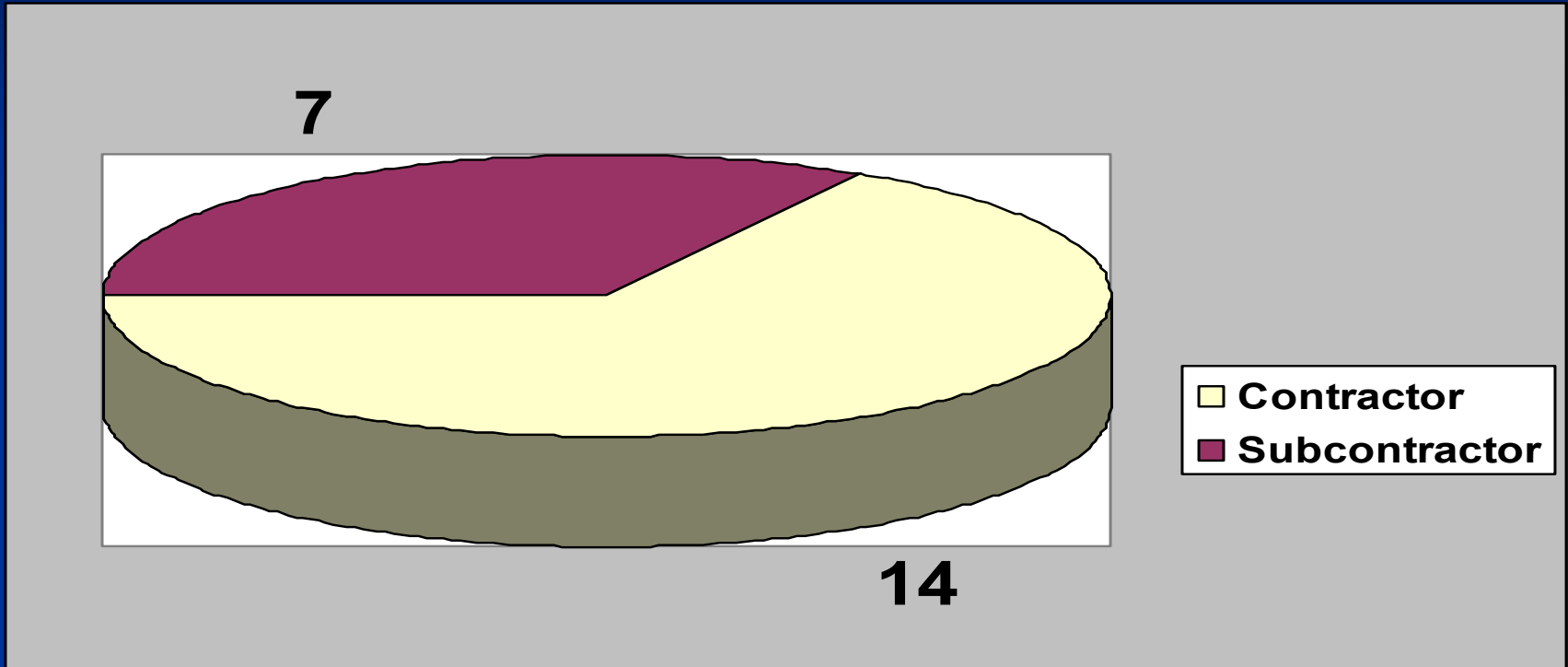


Figure 2. Contractor Vs subcontractor

Consequence

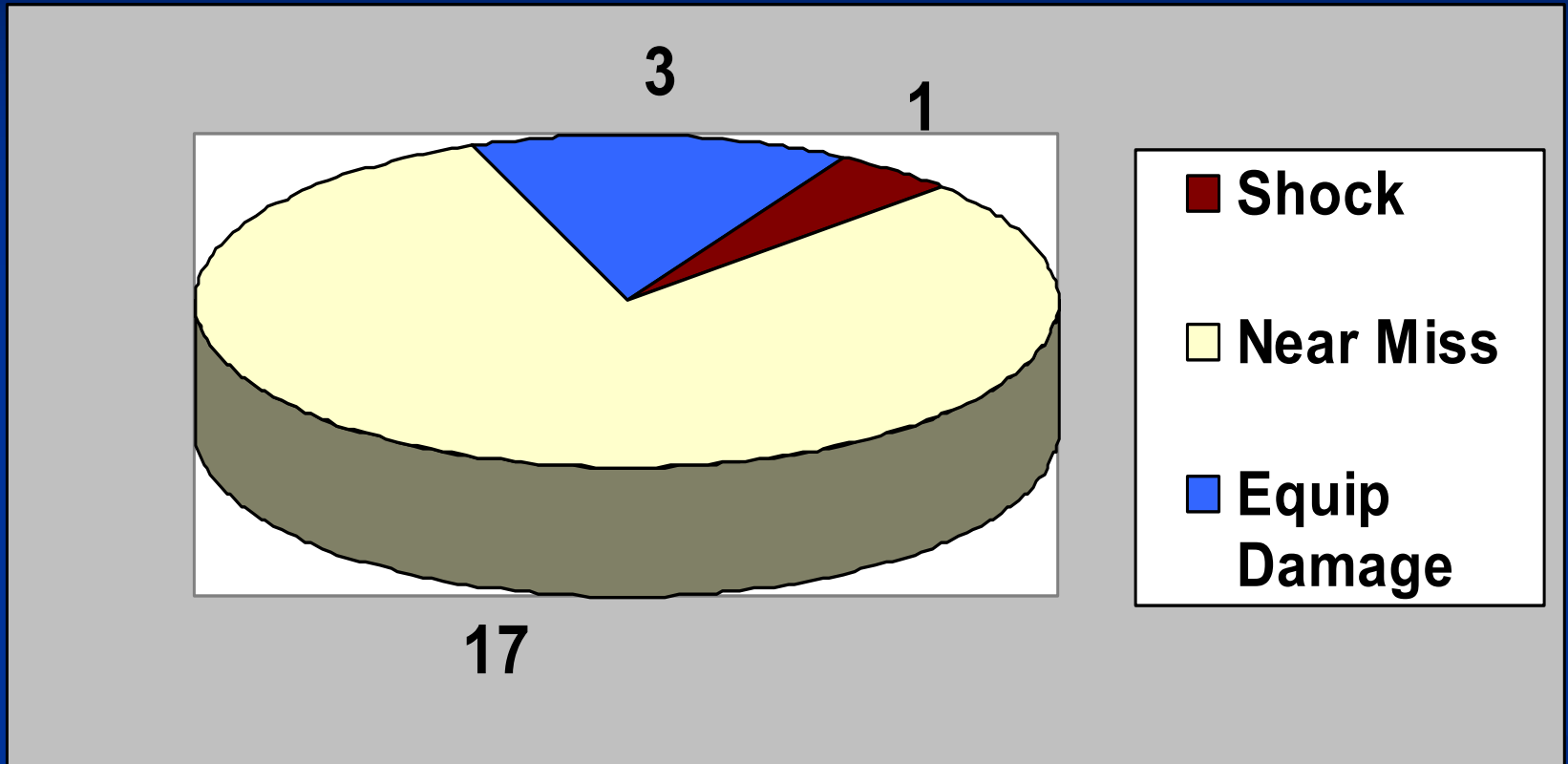
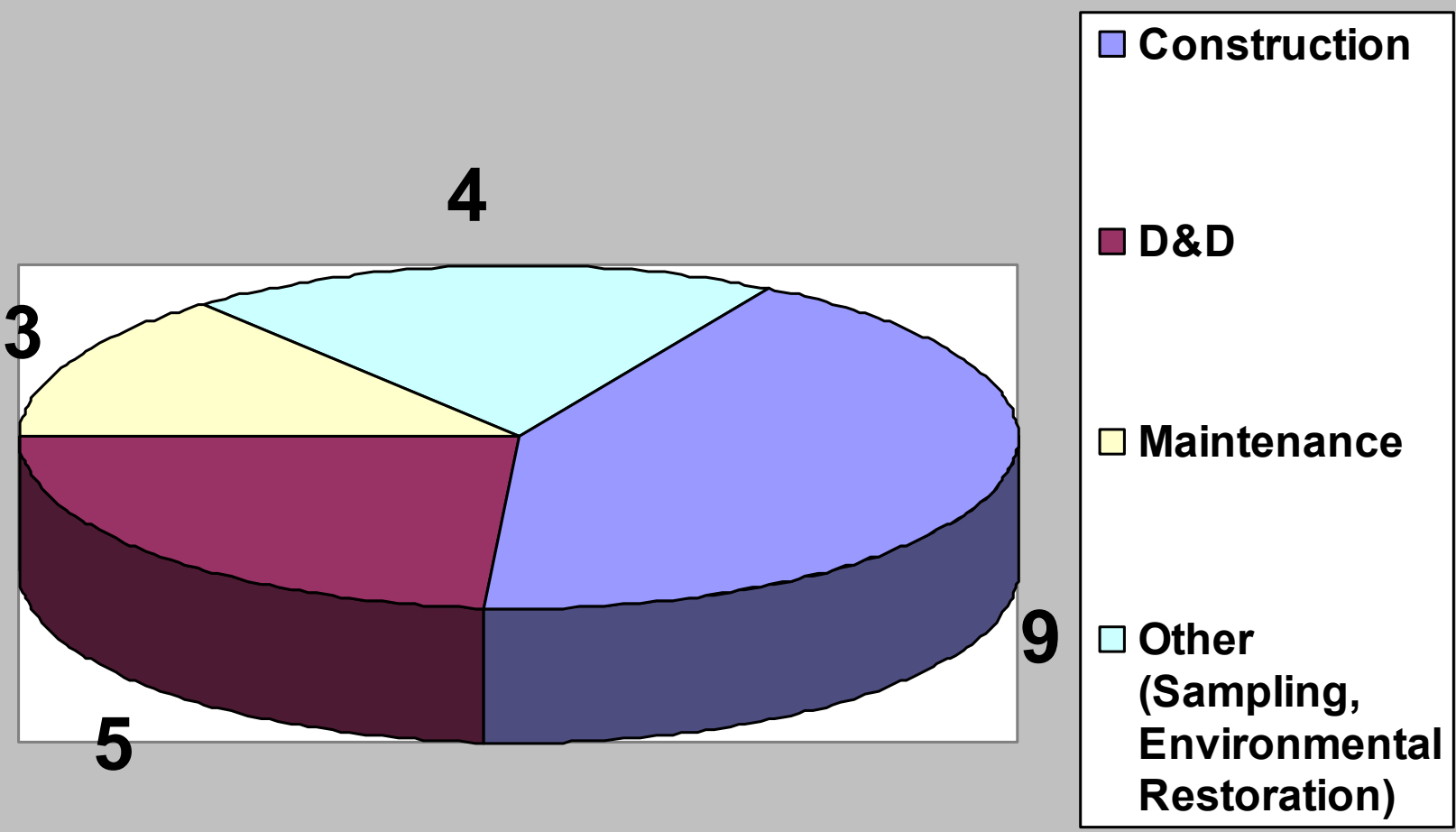


Figure 3. Consequence

Activity



Specific Task

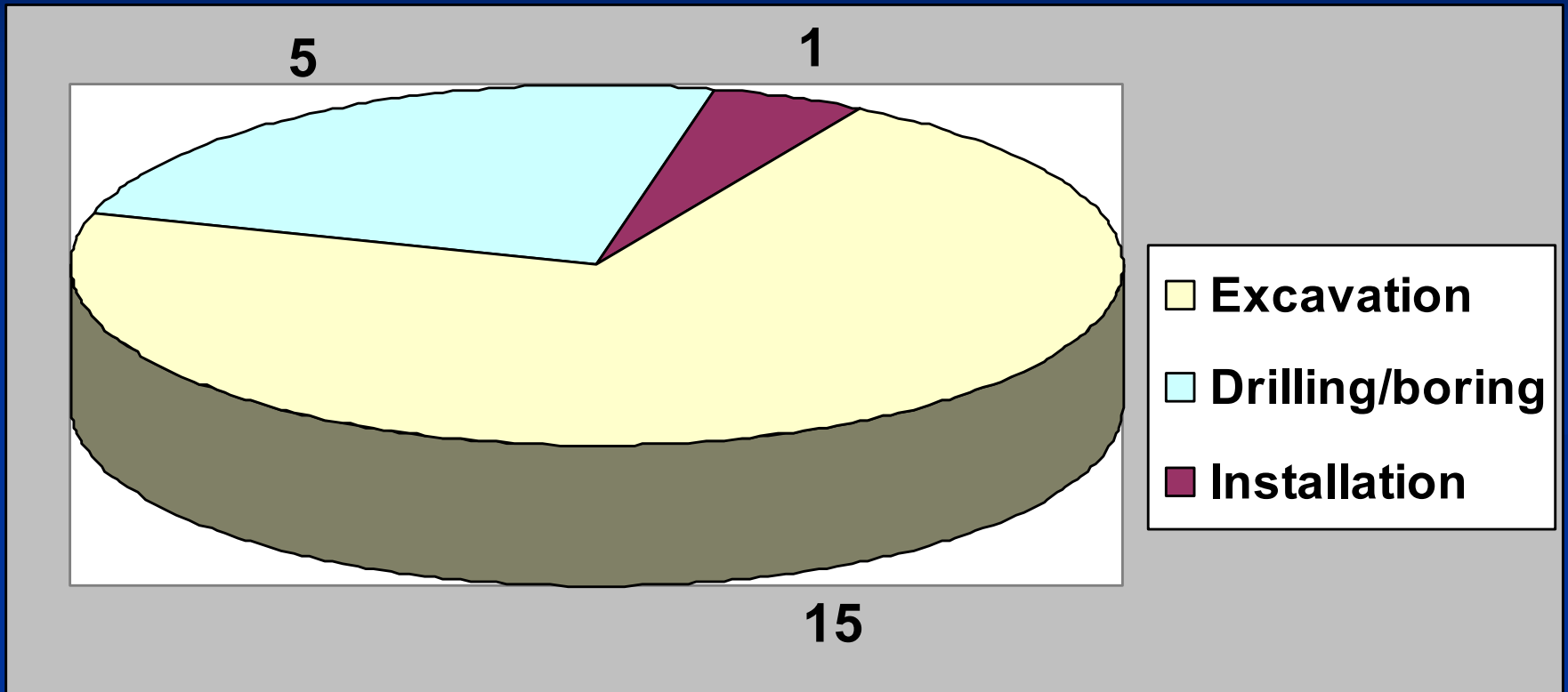


Figure 5. Specific Task

Cause

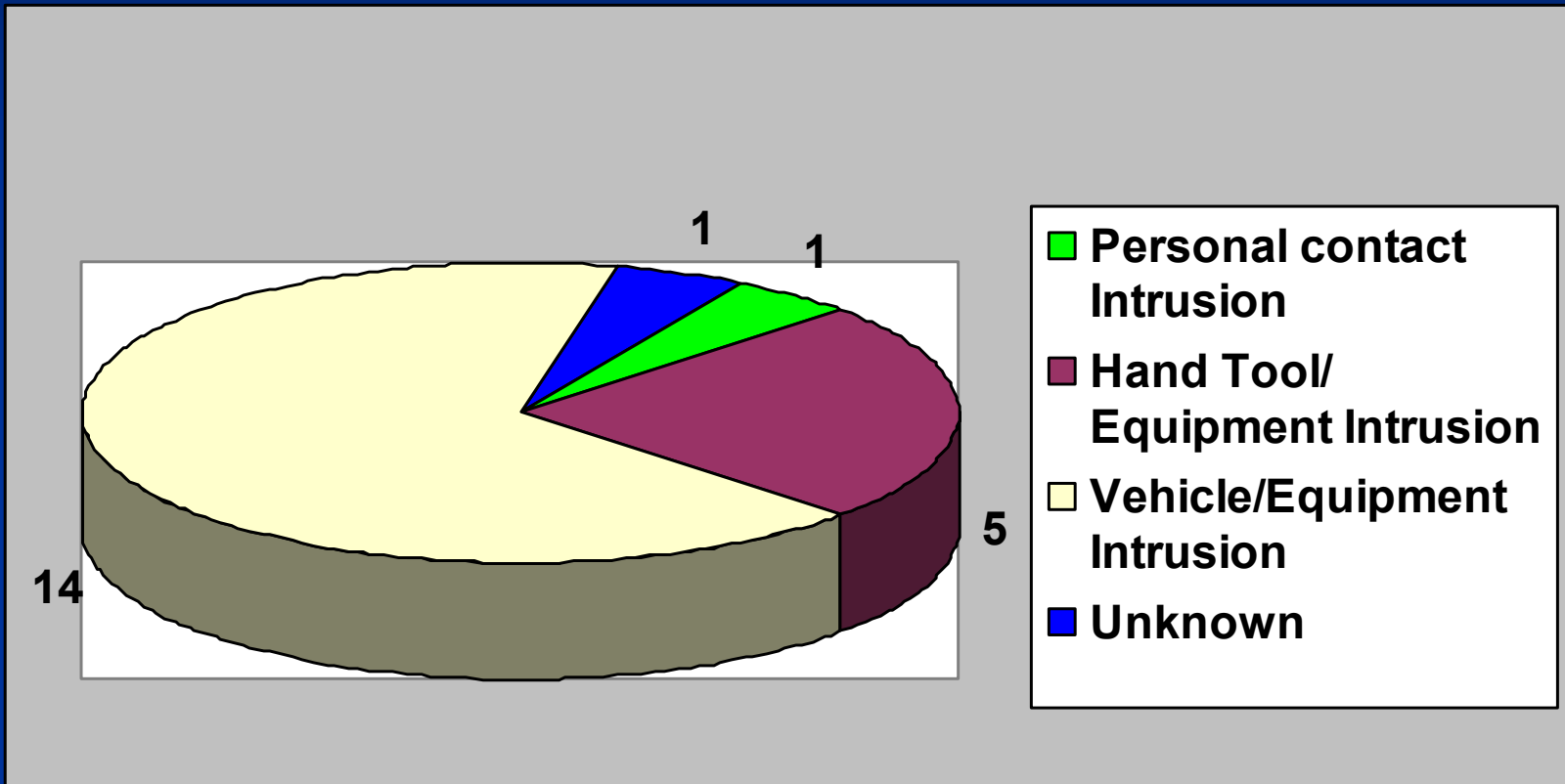


Figure 6. Cause

Unsafe Act Vs Unsafe Condition

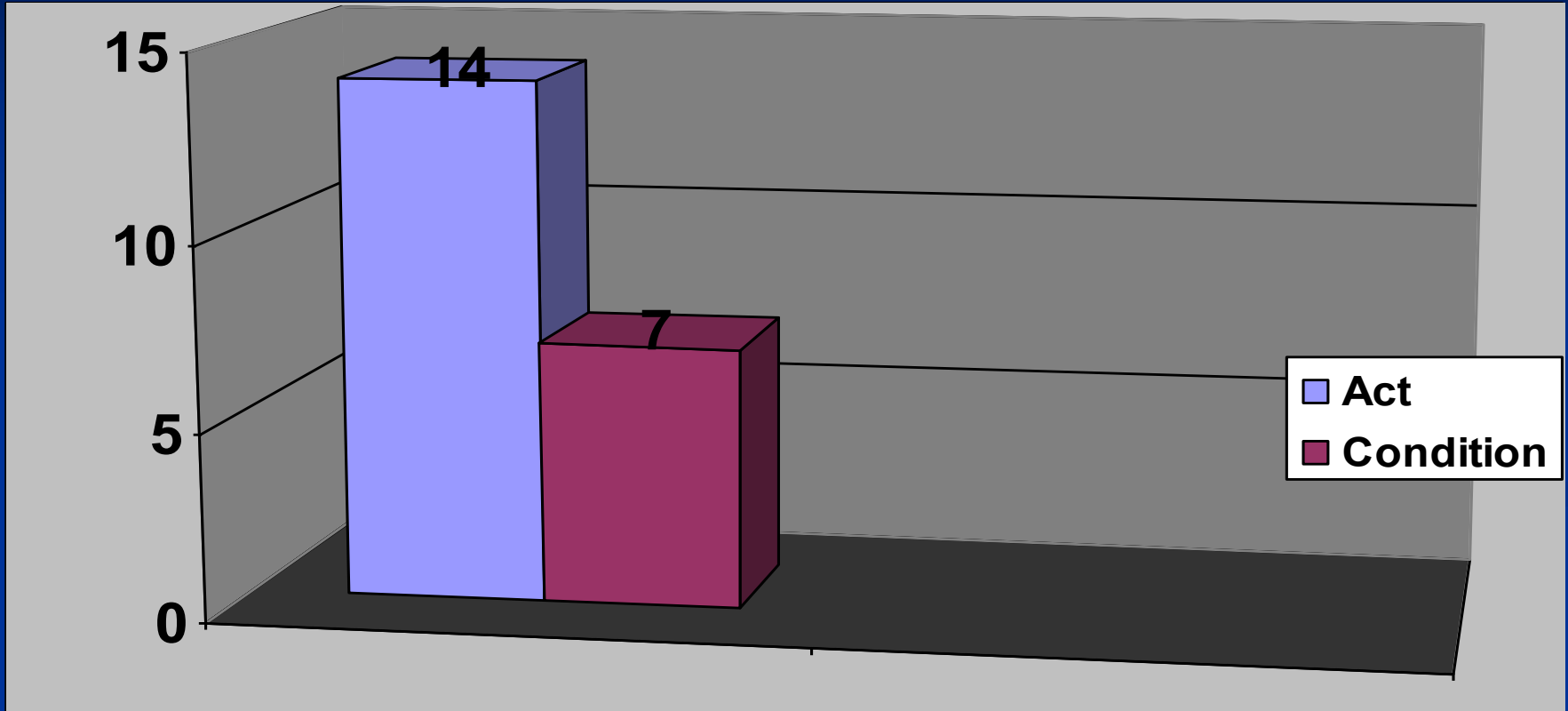


Figure 7. Unsafe act or Unsafe condition

Factors/Issues

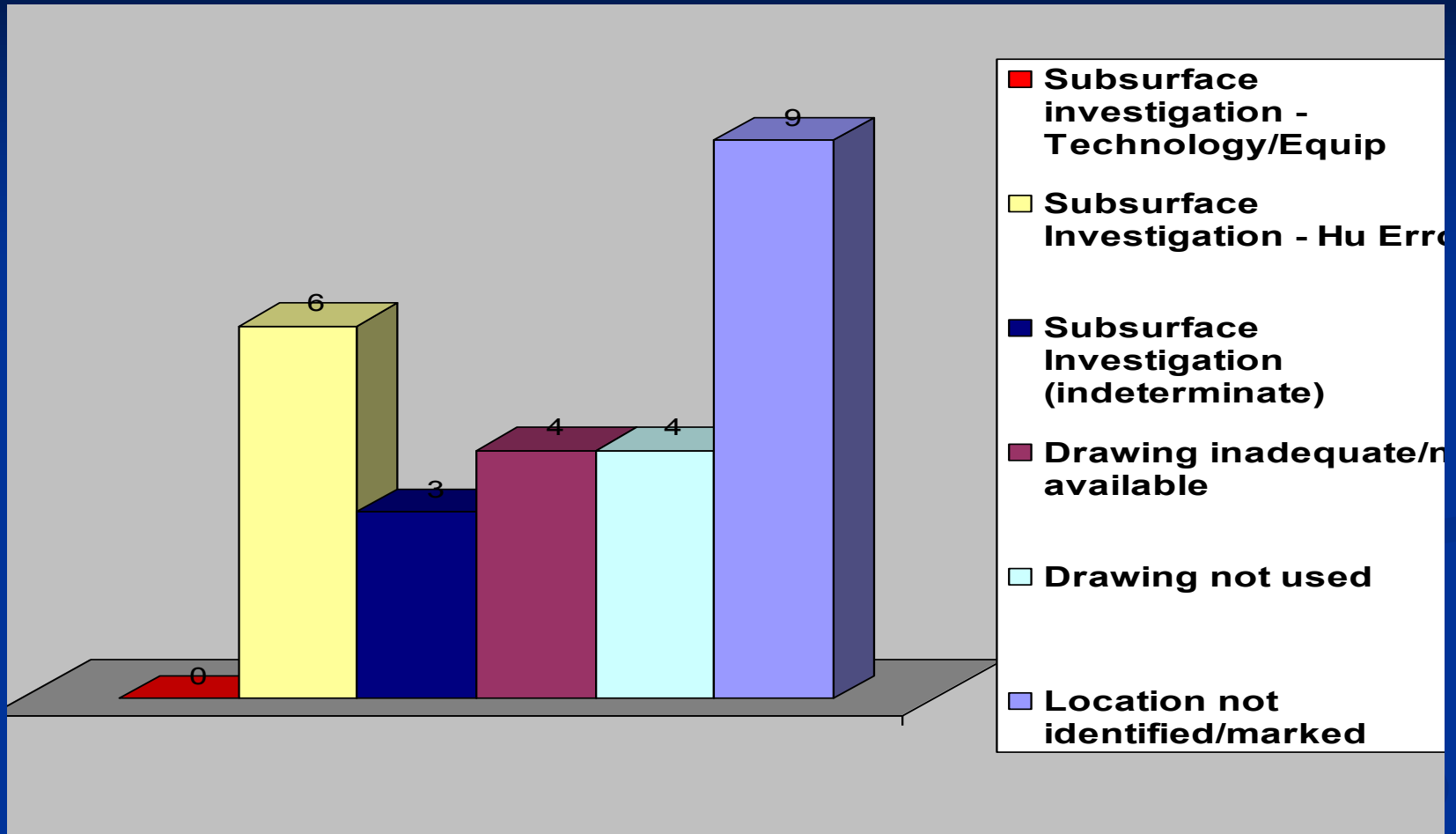


Figure 8. Issues/Factors

Factors/Issues

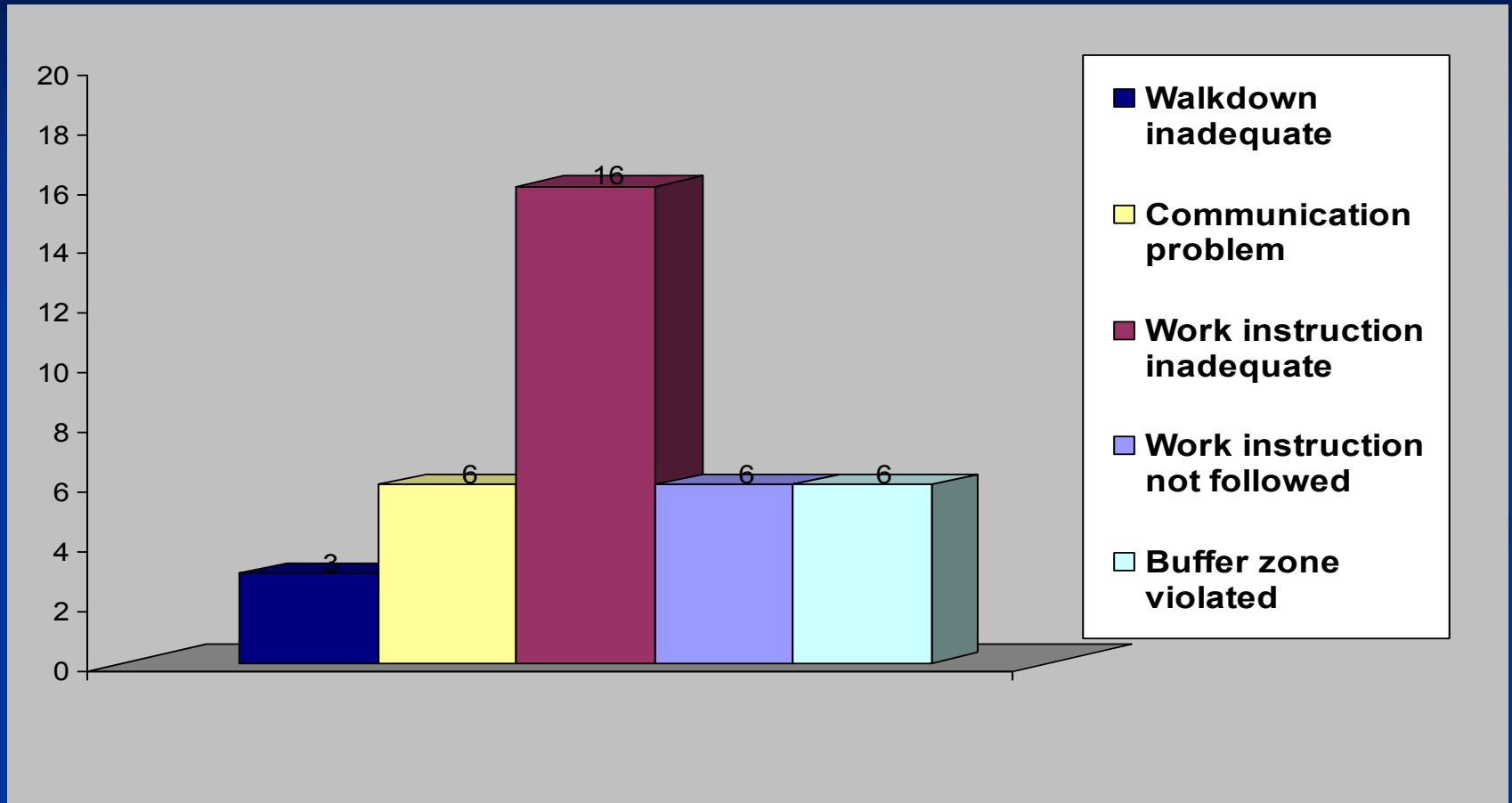


Figure 8. Issues/Factors

Error Type – Performance Shaping Factor

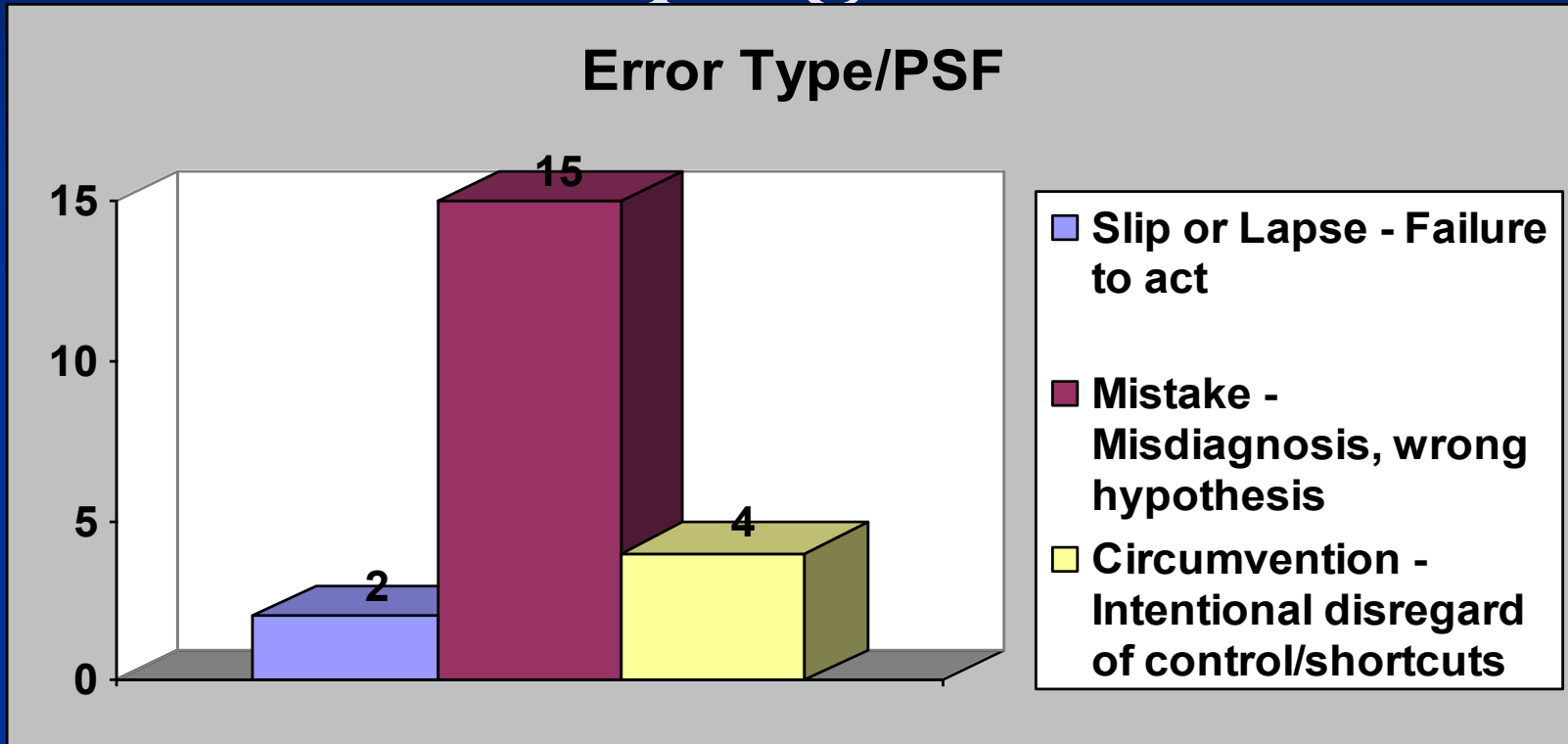


Figure 9. Error Type

Case Study

- A 2400 Volt line struck by auger during drilling and a flash is seen at one of the auger truck outriggers.
 - Subsurface survey using GPR fails to locate utilities in the yard.
 - Marked lines did not identify relative location of underground encumbrances.
 - Controlled drawing not used to complete the subsurface survey.
 - Underground Conduit & Grounding Plan and Details, shows seven (7) conduit in the direct vicinity of the failed excavation. Three run to a manhole and the other four run to a transformer.
- Result - inaccurate mental picture of the position of underground electrical equipment and intrusion into 2400 V utility.

Summary

Imperfect Tools and LTA Controls

- Technology for subsurface investigations have inherent limitations
- Drawings inaccurate, not available, not used
- Marking methods inconsistent
- Administrative barriers not used or adhered to (Buffer zones, warnings not heeded, etc.).
- Work planning and execution LTA
 - Communication problems
 - Mistakes and circumvention of controls
 - Hazards not eliminated or controlled (i.e., Failure to establish electrically safe conditions).

Work Planning

- Ensure work planning is methodical and properly documented.
- Walk-down areas and record location of surface encumbrances and compare to drawings
- Utilize an Up-to-Date Drawing in conjunction with a subsurface investigation.

Work Performance

- **Ensure First Line Supervision is onsite and approves the dig before digging.**
- **Conduct briefings and communicate expectations in meetings with staff**
 - Ensure those involved review the field map, drawing and subsurface survey to ensure a full understanding of the scope of work.
- **Change mindset from “Trust but Verify” to “Distrust until Verified”**
 - Default to LOTO/hand digging when there is any doubt.

No Blind Penetrations

1 1/4 inch allowance results in intrusion (basis appeared to be NEC).

Exceptions:

- Pre-cast concrete panels
- Thickness of cinder block wall. Do not penetrate into void - conduit may be inside channel
- Thickness of sheet rock
- 6 inches for machine grading?

Establish Buffer Zones

- **Depth is a critical factor in intrusions. Depth in the drawing may not be accurate.**
- Buffer zone should be established 360 degrees around commodity. Buffer zone should control vertical dimension for machine digging.
 - No machine digging until utilities have been positively identified by potholing or hand digging.
- **Suggestion:**
 - 5 ft for excavation after scanning
 - 1 foot for wall penetration after scanning

Mapping of Utilities

- **Field map the proposed excavation/trench:**
 - Define location of the system/utility and boundaries including dimensions and depths
 - Define all known (from drawings) commodity interferences within the proposed excavation and within buffer zone of earthen excavations/trenches
 - Define all interferences detected during the non-intrusive (GPR) survey.
- NOTE:** Non-intrusive surveys are not always accurate.

Subsurface Surveys

- Use a variety of subsurface technology

- Recognize limitations of subsurface technology.

NOTE: Non-intrusive surveys do not always detect all underground interferences. In order to obtain accurate readings the non-intrusive survey equipment must be used within manufacturer's specified limitations (e.g., ground moisture content, etc.).

90% is a good accuracy grade for the “outside” locating industry.

- If survey is suspect, default to hand digging methods.
- Evaluate for control of hazardous energy and consider potential impacts to facilities, equipment and personnel for all excavation work.

Scanning Pitfalls

- After uncovering utility
 - Rescan to ensure uncovered utilities are not “shadowed”
- Soil conditions, fences, overhead and underground encumbrances can affect survey.
- Over reliance on subsurface survey is an issue.

Identify Areas of High Risk

- Congested areas, substations, process equipment, etc.
 - When in a high risk area:
 - Default to hand digging/vacuum extraction
 - If machine digging must be done, the hazards must be mitigated first (i.e., establish an electrically safe work condition).
 - Ground equipment (high voltage)

Use Drawings

Use a drawing in conjunction with the subsurface survey.

- If configuration has not been maintained or drawing is not available:
 - Default to hand digging/vacuum extraction,
 - Eliminate all hazards and establish an electrically safe work condition.
- Exception: The excavation is planned in an unimproved/undeveloped area where it is known utilities do not exist.

Eliminate Future Hits

- **Remove abandoned buried utilities entirely.**
 - abandoned-in-place conduit and direct burial cables can be sources for future ORPS reporting (future “hits”).
- **Discourage conduit embedded in walls and slabs.**
 - If engineering deems necessary, ensure configuration of as-built drawings is maintained.
- **Discourage non-metallic conduit (PVC) for underground direct burial applications.**
 - Direct burial cable in PVC is difficult to locate and cables have to be energized to successfully locate in many cases.

GPS/Electronic Photographs

- Use electronic photos to supplement as-built files for configuration management. Some facilities attach them to their excavation permits, along with the mapped layout boundaries. Digital photos are inexpensive and can include GPS coordinates to identify location.
- GPS Survey Quality Instrument - \$50K
 - GPS markers installed with buried utilities can be encoded to GPS location as well as utility descriptive information.

Use Consistent Marking Methods

- Develop consistent underground utilities marking methods and use standard colors. This will improve location efficiency for future excavations marking.
 - Mark location of:
 - Utility, AND
 - Tolerance zones for hand digging and machine digging.

Establish Qualification Requirements

- Establish minimum qualification requirements for locators.
 - Personnel (contract and subcontract) need to be trained and qualified on each piece of equipment they use.
 - Locators need to be knowledgeable regarding limitation of technology.

Technology Improvement Needed

■ Technology for Scanning

- GPR
- Acoustic resonance, use of ambient vibrations
- Electrical conductivity, magnetometers
- Seismic reflective tomography
- Electromagnetic induction, multi-sensor arrays
- Electrical impedance tomography
- Gravitational field
- Nuclear methods
- Gas detection

Technology for Excavation

- Explore feasibility of proximity detection technology for excavators
- Robotics

Next Step

- Draft white paper/Revise Chapter 11
- Center for Excellence candidate
 - R&D Labs have expertise to help develop new and more reliable technology
 - Collaborate with Private Industry and Agencies
 - “Federal Laboratory Consortium for Technology Transfer”