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CONFINED SPACE RESCUE OPERATIONS
STANDARD OPERATING PROCEDURES

Executive Development

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An applied research project submitted to the National Fire Academy as part of the Executive Fire Officer Program

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ABSTRACT

The Vestavia Hills Fire Department did not have a standardized written procedure for operations at confined space emergencies. The purpose of this research project was to develop a standard operating procedure for operations at confined space incidents for the Vestavia Hills Fire Department. The author also explored the readiness of other fire departments in Alabama to perform confined space rescue. The research questions were as follows:

1. What regulations and national consensus standards exist concerning confined space rescue?
2. What type of equipment is needed for confined space rescue?
3. What components are needed for an effective confined space rescue SOP?
4. What is the state of readiness of the fire service within Alabama to perform confined space rescue?

These research questions were answered using the action and evaluative research methods. The action research method was utilized to develop a confined space standard operating procedure and a rescue equipment list for the Vestavia Hills Fire Department. The evaluative research method was used in determining, through a response survey, the readiness of other fire departments within Alabama. The need for fire departments to better prepare for confined space operations by embracing relevant OSHA regulations, consulting the NFPA standards of recommended practices, and developing and implementing standard operating procedures was indicated by this project.

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INTRODUCTION

The Vestavia Hills Fire Department is staffed by 65 paid members operating from four fire stations. The fire department provides several important services to the public, including fire suppression, emergency medical care, hazardous materials mitigation, and rescue. The department executes its tactical operations in these areas by providing the proper equipment, following good incident management principals, and using standard operating procedures (SOP). However, the Vestavia Hills Fire Department does not have a standard operating procedure for confined space rescue and has not identified specific rescue equipment needed for a confined space rescue operations.

The purpose of this Executive Fire Officer research project was to develop a standard operating procedure and a rescue equipment list for confined space rescue for Vestavia Hills Fire Department. The research also attempted to evaluate the readiness of other fire service agencies within the state of Alabama to perform confined space rescue. The action and evaluative research methods were used. This research consisted of an extensive literature review and a two part survey. The research process attempted to answer the following questions:

1. What regulations and national consensus standards exist concerning confined space rescue?
2. What type of equipment is needed for confined space rescue?
3. What components are needed for an effective confined space rescue SOP?
4. What is the state of readiness of the fire service within Alabama to perform confined space rescue?

BACKGROUND AND SIGNIFICANCE

The Vestavia Hills Fire Department has been operating for over 50 years and to date has not experience any firefighter fatalities related to emergency operations. The fire department's proactive approach to safety, awareness of safety issues, and practice of standard operating procedures (SOP's) are contributing factors to this safety record. In order to address the concerns and dangers of confined space rescue with the same diligence and care that has been shown in other areas of rescue, we must prepare our personnel to effect confined space rescue safely.

Before an SOP can be developed for confined space rescue, the problem must be researched. The Executive Fire Office Program of the National Fire Academy assisted this research by introducing the author of this report to the systematic problem-solving sequence covered in Unit 3 (Research) of the Executive Development course manual.

The confined space problem was identified many years ago, but regulatory actions were not started until the early 1970's when the Occupational Safety and Health Administration (OSHA) began promulgating the draft edition of 29 CFR 1910.146,
Titled "Permit Required Confine Spaces"(Tannembaum, 1993). In 1986, realizing the magnitude of the problem, the National Institute of Occupational Safety and Health (NIOSH) issued an "Alert" Titled "Request for Assistance in Preventing Occupational Fatalities in Confined Spaces" (NIOSH, 1986). This Alert requested the assistance of managers, supervisors, and workers in the prevention of casualties in confined spaces.

OSHA published its final rule for safe entry into confined spaces (29 CFR 1910.146) in January, 1993 with an implementation date of April 15, 1993 (Roughton, 1993).
The rule established a regulatory framework to protect employees who enter potentially hazardous confined spaces. OSHA estimated that the new rule would prevent 85 percent of the 63 fatalities and more than 5,000 serious injuries that occurred annually involving confined spaces. Careful review of

the standard reveals that OSHA based the rule on the American National Standards Institute (ANSI) standard 2117.1-1989, titled “Safety Requirements for Confined Spaces” (Bowman, 1993).

In a subsection of the confined spaces standard titled “Fatalities Due to Untrained Rescuers”, OSHA reported information on the hazards of allowing untrained rescuers to enter permit spaces (OSHA, 1993). OSHA concluded that, “where multiple deaths occurred, the majority of the victims in each event died trying to rescue the original entrant from a confined space”. OSHA determined that, “Employees who attempted to rescue fallen co-workers inside permit spaces were also unaware of the hazards involved and the procedures for safe rescue. The result of this lack of training was often the death of these employees”.

More than 60% of confined space fatalities occur among would-be rescuers (NIOSH, 1986). In September 1994, NIOSH issued an “Alert” titled “Preventing Injuries and Deaths of Firefighters” (NIOSH, 1994). To protect firefighters from injury and death NIOSH recommends that fire departments establish and implement an incident management system with written standard operating procedures for all firefighters. The system should include a well-coordinated approach to the emergency accountability of all firefighters, and provisions for their overall safety at the scene of the emergency.

Based on the knowledge of confined spaces and the hazards associated with them, the development of a confined space SOP in compliance with these recommendations will support the proactive effort toward firefighter safety at Vestavia Hills Fire Department while enhancing our ability to protect the people we serve.

LITERATURE REVIEW

To perform a comprehensive literature review, the following agencies, along with numerous periodicals & newspaper articles, were queried for information:

- Occupational Safety & Health Administration(OSHA)
- *National Fire Protection Association*(NFPA)
- National Institute of Safety & Health (NIOSH)
- *American National Standards Institute* (ANSI)

Fortunately there has been a substantial amount of research documented in this area of technical rescue. This section will review and discuss the defining characteristics of confined spaces, the unique hazards of confined space operations, and existing standards for confined space rescue as represented in current literature.

Characteristics of Confined Spaces

According to OSHA's standard for Permit-Required Confined Spaces for General Industry; (29 CFR 1910.146), the term "confined space" means a work area that:

1. is large enough and so configured that an employee can bodily enter and perform assigned work; and
2. has limited or restricted means for entry or exit; and
3. is not designed for continuous employee occupancy (OSHA, 1993).

According to OSHA (1993), a permit-required confined space, or permit space, means a confined space that has one or more of the following additional characteristics:

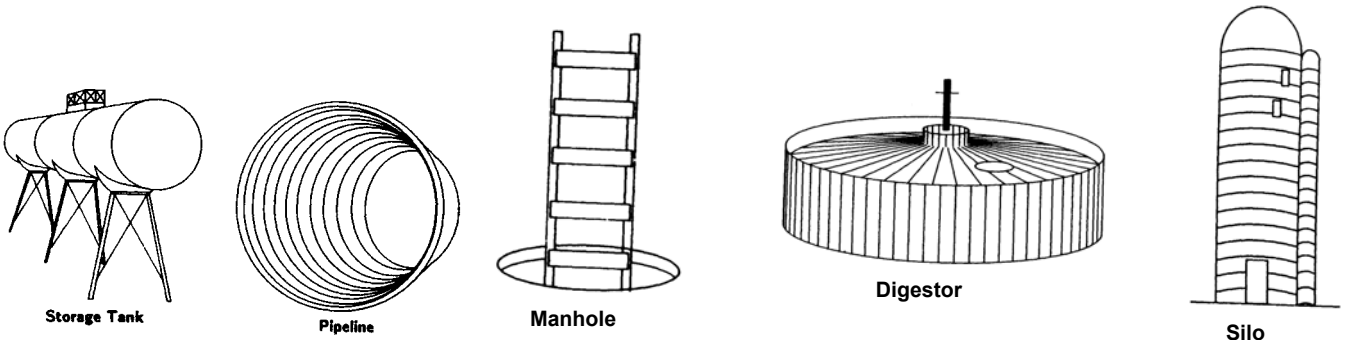
1. contains or has known potential to contain a hazardous atmosphere;
2. contains material with the potential for engulfing an entrant;
3. has an internal configuration such that an entrant could be trapped or asphyxiated by inwardly converging walls, or a floor that slopes downward and tapers to a smaller cross-section; or

4. contains any other recognized serious safety or health hazard.

A non-permit confined space is a confined space that does not contain or, with respect to atmospheric hazards, have the potential to contain any hazard capable of causing death or serious physical harm.

Confined spaces can masquerade in many different shapes and sizes, and can be found in a multitude of configurations. Many are located below ground, however some are found above ground, inside buildings, on the roads, railways and even on water. See table 1 and figure 1 for examples of confined spaces.

Figure 1
Examples of Confined Spaces



Source: National Institute of Occupational Safety and Health. (1994 January)

Hazards of Confined Spaces

According to Valcount and Gatland (1992), OSHA estimates that more than 2 million employees enter permit-required confined spaces in almost 225,000 workplaces each year. Approximately 50,000 emergency responses are required and 300 fatalities occur per year due to occupational confined space incidents.

Table 1

Typical Confined Spaces

Barges	Kilns and similar structures	Stacks
Boilers	Manholes	Steam Condensers
Caissons	Spaces more than 4 feet deep	Storage bins
Caves	Open topped tanks	Storm drains
Cisterns	Ovens	Tank trailers
Closed tanks	Pipelines and similar structures	Tank-like compartments
Degreasers	Pits	Trenches
Digestors	Pumping or lift stations	Tubs
Diked areas	Railroad tank cars	Tunnels (subway, vehicle)
Equipment housings	Septic tanks	Underground utility vaults
Storage tanks	Sewers	Vats
Furnaces	Shafts	Ventilation/exhaust ducts
Grain elevators	Ships' cargo holds	Vessels
Hoppers	Silos	

Source: Valcourt and Gatland (1992)

In addition to being able to recognize confined spaces, a rescuer must also be alert to, and able to identify, the hazards that may be encountered in confined space operations. These hazards include both atmospheric and physical hazards.

Atmospheric Hazards

According to Gallagher and Storment (1994) the greatest danger in confined spaces is hazardous atmospheres. Hazardous atmospheres can be divided into three categories: asphyxiating, flammable, and toxic.

Asphyxiating Atmospheres

OSHA (1993) defines the term "asphyxiating atmosphere" as an atmosphere that contains less than 19.5 percent oxygen. Below this concentration a person's respiratory function may be compromised

and such an atmosphere is therefore considered to be oxygen- deficient. Effects of oxygen deficiency are shown in table 2.

Table 2

Potential Effects of Oxygen-Deficient Atmospheres

Oxygen Content (Percent by Volume)	Effects and Symptoms (At Atmospheric Pressure)
19.5	(Minimum OSHA permissible oxygen level)
15 to 19	Decreased ability to work strenuously; may impair coordination and may induce early symptoms in people with coronary, pulmonary or circulatory problems
12 to 14	Respiration increases with exertion; increased pulse rate; impaired coordination, perception judgment
10 to 12	Respiration further increases in rate and depth; poor judgment; blue lips
8 to 10	Mental failure; fainting; unconsciousness; ashen face, blue lips, nausea and vomiting
6 to 8	Eight minutes-100-perpcent fatal; six minutes-50-percent fatal; four to five minutes-recovery with treatment
4 to 6	Coma in 40 seconds; convulsions; cessation of respiration; death

Source: Valcourt and Gatland (1992)

Vines (1996) reports that an industrial brigade firefighter in Cook County, Illinois died while attempting to rescue three construction workers who fell victim to an asphyxiating atmosphere while excavating a 13-foot-deep pit in preparation for pouring a cement floor and walls. Without monitoring the atmosphere or implementing safety precautions such as the use of a breathing apparatus, the firefighter entered the pit in an attempt to rescue the unconscious workers, and also fell victim to the oxygen-deficient atmosphere.

Walton (1998) reports the deaths of two workers in a similar tragic incident at a chicken plant, in Collinsville Alabama. According to John Hall, OSHA's Birmingham area director, the employees died

from a lack of oxygen after entering a trailer containing waste breading meal that had been frozen with carbon dioxide at the plant. Hall stated that oxygen was displaced by carbon dioxide when the breading was dumped into the trailer, creating the fatal environment.

In these two case histories, monitoring the atmosphere prior to entry could have prevented the death of 5 people, including one trained rescuer. Monitoring the atmosphere before entry into a confined space is a mandatory safety procedure.

Flammable and Explosive Atmospheres

OSHA considers an atmosphere to pose a serious fire or explosion hazard if a flammable gas or vapor is present at a concentration greater than 10% of its lower flammable limit (LFL) or if a combustible dust is present at a concentration that obscures vision at a distance of 5 feet, or less. A flammable atmosphere can also arise from oxygen-enriched atmospheres. Oxygen-enriched atmospheres are defined by OSHA as atmospheres containing more than 23.5 percent oxygen (see table 2).

NIOSH (1994, p. 37) reports an incident involving failure to monitor a potentially flammable/explosive atmosphere that occurred in November of 1984. One worker died from toxic effects after entering a toluene storage tank. During the rescue attempt, one firefighter was killed and several were injured when the tank exploded. Live footage of this tragic event was captured by a news reporter, and is featured in the video "Firefighter Safety" produced by the National Fire Academy (1986).

Toxic Atmospheres

In the third category of hazardous atmospheres, OSHA uses the term "toxic atmosphere" to refer to any atmosphere containing gases, vapors, or fumes known to have poisonous physiological effects. The most commonly encountered toxic gases are carbon monoxide (CO) and hydrogen sulfide (H_2S) as

shown in tables 3 and 4 . Toxic atmospheres may be caused by a manufacturing process, a product stored, or a work activity being performed in a confined space.

According to NIOSH (1994, p. 192) three volunteer firefighters died inside a well after being exposed to carbon monoxide from the exhaust of a portable gasoline engine-powered pump. The incident occurred after four firefighters from a volunteer fire department responded to a request from a local resident to remove the remains of a dead animal from a 33-foot-deep water well. The fire fighters decided to first pump the water out of the well (approximately 12 feet of water).

One fire fighter climbed down into the well on an aluminum ladder and built a wooden platform at the 15-foot level. A second fire fighter climbed down into the well to help position a 9-horsepower gasoline engine-powered pump as it was lowered down to the platform. The two fire fighters started the engine but were unable to prime the pump. Within a few minutes the first fire fighter became dizzy and exited the well. The second fire fighter remained in the well and became unconscious. In a rescue attempt the first fire fighter climbed back down into the well, turned the engine off, and then collapsed unconscious over the engine. By this time, the engine had run for approximately 8 to 9 minutes. Within minutes several other volunteer fire fighters responding to radio emergency calls arrived at the scene. Over the next 3 hours, eight volunteer fire fighters entered the well in rescue attempts. Only two of the rescuing fire fighters wore atmosphere-supplying respirators (SCBA type). The first fire fighter was rescued and revived. The second fire fighter and two other fire fighters attempting rescue died.

NIOSH investigators concluded that, in order to prevent similar occurrences, fire departments should develop standard operating procedures for confined space operations (NIOSH, 1990). Also recommended was the development of a general safety program and the mandatory use of respiratory protection when operating in areas where respiratory hazards could occur. To ensure fire fighters are prepared to safely perform confined space rescue, the investigators emphasized the need for confined space rescue training.

Table 3

Potential Effects of Carbon Monoxide Exposure

Parts per Million	Effects and Symptoms	Time
50	(Permissible exposure level)	8 hours
200	Slight headache, discomfort	3 hours
400	Headache, discomfort	2 hours
600	Headache, discomfort	1 hour
1,000 to 2,000	Confusion, headache, nausea	2 hours
1,000 to 2,000	Tendency to stagger	1 ½ hours
1,000 to 2,000	Slight palpitation of the heart	30 minutes
2,000 to 2,500	Unconsciousness	30 minutes
4,000	Fatal	Less than 1 hour

Source: Valcourt and Gatland (1992)

Table 4

Potential Effects of Hydrogen Sulfide Exposure

Parts per Million	Effects and Symptoms	Time
10	(Permissible exposure level)	8 hours
50 to 100	Mild eye irritation; marked respiratory irritation	1 hour
200 to 300	Marked eye irritation; marked respiratory irritation	1 hour
500 to 700	Unconsciousness; death	1 ½ to 1 hour
1,000+	Unconsciousness; death	Within minutes

Source: Valcourt and Gatland (1992)

Physical Hazards

Silensky (1992), categorizes physical hazards of confined spaces as those associated with (1) limited opportunities for entry and exit; (2) limited size of entry and exit points; (3) limited size of the confined space itself; (4) sharp objects; (5) irregular, dirty, and slippery walking surfaces and (6) stored flowing solids (sand, grain, gravel, etc.). The dangers of physical hazards and the configuration of confined spaces was tragically illustrated in an incident reported by NIOSH (1994, p. 203) in which a maintenance worker suffocated after being engulfed by sawdust in a silo. The worker apparently tripped and fell into a sloping passage leading to the stockpile of sawdust.

Energy sources are also serious hazards in confined space rescue, especially electrical energy. For example, NIOSH (1994 p. 248) reports a confined space incident in which an electrician was electrocuted when he contacted an energized conductor in a manhole in Virginia. This death could have been prevented by taking proper safety precautions including locking out the electrical source prior to entering the space.

Energy hazards must be eliminated altogether or isolated from the entrant or rescuer prior to entry. OSHA Standard 29 CFR 1910.147, Control of Hazardous Energy Sources, outlines lockout/tagout procedures and isolation techniques (OSHA, 1993). In addition to any maintenance lockout/tagout procedures in place at the time of a rescue, rescue personnel should also institute their own lockout/tagout procedures before entering a confined space. Tags used should identify who performed the lockout procedure and keys should be placed under the control of the incident commander. (CMC Rescue, Inc., 1996, p. 6-17).

The most important safety element to a confined space rescuer is that the energy source is abated prior to entering the space. See figure 2 for an example of a rescue lockout/tagout device.

Figure 2

Example of Electrical Lock Out/Tag Out Device

General Requirements of OSHA's Permit-Required Confined Spaces Standard

The OSHA regulations discussed in this report were published to prevent accidents during confined space operations (Grant, 1992). Industries that have permit-required confined spaces are obligated by federal law to make these spaces safe for workers. The failure of an employer to comply with OSHA mandates can bring expensive fines. Penalties for non-compliance can range from a simple warning to fines of $70,000 per day per violation.

According to the language of the OSHA 29 CFR 1910.146 standard, each employer who authorizes an employee to enter a permit space, must develop and implement a written permit-required confined space entry program (OSHA, 1993).

The entry permit that documents compliance with the section and authorizes entry to a permit space must identify:

1. the permit space to be entered;
2. the purpose of entry;
3. the date and the authorized duration of the entry permit;

4. the authorized entrants within the permit space, by name or by such other means as will enable the attendant to determine quickly and accurately, for the duration of the permit, which authorized entrants are inside the permit space;
5. the personnel, by name, currently serving as attendants;
6. the individual, by name, currently serving as entry supervisor, with a space for the signature or initials of the entry supervisor who originally authorized entry;
7. the hazards of the permit space to be entered;
8. the measures used to isolate the permit space and eliminate or control permit space hazards before entry;
9. the acceptable entry conditions;
10. the results of initial and periodic test, accompanied by the names or initials of the tester and by an indication of when the tests were performed;
11. the rescue and emergency services that can be summoned and the means for summoning those services;
12. the communication procedures used by authorized entrants and attendants to maintain contact during the entry;
13. equipment, such as personal protective equipment, testing equipment, communication equipment, alarm systems, and rescue equipment, to be provided for compliance with this section;
14. any other information whose inclusion is necessary, given the circumstances of the particular confined space, in order to ensure employee safety; and
15. any additional permits, such as hot work permits, that have been issued to authorize work in the permit space.

Rescue-Related Requirements of OSHA's Permit-Required Confined Spaces Standard

OSHA estimates that about 2.1 million workers enter dangerous confined spaces each year for various reasons (Valcourt and Gatland, 1992 p. 27). Subsequently, some of these entries result in an accident and require a rescue.

In the event that rescue is required from a permit-required confined space, the rescuers must quickly obtain the entry permit and begin to formulate a rescue plan from the information provided on the permit (see Appendix C for a sample permit).

Permits are only required to list equipment needed for routine work in confined space entry operations. As outlined in 29 CFR1910.146 paragraphs (d) (4) (1) through(d) (4) (ix), this equipment includes the following:

- Testing and monitoring equipment
- Communicating equipment
- Lighting equipment
- Other equipment, such as ladders
- Ventilating equipment
- Personal protective equipment
- Barriers and shields

However, the standard does not specify equipment that may be required by fire departments to effect a confined space rescue.

Further investigation of the literature reveals that OSHA has issued an amendment to the 1910.146 standard that became effective February 1, 1999. The revised standard addresses concerns for confined space rescue in paragraph (k), Rescue and Emergency Services. The revised standard also contains a new non-mandatory Appendix F, intended to clarify the rescue service's responsibilities in confined space emergencies. Excerpts from Appendix F of 1910.146 are included in Appendix D of this report.

As noted by Roop (1999), this OSHA update is significant to both host employers and employers of rescuers, including municipal rescue services. States that have developed their own occupational safety and health plans (see table 5) already require municipal and state agencies to comply with federal OSHA standards or equivalent state standards. These standards include paragraphs (g) titled "Training" and (k) titled "Rescue and Emergency Services" of OSHA's revised confined space regulation. Federal

OSHA has no regulatory authority over public sector employers in the states that have not established state occupational safety and health plans. However, public agencies in the "non-state plan" states will also, in effect, need to comply with the requirements of the revised regulation if they agree to provide rescue services for permit-required confined space operations. This need is based on the fact that they have agreed to be evaluated for their qualifications as well as agreeing to submit to a performance evaluation by the host employer's 'qualified party." They cannot be selected as the designated rescue service unless they meet OSHA's requirements as a rescue service.

Municipal administrators should take note of their liability exposure once they have agreed (or "contracted") to assume this rescue responsibility. In short, OSHA has now made it very clear that employers are required to determine that rescue services are rescue capable, both on paper and in the flesh!

Table 5

States That Developed Their Own Occupational Safety and Health Plans

Alaska	Michigan	Tennessee
Arizona	Minnesota	Utah
California	Nevada	Vermont
Connecticut	New Mexico	Virginia
Hawaii	New York	Virgin Islands
Indiana	North Carolina	Washington
Iowa	Oregon	Wyoming
Kentucky	Puerto Rico	
Maryland	South Carolina	

Source: OSHA, (29 CFR 1910.120)

Other Standards Pertaining to Confined Space Rescue Operations

In addition to the OSHA regulations, there are other documents that must be explored before the components of a confined space rescue SOP can be created. The National Fire Protection Association (NFPA) has published several consensus standards pertaining to firefighter safety at confined space incidents. These standards are NFPA 1500, 1670, and 472.

Also, NFPA 1006, 2000 Edition, Standard for Rescue Technician Professional Qualifications, is presently a draft document (NFPA, 1999). This standard is set to be voted on and accepted as written in the Fall of 1999. Excerpts from relevant NFPA standards are included in Appendix E.

Standard Operating Procedures for Confined Space Rescue Operations

A review of the standards discussed above indicates that standard operating procedures (SOP) for confined space emergencies are vital for safe and effective operations. The SOP must provide guidance for hazard identification, testing and evaluation, entry procedures, ventilation, breathing apparatus, protective equipment, and rescue and removal systems (not only for the victim, but for the rescuer as well). With this in mind the author researched the literature seeking sources that would provide a format or a sample document for an SOP.

As noted by Cook (1999), a SOP manual may be written in any of an unlimited number of formats. However, it is important to choose a format that fits the department's needs. Borrowing someone else's format is permissible, as long as it is not copyrighted. A sample of Cook's SOP format is presented in figure 3. The SOP example format listed in the text titled, "Confined Space Entry and Rescue" by CMC Rescue, Inc. (1996, p.ii-xv), was developed by the Phoenix Fire Department. Both of these SOP formats were instrumental in this research project.

Figure 3
Sample SOP Format

Name Department **SOP Number** **Section or Subject** **Issue: Month/Year** **Page 1 of N** **Revised: Month/Year** **TITLE**
Scope: This section defines the subject or topic to be addressed by the standard and identified the members of the department that are affected by the provision of the Standard.
Purpose: This section provides the user with the reason for the development and promulgation of the Standard.
General: This section may contain statements of policy if not addressed by a separate heading and may include background information about this topic.
Statement of Policy or the Procedure or Guideline to be Followed: This section identifies the tasks that should be performed, specifies who should perform specific tasks and list the order in which the tasks should be performed. More than one section may necessary to address a complex topic. For example, a SOP on the operation of power saws may address the operating procedure in one section and may require that additional sections be included on fueling procedures, maintenance and safety precautions.
Responsibility: This section assigns responsibility to specific individuals and groups for complying with the provisions of the standard and establishes a mechanism for holding members accountable for complying with the Standard.

Equipment Required for Confined Space Rescue Operations

Specific rescue equipment will vary according to the internal configuration of the space and the hazards that are found upon arrival (Bentivoglio, 1998). The equipment requirements of OSHA's revised confined space standard are performance-based, requiring employers to provide rescuers with the equipment they would need to respond to a confined space incident.

Although rescue equipment requirements may vary with the hazards and configurations of confined spaces, there are a number of commonly-required pieces of rescue equipment that should be included in every rescue departments inventory. According to Gallagher and Storment (1994), the following rescue equipment is needed for confined space rescue operations:

- atmospheric monitors
- ventilation equipment
- personal protective equipment
- communication equipment
- retrieval systems
- extrication devices
- lighting equipment
- energy hazard controls
- elevation rescue equipment
- patient paxoginy devices

Based on these recommendations, a specific confined space rescue equipment list was developed and is included as Appendix F.

Summary of Findings in Literature Review

In summary, the literature review reinforced the need for the fire service to extend their routine pre-incident planning efforts to include confined space rescue operations. The existing literature also emphasized that it is important for would-be rescuers to be able to recognize a confined space, identify

the hazards that may be present, utilize proper equipment to abate or isolate the hazards, and utilize proper procedures to ensure a safe rescue. Literary research identified several existing standards that provide excellent guidance in achieving all these requirements.

The literature review emphasized the need for standard operating procedures to be developed and followed during confined space operations and provided this project with a sample document. The literature review also reinforced the need for specialized training for personnel involved in confined space rescue operations.

PROCEDURES

The literature review provided important information that was used in answering research questions 1, 2, and 3, and developing Confined Space Rescue SOP for Vestavia Hills Fire and Rescue, as discussed in the following section. Research for this project also included an evaluation of the Vestavia Hills Fire Department rescue equipment inventory. This equipment inventory, along with information generated through the literature review, was utilized in developing the Confined Space Rescue Equipment list, as discussed in the following section.

In order to assess the state of readiness of the fire service in Alabama to perform confined space rescue, a single page, two part survey was developed.

The survey consisted of five confined space rescue response questions and three rescue equipment questions (see appendix B). These questions required a response of either yes or no, or check mark(s). The survey was developed to assist the author in determining the confined space rescue capability of other fire departments within the state of Alabama and to identify rescue equipment utilized by those departments. To encourage responses to the survey, the author offered to provide any interested department with a copy of the SOP (see appendix G) and/or the equipment list (see appendix F) developed from the applied research project.

The survey was mailed in June, 1999, to 85 fire chiefs using a mailing list provided by the Alabama Fire Chief's Association. The mailing included career, volunteer, and combination departments from across the state. The mailout included the four largest fire departments in the state.

The two-part survey had some notable limitations. One limitation was that not every fire department in the state was surveyed. This was found to be logistically and financially prohibited. Another limitation was that, since respondent fire departments were not asked to identify themselves, it is not known if a representative sample was achieved with regard to size, location, and type (i.e. paid, volunteer, or combination) with the state. Another limitation is that it is not known if all respondents answered the questionnaire truthfully.

RESULTS

Answers to Research Questions

1. What regulations and national consensus standards exist concerning confined space rescue?

- Occupational Safety and Health Administration (OSHA) standards

  29 CFR 1910.146, Permit Required Confined Spaces

  29 CFR 1910, 147, Control of Hazardous Energy Sources

- National Fire Protection Association (NFPA) standards

  NFPA 1500, Standard on Fire Department Occupational Safety & Health

  NFPA 1670, Standard on Operations and Training for Technical Rescue Incidents

  NFPA 472, Standard for Professional Competence of Responders to Hazardous Materials Incidents

  NFPA 1006, Standard for Rescue Technician Professional Qualifications

OSHA promulgated the standards, 1910.146 and 1910.147 to better protect employees who enter potentially hazardous confined spaces. Compliance with these OSHA standards or equivalent standards by public agencies is mandated by law in states that operate under state occupational safety and health plans. However, public agencies are not legally required to comply with OSHA regulations in states such as Alabama that are regulated by federal OSHA. While the NFPA standards are not mandated by law, they are considered the "benchmark" for operational standards for the fire service.

2. What type of equipment is needed for confined space rescue?

It was clear from the literature review that rescue equipment requirements are dictated by the hazards and configurations of the confined spaces within the area of coverage. This information is best found during pre-incident planning. Responses to the survey support this conclusion. Various sources

in the literature review identified the same equipment requirements that respondents reported in the survey.

The OSHA confined space standard identified equipment it requires for confined space entry. The non-mandatory appendix F of the standard also provides helpful criteria for fire departments in assessing their response capability. Predicting rescue operations that may be required allows the identification of specific pieces of equipment that should be available. Using all of these resources and the existing rescue equipment inventory of the Vestavia Hills Fire Department a confined space rescue equipment list was developed and is included as appendix F to this report.

3. What components are needed for an effective confined space rescue SOP?

The key components of a standard operating procedure must include language to assure that the safety of rescuers is maintained at all times. This includes the requirement of pre-planning all confined spaces in the area of coverage. The policy should also include a "definition" section to ensure that the unique hazards of confined spaces are clearly understood. Finally, the SOP must also include sections required by the AHJ to be consistent with the department's other operational policies such as "emergency radio traffic, " and "accountability" procedures.

Using the SOP model and other relevant information found through the literature review a standard operating procedure for confined space rescue operations was developed for the Vestavia Hills Fire Department and is included as Appendix G to this report. The SOP and equipment list for confined space rescue were reviewed and affirmed by the Chief of the department on October 15, 1999. Final implementation of the SOP will conclude with the training of personnel. These training sessions are scheduled to begin immediately.

4. What is the state of readiness of the fire service within Alabama to perform confined space rescue?

Data provided by 48 fire departments that responded to the survey were used in answering this question. These 48 fire departments represented a wide range of populations served and types of

service. The department size and types ranged from no paid personnel to more than 600 personnel and from all volunteer departments to all paid departments (survey item 2).

Thirty six of the 48 respondent fire departments reported that they provide confined space rescue (survey item 1). However, of these 36 fire departments, only five reported having a confined space SOP. Twelve of the 48 fire departments reported they did not provide confined space rescue. Only six fire departments of the 48 reported spending more than 24 hours annually in training (survey item 5). Eleven fire departments requested a copy of the SOP when completed. The survey listed a variety of opinions concerning ventilation and rescue equipment, but Self Contained Breathing Apparatus (SCBA) remained the primary method of respiratory protection used by the fire departments that responded.

DISCUSSION

Through this research project the author explored and examined the information available on confined space operations. The literature review was comprehensive and broad in this subject area. The National Fire Protection Association offered several recent editions of recommended practices pertaining to confined space operations. The Occupational Safety and Health Administration promulgated two of the most important documents to date, 29 CFR 1910.146 and 29 CFR 1910.147. These two standards, especially the non-mandatory appendix F to 29 CFR 1910.146, were instrumental in the development of this project. Although public sector agencies are not legally required to comply with OSHA standards in "non-state plan states" many departments located in those states have determined that this important safety regulation should be adopted by their organization since it will become the "measuring stick" by which they may be judged in the event of a firefighter fatality or injury (Sears, 1998). The intent of the regulation is clear: provide for the safest operational environment that can reasonably by attained. The author of this report agrees with Sear's viewpoint and urges other fire departments to consult these regulations in developing their safety procedures.

Equipment requirements for confined space rescue vary greatly, as discovered through the literature review and the survey. The basic inventory recommended by Gallagher and Storment (1994) was supported by other findings in the literature review and the respondents to the survey. The consensus of the findings indicated that equipment requirements are performance-based and vary with the hazards and configurations of the spaces from which rescue may be required.

The equipment list included in Appendix F was developed based on the results of the literature review, preplanning information, and the present equipment inventory of the Vestavia Hills Fire Department. Other response agencies may need to modify this list based on needs identified through preplanning efforts within their jurisdiction.

Results of the survey conducted for this project indicate that a high percentage of fire departments in Alabama may be conducting confined space operations without standard procedures, and with little

time spent on training. In an attempt to raise awareness about these deficiencies, the author of this project wrote an article titled "Confined Spaces Deadly Places" (see appendix H). The article consisted of an overview of confined spaces and the hazards they present. Through a familiar tragic incident and the results of the NIOSH study previously cited, the article also pointed out the need for training and SOPs. The author also related the low percentage of SOP's reported in the survey. The lack of training was addressed and recommendations were made. The intent of the article was to raise awareness about the confined space problem and offer all fire departments interested a copy of the SOP and equipment list developed in the project. The article was submitted to three fire publications: "The Bugle" (Alabama Fire Chief Association), "Command Post" (Alabama Firefighters Association), and "The Volunteer" (Alabama Association of Volunteer Fire Departments).

RECOMMENDATIONS

The following recommendations are based on an extensive search of applicable literature, federal regulations, national consensus standards, and a response survey conducted by the author:

Recommendation 1. Fire departments providing confined space rescue should embrace the applicable OSHA regulations and incorporate them into their policies and procedures. NFPA standards of recommended practice should be consulted for guidance in establishing the requirements for an effective training program.

Recommendation 2. Fire service training officers should explore training and educational opportunities for confined space rescue. Some institutions offer inexpensive confined space training to public sector emergency response agencies.

Recommendation 3. Fire service managers should begin determining their department's confined space rescue capability immediately. Once this is determined the selection of the proper equipment and the development of standard operating procedures can proceed.

CONCLUSION

The need for all fire departments to better prepare for safe confined space operations was identified in the NIOSH "Alert" publication in 1986 and again in 1994. The need for more emphasis on safety in confined space operations was the urgent message. Fire departments were advised by NIOSH to develop and implement standard operating procedures. The response survey conducted for this project appears to indicate that few departments within Alabama have complied with the NIOSH recommendation.

As noted by Grant (1991), "It's time to get serious about confined space rescue operations, just as we got serious about vehicle rescue operations in the late 70's and HAZMAT operations in the late 80's. First, learn where confined spaces are in your service area, and what dangers they pose to workers and rescuers.

If you find that your organization will be called to respond, review your equipment and add specialty items to the inventory as needed. Then train until you think your people have trained enough, then train some more! Train in the actual confined spaces during shutdown periods, and what's more important, participate in the procedures designed to make the space safe. And don't forget to train in patient packaging, patient moving, and rope rescue procedures. Moving a sick or injured person from the opening of a structure or vessel to ground floor level may be the most difficult part of a confined space operation."

In conclusion, the author of this report agrees with Grant on the need to be fully committed to adequate preparation before dealing with confined space operations. This report has been the first step in a series of proactive measures to ensure the safety of all personnel through training, proper equipment, and developing and following standard operating procedures in the Vestavia Hills Fire and Rescue Department.

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Appendix A
Cover Letter for Response Survey

Dear Chief;

My name is Sam Hansen and I need your assistance! I service as a Fire Captain with the Vestavia Hills Fire Department. Part of my responsibilities with the City of Vestavia Hils is to participate in the Executive fire Officer Program at the National Fire Academy. An important part of the program is to develop an applied research paper and implement the results in my department. My research topic is confined space rescue.

The National Institute for Occupational Safety and Health (HIOSH), reports a full 60 percent of all confined space deaths occur among would-be rescuers. Many of these fatalities might have been prevented by following standard operating procedures.

My objectives with this research project is to explore the typical degree of readiness of the fire service to perform confined space rescue within Alabama and to develop a set of standard operating procedures for permit-required confined space rescue operations for the Vestavia Hills Fire Department.

Attached to this letter you will find a questionnaire entitled, “Confined Space Rescue, SOP’S. Please take a few minutes and complete this form and return it to me by June 25, 1999. Also, if your department has a confined space SOP, please include a copy of it. If your department would like to have a copy of the SOP that I develop during this project I will be glad to forward it by request. For your convenience I have provided a self-addressed, stamped envelope.

Thank you for your assistance in this important matter. Please contact me if you have any questions.

Appendix B
Confined Space Response Survey

Confined Space Rescue SOP's

Response Questions:

1. Does your department provide confined space rescue? **YES_____NO_____**

2. Check the statement below which most accurately describes the type of staffing your department operates on a daily basis.

   Career___Volunteer___Combination___other___

3.Does your department currently have a SOP in-place for confined space rescue **YES___NO___.**

4.Does your department have a dedicated confined space rescue team? **YES___NO___**

5.How many hours of confined space training do your response personnel receive annually?

8___10___12___16___>24___

Equipment questions:

1. What types of rescue equipment does your department use at confined space rescues?

Ropes_____Harnesses_____Tripod/Winch_____Pulleys&Hardware_____

2. What type of air supplied respiratory equipment does your department use at a confined space rescue?

SCBA___SAR___Combination___

3. What type of ventilation equipment does your department use at a confined space rescue?

Smoke ejector___power blower___other___

Appendix C
Entry Permit

PERMIT VALID FOR 8 HOURS ONLY. ALL COPIES OF PERMIT WILL REMAIN AT JOB SITE UNTIL JOB IS COMPLETED.

DATE: _____ SITE LOCATION AND DESCRIPTION: _____

PURPOSE OF ENTRY:_____

SUPERVISOR(S) IN CHARGE OF CREWS: _____ TYPE OF CREW PHONE # _____

COMMUNICATION PROCEDURES: _____

RESCUE PROCEDURES (PHONE # AT BOTTOM): _____

***BOLD DENOTES MINIMUM REQUIREMENTS TO BE COMPLETED AND REVIEWED PRIOR TO ENTRY ·**

REQUIREMENTS COMPLETED	**DATE**	**TIME**	**REQUIREMENTS COMPLETED**	**DATE**	**TIME**
LOCK OUT/DE-ENERGIZE/TRY-OUT	_____	_____	**FULL BODY HARNESS *WI"D"* RING**	_____	_____
LINE(S) BROKEN-CAPPED-BLANKED	_____	_____	**EMERGENCY ESCAPE RETRIEVAL EQUIP**	_____	_____
PURGE-FLUSH AND VENT	_____	_____	**LIFELINES**	_____	_____
VENTILATION	_____	_____	FIRE EXTINGUISHERS	_____	_____
SECURE AREA (POST AND FLAG)	_____	_____	LIGHTING (EXPLOSIVE PROOF)	_____	_____
BREATHING APPARATUS	_____	_____	PROTECTIVE CLOTHING	_____	_____
RESUSCITATOR - INHALATOR	_____	_____	**RESPIRATOR(S) (AIR** PURIFYING)	_____	_____
STANDBY SAFETY PERSONNEL	_____	_____	**BURNING AND WELDING** PERMIT	_____	_____

NOTE: ITEMS THAT DO NOT APPLY ENTER N/A IN THE BLANK.

·· RECORD CONTINUOUS MONITORING RESULTS EVERY 2 HOURS

CONTINUOUS MONITORING TEST(S) TO BE TAKEN	PERMISSIBLE ENTRY LEVEL	MONITORING RESULTS EVERY 2 HOURS							
PERCENT OXYGEN	19.5% TO 23.5%	_____	_____	_____	_____	_____	_____	_____	_____
LOWER FLAMMABLE LIMIT	UNDER 10%	_____	_____	_____	_____	_____	_____	_____	_____
CARBON MONOXIDE	35 PPM	_____	_____	_____	_____	_____	_____	_____	_____
HYDROGEN SULFIDE	10 PPM~ 15 PPM*	_____	_____	_____	_____	_____	_____	_____	_____
SULFUR DIOXIDE	2 PPM~ 5 PPM*	_____	_____	_____	_____	_____	_____	_____	_____

· SHORT-TERM EXPOSURE LIMIT: EMPLOYEE CAN WORK IN THE AREA UP TO 15 MINUTES.

+ 8 HR. TIME WEIGHTED AVG.: EMPLOYEE CAN WORK IN AREA 8 HRS. (LONGER WITH APPROPRIATE RESPIRATORY PROTECTION).

REMARKS: _____

GAS TESTER NAME & CHECK #	INSTRUMENT(S) USED	MODEL &/OR TYPE	SERIAL &/OR UNIT #
_____	_____	_____	_____
_____	_____	_____	_____

SAFETY STANDBY PERSON IS REQUIRED FOR ALL CONFINED SPACE WORK

SAFETY STANDBY PERSON(S)	CHECK #	CONFINED SPACE ENTRANT	CHECK #
_____	_____	_____	_____
_____	_____	_____	_____

SUPERVISOR AUTHORIZATION_____ AMBULANCE # _____ FIRE # _____
ALL CONDITIONS SATISFIED_____ SAFETY OFF # _____GAS COORDINATOR #_____
DEPARTMENT_____ PHONE _____

Source: Occupational Safety and Health Administration: Standard 29 CFR 1910.146, Appendix D-1C

Appendix D
Selected Excerpts From Appendix F, 29 CFR 1910.146

Note: Only excerpts directly relevant to this project were selected from Appendix F.

Rescue Service Evaluation Criteria

1. This appendix provides guidance to employers in choosing an appropriate rescue service. It contains criteria that may be used to evaluate the capabilities both of prospective and current rescue teams.
2. For all rescue teams or services, the employer's evaluation should consist of two components: An initial evaluation, in which employers measure the performance of the team or service during an actual or practice rescue and whether such rescuers can respond in a timely manner, and a performance evaluation, in which employers measure the performance of the team or service during an actual or practice rescue.

Initial Evaluation

7. For rescues into spaces that may pose significant atmospheric hazards and from which rescue entry, patient packaging and retrieval cannot be safely accomplished in a relatively short time (15 to 20 minutes), employers should consider using airline respirators (with escape air cylinders) for the rescuers and to supply rescue to the patient. If the employer decides to use SCBA, does the prospective rescue service have an ample supply of replacement cylinders and procedures for rescuers to enter and exit (or be retrieved) well within the SCBA's air supply limit?

8. If the space has a vertical entry over 5 feet in depth, can the prospective rescue service properly perform entry rescues? Does the service have the technical knowledge and equipment to perform rope work or elevated rescue, if needed?
9. Does the rescue service have the necessary skills in medical evaluation patient packaging and emergency response?
10. Does the rescue service have the necessary equipment to perform rescue, or must the equipment be provided by the employer or another source?

Performance Evaluation

1. Have all member of the service been trained as permit space entrants, at a minimum, including training in the potential hazards of all permit spaces, or of representative permit spaces, from which rescue may be needed? Can team members recognize the signs, symptoms, and consequences of exposure to any hazardous atmospheres that may be present in those permit spaces?

2. Is every team member provided with, and properly trained in, the use and need for PPE, such as SCBA or fall arrest equipment, which may be required to perform permit space rescues in the facility? Is every team member properly trained to perform his or her functions and make rescues, and to use any rescue equipment, such as ropes and backboards, that may be needed in a rescue attempt?

3. Are team members trained in the first aid and medical skills needed to treat victims overcome or injured by the types of hazards that may be encountered in the permit spaces at the facility?

4. Do all team members perform their functions safely and efficiently? Do rescue service personnel focus on their own safety before considering the safety of the victim?

5. If necessary, can the rescue service properly test the atmosphere to determine if it is IDLH?

6. Can the rescue personnel identify information pertinent to the rescue from entry permits, hot work permits, and MSDSs?

7. Has the rescue service been informed of any hazards to personnel that may arise from outside the space, such as those that may be caused by future work near the space?

8. If necessary, can the rescue service properly package and retrieve victims from a permit space that has a limited size opening (less that 24 inches (60.9 cm) in diameter), limited internal space, or internal obstacles or hazards?

9. If necessary, can the rescue service safely perform an elevated (high angle) rescue?

10. Does the rescue service have a plan for each of the kinds of permit space rescue operations at the facility? Is the plan adequate for all types of rescue operations that may be needed at the facility? Teams may practice in representative spaces, or in spaces that are "worst-case" or most restrictive with respect to internal configuration, elevation, and portal size. The following characteristics of a practice space should be considered when deciding whether a space is truly representative of an actual permit space:

(1) Internal configuration.

(a) Open—there are no obstacles, barriers, or obstructions within the space. One example is a water tank.

(b) Obstructed—the permit space contains some type of obstruction that a rescuer would need to maneuver around. An example would be a baffle or mixing blade.

Large equipment, such as a ladder or scaffold, brought into a space for work purposes would be considered an obstruction if the positioning or size of the equipment would make rescue more difficult.

(2) Elevation.

(a) Elevated—a permit space where the entrance portal or opening is above grade by 4 feet or more. This type of space usually requires knowledge of high angle rescue procedures because of the difficulty in packaging and transporting a patient to the ground from the portal.

(b) Non-elevated—a permit space with the entrance portal located less than 4 feet above grade. This type of space will allow the rescue team to transport an injured employee normally.

(3) Portal size.

(a) Restricted—A portal of 24 inches or less in the least dimension. Portals of this size are too small to allow a rescuer to simple enter the space while using SCBA. The portal size is also too small to allow normal spinal immobilization of an injured employee.

(b) Unrestricted—A portal of greater than 24 inches in the least dimension. These portals allow relatively free movement into and out of the permit space.

(4) Space access.

(a) Horizontal—The portal is located on the side of the permit space. Use of retrieval lines could be difficult.

Vertical—The portal is located on the top of the permit space, so that rescuers must climb down, or the bottom of the permit space, so that rescuers must climb up to enter.

Appendix E
Excerpts From Relevant NFPA Standards

Note: The following excerpts are directly quoted from these standards.

NFPA 1500, 1997 Edition, Standard on Fire Department Occupational Safety and Health

Chapter 3-4.2 The fire department shall develop written standard operating procedures that describe the action to be taken in situations involving special operations and shall include these standard operating procedures in the advanced training and education program.

NFPA 1670, 1999 Edition, Standard on Operations and Training for Technical Rescue Incidents

Chapter 2 General Requirements

2-1.1 The authority having jurisdiction (AHJ) shall establish levels of operational capability needed to conduct operations at technical rescue incidents safely and effectively based on hazard analysis, risk assessment, training level of personnel, and availability of internal and external research.

2-1.2 The AHJ shall establish written SOP's consistent with one of the following operational levels.

(a) Awareness

(b) Operations

(c) Technician

2-1.3 The AHJ shall establish operational procedures to ensure that technical rescue operations are performed in a safe manner consistent with the identified level of operations/capability.

Chapter 5 Confined Space

5-1 General Requirements

5-1.1 Organizations operating at confined space incidents shall meet all the requirements specified in Chapter 2 of this standard.

5-2.1 Organizations operating at the awareness level shall meet the requirements of Sections 4-2 and 5-2 of this document and Chapter 2 of NFPA 472, *Standard for Professional Competence of Responders to Hazardous Materials Incidents*. Organizations at this level shall be responsible for performing certain non-entry rescue retrieval operations.

5-3 Operations

5-3.1 Organizations operating at the operations level shall meet the requirements of Sections 5-2 and 5-3. The organization at this level shall be responsible for the development and training of a confined space rescue team consistent with the requirements of this section.

5-3.2 Organizations operating at the operations level shall meet all operations-level requirements specified in Section 4-3 and the requirements of a confined space rescue team as defined herein. In addition, organizations operating at the operations level shall meet all requirements specified in Section 9-3.

5-4 Technician.

5-4.1 Organizations operating at the technician level shall meet the requirements of Sections 5-2, 5-3, and 5-4. The organization at this level shall be responsible for the development and training of a confined space rescue team consistent with the requirements of this section.

NFPA 1006, 2000 Edition, Standard for Rescue Technician Professional Qualification

Chapter 7 Confined Space Rescue

7-1 General. The job performance requirements defined in 7-1.1 through 7-1.9 shall be met prior to certification in confined space rescue.

7-1 General. The job performance requirements defined in 7-1.1 through 7-1.9 shall be met prior to certification in confined space rescue.

7-1.1 Preplan a confined space incident, given applicable guidelines and regulations and a preplan form, so that a safe, standard approach is used during a confined space rescue emergency, hazards are recognized and documented, isolation methods are identified and documented, all accesses to the location of the entry opening are identified and documented, all types of entry openings are identified and documented and internal configurations and special resource needs are documented for future rescuer use.

(a) Requisite Knowledge: Operational protocols, specific preplan forms, types of hazards common to jurisdictional boundaries, hazards that should and must be identified on preplans, isolation methods and issues related to preplanning, considerations and

constraints relating to the types of confined space opening, internal configuration special resource needs of a confined space, and applicable legal issues.

(b) Requisite Skills: The ability to select a specific preplan form; draft or draw a sketch of confined spaces; complete supplied forms; identify and evaluate various configurations of confined spaces, access points, entry openings, isolation procedures, and energy control locations; recognize general and site-specific hazards; document all data; and apply all regulatory compliance references.

7-1.2* Assess the incident, given a preplan of the space or size-up information, information from technical resources, monitoring equipment, and personal protective equipment necessary to perform the assessment, so that general area and space-specific hazards can be identified, bystanders and victims are interviewed, immediate and ongoing monitoring of the space is performed, the victims' conditions and location can be determined, a risk/benefit analysis can be performed, methods of ingress and egress for rescuer and victims are identified, rescue systems for victim removal are determined, and an emergency means of retrieval for rescue entrants can be established.

(a) Requisite Knowledge: Use of preplans, size-up, and interviewing techniques; types of personal protective equipment; monitoring equipment protocols, rescue and retrieval systems; the impact of permit programs; types of and uses for available resources; risk/benefit analysis methods; common hazards and their influence on the assessment; methods to identify egress and ingress into the space; and processes to identify size, type, and configuration of the opening(s) and internal configuration of the space.

(b) Requisite Skills: The ability to select and interpret preplan and size-up information, conduct interviews, choose and utilize personal protective equipment, operate monitoring equipment, identify hazard mitigation options, identify probable victim location, perform risk/ benefit analysis, recognize characteristics and hazards of confined spaces, and evaluate specific rescue systems for entry and retrieval of rescuers and victims during confined space incidents.

7-1.3* Conduct monitoring of the environment, given monitoring equipment reference material, personal protective equipment, properly calibrated detection and monitoring equipment, and size-up information, so that a representative sample of the space is obtained, accurate readings are made, readings are documented, and effects of ventilation in determining atmospheric conditions and the conditions of the space have been determined for exposures to existing or potential environmental hazards.

(a) Requisite Knowledge: Capabilities and limitations of detection and monitoring equipment, ways to confirm calibration, defining confined space configuration as it applies to obtaining a representative sample of space, basic physical properties of contaminants, and how to determine contents of a confined space.

(b) Requisite Skills: The ability to use and confirm calibration of detection and monitoring equipment and acquire representative sample of space.

7-1.4 Control hazards, given personal protective equipment and confined space tool kit, so that the rescue area is established; access to the incident scene is controlled; rescuers are protected from exposure to hazardous materials and atmospheres, all forms of harmful energy releases, and physical hazards; and victims are protected from further harm.

(a) Requisite Knowledge: Proper personal protective equipment; safety protocols; monitoring equipment and procedures; ventilation equipment and procedures; incident hazards; types of hazardous materials exposure risks; forms, sources, and control of harmful energy; and physical hazards in the confined space.

(b) Requisite Skills: The ability to utilize personal protective equipment place scene control barriers, operate atmospheric monitoring equipment, isolate dangerous forms of energy, and mitigate physical and atmospheric hazards.

7-1.5 Prepare for entry into the confined space, given a confined space and a confined space rescue tool kit, so that patient communication is established when possible, continuous atmospheric monitoring is initiated, rescuer readiness is verified, rescuers' limitations are identified and considered, rescuers unsuitable to entry operations are reassigned and replaced, route and methods of entry are determined, and rescuer evacuation is considered.

(a) Requisite Knowledge: Effects of hazardous atmospheres on victims and rescuers, types and operations of required hazard-specific monitoring equipment, organization protocol for medical and psychological evaluation related to entry, methods of entry into confined space in accordance with operational protocols, and rescuer evaluation methods.

(b) Requisite Skills: The ability to operate monitoring equipment, perform rescuer pre-entry medical exam, determine rescuer suitability, relate limitations to operational needs, identify victim communication needs, evaluate for point and route of entry, and select evacuation methods.

7-1.6 Enter a confined space, given personal protective equipment; safety, communication, and operational protocols; and a confined space rescue tool kit, so that

the victim is contacted, safety entry is established and maintained, atmosphere is continuously monitored, the victim's mental and physical condition can be further assessed, patient care is initiated, the patient is packaged to restrictions of the space, and patient removal can be initiated.

(a) Requisite Knowledge: Principles of operation for atmospheric monitoring equipment; methods for patient care in confined spaces; safety, communication, medical, and operational protocols; and safe entry and egress procedures for confined spaces.

(b) Requisite Skills: The ability to use and apply personal protective equipment and rescue-related systems and equipment; implement safety, communication, and operational protocols; use medical protocols to determine treatment priorities; use medical equipment specific to confined space victim needs; and reassess and confirm mode of operation.

7-1.7* Package the victim for removal from a confined space, given a confineed space rescue tool kit, so that damage to the rescue/retrieval equipment is prevented, the victim is given the smallest possible profile, and further harm to the victim is minimized.

(a) Requisite Knowledge: Spinal management techniques, victim packaging techniques, how to use low-profile packaging devices and equipment, methods to reduce or avoid damage to equipment, and the similarities and differences between packaging for confined spaces and other types of rescue.

(b) Requisite Skills: The ability to immobilize a victim's spine; package victims in harnesses, low-profile devices, and litters; recognize and perform basic management of various traumatic injuries and medical conditions; support respiratory efforts; and perform cardiopulmonary resuscitation if appropriate to the environment.

7-1.8 Remove all entrants from a confined space, given personal protective equipment, rope and related rescue/retrieval systems, personnel to safely operate rescue/retrieval systems, and a confined space rescue tool kit, so that internal obstacles/hazards are negotiated, all persons can be extricated from a space safely in the selected transfer device, the victim and rescuers can be decontaminated as necessary, and the victim can be delivered to the emergency medical services (EMS) provider.

(a) Requisite Knowledge; Personnel and equipment resource lists, specific personal protective equipment, types of confined spaces and their internal obstacles/hazards, rescue/retrieval systems and equipment, operational protocols, medical protocols, EMS providers, and decontamination procedures.

(b) Requisite Skills: The ability to select and use personal protective equipment, select and operate rescue/retrieval systems used for victim removal, utilize medical equipment, and the equipment and procedures for decontamination.

7-1.9 Secure the confined space access during termination, given isolation barriers, documentation forms, and a confined space rescue tool kit, so that all personnel are accounted for and removed from the space, injuries are avoided, further entry into the space is denied, and the scene is rendered safe.

(a) Requisite Knowledge: Methods to secure a scene, forms for documentation, tools for securing space access points, accountability protocols, methods for denying further entry, and what constitutes a safe scene.

(b) Requisite Skills: The ability to apply regulations as needed, use tools, complete reporting documentation of the incident, and apply protocols.

Appendix F
Confined Space Rescue Equipment

Lifting/Lowering Device

Tripod (8' – 10' height)

Reel hoist(50' – 75' cable spool)

Air Surveillance Equipment

Oxygen, Combustibility, H_2S/CO detector

Ventilation

Flexible 8" duct tubing

Saddle Vent device

Gasoline-powered ventilation

Ropes/Harnesses/Hardware

(4) 12.5 mm Static Kernmantle Ropes/200 ft.

(4) Class IV Body Harnesses

(4) Rope Storage bags

(3-5) 3 ft – 5 ft. snaphook ropes

(10-12) Steel 3 ½" Carabiners

(2) Figure 8 descenders with ears

(2) Ascender devices

Assortment 1" flat webbing

(3) Single 3" pulley

(2) Double 3"pulley

(2) Descending brake racks

Lighting

(5) Helmet mounted lights (explosion proof/intrinsically safe)

Assortment Cylume light sticks

(1-2) Quantity portable tripod light

Extrication/Packaging Equipment

(1) Sked stretcher (basic system)

(1) Life Support Half Back Vest

(1) Stokes basket (wire/plastic)

(1) Assortment of P- collars

(1) Small Soft trauma bag

Safety Equipment

Protective helmets (small profile type)

Gloves (rappel type)

Lockout Tagout kit

Eye protection

Personal alarm device

Barrier tape

ICS identification vests

Appendix G
Confined Space Standard Operating Procedure

Vestavia Hills Fire & Rescue

Standard Operating Procedure

SUBJECT: Operations Section 22

TOPIC: Confined Space Rescue

SCOPE: The procedure applies to all Vestavia Hills fire personnel assigned to emergency response.

DEFINITIONS:

Confined Space Entry: any action that occurs if any part of an entrant's body breaks the plane of any opening to a confined space.

Confined Space Incident: an incident in which a victim is trapped in an area with limited access and egress, and with the possible existence of hazards such as an oxygen deficient, flammable or toxic atmosphere or physical hazards. Confined spaces can be tanks, pipes, culverts, voids in a structural collapse, sewers, electrical vaults, manholes, or any area not intended for continuous human occupancy.

Confined Space Entry Permit: the form required by OSHA to list all hazards inherent to a particular space; the procedures necessary to protect an entrant from such hazards; and the list of personnel in required positions.

Confined Space Attendant: the person required to stand-by outside the space(s) and monitor the location and condition of authorized entrants and perform the other duties listed in the employer's permit space program.

Oxygen Deficiency: air containing 19.5% oxygen or less.

Oxygen Enriched: air containing 23.5% oxygen or more.

Lower Explosive Limit (LFL): the lowest concentration (air/ fuel mixture) at which a gas will ignite.

Upper Explosive Limit(UEL): the highest concentration at which a gas will ignite.

Permissible Exposure Limits (PEL): the airborne concentration of a contaminant established by OSHA.

Engulfment: the surrounding and capture of a person by a liquid or finely divided (flowable) solid substance.

Blanking: the absolute closure of a pipe, line, or duct.

Immediately Dangerous to Life and Health (IDLH): any condition that poses an immediate or delayed threat to life or would cause irreversible adverse health effects or that would interfere with an individual's ability to escape unaided from the permit space.

Intrinsically Safe: a device that is not capable of releasing sufficient electrical or thermal energy under normal or abnormal conditions to cause ignition of a specific hazardous atmospheric mixture in its most easily ignited concentration.

Part Per Million (PPM): used to measure the concentration of toxic materials.

Explosion Proof: equipment that is designed to: withstand the explosion forces resulting from internal ignition.

Public Information Officer (PIO): a person appointed by the Incident Commander to provide appropriate information to the public, through the media.

Critical Incident Stress Debriefing: a confidential group discussion of a highly traumatic incident that usually occurs within 24 to 72 hours of the incident.

Class III Body Harness: a body harness consisting of two sets of straps, one of which is secured around the rib cage, the other over the shoulders. The back of the harness is equipped with a D-ring to permit lifting or retrieval from a confined space.

Lockout Device: a device that utilizes a positive means such as a key or combination lock to hold an energy-isolating device in the safe position preventing energizing of equipment or machinery.

Tagout Device: a prominent warning device such as a tag and means of attachment which can be securely fastened to an energy-isolating device in accordance with an established procedure to indicate that the energy-isolating device and the equipment being controlled may not be operated until the tagout device is removed.

TACTICAL GUIDELINES

Phase I. **Arrival On-Scene. Take Command. Size Up**

I. THE PRIMARY ASSESSMENT

A. Command should attempt to secure a space attendant or witness to the accident to determine exactly what happened.

B. An immediate assessment of the hazards present to rescuers should be done.

C. If no witness is present, Command should look for clues on the scene that may indicate what has happened.

D. An assessment of the victim(s) should be done.

E. Command should determine how many victims are involved.

F. Command should determine how long the victims have been down, the mechanism of injury, and the survivability profile of the victim.

G. Command must make an early decision as to whether the operation will be conducted as a rescue or recovery.

H. Establish communications with the victim as soon as possible.

I. Locate confined space permit and all other information about the space.

II. THE SECONDARY ASSESSMENT

A. The Confined Space

1. Command should determine what type of confined space is present.
2. What type of products are stored or used in this space.
3. What known hazards are present; electrical, mechanical, stored energy etc?
4. Location and number of victims affected.
5. Diagram of space, including points of ingress and egress.
6. Stability of confined space.
7. Hazardous material size up.
8. Obtain a copy of space permit.

B. On-Scene Personnel and Equipment

1. Command should determine if there is an adequate number of trained personnel on scene to perform the rescue/recovery.

C. Command should consider if the proper equipment is on the scene to safely complete operation. This includes, but is not limited to:

1. Atmospheric monitoring equipment.
2. Explosion-proof lighting.
3. Explosion-proof communication.
4. Self-Contained Breathing Apparatus (SCBA)

5. Victim removal systems/equipment (sked, stokes, retrieval system).
6. Ventilation equipment, when needed.

Phase II Pre-Entry Operations

I. MAKE THE GENERAL AREA SAFE

A. Establish a perimeter

B. The size of perimeter should be dictated by the atmospheric conditions, wind direction, size and shape of the space.

C. Stop or divert all interfering traffic in the area.

D. Establish ventilation if needed.

E. Assign all sectors for operations.

II. MAKE THE RESCUE AREA SAFE

A. Command should assign a Hazard Sector officer to determine the hazards and products within the confined space.

B. Hazard Sector shall do atmospheric testing in the space to determine oxygen level, flammability, and toxicity. Based on readings, Hazard Sector should advise Command of the proper level of personal protective equipment. Any instruments used to monitor the confined space shall have:

1. Have an audio-alarm
2. Be calibrated to 10% of the LEL of the calibrant gas.
3. Have the audio-alarm set at:

- oxygen-deficiency: 19.5% and oxygen-enrichment: 23.5%
- flammability: 10% alarm set
- toxicity: carbon monoxide 35 ppm and hydrogen sulfide 10 ppm

4. For any oxygen readings below 12%, Command should recognize that the LEL reading will not be accurate.
5. Hazard Sector shall give Command atmospheric readings in a timely manner.

C. Utilities, including electrical, gas and water should be secured and locked-out.

D. Any product that is in or flowing into the confined space must be secured and blanked off if possible.

E. Any manufacturing or processing equipment must be shut down prior to entry. All equipment involved in the confined space operation must be locked out and maintained in a zero energy state until operation is terminated.

F. The structural stability of the confined space should be evaluated. All measures should be taken to assure the structural stability of the space.

III. VENTILATION

A. Command should assign Ventilation Sector.

B. Ventilation Sector should consult with Safety Sector and Hazard Sector to determine the proper type of ventilation for the space

C. Ventilation Sector must consider the effects on the atmosphere that positive or negative pressure ventilation will have (i.e., increase or decrease flammability of atmosphere). It could require both positive and negative ventilation. This will be based on the vapor density or molecular weight of the product.

D. Ventilation Sector may consider negative pressure ventilation if there is only one entry point. Atmospheric monitoring will be required to ensure a non-explosive environment is present in the exhausted vapor area.

E. Ventilation Sector must also consider the effects the exhaust is having on the operation.

Phase III. **Entry Operations. Victim Removal.**

I. SELECTION OF PERSONNEL

A. The proper personnel shall be selected to make entry into the confined space. (Only Vestavia Hills Fire personnel trained to the confined space rescue technician level will serve in this role and as back-up personnel.)

B. Command shall ensure that back-up personnel are on stand-by at all times when an entry team is committed into the space.

II. SELECTION OF PERSONNEL PROTECTIVE EQUIPMENT

A. The proper level of personal protective equipment should be worn by all entry and backup personnel. This shall include rescue type helmet, gloves, proper footwear, eye protection, appropriate skin protection, and a Class III harness as a minimum.

B. All entry and backup personnel shall wear SCBA when making entry into the confined space. SAR (supplied air respirator) is permissible when available with escape cylinder.

C. If entry personnel are on SCBA, they shall enter no further than one half the amount of supplied air minus 500 lbs.

Example: 2000 psi tank guage pressure

- ½ = 1,000 psi minus 500 psi =

500 psi = 500 psi usage.

D. Entry personnel shall use air monitoring devices that monitor the air continuously while inside the space.

E. Entry personnel shall have a Class III harness and safety tag line on prior to entry.

III. COMMUNICATIONS AND LIGHTING

A. If the confined space has a flammable atmosphere, entry personnel should have intrinsically safe or explosion-proof communication equipment. If that equipment is not available, Entry Sector may decide to use a tag line for communications or a message relay person. Remember, these are Class I/Division I A-D type atmospheres until proven otherwise.

B. If the entry team entering a dark confined space, Entry Sector must ensure that the proper type of lighting is used. If explosion-proof lighting is not available, then cylume type lights must be used by the entry team.

IV. ORIENTATION OF CONFINED SPACE

A. Prior to entry into the confined space, the Entry Sector will make available all diagrams and other pertinent information regarding the layout of the space to the entry team.

B. All entry and backup personnel, Command, and Safety shall be made aware of the action plan and the backup plan prior to entry.

C. Rescue tag lines may or may not be appropriate in the confined space, depending on the configuration. It could be an entanglement hazard.

V. VICTIM REMOVAL EQUIPMENT

A. If possible, the entry team should bring a supply of breathable air for the victim.

B. Remove all tools and equipment used for rescue/recovery. If there has been a fatality, Command may consider leaving tools and equipment in place for investigative purposes.

C. If entry personnel and/or equipment have been contaminated during the operations, proper decontamination procedures shall be followed prior to placing the equipment back in service.

D. Secure the scene. Prior to turning the property (confined space) over to the responsible party, one final reading of atmospheres should be taken and recorded. Command may consider activating the CISD if the situation dictates it.

E. Command may consider a debriefing and critique.

F. Return to service.

Additional Considerations

I. ESTABLISH COMMAND EARLY

A. Assign all sectors according to Vestavia fire department's Command procedures

B. Command may choose to be isolated from the confined space.

II. CONSIDER AMBIENT CONDITIONS

A. Heat. Consider rotation of crews

B. Cold. Consider effects of hypothermia on rescuers and victim.

C. Rain. Consider the effects of rain on the hazard profile.

D. Time of Day. Is there sufficient lighting for operations extending into the night?

E. Consider the effects on family, friends; keep family informed.

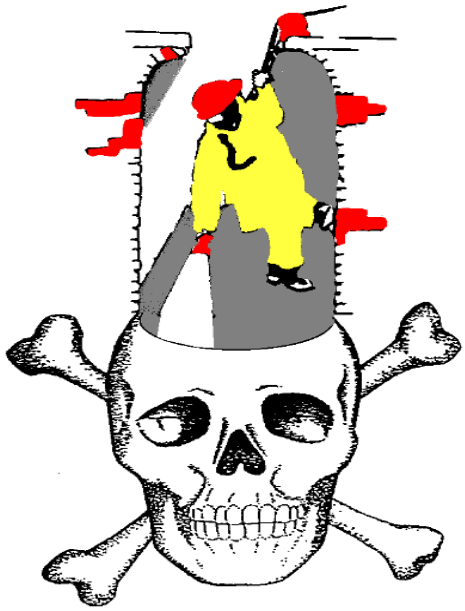
F. Consider news media; assign a PIO.

Command should call for police if there is a death.

APPENDIX H
News Letter Article

Confined Spaces Deadly Places

By Captain Sam Hansen
Vestavia Hills Fire & Rescue



On November 15, 1984 one worker died after entering a toluene storage tank. During the rescue attempt, a firefighter was killed when the tank exploded. Live footage of this tragic confined space incident was captured by a news reporter, and is featured in the familiar, "Firefighter Safety," video produced by the National Fire Academy.

Unfortunately, confined space rescues continue to be high-risk operations for firefighters. Confined space incidents are unique due to the range of hazards they present. These hazards are often overlooked or underestimated by rescuers. The National Institute of Safety and Health (NIOSH) reports that 60% of confined space deaths involved a would-be rescuer.

This article is based on information developed in an applied research project submitted to the National Fire Academy's, Executive Officer Program. As part of his applied research project in confined space operations, the author developed a standard operating procedure and a rescue equipment list. The readiness of fire departments within Alabama to perform confined space rescue was also explored.

A confined space readiness survey was sent to 85 fire departments, both career and volunteer, with 48 of these departments responding. The results were disturbing. The most disturbing information provided by these 48 departments was that only five reported having a standard operating procedure (SOP) for confined space operations. The survey also indicated the need for a confined space rescue equipment list and additional rescue training.

In order to better understand the dangers of confined space rescue and prevent future rescuers deaths, rescuers must be able to recognize confined spaces and identify the hazards that make these spaces deadly places. SOP's must be implemented by fire departments and followed by all personnel when operating at confined space incidents.

According to the Occupational Safety and Health Administration (OSHA) standard for permit-required confined spaces (29 CFR 1910.146) a permit-required confined space is "a space that is large enough to enter, is not designed for human occupancy, has restricted entry/exit pathway, and may contain either a hazardous atmosphere, a material that could engulf the rescuer, internal parts that could trap the rescuer, or any other unrecognized hazard such as exposure to energized electrical wires or moving unguarded equipment."

Confined spaces may be found in many shapes and sizes and can present the rescuer with a multitude of dangerous challenges. These spaces can be found throughout any city, town, or local community. They can be located below or above the ground. Some can be found inside buildings, on roads, and on railways (see examples table 1).

Table 1

Examples of Typical Confined Spaces

Cisterns	Tank trailers	Storage Tanks
Silos	Storm Drains	Stacks
Sewers	Railroad Rank Cars	Storage bins
Septic Tanks	Underground Utility Vaults	Hoppers
Tunnels	Manholes	Pits

Source: Valcourt and Gatland (1992, September-October. Rescue, p.28.)

Hazardous atmospheres found at confined spaces by far pose the greatest risk to the rescuer. In fact a 1990 report published in the "Safety and Health" magazine, indicated approximately two-thirds of all deaths in confined spaces were contributed to atmospheric hazards.

According to OSHA, the three categories of atmospheric hazards are, asphyxiating, flammable/explosive or toxic. OSHA considers an atmosphere to be oxygen deficient when it contains less than 19.5 percent oxygen. An atmosphere containing an oxygen content of greater than 23.5 percent is considered to be oxygen enriched. Oxygen deficient atmospheres pose a serious threat to unprotected rescuers through asphyxiation.

An oxygen enriched atmosphere along with flammable gases, vapors, or mists in excess of 10% of the lower flammable limit (LFL) can present a tremendous flammability hazard to a confined space rescuer. Toxic atmospheres are atmospheres containing gases, vapors, or fumes known to have a poisonous effect on humans. This too can pose a serious health threat to an unprotected rescuer.

Energy hazards such as electricity can be found at many confined spaces. These energy sources also come in a variety of different stored energy forms. (eg., pneumatic, spring loaded, hydraulic fluid, gears). These hazards must be abated or locked-out before a rescuer enters a confined space. Along with these energy hazards a rescuer must also deal with the hazards the space itself presents from its shape, size, and configuration. Engulfment hazards can be present at these sites and may quickly overcome the unexpecting rescuer.

In order to reduce the alarming number of fatalities in confined space incidents, several proactive steps must be considered. First, rescuers must learn what hazards they may encounter at these spaces. This can be accomplished through an aggressive plan to locate these spaces in your jurisdiction and include them in a pre-planning effort as we presently do for hazardous material and fire suppression targets. Second, determine your departments capability to perform a confined space rescue. This determination must include the proper rescue equipment, level of training, and a comprehensive standard operating procedure. The following are several resources available to assist in these efforts:

National Fire Protection Association (NFPA)

- 1670 Standard on Operational and Training for Technical Rescue Incidents
- 1006 Standard for Rescue Technician Professional Qualifications
- 1500 Standard on Fire Department Occupational Safety and Health

Occupational Safety and Health Administration (OSHA)

- 29 CFR 1910.146 Permit Required Confined Spaces
- 29 CFR 1910.147 Control of Hazardous Energy Sources

To obtain a copy of the standard operating procedure and the equipment list developed in this project, contact: Sam Hansen, email- firecapt@Vestavia.org.

Incorporating these resources will assist in a more proactive approach to the problem. An aggressive attitude, focusing on, pre-planning, training, and selection of the proper equipment, will enable the fire service to meet the future challenges of these, "Confined Spaces Deadly Places", with a safer outcome.