CONFINED SPACE RESCUE PROGRAM FOR THE BIRMINGHAM FIRE DEPARTMENT

EXECUTIVE DEVELOPMENT

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ABSTARCT

The purpose of this research was to address the problem within the City of Birmingham, Michigan. The problem was the State of Michigan's OSHA cited the City for not having a designated rescue team for their employees who enter confined spaces. The local fire department was mandated, by the City, to become the rescue team for public services workers. The purpose statement of this research was to design a confined space rescue program for the local fire department.

The research method used to answer the following questions was the action research methodology.

1. What is a permit required confined space?
2. What type or types of permit required confined spaces exist in the City of Birmingham that required the Department of Public Services personnel to enter?
3. What Federal or State standards address rescue operations in respect to a permit required confined space?
4. What level of confined space rescue do area fire department provide?
5. What training programs are available?
6. What local resources are available to develop a confined space rescue system for the Birmingham Fire Department?

The procedures used to research these questions were an interview, a literature review, two surveys, and a review of the fire department equipment and operations. There was major limitation, time. The City placed a 60 day compliance date on the research.

The results of this research included defining and clarifying the problem, the

identification of the varied operating levels and training in the area, detection of the shortcomings of the current fire department operations and training, discovery of fire department practices that could be identified and incorporated into the final rescue system, and identification of the specific operations development necessary to comply with the OSHA standard.

The recommendations of this research project included the development of a complete training package and standard operational plan for the Birmingham Fire Department.

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INTRODUCTION

The City of Birmingham, Michigan, was issued a citation from the Michigan Occupational Safety and Health Administration for not having a designated rescue team for City of Birmingham employees that enter a permit required confined space. The employees that would enter this type of confined space are members of the Department of Public Services. The City of Birmingham is not permitted to allow any employee to enter a permit required confined space, without a designated rescue team.

The City of Birmingham's Department of Public Services does have a confined space entry plan, which names the fire department as the rescue team. The Birmingham Fire Department was not trained to provide this service.

The problem is that the City of Birmingham needs to have their fire department personnel trained in confined space rescue operation, so they can provide this service for the public service department.

The purpose of this research project was to design a confined space rescue program for the Birmingham Fire Department. This research project will attempt to answer the following questions:

1. What is a permit required confined space?
2. What type or types of permit required confined spaces exist in the City of Birmingham that required the Department of Public Services personnel to enter?
3. What Federal or State standards address rescue operations in respect to a permit required confined space?
4. What level of confined space rescue does the areas fire departments provide?
5. What training programs are available?

6. What local resources are available to develop a confined space rescue system for the Birmingham Fire Department?

The procedure used to complete this research project was action research methodology.

BACKGROUND AND SIGNIFICANCE

The Oakland Training Institute (OFTI) is a division of Oakland Community College. OFTI is the largest provider of fire service training in the State of Michigan. They provide a full range of fire service and emergency responder training from the entry level to the administration level. OFTI has a long history of developing training programs, consulting and or designing fire department systems to assist the fire service providers in Oakland County and throughout the State of Michigan. As it is stated in the OFTI mission statement, "We are dedicated to training fire service personnel in whatever the need may be" (Oakland Fire Training Institute, 1986, p. 2).

OFTI has developed confined space training programs that are currently being used throughout the State of Michigan. These programs are recognized as the standard by the Consumer and Industrial Services division of the State of Michigan. These programs are used in an industrial setting.

The Birmingham Fire Department requested that OFTI research and develop a confined space rescue training program that would be easily integrated to their existing emergency operations. "This program must be comprehensive but not expensive", stated Fire Chief David Edginton (personal communication, June 19, 2000).

The City of Birmingham is approximately five square miles. It is a suburban community located six miles northeast of Detroit, Michigan. It is a mixed community having a light

industrial area, large downtown commercial district and upscale residential.

The Birmingham Fire Department is a career based fire and emergency service provider, with 40 members. Thirty-five of the members are assigned to shift or duty work, while the remaining five members serve an administrative function. The minimum staffing is two engines, one tower and one rescue, manned by nine personnel. The fire department provides fire protection and advanced life support emergency medical protection to their community. Also, the fire department is an active member the OAKWAY Hazardous Material Response Team.

OAKWAY is the mutual aid pack that Birmingham and nine other career-based fire departments belong to in Oakland County, Michigan. While it covers every area of fire suppression, medical, and hazardous material response, it does not directly address confined space rescue.

All of fire department shift personnel are trained to the National Fire Protection Association Standard 1001, chapters three and four (National Fire Protection Association, 1997), and are all minimal trained to the Medical First Responder-Automatic Defibrillator level.

The Confined Space Problem in Birmingham

In 1993, the Occupational Safety and Health Administration enacted the confined space standard. The Occupational Safety and Health Administration (OSHA) has published this document in the Federal Register to clearly define safety requirements pertaining to confined spaces and rescue from a confined space. This document defines a confined space a space with special dangers for entrants. These dangers exist because of their configuration, content, and or other features, unique to that space (Permit Required Confined Spaces, 1998).

The Department of Public Services does enter into this type of space, but not as a normal course of doing business. Over 95% of all work requiring the entrance into a permit required

confined space is performed by outside contractors (D. Middelwood, personal communication, Oct. 18, 1993).

In the City of Birmingham's Department of Public Services Confined Space Program it states that the fire department is the rescue team for their employees (City of Birmingham, 1993). In numerous letters between these two agencies it is clearly stated that the fire department is not trained and does not qualify as a confined space rescue team (D. Edginton, personal communication, June 19, 2000).

In June of 2000, an employee of the DPS suffered a minor injury while leaving a permit required confined space. Michigan Occupation Safety and Health Administration investigated the injury and found that, while the fire department would respond to any incident, they were not trained and do not meet the current OSHA standard as a rescue team provider. A fine was issued and multiplied by ten for being a life safety hazard. A fine was issued for everyone that has entered a permit required confined space since the enactment of the standard, in 1993. OSHA did allow for the abatement of the life safety multiplier, if the City of Birmingham has a qualified confined space rescue team in place ninety days after citation (D. Edginton, personal communication, June 19, 2000).

The Birmingham Fire Department was given a mandate from the City Officials to provide all rescue services that are needed for City employees, by the end of August of 2000 (D. Edginton, personal communication, June 19, 2000).

The Projects Relationship to the National Fire Academy Executive Officer Program

As taught by the National Fire Academy, in the Executive Development program, the ability to understand a situation is first to analyze the existing situation, assess what affects the situation, and research a solution to the situation. In accordance to these teachings, the

researcher has taken the necessary steps to understand the needs and implement effective training.

LITERATURE REVIEW

This section of the research will review the relevant work of other researchers. This section will summarize the works as they pertain specifically to the research. This review will include interviews the researcher conducted.

What is a Permit Required Confined Space

On January 14, 1993, OSHA issued a final rule that established safety requirements, including a permit system, for entry into confined spaces, designated as permit required confined spaces. Permit-required confined spaces present special dangers for entrants because their configurations hamper efforts to protect entrants from serious hazards, such as, toxic, explosive or asphyxiating atmospheres. The standard provides a comprehensive regulatory framework within which employers can effectively protect employees who work in permit-required confined spaces. The federal final rule became effective on April 15, 1993 (Permit Required Confined Spaces, 1998).

The Occupational Safety and Health Standards, Part 1910 of Title 29 of the Code of Federal Regulations, Subsection 1910.146 contains requirements for practices and procedures to protect employees in general industry from the hazards of entry into permit-required confined spaces. This paragraph explicitly excludes agriculture, construction, and shipyard employment from the scope of the standard (Permit Required Confined Spaces, 1998, paragraph a).

OSHA is aware that confined space accidents occur in agriculture, construction, and

shipyard work and that employees in those industries do face a significant risk of death and serious injuries from these accidents. However, OSHA believes that sufficient differences exist between these industries and general industries to warrant separate rule making activities (Permit Required Confined Spaces, 1998).

OSHA states that in order to qualify as a confined space, a space must have all three characteristics. The space is large enough and so configured that an employee can bodily enter and perform assigned work. The space is limited or restricted means for entry or exit and is not designed for continuous employee occupancy (Permit Required Confined Space, 1998).

OSHA defines 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 (Permit Required Confined Spaces, 1998, paragraph b).

Examples of non-permit confined spaces include vented vaults, motor control cabinets, and dropped ceilings. Although they are confined spaces these spaces have either natural or permanent mechanical ventilation to prevent the accumulation of a hazardous atmosphere, and they do not present engulfment or other serious hazards.

OSHA has determined that spaces that have had all hazards eliminated can be reclassified as non-permit spaces for as long as the hazards remain eliminated (Permit Required Confined Spaces, 1998). For example, spaces posing only non-atmospheric hazards, if those hazards can be removed without entry into the space, the permit space may be reclassified as a non-permit confined space after the hazards are removed. It is important to note that control of a hazardous atmosphere is not the same as its elimination (Permit Required Confined Spaces, 1998, paragraph c, [7]).

OSHA defines a permit required confined space as a confined space that has one or more

of the following characteristics:

> Contains or has a potential to contain a hazardous atmosphere; contains a material that has the potential for engulfing an entrant; has an internal configuration such that an entrant could be trapped or asphyxiated by inwardly converging walls or by a floor which slopes downward and tapers to a smaller cross-section; or contains any other recognized serious safety or health hazard (Permit Required Confined Spaces, 1998, paragraph b).

What Type of Permit Required Confined Spaces Requiring Birmingham Public Services Personnel to Enter

The Michigan Department of Labor Part 90, mandates employers to evaluate the workplace of their employees to determine if any spaces are permit required confined spaces. It continues by mandating that if permit required confined spaces exist the employer must inform, identify, and educate their employees of the location, and dangers posed by these spaces (Michigan Department of Labor, 1993).

In accordance to the OSHA standard 1910.146:

> If the employer decides that its employees will enter permit spaces, the employer shall develop and implement a written permit space program that complies with this section. The written program shall be available for inspection by employees and their authorized representatives (Permit Required Confined Spaces, 1998, paragraph c, [4]).

The City of Birmingham has developed a Confined Space Program (City of Birmingham, 1993). In this Program, it clearly describes the two types of confined spaces that their employees must by trained to enter (p. 3). The first is a manhole or sewer vault and the second is a water pit. Both must be entered at grade and through a manhole opening of 24 inches (p. 4). The plan identifies a total of thirteen sites within the City. "At no time should an employee enter into a

space that is not listed in this plan" (p. 4).

Federal or State Standards on Rescue Operations in a Permit Required Confined Space

The Occupational Safety and Health Standards, Part 1910 of Title 29 of the Code of Federal Regulations, Subsection 1910.146, contains requirements for practices and procedures for the designated rescue team. "Develop and implement procedures for summoning rescue and emergency services, for rescuing entrants from permit spaces, for providing necessary emergency services to rescued employees, and for preventing unauthorized personnel form attempting a rescue." (Permit Required Confined Spaces, 1998, paragraph c, [7]).

Prior to any rescue training OSHA 1910.146 requires that all employees assigned to perform rescue duties must be trained and proficient as an authorized entrant (Permit Required Confined Spaces, 1998, paragraph k, [2ii]). Authorized entrant training encompasses all the base knowledge necessary to work in and around a confined space. This knowledge is referenced in the rescue paragraph in the standard when describing non-entry rescue. This type of rescue requires proficiency in retrieval systems and full body harness, as required for entrants when entering a vertical type of permit spaces more than five feet deep (Permit Required Confined Spaces, 1998, paragraph k, [3ii]).

The Michigan Department of Labor, Part 90 (1993) paraphrases the OSHA standard 1910.146 in mandating the training requirements for the designated rescue team. Part 90 requires that the employer shall ensure that each rescue service provider is trained in the proper use of personal protective equipment and rescue equipment necessary for making rescues from permit spaces. Each member of the rescue service shall be trained to perform their assigned rescue duties. It continues by explain that each member of the rescue service shall also receive the training required of authorized entrants under paragraph (g) and (h) of this standard and that

each member must be trained in basic first aid and in Cardiopulmonary Resuscitation (Michigan Department of Labor, 1993, paragraph k).

Both of these standards require that each member of the rescue service shall practice making permit space rescues at least once every twelve months. This must be done by means of simulated rescue operations in which they remove dummies, manikins, or actual persons from the actual permit spaces or from representative permit spaces. The spaces used to meet this requirement must be representative permit spaces, with respect to opening size, configuration, and accessibility. The simulated rescue must be of the type of permit spaces from which the rescue is to be performed.

OSHA standard 1910.146 (Permit Required Confined Spaces, 1998) requires the rescue service to be informed of the hazards they may confront when called on to perform rescue at the employer's facility. Their reasoning is if an injured entrant is exposed to a substance for which a Material Safety Data Sheet (MSDS) or other similar written information is required to be kept at the work site, that MSDS or written information shall be made available to the medical facility treating the exposed entrant. The other reason is to provide the rescue team with access to all permits spaces from which rescue may be necessary so that the rescue service can develop appropriate rescue plans and practice rescue operations as mandated.

Paragraph k, of OSHA 1910.146 (Permit Required Confined Spaces, 1998), requires the designated rescue team to be,"…equipped for and proficient in performing the needed rescue services" (paragraph K [1][iii][B]). OSHA defines the work proficient, "means meeting a stated level of achievement" (Training Curriculum Guidelines, 1996, definitions) in OSHA 1910.120 Training Curriculum Guidelines.

OSHA 1910.146 (Permit Required Confined Spaces, 1998) requires an employer to

evaluate a rescuer's ability to respond, when summoned, in a timely manner (paragraph F). What classifies a timely response is proportionate to the hazard or hazards identified. If the hazards identified qualify as immediate danger to life or health (IDLH) atmosphere, then the employer must provide a standby team capable of immediate action to rescue employees (Respiratory Protection Standard, 1998).

OSHA 1910.146 (Permit Required Confined Spaces, 1999), Appendix F, Rescue Team or Rescue Service Evaluation Criteria was added in February of 1999, to assist employers in making sound decisions in their selection of rescue services (see Appendix A).

The Level of Confined Space Rescue Provided by Area Fire Departments

Of the 43 Fire Departments in Oakland County, Michigan, only three have a established confined space rescue teams, as part of their technical rescue teams (see Appendix B). Two of these fire departments are part of the OAKWAY mutual aid pack, Southfield and Pontiac. OAKWAY has taken the position of not organizing nor supporting a technical rescue team (OAKWAY, 1995). Southfield and Pontiac will only respond with a fire engine and four men, as designated in the mutual aid agreement, to a confined space rescue when requested. They will respond with their technical rescue truck, if requested, and once on the scene they will call in off duty personnel to assist (OAKWAY, 1995).

The other fire department, Troy, is a volunteer department. Their team is designed to respond from home or work, as is their fire operations.

The Training Programs That are Available

The Michigan Department of Labor has a fire fighting standard. Subsection R 408.17411 of the standard states:

An employer shall comply with all of the following requirements:

(a) Provide training to an employee commensurate with those duties and functions that the employee is expected to perform. Such training shall be provided before the employee is permitted to perform emergency operations (Michigan Department of Labor, 2000, Rule 7411).

Currently, the State of Michigan does not certify or support any level of training in confined space rescue (Michigan Fire Fighters Training Council, 2000). Michigan Urban Search and Rescue (MUSAR) recognizes only one training system for their members. It is a series of five programs. The first is the National Fire Academy Incident Command System, a 12 hour incident management system training. The next step is the MUSAR Rope Rescue One, a 32 hour basic rope training program. Once these courses are completed, the next step is the MUSAR Basic Rigging for Confined Spaces, a 16 hour basic rigging program. The next step is Michigan Hazardous Material Training Center Basic Air Monitoring course, a eight hour program. The finial step is the MUSAR/Michigan State University Confined Space Rescue program, a 32 hour training program (Michigan Urban Search and Rescue, 2000).

In addition to the 100 initial training hours required by MUSAR, students are required to demonstrate proficiency after step two, three and four, at MUSAR monthly training. The minimum time to complete this program is approximately six months (Michigan Urban Search and Rescue, 2000).

In the Birmingham, Michigan area there are a total of nine other training agencies that provide training in confined space rescue. In a response to a phone survey, none of these agencies have established training programs designed around fire service confined space rescue. These agencies have designed their programs to the industrial in house response team. Six of the agencies surveyed stated that they were willing to develop a training program, but none could

have it on line in the time frame needed (see Appendix C).

Training is available outside the area. CMC Rescue, Inc. offer a 40 hour program in confined space rescue. This course is recognized by California State Marshal and the California Board of Fire Services (CMC Rescue School, 1999). CMC Rescue, Inc. strongly recommends completion of a Rope Rescue program prior to attending confined space rescue training.

Mosby Lifeline Publishing offers generic training program in rescue operations. Confined space rescue is one of the topics covered in this training program (S. Kidd, J. Czajkowski, 1997). This program comes with an instructor guide and course book. The instructor, using this manual and training package, is the responsibility of the local authority purchasing the program.

Additional confined space rescue training programs are available on video. These too are generic in design. Working Fires offers a training video series on confined space rescue (D. Marsh, 1997). No instructor guides are available for this program.

Michigan State University recommends the following steps in evaluating and implementing confined space rescue training.

1. Determine types of confined spaces in your jurisdiction by conducting survey.
2. Define level of service your organization will provide.
3. Provide Awareness level training for all personnel.
4. Develop rescue plans for spaces for which rescue service will be provided.
5. Obtain equipment as determined by rescue plans.
6. Select personnel and assign levels of training.
7. Provide basic level of training for rescue team members.
8. Develop Standards Operating Guidelines for all levels of response.

9. Provide Confined Space Rescue training, initial and on-site.
10. Conduct post incident analysis on all incidents and practice rescues; revise Standard Operating Guidelines and training based on evaluation. (Michigan State University, 1994, p. i).

Local Resources Available to Develop a Confined Space Rescue System

In 1994, "The start up cost of approximately $243,000 and annual maintenance costs of $70,000" (Petersen, 1994, p. 38) to provide a confined space rescue team. The start up cost for the Southfield Fire Department, Michigan, was well over $100,000 in equipment purchases, as stated in their survey response. Both of these systems are designed to meet all possible scenarios, in confined space rescue operations that exist in their response areas. The Birmingham Fire Department is not planning on extending their rescue response service beyond the limited need of the Department of Public Services (D. Edginton, personal communication, June 19, 2000).

The existing resources available in the Birmingham Fire department are similar to those in any area fire department. Along with the personnel protection equipment issued to each firefighter, both engines meet the equipment standards as prescribed by the National Fire Protection Association (NFPA) as stated in chapter seven of standard 1901 (1991) and 1902 (1991). The tower meets the equipment standard in NFPA 1904 (1994), as listed in chapters six, seven and eight. In addition to this equipment, they have placed a four gas atmospheric monitor and two 100 foot life line ropes on all pieces of apparatus. They have place equipment on the tower which include four class III body harnesses and associated rope rescue equipment needed in a high angle rescue. A lockout/tagout kit is on each fire engine, which has been used for elevator emergencies.

The Birmingham Fire Department is used as the central housing location for the OAKWAY hazardous material response vehicle. This vehicle has a built in command post and numerous atmospheric monitoring devices, as well as other associated hazard material equipment needed in the removal or abatement of an incident.

All members of the Birmingham Fire Department have been trained in high angle rescue, so they are knowledgeable in the use of ropes, riggings, and the associated hardware. Each member has had training in atmospheric monitoring, hazardous material operations level, medical first responder, incident command system, and lockout/tagout.

The City of Birmingham has allocated funds to support the man hours needed in the training of their personnel, but has been very limited to new equipment purchases. The direction given to the fire chief was to use existing equipment, if available. "The Birmingham Fire Department is not attempting to design a confined space rescue team to meet any other need, other than the one currently at hand" (D. Edginton, personal communication, June 19, 2000).

Additional equipment is available from the Department of Public Service, if not already being used in another of their operations. Their equipment is limited to a tripod, two four gas atmospheric monitors, and two class III body harnesses.

The Birmingham Fire Department has one member that is an instructor in confined space attendant and entry, supervisor, and rescue operation. This firefighter is not a member of MUSAR, but has been trained to the MUSAR standard and trains with many local MUSAR members.

Literature Review Summary

The literature review began with an understanding of what a permit required confined space was. OSHA and the Michigan Department of Labor detail what a confined space is and

what contributes a permit required confined space (Permit Required Confined Spaces, 1998; Michigan Department of Labor, 1993).

The understanding of what a confined space is and what constitutes a permit required confined space is essential in classifying the type of spaces used by the Department of Public Services personnel. The City of Birmingham's Department of Public Services Confined Space Program detailed the limitations placed on their employees and the designated spaces they enter (City of Birmingham, 1993).

A review of the literature indicates that Michigan Department of Labor Standards and OSHA have established operational guidelines in confined space rescue (Permit Required Confined Spaces, 1998; Michigan Department of Labor, 1993). These standards stress employee safety and employer responsibility, but are not designed to direct local interpretation of the standards, as they apply to the spaces in your area.

Only three Oakland County fire departments have addressed confined space rescue operations in the jurisdiction. Two of three fire departments have direct ties to the Birmingham Fire Department and are willing to assist them, in a limited way (OAKWAY, 1995).

Third party training providers are available is numerous forms. Companies will come in and provide the training needed, while other agencies will provide the training materials. Although, OFTI must provide the instructors. Both of these programs have their limitation as they apply to the Birmingham situation. The Michigan State University (1994) model for evaluating and implementing a confined space rescue training program could be used in determination of the final training used.

The direction given to OFTI is a limited one. The financial controls on this project will be strictly reviewed. The focus of the fire department is to solely meet the need of the

Department of Public Services (D. Edginton, personal communication, June 19, 2000).

PROCEDURES

This research project employed an action research methodology. The object if this research project is to design a confined space rescue program for the Birmingham Fire Department to meet the need established by the City's Department of Public Services. This was to be accomplished through the interpretation of the information collected in an interview, the literature review, two surveys, curriculum review of existing training programs, and review of the resources provided by the Birmingham Fire Department. The information collected was used in an attempt to answer the research questions of this project.

Interview of Fire Chief

An interview of the Birmingham Fire Department's Fire Chief, David Edginton, was done to understand the circumstances surrounding the purpose of this project, the perimeters placed on the development of the protect and the level the project could be integrated into existing operations.

Literature Review

The literature review was the basis of all the research performed in this project. The literature review indicated that preexisting governmental documents and standards were established, pertaining to permit confined spaces. These standards were the foundation in the citation issued to the City of Birmingham.

The specific area cited was the issue of a designated confined space rescue team. The OSHA standard clearly indicates that a rescue team must be designated and capable to perform a rescue in a timely manner (Permit Required Confined Spaces, 1998, paragraph k). The literature

review targeted State and Federal standards that contained information on confined space, confined space rescue, and training in an attempt to meet the intent of those existing OSHA standards.

Documents developed by the City of Birmingham were reviewed as to how they addressed the State and Federal standards. The City of Birmingham's Confined Space Program is designed after the example provided in OSHA 1910.146, Appendix c (Permit Required Confined Spaces, 1998). This program has met the review standards of the Michigan Occupational Safety and Health Administration in all areas, except the designed confined space rescue team (D. Edginton, personal communication, June 19, 2000).

Area Fire Department Survey

A service evaluation survey was distributed, by way of facsimile, to 42 of the 43 fire departments in Oakland County, Michigan (see Appendix B). The Birmingham Fire Department was the only excluded fire service provider.

Oakland County is the largest and most affluent county in Michigan. Birmingham is located in the middle region of the county. The survey was designed to obtain remaining information that could be implemented in the project.

The survey had three parts: assessment to whether each fire department provides any confined space rescue service (Part I), assess the level of the confined space rescue operation they have committed to provide (Part II), and the costs associated with providing this service (Part III). Part I of the survey was a series of questions. The basis of this part of the survey was a scenario. The scenario was directly associated with a potential situation in one of the Birmingham designated permit required confined space. Part II referenced the answers they provided in Part I of the survey. This part of the survey asked respondents to answer yes or no

questions concerning the rescue in the scenario in Part I. Part III of the survey was limited to the respondents who indicated they have formed confined space rescue teams. The respondents were asked to document the cost of starting and providing this service.

The responses from the area fire department survey were calculated in a standard format. The number of positive responses were added together and subtracted from the total number of responses. The narrative section of the surveys, Part III, were taken on face value.

Training Survey

A telephone survey was done with potential agencies that could provide training to the Birmingham Fire Department in confined space rescue operation, in compliance to the OSHA 1910.146 (Permit Required Confined Spaces, 1998) and the restriction placed by the fire department. A total of 18 potential agencies were found, through the internet and the yellow pages, in the Birmingham area. Of those 18 contacted, nine provide confined space rescue training. A telephone survey (see Appendix C) was performed by the researcher. Each agency was asked yes or no questions. Each question elaborates on the previous question.

Curriculum Review

A review of potential training program was reviewed. Each program was reviewed in three ways: did the program meet paragraph k, of the 1998 standard OSHA 1910.146, could the program be structured to met the specific need of the Birmingham Fire Department, and was an instructor available to teach the curriculum within the time frame given.

To determine a programs' ability to be structured to meet the Birmingham Fire Department's needs was based on the Michigan State University model described earlier in the research.

Resources Available

An inventory of all equipment available to the Birmingham Fire Department was given to the researcher. The inventory was to be as complete as possible, including the simplest of equipment.

The next step was a review of the training records of all members of the Birmingham Fire Department. Each firefighter and officer was reviewed for basic and specialized training that they had received. The specialized training focused on rope, rigging, repelling, air monitoring,

lockout/tagout, rescue operations, hazardous material, and incident command training.

Assumptions

The procedures employed in this research project were based on four assumptions. First, it was assumed that all information gathered in an interview was unbiased. Second, that the records and information obtained from the Birmingham Fire Department and the City of Birmingham was accurate and correct. Third, it was assumed that each survey respondent answered all questions fairly and objectively. Fourth, it was assumed that survey respondents did not discuss issues related to operating condition, performance levels, or cost values with each other prior to completing the survey.

Limitations

The limitations that affected this project included time, resources, and those placed by the Birmingham Fire Department. The sixty-day time limit imposed by the Birmingham Fire Department for completion of the confined space rescue system, did not allow for a more comprehensive review. The time limit also prohibited a comprehensive survey of the fire departments and the agencies available to provide training. It also prohibited a detailed study of the existing confined space rescue systems in the county.

The Birmingham Fire Department placed numerous limitations on the project. The most significant was the sixty-day project completion date. Any new equipment purchases were not allowed, nor were future purchases to be designed into the program. The confined space rescue operation system must adapt to existing operational guidelines within the organization. The last, required all shift personnel to be trained in confined space rescue, a total of 35 people.

Definition of Term

Lockout/Tagout – the isolation and control of any energy or stored energy source.

Space – refers to a confined space.

RESULTS

The results of the research clearly define confined spaces. As described in the literature review, OSHA and the State of Michigan have established consistencies to what qualifies as a permit required confined space. The City of Birmingham employees are required to operate in areas that meet these criteria and in doing so, must meet the standards of these governing bodies.

OSHA states that in order to qualify as a permit required confined space, a space must have all three characteristics of a confined space. The space is large enough and so configured that an employee can bodily enter and perform assigned work. The space has limited or restricted means for entry or exit and is not designed for continuous employee occupancy. The space must also have at least one of the following characteristics:

1. Contains or has a potential to contain a hazardous atmosphere;
2. Contains a material that has 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 by a floor which slopes downward and tapers to a smaller cross-section; or
4. Contains any other recognized serious safety or health hazard (Permit Required Confined Spaces, 1998, paragraph B).

The City of Birmingham's Department of Public Services Confined Space Program references the OSHA definition of a permit required confined space in their confined space entry plan (1993, p. 6). It also lists the two types of confined spaces that require entry and that

are covered by this plan.

The first confined space type is defined as a water pit. There are six water pit locations throughout the City of Birmingham. These sites must be entered on the first, fifteenth, and last day of every month.

The second confined space type is defined as a emergency auxiliary sewer pumping station. There are seven sewer pumping stations throughout the City of Birmingham. These spaces are entered on a monthly basis for maintenance, or whenever an alarm is activated, indicating the pump is not operating properly.

The types of spaces that the City employees must operate in are very specific in design and configuration. They all could be classified as one type of space. Each space, whether a water pit or a sewer check point, allow entry through a manhole opening of 24 inches in diameter. All openings are quickly accessible, being located in a road or roadside. The water pit spaces do not have a power source inside or associated with these spaces, while the auxiliary sewer pumping stations have a control box located next to the opening, at grade level. They both have associated engulfment and atmospheric hazards associated with them (City of Birmingham, 1993, pp. 7-12).

The annual permit reviews have identified the engulfment hazard as water. The terrain that these spaces are located allows for them to collect water runoff from the road. There is also possible leakage or rupture of the sewer lines. In Birmingham, storm and sewage use the same pipe. The water pits have water that pass directly through them, but it is in encapsulated in a 20 inch water main, and is capable of the same possibilities.

The same annual permit reviews indicate that the atmospheric hazards are carbon monoxide and methane gases. Over the past year years, only three times has the level of either

of these gases risen to a level that would not allow entry, without respirator protection.

OSHA requires that a confined space rescue team must be trained to the level of proficiency as authorized confined space entrants. OSHA also requires that each member of the rescue team train annually in each type of confined space they are designated to provide rescue service in (Permit Required Confined Spaces, 1998, paragraph k).

OSHA and the Michigan Department of Labor are specific to the standard a confined space rescue team must be held to, but they do not specify how a rescue team is formed or must operate at each possible permit required confined space scenario.

> We cannot be more defined than this because OSHA did not attempt in the standard to specify the equipment that would be needed for rescue and escapes in every type of permit required confined space. Instead we have adopted a performance-type standard that requires each employer to determine what equipment would be necessary in the circumstances that they face in each instance (R. Gurnham, 1996).

OSHA contends that it is the responsibility of the employer to prove compliance with the standard.

OSHA suggests, in Appendix F of the Permit Required Confined Spaces Standard (1998), that the employer evaluate two components of a rescue team. The first step is when an employer must determine if a potential rescue service is adequately trained and equipped to perform a rescue in the space needed. These include the ability to respond in a timely manner. They suggest the best method to evaluate a rescue team's ability is in observing an actual or practice rescue. On completion of a practice exercise, the employer can determine if the service provided is adequate for their needs. The employer makes this determination.

Michigan Department of Labor, Part 74 Fire Fighting, requires an employer to:

(a) Provide training to an employee commensurate with those duties and functions that the employee is expected to perform. Such training shall be provided before the employee is permitted to perform emergency operations.

(b) Assure that prospective fire service personnel are physically fit and have the ability to perform assigned emergency operations.

(c) Assure that job required equipment and tools are maintained free of recognized defects which could cause injury.

(d) Develop a basic procedure that covers the treatment and transport of injured employees from the emergency scene to a medical facility.

(e) Prepare and maintain a statement or written policy which establishes its basic organizational structure and which establishes the type, amount, and frequency of training to be provided to fire service personnel (Michigan Department of Labor, 2000, Rule 7411 [1]).

The Birmingham Fire Department has met some of this standard, as it pertains to confined space rescue operations. The areas that needed to be addressed were sections (a), and (e). Sections (b), (c) and (d) have been established and are in compliance (Birmingham Fire Department, 2000).

Without a mandate from OSHA, most fire departments in Oakland County are hesitant to commit to providing any form of confined space rescue services. In response to the confined space readiness survey (see Appendix B), three of the 43 fire service providers in Oakland County, Michigan, have established technical rescue operations which include confined space rescue capabilities. All 42 fire departments responded to the survey. Birmingham Fire Department was the only fire department not surveyed.

The Southfield and Pontiac Fire Departments are the designated rescue providers for their public service departments. They are also prepared to address every scenario they have identified in their communities.

The third fire department is the Troy Fire Department. They were formed to meet the original form of the Permit Required Confined Space Standard, in 1993, but once the standard was amended in 1998 they no longer qualified. They are a volunteer organized fire department and cannot meet the amended paragraph k, *Rescue and emergency services,* "Has the capability to reach the victim within a time frame that is appropriate for the permit space hazard identified."

In response to the fire department confined space readiness survey, it was determined that the cost of establishing an all encompassing confined space rescue operations is an expensive endeavor. Both Southfield and Pontiac stated that their start up cost was $80,000 to $100,000 just for equipment purchases. These purchases were made over a two-year period from 1993 through 1994 fiscal years.

Their maintenance costs is heavily weighted toward the personnel and training costs. Confined space rescue training requires that every member of the team be proficient in every type or design of the spaces within their jurisdiction (Permit Required Confined spaces, paragraph k). To meet this requirement in the City of Pontiac, it requires all members of the team to annually train on twelve different confined space types and or designs.

The Troy Fire department did not supply any financial information in response to the survey.

Other fire service providers in Oakland County, Michigan, have no established recognition of confined space rescue operation. To paraphrase the feeling expressed by survey

respondents to Part I, within the confined space readiness survey (see Appendix B), they would do what was needed at the time to get the job done with the training and equipment they already have, and OSHA can do whatever it must in response to their actions.

The level of confined space rescue training required by each of the three fire departments that provide confined space rescue operations is different. The Pontiac Fire Department is Oakland County's only member of MUSAR. They have the highest standard of training. They required 100 hours of basic MUSAR certified training prior to being a member of the entry team in a confined space rescue incident. All members of their fire department are trained in air monitoring, basic ropes and knots, low angle rescue, confined space awareness, and incident command system.

The Southfield Fire Department personnel are trained in an in-house program, through a process of sending several members to certified programs and, on their return to train the in-house programs. All members of the fire department are trained in air monitoring, high and low angle rescue, rigging, confined space entrant, and the incident command system, while the technical rescue members are also trained in confined space rescue operations.

The Troy Fire Department's members are trained to perform confined space rescue operations, but additional information was not forwarded through the survey.

There was a need for a Standard Operating Procedure (SOP) for confined space rescue operations within the Birmingham Fire Department. The SOP should be the target and focus in developing a confined space rescue training program (see Appendix D).

The necessity of training was mandated in the standards reviewed. The type of training and the use of existing programs were studied. The adherence to the MUSAR training model was not feasible simply because of the time requirements. The Birmingham Fire Department has

an estimated 30 days. This is based on a timetable of 30 days to research and develop a plan, 30 days to train personnel, and 30 days to practice proficiency in rescue operations.

The survey of confined space training programs (see Appendix C) indicated that MUSAR dominates the market in training fire service personnel. The other agencies are designed to provide OSHA compliant training in an industrial setting. Only nine agencies surveyed have developed confined space rescue training programs, but all are tailored to private industry. Six of the nine agencies where interested in customizing a program for the Birmingham Fire Department. The development time would be 60 to 90 days, dependent on the resources available. The cost range from $6,000 to $18,500 to develop a program and an unknown additional cost to train the employees. The standard cost for industrial confined space training is $1,200 to $1,850 per student for an 8 to 16 hour program. An additional cost of $500 to $650 per student cost for confined space entrant training, which is a prerequisite for the rescue program. None of the outside agencies were willing to commit to the 6o day comply deadline of this project.

The equipment needed to provide confined space rescue operations for the specific spaces used by Public Service employees, was determined to be available within the fire department. The use of ladders to make an a-frame or ladder gin pole to be used as anchor points to assist in the hoisting and removal of victims. The availability of an elevated platform was also available to be used as an elevated anchor point. The fire department has the necessary ropes and associated equipment to be used in the raising and lowering of rescuers and the removal of victims. Four gas air monitoring equipment is on every apparatus as well as personal protective equipment required to enter a confined space.

Communication equipment is available. Fire department radios have the capability to

monitor and transmit on the same frequency as the Public Services personnel. The use of rope to communicate, as spelled out in the Birmingham Fire Department's *Policy and Procedures Manual*, is used in the fire department's high angle rescue operations (Birmingham Fire Department, 1999, Article K).

The fire fighters personnel of the Birmingham Fire Department have been trained to the NFPA 1001 standard, and have also had training in hazardous material operations level. Their employees have received training on high angle rescue operations, air monitoring, lockout/tagout, and incident command system (Birmingham Fire Department, 2000, p. 12).

DISCUSSION

This research confirmed the facts that the fire service is reactive and not proactive. In the survey (see Appendix B), an attempt was made in determining a fire department's ability to rescue a victim from a confined space and provide a safe environment for the rescuers. The scenario simply asked what steps would be taken in rescuing another City employee, who happens to be in a confined space.

While only three fire departments would have activated a special response team, the other would do something different. Paraphrasing the majorities of the responses, they indicated that they would go down and get the victim out and OSHA can do what they need to do, after the fact. Additional comments added, that were not solicited in the survey, were condemning OSHA for forcing a standard upon the fire service that cannot be met.

The research indicated that the financial burden is great. When an OSHA standard is enacted, little time is allowed for determining methods to be compliant and or budgeting to meet the new standard. The Birmingham Fire Department believed this to be true. Birmingham retired Fire Chief Edward Weber stated, "We do not have the budget or the resources to do someone else's work." (D. Edginton, personal communication, June 19, 2000). This position was recently changed because, "…we were forced into it.", according to Fire Chief David Edginton (personnel communication, June 19, 2000).

The Birmingham Fire Department could have and should have addressed this issue the first time it was brought before them, in 1993. They, like so many other fire service providers in Oakland County, Michigan, believed that OSHA standards are designed for others, not them. Compliance to the OSHA standard, while complex, was not impossible.

The OSHA standard referred to training rescue team member to the specific type of sites

that rescuers would be required to rescue victims from (Permit Required Confined Spaces, 1998, paragraph k [1iii]). The City of Birmingham has a very limited number of permit required confined spaces (City of Birmingham, 1993).

The research indicted to the City of Birmingham, for the first time, that each of these sites are similar in design and configuration, so they were all classified as one type of site. This requires only training and proficiency in one type of site. This too only requires practice and evolution drills once a year to be compliant with the OSHA standard (Permit Required Confined Spaces, 1998, paragraph k).

"Representative permit spaces shall, with respect to opening size, configuration, and accessibility, simulate the types of permit spaces from which rescue is to be performed" (Permit Required Confined Spaces, 1998, paragraph k [1iii]). When any training can be refined to a singular focus, the resources needed, the training required, and the cost involved can be controlled and refined. The survey of the training providers (see Appendix C) directly supported this position. The agencies surveyed indicted that the cost of providing the training and equipment required was in direct proportion to the number of different type of spaces requiring compliant training.

The research also indicted that the ability of the Birmingham Fire Department, to meet the OSHA standard would not be an extreme burden. In the *Permit Required Confined Spaces* OSHA standard, Appendix F, details of compliance criteria for rescue teams (see Appendix A). OSHA has develop a list of questions, under *Initial Evaluation*, that need to be addressed to assure compliance with the standard. The questions refer to: response time; availability of the rescue team; an adequate method of communication between the entry team and the rescue team; the rescue teams ability of package, retrieve and treat the victim; training of personnel to that

specific type of confined space; and equipment needed to perform the rescue.

The Birmingham Fire Department has an average response time of two minutes and six seconds, on all emergency call within the City. They have a three percent accuracy of overlapping alarms, during the period designated for normal confined space operations by the public service employees, 6 am to 8 pm (Birmingham Fire Department, 1999, pp. 3, 7). They share the same communication center and have capabilities to communicate on the same radio frequency as the Department Of Public Service personnel. All of their personnel are minimally trained to the medical first responder level and high angle rescue operation, which includes retrieving victims from vertical openings. The equipment needed to provide rescue from the specific type of confined space needed by the Public Service Department exists within the fire department.

The need for specific equipment, unique to the confined spaces, is not necessary. OSHA does require specialized equipment if the confined space in configured as follows:

(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 simply 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.

(b) 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 the space. Vertical portals may require knowledge of rope techniques, or special patient packaging to safely retrieve a downed entrant (Permit Required Confined Spaces, 1998, Appendix F, Sections 3 and 4).

The entrance openings into these confined space, as stated earlier, are 24 inch manhole openings. These spaces are of a vault design. This design does not allow for any horizontal travel once in the space. The vaults is configured of a flat floor and straight vertical walls. This type of design is not recognized as a hazard, in and of itself (Permit Required Confined Space, 1998 paragraph b).

The Birmingham Fire Department has 30 minute high-pressure self contained breathing apparatus. This type is slimmer and allows for easy access through the manhole opening of 24 inches that Birmingham employees operate in. They also have a narrow stoke stretcher, used in low angle rescue that is designed place through a 23 inch opening.

For the fire department to be the designated rescue team for the public works department, they need to be trained and proficient in confined space rescue operations. The research has indicated that the Birmingham Fire Department has in place the equipment needed and their personnel have a strong training background. The research also indicate that the fire department needs to address two major issues to be compliant with the OSHA standard for confined space rescue, under paragraph K, of the *Permit Required Confined Space* standard, training and supporting documentation.

RECOMMENDATIONS

The recommendations conceived through the research were to develop a confined space rescue program, based on the City's existing Department of Public Services Confined Space Program. The Confined Space Program has already been scrutinized by the Michigan Occupational Safety and Health Administration and passed, with the exception of the designated rescue team.

The research indicates that to have the fire department designated as the rescue team, they must establish a written action plan or standard operating procedure. They, then must train their personnel for the specific rescue needs of the public service department.

After reviewing the *Birmingham Fire Department Polices and Procedures Manual* (1999), the researcher designed a Standard Operating Procedure (SOP) for confined space rescue operations with cooperation with the Birmingham Fire Department (see Appendix D) . This SOP was the basis in developing a confined space rescue training program.

The training of the Birmingham Fire Department was uniquely designed (see Appendix E). This program was develop based on the City of Birmingham's Confined Space Program (1993) and to enhance the existing knowledge base of the Birmingham firefighters. The program was designed to meet the OSHA standard (Permit Required Confined Spaces, 1998).

The training program was designed around the Birmingham firefighters existing knowledge of ropes and knots, basic rigging, air monitoring, and incident command system. All of these subjects were reinforced in the training program. The program concentrated on the areas of identifying a confined space, the hazards associated in operating in a confined space, entrant and attendant roles, the equipment used in confined space entry and rescue operations, and rescue operations. Each section of the training program was validated through a written test and or practical skill sheet. The program was designed to be 24 hours in length. The first six

hours of training were in the classroom. The next nine hours of training were on the drill ground, while the last nine hours were in evolution training. Validation of knowledge was verified through written tests, skill sheets, and time evolutions.

The first step in the evolution training was actual practical exercises using a confined space site similar to the spaces used by the public service worker. This six hours of training was designed to develop proficiency of the operation, which required the removal of a 185 pound mannequin from within the confined space. This training was divided into two three hour sections. After the first section was completed, an evaluation to the effectiveness of the training would be done. Any need for modification to the program must be done at that time, so the final section of this training could solidify and validate the program to the student.

The last three hours would be used for real time scenario practice using one of the actual confined spaces used by public service personnel, and includes the removal of the mannequin.

The equipment used in all confined space entry and rescue training was the existing equipment available within the Birmingham Fire Department. All the ropes, body harnesses, helmets, gloves, eye protection, respirator protection, tools, and rigging systems were existing equipment within the fire department, but would require the centralization of some of the equipment.

To assist in a timely, proficient, operation the research recommends that much of the rope equipment needed to be centrally located on one piece of apparatus. Tower 34, the elevated platform, would be the best suited for this equipment. The reasoning for this recommendation is that Tower 34 is centrally located to the confined space sites. Its normal response is to only structure fires, but is normally manned by at least one paramedic. This apparatus already carries much of the other needed equipment designated to be used in the confined space rescue

operations.

The purpose of this research was to develop a complete confined space rescue operation for the Birmingham Fire Department, so they could provide this service to the Public Service Department. The recommendations of this research have addressed and clearly guided the fire department in correcting this problem. The complete written plan (see Appendix D), and training program (see Appendix E) were integrated into one confined space rescue operational system that needs to be reviewed, with the Department of Public Services Confined Space Program on an annual basis.

The researcher would make a recommendation to Oakland Fire Training Institute. The committing of one organizations resources to correcting a problem of an other agency, when the total scope of the problem is not totally understood, is dangerous. This is especially true when a tight, and somewhat unrealistic, time constant is placed on the solution.

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APPENDIX A

NON-MANDATORY APPENDIX F

RESCUE TEAM OR RESCUE SERVICE EVALUATION CRITERIA

APPENDIX A
Non-Mandatory Appendix F -- Rescue Team or Rescue Service Evaluation Criteria

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- **Standard Number:** 1910.146 App F
- **Standard Title:** Permit-required confined spaces
- **SubPart Number:** J
- **SubPart Title:** Non-Mandatory Appendix F -- Rescue Team or Rescue Service Evaluation Criteria

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Non-Mandatory Appendix F -- Rescue Team or 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. Before a rescue team can be trained or chosen, however, a satisfactory permit program, including an analysis of all permit- required confined spaces to identify all potential hazards in those spaces, must be completed. OSHA believes that compliance with all the provisions of §1910.146 will enable employers to conduct permit space operations without recourse to rescue services in nearly all cases. However, experience indicates that circumstances will arise where entrants will need to be rescued from permit spaces. It is therefore important for employers to select rescue services or teams, either on-site or off-site, that are equipped and capable of minimizing harm to both entrants and rescuers if the need arises.

(2) For all rescue teams or services, the employer's evaluation should consist of two components: an initial evaluation, in which employers decide whether a potential rescue service or team is adequately trained and equipped to perform permit space rescues of the kind needed at the facility 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. For example, based on the initial evaluation, an employer may determine that maintaining an on-site rescue team will be more expensive than obtaining the services of an off-site team, without being significantly more effective, and decide to hire a rescue service. During a performance evaluation, the employer could decide, after observing the rescue service perform a practice rescue, that the service's training or preparedness was not adequate to effect a timely or effective rescue at his or her facility and decide to select another rescue service, or to form an internal rescue team.

A. Initial Evaluation

I. The employer should meet with the prospective rescue service to facilitate the evaluations required by §1910.146(k)(1)(i) and §1910.146(k)(1)(ii). At a minimum, if an off-site rescue service is being considered, the employer must contact the service to plan and coordinate the evaluations required by the standard. Merely posting the service's number or planning to rely on the 911 emergency phone number to obtain these services at the time of a permit space emergency would not comply with paragraph (k)(1) of the standard.

II. The capabilities required of a rescue service vary with the type of permit spaces from which

rescue may be necessary and the hazards likely to be encountered in those spaces. Answering the questions below will assist employers in determining whether the rescue service is capable of performing rescues in the permit spaces present at the employer's workplace.

1. What are the needs of the employer with regard to response time (time for the rescue service to receive notification, arrive at the scene, and set up and be ready for entry)? For example, if entry is to be made into an IDLH atmosphere, or into a space that can quickly develop an IDLH atmosphere (if ventilation fails or for other reasons), the rescue team or service would need to be standing by at the permit space. On the other hand, if the danger to entrants is restricted to mechanical hazards that would cause injuries (e.g., broken bones, abrasions) a response time of 10 or 15 minutes might be adequate.

2. How quickly can the rescue team or service get from its location to the permit spaces from which rescue may be necessary? Relevant factors to consider would include: the location of the rescue team or service relative to the employer's workplace, the quality of roads and highways to be traveled, potential bottlenecks or traffic congestion that might be encountered in transit, the reliability of the rescuer's vehicles, and the training and skill of its drivers.

3. What is the availability of the rescue service? Is it unavailable at certain times of the day or in certain situations? What is the likelihood that key personnel of the rescue service might be unavailable at times? If the rescue service becomes unavailable while an entry is underway, does it have the capability of notifying the employer so that the employer can instruct the attendant to abort the entry immediately?

4. Does the rescue service meet all the requirements of paragraph (k)(2) of the standard? If not, has it developed a plan that will enable it to meet those requirements in the future? If so, how soon can the plan be implemented?

5. For off-site services, is the service willing to perform rescues at the employer's workplace? (An employer may not rely on a rescuer who declines, for whatever reason, to provide rescue services.)

6. Is an adequate method for communications between the attendant, employer and prospective rescuer available so that a rescue request can be transmitted to the rescuer without delay? How soon after notification can a prospective rescuer dispatch a rescue team to the entry site?

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 (15-20 minutes), employers should consider using airline respirators (with escape bottles) for the rescuers and to supply rescue air 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 limits?
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 rescues, or must the equipment be provided by the employer or another source?

B. Performance Evaluation

Rescue services are required by paragraph (k)(2)(iv) of the standard to practice rescues at least once every 12 months, provided that the team or service has not successfully performed a permit space rescue within that time. As part of each practice session, the service should perform a critique of the practice rescue, or have another qualified party perform the critique, so that deficiencies in procedures, equipment, training, or number of personnel can be identified and corrected. The results of the critique, and the corrections made to respond to the deficiencies identified, should be given to the employer to enable it to determine whether the rescue service can quickly be upgraded to meet the employer's rescue needs or whether another service must be selected. The following questions will assist employers and rescue teams and services evaluate their performance.

1. Have all members 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 than 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 simply 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.

(b) 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 the space. Vertical portals may require knowledge of rope techniques, or special patient packaging to safely retrieve a downed entrant.
[63 FR 66039, Dec. 1, 1998]

APPENDIX B

CONFINED SPACE READINESS SURVEY OF OAKLAND COUNTY FIRE DEPARTMENTS

APPENDIX B – Confined Space Readiness Survey

Please complete this survey from OFTI. It will be used to help develop a confined space rescue plan for the Birmingham Fire Department. This is a time sensitive issue, so please complete ASAP and fax to 248-552-2602 or call 248552-2638 and someone will pick it up.

PART I

Scenario: Your Fire Department is called to a City/Township workers that has been injured in a manhole. On arrival, FD personnel find a man at the bottom of a 20' deep manhole, not moving or responding to verbal commands given at the surface. A co-worker found the man when he came to met him for lunch.

Do you have a confined space rescue plan? YES NO

If no, what would your people do in this situation?

(This is the end of the survey, if your answer was no)

If yes, are your people trained in confined space rescue? YES NO

PART II

What level or type of training has all your personnel received in confined space rescue? (circle all that apply)

Basic Ropes and Knots	Air Monitoring	Basic Rigging
High Angle Rescue	Low Angle Rescue	
Confined Space Awareness	Confined Space Entrant	Confined Space Rescue

Is your FD a designated confined space rescue team provider? YES NO

If yes, to what group?

Is your confined space rescue training incorporate all possible scenarios or only those you are the designated rescue team provider?

PART III

What was your start-up costs in developing your team?

Estimated or Actual Personnel/Training Costs

Estimated or Actual Equipment Cost

What is your estimated annual cost to maintain your team?

Thank you for taking the time to complete this survey. Please fax to 248-552-2602 or call 248-552-2638 and it will be picked up.

APPENDIX C

PHONE SURVEY OF CONFINED SPACE TRAINING PROGRAMS

Appendix – C: Phone Survey of Confined Space Training Programs

Name of agency:_____ Phone #:_____

Contact person:_____

1. What type of confined space training do you provide?

2. Do you provide confined space rescue training that is in compliant with MIOSHA?

3. Have you provided confined space rescue training to a fire department?

4. If yes, who? If no, why not?

5. Do you customized rescue training?

6. How long would it take to develop and deliver a customize training program? Hours needed to trained each person, and what equipment is needed?

7. What is the cost of providing this training?

APPENDIX D

STANDARD OPERATING PRODURE FOR THE

BIRMINGHAM FIRE DEPARTMENT

CONFINED SPACE RESCUE OPERATIONS

Appendix D – Standard Operating Procedure: Confined Space Rescue Operations

ARTICLE K **FIREFIGHTING**

Section 9 Confined Space Rescue Operations

A Confined Space Rescue Team consists of at least two experienced firefighters that have been trained in this type of rescue operations. The Confined Space Rescue Team must be prepared to immediately respond to the assistance or rescue any victim(s) who have been trapped, injured, or are in imminent danger and are unable to remove themselves from a confined space. The Birmingham Fire Department Confined Space Rescue Operations will be limited to the current level of training they have received. No attempt should be made to advance beyond the training and resources available to the Birmingham Fire Department.

If any confined space rescue operations is believed to be, or assessed to be beyond the resources immediately available to the Birmingham Fire Department, a mutual aid call should be made to the Southfield Fire Department and/or Pontiac Fire Department's Technical Rescue Teams for assistance.

Confined Space Rescue Team

. Operate as one team, a full response, responsible to only the Incident Commander.

. Don, or have immediately available, all necessary PPE (including SCBA) to enter an environment that may be hazardous.

. Environmental monitoring devices (four gas monitors, etc.) shall be used to test a confined space environment, prior to any rescue operations beginning.

. Any mechanical advantage and personal safety equipment must be set up and inspected prior to entry. Only rescue rated equipment will be used. Equipment on site, prior to fire department arrival, may not meet rescue requirements.

. Forcible entry equipment, additional complete SCBA (including a facepiece) should be immediately available for use.

. If resources are not immediately available (manpower, equipment, monitoring devices, etc.) call for mutual aid.

ARTICLE K **FIREFIGHTING**

Section 9 Confined Space Rescue Operations (Continued)

Operations

- All confined space rescue operations will be managed under the Birmingham Fire Department Incident Command System, and to the scope of the capabilities and training of the personnel on scene.

- Confined space operations will be broken into four phases.

  Phase I: Size-up (primary and secondary assessments)

  Phase II: Pre-Entry Operations

  Phase III: Rescue Operations

  Phase IV: Termination

- Every phase will be addressed during all confined space rescue operations.

Phase I

PRIMARY ASSESSMENT

1. The size-up of the incident, including the immediate evaluations of the hazards associated in that confined space, the nature of the rescue (injury, illness), and any observations that must be made (monitoring the environment) prior to establishing rescue operations.

2. Securing of witnesses or competent person associated to incident.

3. Determine the location, number and condition of victims.

4. Secure the Entry Permit, Pre-Incident Survey and MSDS that are available.

   a. If no information is available, this site will be considered to permit required site and all PPE will be used.

ARTICLE K **FIREFIGHTING**

Section 9 Confined Space Rescue Operations (Continued)

SECONDARY ASSESSMENT

1. Identify the type of space:
   Configuration, entry site, additional entry sites, topographic layout.

2. Products that may be in the space
   Natural to space: water, animals, and atmosphere

   Man-made or introduced into space: work equipment, by-products of work (i.e. welding), and tools

3. Hazard identification: atmospheric, mechanical, electric.
   Need for lock-out/tagout

4. Diagram of space.

5. Proper personnel and equipment on scene.

6. Need for additional resources - personnel, specialized equipment, atmospheric monitoring, ventilation, respiratory, retrieval system.

7. Recon Assessment - rescue or recovery?

Phase II

1. Establish perimeter area operational area.
   Hot, warm, and cold zones

2. Removal of all unnecessary personnel and establish staging area.

3. ICS - accountability.

4. Atmospheric testing.

5. Ventilation of site, if necessary.

6. Secure hazards - lockout/tagout.

ARTICLE K **FIREFIGHTING**

Section 9 Confined Space Rescue Operations (Continued)

Phase III

1. Action Plan: The plan of action to rescue or removal of all victims.

    a. Back-up Action Plan: Alternative plan of action addressing any need for variance from the initial action plan.

    Rescue Operations priorities shall be:

    1. To supply continuous air supply to any and all trapped victims, if necessary.
    2. To initially and continually monitor the scene and confined space for the possibility of atmospheric hazards, protecting the rescue team.
    3. Attempt to draw any hazardous environment away from the trapped victims, through use of continuous ventilation, or any other means available (lockout/tagout).
    4. Rescue and back-up entry teams will be in place prior to entry team beginning operations.
    5. To prepare to gain immediate access to victim(s) using conventional means (ladders, stairs, etc.) when available, or establishing a safe means to gain access.
    6. Access victim for injuries or illness. Package and remove victim to safe location outside of confined space.
    7. Return all fire personnel and equipment back in service.

2. Entry Team Readiness with Attendants in place

    a. Back-up Team Readiness

        1. PPE needed including SCBA, if necessary
        2. Lighting/communications equipment
        3. Remote air monitoring
        4. Personnel air monitoring equipment with entry team
        5. Class 3 harness and retrieval system with back-up system

ARTICLE K **FIREFIGHTING**

Section 9 Confined Space Rescue Operations (Continued)

3. Rescue Operations

   a. Victim location and assessment
   b. Supply of clean air, if necessary and possible
   c. Packaging of victim
   d. Removal of victim/extrication
   e. Removal of rescue personnel

Phase IV

1. Accountability of all rescue personnel and personnel on scene.

   a. Documented

2. Remove tools and equipment from site.

   a. Equipment inventory and inspection

3. Decontamination

   a. Cleaning of all equipment used

4. Secure scene, including opening to the confined space.

   a. Investigation will always follow a rescue

5. Consider debriefing.

   a. Incident critique

6. Call OSHA

Documentation of the action plan, ICS, and rescue operations are required on every Confined Space Rescue.
(City of Birmingham, 2000, Article K, pp. 12-16)

APPENDIX E

BIRMINGHAM FIRE DEPARTMENT:

CONFINED SPACE RESCUE TRAINING

STUDENT MANUAL

BIRMINGHAM FIRE DEPARTMENT: Confined Space Rescue Training

Student Manual

Presented By:

Oakland Fire Training Institute

Oakland Community College

CONFINED SPACE: RESCUE TRAINING

Table of Contents

INTRODUCTION TO CONFINED SPACES

CHAPTER OBJECTIVES

1. Identify the scope and application of 29 CFR 1910.146.
2. Define a confined space.
3. Define a permit-required confined space.
4. Define a non-permit confined space.
5. Identifying a hazardous situation.

INTRODUCTION

On January 14, 1993, OSHA issued a final rule that established safety requirements, including a permit system, for entry into confined spaces, designated as permit-required confined spaces. Permit-required confined spaces present special dangers for entrants because their configurations hamper efforts to protect entrants from serious hazards, such as, toxic, explosive or asphyxiating atmospheres. The standard provides a comprehensive regulatory framework within which employers can effectively protect employees who work in permit-required confined spaces. The federal final rule became effective on April 15, 1993 (Michigan-October 31, 1993).

SCOPE AND APPLICATION

Paragraph(a) states that §1910.146 contains requirements for practices and procedures to protect employees in general industry from the hazards of entry into permit-required confined spaces. This paragraph explicitly excludes agriculture, construction, and shipyard employment from the scope of the standard.

OSHA is aware that confined space accidents occur in agriculture, construction, and shipyard work and that employees in those industries do face a significant risk of death and serious injuries from these accidents. However, OSHA believes that sufficient differences exist between these industries and general industries to warrant separate rule making activities.

WHAT IS A CONFINED SPACE?

A confined space is a space that:

1. is large enough and so configured that an employee can <u>bodily</u> enter and perform assigned work; and
2. has limited or restricted means for entry or exit; and
3. is not designed for continuous <u>employee</u> occupancy and has one or more of the following characteristics:
    a. has the potential to contain, or contains a hazardous atmosphere,
    b. has the elements necessary for a potential engulfment hazard,
    c. configured in such away, sloping downward floors or inward converging walls, as to trap or asphyxiate an occupant,
    d. contains any other recognized, or potential serious health or safety hazard.

While OSHA is concerned that spaces too small for complete bodily entry may pose hazards for employees, OSHA

did not intend to cover such spaces under the permit-required space standard.

OSHA notes that entry, as defined in the final rule, begins when any part of the entrant's body breaks the plane of the entry portal. OSHA notes that doorways and other portals through which a person can walk are not considered to be limited means for entry or exit.

Also, OSHA states that one of the characteristics of a confined space is that it is not designed for humans to enter and work for prolonged periods without any additional consideration for safety and health.

EXAMPLES OF CONFINED SPACES:

Confined spaces exist in every community in a variety of forms. Some are found in churches, schools, industrial areas, and even fire halls. There are many easily identified confined spaces. Some examples could include:

. Tanks, vaults, bins, silos, or other structures where the top of one side is usually open and the enclosure is sufficiently deep to require special means of entry and exit.

. Pits, tunnels, and underground shafts, which are not designed for continuous occupancy and are not provided with adequate ventilation and a permanent means of entry and exit.

. Ducts, sewers, wastewater treatment tanks, boilers, pipelines, furnaces, and sluice-ways.

. Rooms or areas with deficient oxygen supply.

WHAT IS A PERMIT-REQUIRED CONFINED SPACE?

A permit-required confined space is confined space that has one or more of the following characteristics:

1. contains or has a potential to contain a hazardous atmosphere;

2. contains a material that has 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 by a floor which slopes downward and tapers to a smaller cross-section; or

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

In order to qualify as a permit space (permit-required confined space), a space must have **all** three characteristics of a confined space:

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,

and at **least one** of the following characteristics:

1. contains or has a potential to contain a hazardous atmosphere;

2. contains a material that has 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 by a floor which slopes downward and tapers to a smaller cross-section; or

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

WHAT IS A NON-PERMIT CONFINED SPACE?

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.

Examples of non-permit confined spaces include vented vaults, motor control cabinets, and dropped ceilings. Although they are "confined spaces" these spaces have either natural or permanent mechanical ventilation to prevent the accumulation of a hazardous atmosphere, and they do not present engulfment or other serious hazards.

OSHA has determined that spaces that have had all hazards eliminated can be reclassified as non-permit spaces for as long as the hazards remain eliminated. For example, spaces posing only non-atmospheric hazards, if those hazards can be removed without entry into the space, the permit space may be reclassified as a non-permit confined space after the hazards are removed. It is important to note that control of a hazardous atmosphere is not the same as its elimination.

WHAT IS HAZARDOUS SITUATIONS?

Anytime a person is placed in an area that limits their ability to enter or exit, mobility, or an environment that potentially limits their ability to breath freely, without worry of atmospheric changes, is considered a potential hazardous situation.

Confined spaces are hazardous by design. There may also be hazardous situations that will call for precautions similar to confined space entry even though they occur in an area not identified as a confined space.

Confined spaces have unique problems associated with them because of their contents and/or configurations. Some hazards may restrict air circulation so that hazardous atmospheres accumulate quickly. Other hazards may risk the surrounding and effective capture of a person by a liquid or finely divided substance found in the space.

The hazards associated with any job, trip and fall, chemical exposure, mechanical and electric hazards, fire, explosion, and temperature exposure are all amplified when the exposure is in a confined space. Other directly related hazardous may be fumes, solvent vapors, or cutting tools, depending on the work being done in the confined space.

OSHA and MIOSHA have determined that operating within a confined space has the potential to be a very hazardous situation and requires specialized training to work in and around a confined space.

WHY THE NEED FOR RESCUERS?

When workers are exposed to a hazardous working environment, the potential for injuries is dramatically increased. Most employee injuries and deaths, occurring in a confined space, occur in toxic or asphyxiating atmospheres. In addition, when workers outside the confined space become aware that an entrant is having difficulties, they often attempt to enter the space to assist or rescue the entrant, many times, this has devastating consequences.

OSHA has determined that where multiple deaths in confined space accidents occurred, the majority of the victims died while trying to rescue the entrant. Over 60% of confined space related deaths, are those of the would be rescuers.

SUMMARY

OSHA on January 14, 1993 issued a final rule to require employers to take appropriate measures for the protection of any employee assigned to enter a permit-required confined space.

The final rule contains definitions for:

confined spaces,

permit-required confined spaces, and

non-permit confined spaces.

The final rule provides a comprehensive regulatory framework within which employers can effectively protect employees who work in permit-required confined spaces.

Confined spaces are hazardous by design. There may also be hazardous situations that will call for precautions similar to confined space entry even though they occur in an area not identified as a confined space. Confined spaces have unique problems associated with them because of their contents and/or configurations.

Over 60% of confined space related deaths, are rescuers.

PRACTICE EXERCISE

1. Identify the scope of 29 CFR 1910.146.

2. 29 CFR 1910.146 applies to

   ☐ Agriculture
   ☐ Construction
   ☐ General Industry
   ☐ Shipbuilding

3. Define a confined space.

4. Define a permit-required confined space.

5. List four examples of permit-required confined spaces at your community or work place.

   1)

   2)

   3)

   4)

6. Define a non-permit confined space.

7. Identify what a hazardous condition is and how they are related to confined spaces.

8. What hazards are associated with a rescuer in a confined space incident?

CONFINED SPACE HAZARDS

CHAPTER OBJECTIVES

1. Identify four permit-required confined space hazards as defined by OSHA.
2. Identify atmospheric hazards.
3. Define engulfment.
4. Define a hazardous atmosphere.
5. Define an IDLH.
6. Define an oxygen-deficient atmosphere.
7. Define an oxygen-enriched atmosphere.
8. Define the term "flammable range."

INTRODUCTION

OSHA guidelines have defined confined space hazards as:

- atmospheric
- engulfment
- configuration, and
- other hazards, such as, mechanical, electrical, radiation, and noise.

OSHA has determined that working in permit-required confined space involves significant risks for employees and that a permit-required confined space program is necessary to control such risks.

ATMOSPHERIC HAZARDS

More deaths, in confined space accidents, are directly associated with atmospheric hazards than any other hazard. A hazardous atmosphere in a confined space is an atmosphere that may expose employees to the risk of death, incapacitation, impairment of ability to self-rescue, serious injury or acute illness due to:

1. an atmospheric oxygen concentration that is less than 19.5%,

2. an atmospheric oxygen concentration above 23.5%,

3. flammable gas, vapor, or mist in excess of 10% of the lower flammable limit (LFL),

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Lower Flammable Limit (LFL)

When the amount of fuel is too little for a self-sustaining reaction, the mixture is said to be "too lean." It is below the lower flammable limit (LFL).

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4. an airborne combustible dust at a concentration that meets or exceeds its LFL.

5. atmospheric concentration of any substance for which a dose or a permissible limit is published in Subpart G or Subpart Z or Part 1910 and that could result in employee exposure above the pertinent dose limit or permissible exposure limit.

Permissible Exposure Limit (PEL)

The airborne concentration of a substance above which exposure is not legally permitted. PELS are normally eight-hour-time-weighted average values.

6. any other atmospheric condition recognized as immediately dangerous to life or health (IDLH).

Immediately Dangerous to Life or Health

Immediately dangerous to life or health is any condition that poses an immediate or delayed threat to life or that would cause irreversible adverse health effects or that would interfere with an individual's ability to escape unaided from a permit space.

A hazardous atmosphere in a confined space is an atmosphere that exposes employees to a risk of death, incapacitation, injury, or acute illness.

OXYGEN DEFICIENT ATMOSPHERE

An oxygen deficient atmosphere is an atmosphere containing less than 19.5% oxygen by volume. Any atmosphere with less than 19.5% oxygen should not be entered without an approved supplied-air respirator (SAR). A SAR is a self-contained breathing apparatus (SCBA) or an airline respirator with a 5-minute escape bottle (when operating in a sewer, a 10-minute escape bottle is required). The oxygen level in a confined space can decrease because of work being done, such as welding, cutting or brazing. It can also be decreased by certain chemical reactions or bacterial action.

The oxygen level is also decreased if oxygen is displaced by another gas such as carbon dioxide or nitrogen. This process is referred to as inerting. Inerting is the displacement of the atmosphere in a permit space by a noncombustible gas to such an extent that the resulting atmosphere is noncombustible. This procedure produces an immediately dangerous to life or health oxygen-deficient atmosphere.

Oxygen Volume (%)	Symptoms
16-12	Increased breathing and pulse rate; slight disturbance of muscular coordination.
14-12	Emotional upset; abnormal fatigue upon exertion; disturbed respiration.
10-6	Nausea and vomiting; inability to move freely; possible loss of consciousness; possible physical collapse; may be unable to move or cry out although aware of difficulties.
Below 6	Convulsive movements; gasping respiration; respiration stops followed by heart stoppage.

CASE STUDY

A worker in Oklahoma prepared to enter a molasses tank. Following a common practice in that plant, employees removed the tank lid and allowed the tank to ventilate naturally for several hours before entering. The first entrant reported feeling ill as soon as he entered and collapsed almost immediately. Two standby workers required by the plant's confined space procedure entered to rescue him. All three employees died.

CONTRIBUTING CAUSES

_____

_____

_____

_____

CASE STUDY

A three man work crew ruptured a water line while boring through a street to prepare the way for extended water service. The workers were instructed to close off three valves in order to cut off water flow to the damaged pipe. They were aware of a company policy which required atmospheric testing before entry, but they decided that expediently shutting off water was more important.

They had no trouble with the first valve pit. However, the employees who entered the second pit, which had not been opened in three years, soon called for help. The local Fire department arrived in just a few minutes.

Firefighters entered the pit wearing self-contained breathing apparatus (SCBA). The firefighters discharged an oxygen cylinder in the pit to increase the oxygen level and retrieved the victims.

Two victims died from oxygen deprivation. The accident report noted that the oxygen level at a valve pit two miles downstream was only 3%. No atmospheric readings were done at the accident site.

CONTRIBUTING CAUSES

_____

_____

_____

_____

OXYGEN ENRICHED ATMOSPHERE

An oxygen enriched atmosphere is an atmosphere containing more that 23.5% oxygen by volume. An oxygen enriched atmosphere will cause combustible materials such as clothing and hair to burn violently if ignited. Oxygen **should never** be used to ventilate a confined space.

FLAMMABLE ATMOSPHERES

Conditions that can make an atmosphere flammable are:

1. the oxygen in the air, and

2. a flammable gas, vapor, mist, or dust in the proper mixture.

Flash Point

There are several terms that should be understood in relation to flammable atmospheres. The first term is flash point. **Flash point** is the temperature at or above which a flammable or combustible liquid or solid will give off enough vapors to form an ignitable mixture. Flammable gases may not have flash points listed on their MSDS's due to the fact that they are already in a gaseous state.

Examples of Flash Point for Various Liquids	
GASOLINE	**-45°F**
ACETONE	**0°F**
TOLUENE	**40°F**
METHANOL	**52°F**
GLYCERINE	**320°F**

Ignition temperature

Another term that should be understood in relation to flammable atmospheres is ignition temperature. Ignition temperature is the minimum temperature required to initiate or cause self-sustained combustion independent of the heating element.

Examples of Ignition Temperatures

Carbon disulfide	212^0F
Gasoline	536^0F
Methanol	878^0F

When the atmosphere in a permit-required confined space is found to be flammable, it is easier to change the atmosphere than to control the ignition sources. It should be noted that continuous forced air ventilation of a confined space may control atmospheric hazards - it does not eliminate them.

Cigarettes as a source of ignition have been blamed for many fires. It must be pointed out that cigarettes vary considerably from brand to brand in their burning rates. Modern tobacco cigarettes contain a complex chemistry of additives to control burning rates and moisture content of both the paper and tobacco. The maximum temperatures produced range from 760^0 F for one variety to 1440^0 F for another. In this situation the device used to light the cigarette, match or lighter flame, is sure to ignite any flammable atmosphere.

When the atmosphere in a confined space is found to be flammable, it is easier to change the atmosphere than to control the ignition sources.

Flammable and Combustible Liquids

A flammable liquid means any liquid having a flash point below 100^0 F. Flammable liquids are known as Class I liquids. A combustible liquid means any liquid that has a flash point at or above 100^0 F. Combustible liquids are known as Class II and Class III liquids.

A combustible liquid means any liquid that has a flash point at or above 100^0 F. Combustible liquids are divided into two classes, Class II and Class III. Class II liquids include those with the flash point at or above 100^0 F and below 140^0 F, except any mixture having components with flash points 200^0 F or higher, the volume of which makes up 99% or more of the total volume of the mixture. Kerosene is an example of a Class II combustible liquid.

Class III liquids include those flash points at or above 140^0 F. Class III liquids are subdivided into two subclasses:

- Class IIIA liquids have flash points at or above 140^0 F and below 200^0 F (i.e.; fuel oil)
- Class IIIB liquids include those with flash points at or above 200^0 F. (I.e.; brake fluid)

Flammable Range

OSHA defines a flammable or explosive atmosphere as an atmosphere which poses a hazard because flammable gases, vapors, or mists are present at a concentration greater than ten percent (10%) of their lower flammable limit. (LFL).
Flammable limits are the lowest and highest percentages, by volume, of fuel gas or vapors in air at one atmosphere

that will burn. The range between the two percentages is the flammable range of the material.

When the amount of fuel present is too little for a self-sustaining reaction, the mixture is said to be too lean. It is **below** the lower flammable limit (LFL).

When the fuel is plentiful and there is an inadequacy of oxygen, the mixture is too rich. It is **above** the upper flammable limit.

Also, OSHA defines an airborne combustible dust as a concentration that meets or exceeds its LFL. This concentration may be approximated as a condition in which the dust obscures vision at a distance of 5 feet or less. This "rule of thumb" should be used very carefully. There are some dusts which are combustible at concentrations that would not obscure vision at 5 feet or less.

Vapor Density

The weight of a pure gas or vapor compared with the weight or an equal volume of dry air at the same temperature and pressure. If the vapor density is less than one, the material is lighter than air and may rise. If the vapor density is greater than one, the material is heavier than air and will stay low to the ground.

Toxic Atmospheres

The term "toxic atmosphere" refers to atmospheres containing gases, vapors, fumes, mists, or dusts known to have a poisonous physiological effects. The toxic effect is independent of the oxygen concentration which may in fact, be within OSHA specified range. The most commonly found toxic gases in confined spaces are carbon monoxide and hydrogen sulfide.

Some toxic atmospheres may have severe effects which may not show up until years after the exposure. Others may kill quickly. The difference in these exposures are known as "acute" and "chronic."

"Acute exposure" refers to a large dose of a toxic material over a short period of time. This usually results in an immediate reaction. However, the reaction from some materials can be delayed as much as 72 hours.

"Chronic exposure" refers to a relatively smaller dose of a toxic material over a prolonged period of time. Chronic exposures result in delayed health effects.

"Toxicity" refers to the adverse effects on the body when a toxic substance has entered the bloodstream. There are four primary routes or modes by which toxic materials can enter the bloodstream.

They are:

1. inhalation,
2. absorption,
3. ingestion, and
4. injection.

ROUTES OF ENTRY

Inhalation

Inhalation occurs when a substance enters the body by way of the respiratory system. The average person breathes about 12 to 20 times a minute which equals about five quarts by volume of air taken in. If an airborne contaminant is present, it is most likely that it will enter the body through the respiratory system. For industrial exposures to chemicals, the most important route of entry is usually inhalation. Nearly all materials that are airborne can be inhaled.

Absorption

Absorption is another way for chemicals to enter the body. The body's skin is actually the largest organ of the body (19 square feet). Many chemicals can penetrate the dermal layers of the skin and find a direct route of entry to the bloodstream. Employees should cover any cuts, sores, burns, or scratches before entering a confined space.

Ingestion

Ingestion is the most controllable route of entry into the body. Employees should not take food or drink into a toxic atmosphere. Entrants going into confined spaces shouldn't carry gum or cigarettes so they can't absorb any hazardous chemicals.

Ingestion of inhaled materials can also occur because contaminants deposited in the respiratory tract can be carried out to the throat by the action of the ciliated lining of the respiratory tract. These contaminants are then swallowed and significant absorption of the material may occur from the gastrointestinal tract. Approximately one quart of mucus is produced daily in the lungs of an adult, this constant flow of mucus can carry contaminants out of the lungs into the throat to be swallowed with the saliva or coughed up and expectorated.

Injection

A material can be injected into some part of the body. Injection of toxic material can result from being cut by a contaminated object. This may present a problem to the employee because injection short-circuits protective mechanisms in the body, which prevent substances from entering the blood. Injection is not a common route of worker exposures.

Physical Warning Signs

dizziness

disorientation

weakness in the knees

shallow, rapid breathing

blurred vision

exaggerated sense of feeling good

profuse sweating

chest pains

loss of manual dexterity

loss of coordination

change in heartbeat

ringing in the ears

skin irritation

odor of solvents, gases, or vapors

nausea

Permissible Exposure Limits (PELs) and Short-Term Exposure Limits (STELs)

The airborne concentration of a substance above which exposure is not legally permitted. PELs are established by OSHA or its equivalent state agency. PELs are normally eight-hour time-weighted average values. However, there are also short-term exposure limits (15 minute averages) and ceiling limits (exposure concentrations not to be exceeded at any time).

Threshold Limit Value-Times-Weighted Average (TLV-TWA)

Threshold Limit Values (TLVS) refer to airborne concentrations of substances and represent conditions under which it is believed that nearly all workers may be repeatedly exposed day after day without adverse health effects.

OSHA defines an atmospheric concentration of any substance for which a dose or a permissible exposure limit is published in Subpart G, Occupational Health and Environmental Control, or in Subpart Z, Toxic and Hazardous Substances, which could result in employee exposure in excess of its dose or permissible exposure limit as a hazardous atmosphere. It is important to note that an atmospheric concentration of any substance that is not capable of causing death, incapacitation, impairment of ability to self-rescue, injury or acute illness due to health effects is not covered by the standard. An atmosphere that contains a substance at a concentration exceeding a permissible exposure limit intended solely to prevent long-term adverse health effects is not considered to be a hazardous atmosphere on that basis alone.

Immediately Dangerous to Life and Health (IDLH)

Immediately dangerous to life and health (IDLH) means any condition that poses an immediate or delayed threat to life or that would cause irreversible adverse health effects or that would interfere with an individual's ability to escape unaided from a permit space. For air contaminants for which OSHA has not determined a dose or permissible exposure limit, other sources of information, such as Material Safety Data Sheets that comply with the Hazard Communication Standard (29 CFR 1910.1200), published information, and internal documents can provide guidance in establishing acceptable atmospheric conditions.

Common Substances Which May Be Found In Confined Spaces

Hazardous Substances	**Hazards**
Nitrogen	Asphyxiant
Nitrogen Oxides	Toxic
Ozone	Highly toxic

Propane	Asphyxiant; narcotic; highly flammable
1,1,1- Trichloroethane	Narcotic; may emit highly toxic fumes in presence of hot work
Trichloroethylene	Narcotic; may emit highly toxic fumes in presence of hot work
Welding fumes	May contain lead, zinc, nickel, cadmium, or chromium
Xylene	Flammable and narcotic

ENGULFMENT HAZARDS

Engulfment is the surrounding and effective capture of a person by a liquid or finely divided (flowable) solid substance that can be aspirated to cause death by filling or plugging the respiratory system or that can exert enough force on the body to cause death by strangulation, constriction, or crushing.

The engulfed entrant can be asphyxiated by:

1. filling of the respiratory system as the engulfing material is inhaled, and

2. the inability of the chest to expand.

In some cases, engulfing materials may be so hot or corrosive that victims sustain fatal chemical or thermal burns, but are not buried to a point where they cannot breathe.

CONFIGURATION HAZARDS

Confined spaces that can wedge or otherwise pin an employee and cause suffocation, physical harm, incapacitation or death are hazards that are specifically enumerated in the definition of "permit-required" confined spaces. A confined space which has an internal configuration such that an entrant could be trapped or asphyxiated by inwardly converging wall or by a floor which slopes downward and tapers to a smaller cross-section will be considered a permit-required confined space.

CASE STUDY

Early on morning, three employees were assigned to clean an iron ore bin. Cleaning these bins requires that employees physically enter the bin.

In this case, two of the employees were to clean the bin in preparation for the storage of a different material. The third employee was assigned to perform the duties of the attendant. The attendant's job was to warn the employees working in the bin of an approaching ore car. The specific safety procedure for the job called for the employees to exit the bin prior to the passage of the ore car overhead. The operators of the ore were advised that employees would be working in the bin and not to dump into the bin or to pull the bottom gates.

At 1:15 p.m., the attendant said he would take a turn in the bin while one of the two entrants performed as the attendant. The new attendant went to a phone, approximately 70 feet from the bin, to notify the operator that the work crew would be reentering the bin and not to open the gates.

As the new attendant completed his phone call and was returning to the bin, the new entrant began his descent into the bin. One worker was already inside the bin. An ore car was traveling north toward the bin and stopped in position over the bin where the entrants were located. While the ore car operator intended to dump iron ore pellets into an adjacent bin, he inadvertently opened the wrong gate. The pellets were dumped into the bin where the entrants were located.

The entrants were standing on a ladder on the east wall of the bin and were not directly below the ore car. When the ore discharged its load, the pellets struck the lower portion of the ladder and one worker fell. He was completely engulfed by pellets. The other employee, who was standing below the victim, was buried to the neck and rescued by the attendant. The victim was freed by fellow employees. An ambulance was called, and CPR was administered. The victim was transported to the hospital and was pronounced dead at 2:20 p.m.

CONTRIBUTING CAUSES

MECHANICAL AND ELECTRICAL HAZARDS

OSHA has discovered that some confined space accidents have resulted from a failure to isolate equipment from sources of mechanical or electrical energy. When service or maintenance work is being performed on machinery or equipment located in a confined space, OSHA's standard on the control of hazardous energy sources (29 CFR 1910.147) also applies. The permit-required confined space standard requires employers to evaluate any mechanical or electrical hazards found in permit spaces and to take all steps necessary to protect entrants.

PHYSICAL OR SPECIAL HAZARDS

There may also be special hazards associated with confined spaces. There may be physical hazards associated with confined spaces such as temperature extremes and noise.
Excessive heat and humidity may be found in a confined space because of the work that is being preformed in the space and the lack of natural ventilation. Excessive heat may also occur because of the protective equipment that must be worn while operating in a confined space. Anytime a body is exposed to excessive heat and humidity, it may cause serious health problems.

Extreme cold can also cause serious health problems. Many confined spaces are not heated. Cold conditions cause workers to tire easily, become clumsy, and make more mistakes. These all lead to a greater risk of injury.

Noise

This characteristic is not true of all confined space areas, but may be found in tunnels or tanks that are associated with industrial operations. Although noise may not be a consideration prior to the start of a confined space rescue, due to the nature of the work, noise levels may become hazardous once an operations begin.

Any noise in a enclosed or confined space is amplified because of the design and acoustical properties of the spaces. Excessive noise will hamper and affect all communication in and around the spaces. A simple shouted warning, from someone inside the confined space, may go heeded.

The Confined Space Work Environment

Even after all the hazard mentioned above have been controlled or eliminated, there are other conditions that can make working in any confined space hazardous:

- insecure footing,
- stagnant air
- poor lighting, and
- presence of animals.

All of these conditions can and will hamper any rescue operation.

SUMMARY

OSHA has determined that there are three circumstances that define a confined space. They are:

- mobility-limiting size and configuration,
- limited means of access and egress, and
- not designed for continuous employee occupancy.

A permit space is a confined space that has certain characteristics that make it hazardous for employees to enter without taking special precautions.

Atmospheric hazards are the most common cause of confined space accidents. Confined spaces can result in oxygen-deficiency, flammable atmospheres, and toxic atmospheres. Engulfment hazards, though not as widely recognized, also caused the death of many confined space entrants by suffocating or drowning the victims. Confined space can wedge or pin an employee and may cause his or her suffocation. Other hazards in confined spaces may pose serious hazards to employees are wide ranging and must be evaluated by employers.

OSHA requires all affected employees, this includes rescue personnel, to be thoroughly trained in the procedures required in lockout of energy sources.

PRACTICE EXERCISE

1. List four hazards that make a confined space a permit-required confined space.

2. Identify six atmospheric hazards.

3. An oxygen-deficient atmosphere has less than:

   20.9% oxygen
   19.5 % oxygen
   16% oxygen
   12.5 % oxygen

4. An oxygen-enriched atmosphere has an oxygen concentration above:

   19.5% oxygen
   20.9% oxygen
   22% oxygen
   23.5% oxygen

5. A flammable atmosphere will exist in excess of ____% of its lower flammable range.

   10
   20
   50
   100

6. The route of entry where a hazardous substances can enter the bloodstream is by:

   inhalation
   absorption
   ingestion
   injection

7. Special hazards may include:

   electrical hazards
   mechanical hazards
   radiation hazards
   noise hazards

CONFINED SPACE PROCEDURES

CHAPTER OBJECTIVES:

1. Describe the main components of the written plan.

2. Describe the duties and responsibilities of the permit issuer/entry supervisor.

3. Describe the function of the entry team.

4. Describe the duties and responsibilities of the authorized entrant(s).

5. Describe the duties and responsibilities of the attendant(s).

6. Describe the duties and responsibilities of the rescue team.

THE WRITTEN PLAN

Each employer must prepare, maintain, and update a written plan describing the confined space locations. The plan must include the associated hazards, special monitoring requirements, and equipment needs. The rescue procedure must be prepared along with the written plan. A written plan includes the following information:

Location of Confined Spaces by the Authority Having Jurisdiction

A survey of all possible confined space site must be performed by the Authority Having Jurisdiction (AHJ). They will evaluate the confined space for health and safety hazards, entry procedures, special equipment needs, and design a rescue procedure for each type of space.

Procedures

It is the responsibility of AHJ to review all entry procedures, with their employees prior to any entry into a confined space. An Entry Supervisor is responsible for evaluating the predetermined hazards associated with the space, atmospheric monitoring and recognizing any unforeseen hazards that may present themselves before issuing an entry permit.

The entry permit must describe the type, focus, and period of time any and all work is to be performed in the confined space and use of any special equipment (solvents, welding torches, etc.). The permit must detail the need for atmospheric monitoring and additional ventilation as required. A list of all personnel that have entered the confined space and any attendant on the site.

Detailed rescue procedures have been written for each identified confined space. These procedures must be followed by rescue personnel when required.

These procedures are designed for the predetermined rescue team and may not include specialized rescue team that may be called to assist or replace the AHJ rescue team.

Pre-Entry Briefing

A pre-entry briefing and/or review of the entry permit shall be conducted before entering a confined space. The permit issuer, entrant, and any other member are involved in the work shall be included in the briefing. The briefing will review the written plan, entry procedures, details and restrictions, as well as the contents of the entry permit. The briefing may include the kinds of rescue equipment to be used and what rescue operations might be required.
Duties and Responsibilities of the Confined Space Entry Team

The written plan should include the duties and responsibilities of the confined space entry team. The team should consist of:

- the entry supervisor,
- the authorized entrant(s),
- the authorized attendant(s), and
- the rescue team.

Entry Supervisor

The entry supervisor will:

- review the written plan,
- identify the scope of the work to be preformed,
- identify the entrant(s),
- identify the attendant(s),
- evaluate the confined space,
- perform pre-entry atmospheric monitoring
- identify the hazards present in the confined space,
- determine the need for a rescue team to standby on scene,
- define the safety requirements to be used while operating in and around the confined space,
- complete the entry permit,
- conduct a pre-entry briefing,
- cancel the entry authorization and terminate entry, and
- take necessary measures for concluding an entry operations, closing off the permit space, and canceling the permit.

Authorized Entrant(s)

Only individuals who have been trained in confined space entry may enter a confined space. These individuals are responsible for performing the work or duties describe in the entry permit. These individual are required to follow all entry procedures established in the AHJ written plan, and the entry permit. While in the confined space, these individuals will:

- recognize hazards that they may face,
- recognize the signs and symptoms of exposure to a hazard,

- follow communication requirements,
- proper use of personnel protective equipment,
- evacuate a confined space when a perceive danger may exist, and
- lockout of energy sources.

Attendant(s)

At least one attendant will remain outside of the confined space and in communications with the entrant(s) when occupying a confined space. Only trained individuals will be used as attendants. Attendant duties and responsibilities will be:

- remain outside of the space during any authorized entrant is in the space,
- never enter the confined space,
- never enter a confined space to attempt rescue,
- verify the security of the confined space and the area around it,
- maintain continuous communications with entrants,
- know emergency rescue procedures,
- recognize any potential dangers or hazards to entrants,
- maintain an accurate account of persons in the confined space, and
- order evacuation.

Rescue Team

As described in the AHJ written plan, a rescue team shall be notified prior to any entry into a confined space. The rescue team must be familiar with the confined space and agree to perform this service for the AHJ. The rescue team shall have notification prior to any confined space entry by the entry supervisor or AHJ.

Rescue Procedures

The rescue procedure is developed during the confined space analysis and become shall become a part of the written plan. All entry and attendant personnel must know the emergency rescue procedures and understand their responsibilities if an emergency arises. They should have:

- prior knowledge and training in this space, or a similarly configured confined space,
- training in confined space rescue procedures,
- personal protective equipment, including respirators and rescue equipment necessary for making rescues from the permit spaces in our facility,

- assigned rescue functions,
- authorized entrant and attendant training,
- basic first aid, and
- cardiopulmonary resuscitation (CPR).

OSHA mandates confined space rescue teams to simulate rescue efforts annually. OSHA continues to mandate, that each year these simulations must be performed on every type of confined space, that the team is responsible to respond too. Use of mannequins, weighted to simulate a person, is recommended. Like all training, this must be documented.

CASE STUDY

A fuel company owner sent an employee into a large underground vault. The vault's only means of access and ventilation was straight down through six feet of 30-inch steel culvert pipe. The employer reportedly told police that "he heard a clunk" soon after his employee descended into the vault. Concerned because he had lost contact with the employee, he sent in a second employee. The rescuer collapsed at the foot of the ladder. The employer then directed a third employee to go in and help the others. The second rescuer collapsed before he got caught between two ladder rungs. This left the employee upside-down, interfering with rescue efforts by firefighters who were summoned to the scene.

Both rescuers were pronounced dead at the scene. The initial entrant died two days later from massive brain damage caused by prolonged oxygen deprivation.

CONTRIBUTING CAUSES

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Entry Permit

The entry supervisor is responsible for preparing an entry permit for a confined space. The AHJ written plan shall describe the form and method of completing an entry permit. The entry permit will specify the place, time, purpose, and persons assigned to the entry team.

An entry permit is issued to certify that the existing confined space has been evaluated by a trained and authorized member, and all protective measures have been taken, as described in the written plan. The permit will remain at the site.

Duration of the entry permit is spelled out on the permit, and is issued for time allotted to perform the duties described in the permit. If additional time is needed to completed the work assigned, all entry team members must evacuate the confined space and a new permit must be issued (or as defined in the AHJ written plan).

A written entry permit program is important for three reasons:

1. Entry procedures can be reviewed so that all hazards within the confined space are recognized and all corrective measure can be met for the entry team personnel safety.

2. Entry procedures can be reviewed so that unsafe practices can be recognized and corrected before and incident occurs.

3. If an incident occurs, the permit procedures provide the tools necessary for the effective rescue of the entry team.

SUMMARY

Each "Authority Having Jurisdiction" must prepare, maintain, and update a written plan describing confined space locations. The written plan includes associated hazards, special considerations, and equipment requirements for all confined spaces in that jurisdiction. The written plan will include the roles and responsibilities of the entry supervisor, entrant, attendant, and the rescue team.

A written emergency rescue procedure for confined space rescue must be developed along with the written plan.

A pre-entry briefing will be conducted before entry into a confined space.

A written entry permit will be prepared and issued before entry into a confined space is allowed. It provides for authorization, supervision, and termination.

A rescue team must be available to respond while all operations are occurring in a confined space. The rescue team shall be spelled out in the AHJ written plan and the entry permit.

PRACTICE EXERCISE

1. Describe the three main components of the written plan.

2. Describe the importance of a pre-entry briefing.

3. Describe the duties and responsibilities of the entry supervisor.

4. Describe the duties and responsibilities of the authorized entrant and attendant.

5. Describe the duties and responsibilities of the rescue team.

6. Identify three important reasons for a written entry permit.

CONFINED SPACE SAFETY EQUIPMENT

CHAPTER OBJECTIVES

1. Identify the three types of confined space safety equipment.
2. Identify the role of ventilation equipment and procedures in a confined space entry.
3. Describe the two types of supplied air respirators.
4. Describe the use of a self-contained breathing apparatus, when entering and operating in a confined space.
5. Describe the personal affects a confined space may have on the employee, when using a supplied air or self-contained breathing apparatus.
6. Describe the use of air monitoring equipment.
7. Describe personal monitoring devices.
8. Identify equipment for head, eyes, face, ears, hand, foot, and full body protection.
9. Identify the type of equipment used in a confined space rescue.

INTRODUCTION

Any work inside a confined space may be dangerous, therefore, rescue team members must use specialized equipment to ensure their safety. There are three types of specialized confined space safety equipment:

- precautionary equipment,
- work-assigned equipment, and
- rescue equipment.

Precautionary Equipment

Precautionary equipment warns other, which may be working in the area, that the nearby area is or may become hazardous. Precautionary equipment also notifies workers that work is being done at the site at that time. Examples of this type of equipment include warning signs, hazards warning tape, barricades, and pylons.

Work-Assigned Equipment

Work assigned equipment is any specialized equipment necessary to perform the job assignment, while providing for the personal safety of the rescuer. Examples of some of the standard equipment issued are:

- Personal Alert Safety System (PASS),
- ventilation equipment,
- portable lighting (explosion proof),

- hand and/or power tools(non-sparking),
- lockout equipment,
- respiratory equipment (SABA, SCBA),
- atmospheric monitoring equipment,
- head protection,
- eye and face protection,
- hearing protection, and
- hand, foot, and full body protection.

Personal Alert Safety System (PASS)

Personal Alert Safety System, or PASS device, are motion detectors worn by workers to scene the body movement of the person wearing the device. If movement stops, an alarm sounds to alert other employees in the immediate area. This type of device omits a load audible alarm when triggered. A PASS device worn by an incapacitated or injured worker, will alert the attendant, usually within 30 seconds, of the need for immediate assistance.

Ventilation Equipment

A ventilator is basically a fan that moves air. There are two types of commonly used ventilation techniques:

1. Positive Ventilation

2. Negative Ventilation

When attempting to exchange air within a confined space, you must realize that an exist and entrant opening is required. This can become a problem when only the entry site is known to the attendant on site.

Negative ventilation is a technique of drawing air from within the space through a fan to the open atmosphere outside of the confined space. This is the oldest mechanical forced ventilation technique. This technique has advantages over natural ventilation:

- supplements any natural ventilation currently available,
- speeds removal of contaminants (30-60 cfm; cubic feet of air per minute), and
- allows for safer and quicker entry in to a confined space.

There are also disadvantages to using a negative ventilation technique:

- it must have a opening to the outside atmosphere, different than the opening used for exhausting (fan placement),
- does not allow for large volumes of air to be moved quickly,
- does not allow for directional flow of air,
- allows for possible churning of air in the space not allowing fresh air in,
- may allow a extremely rich air mixture to pass through it flammable limits,
- is dependent on an electrical power source, and
- allows for the confined space atmosphere, flammable and/or explosive, to pass through a possible ignition

source (the fan motor).

Positive ventilation is a technique of forcing fresh air into a confined space. This technique is the recommended method of displacing an atmosphere in a confined space. While having all of the same advantages of negative ventilation, positive ventilation has many more:

- move 10 times the air volume, compared to negative ventilation (minimum is 600 cfm; cubic feet of air per minute),
- supplied with flexible duct that allows for directional flow and use of the same opening for an entry and exhausting an atmosphere.
- accelerates entry into a confined space for rescue,
- causes a venturi-type air movement, drawing an atmosphere from all corners of a confined space,
- normally needs no outside power source (internal gas powered engine), and
- does not allow atmosphere to knowingly pass through an ignition source.

Positive ventilation has a negative side, as any mechanical ventilation technique does:

- requires special equipment,
- can cause a rich atmosphere to pass through its flammable/explosive range, and
- can introduce carbon dioxide into the space if the exhaust from the power source is not diverted away from the fan.

Ventilation of a confined space is mandatory before entry. Positive ventilation is the recommended method. Positive ventilation allows for the pressurization of the space and also moves good air in and poor air, toxic and flammable air out. This pressurization causes the exchange of air to occur ten times faster than negative ventilation. Continuous monitoring of an atmosphere is required, even though the confined space is being ventilated. Ventilation should not be substituted for air monitoring.

Portable Lighting

Most, if not all, confined spaces are poorly lit. Many times there may be no existing lighting inside the confined space. If there is lighting available, it may be necessary for the power source to be locked out. Under this type of working conditions, it is apparent that the rescue team must supply their own source of portable lighting.

It is recommended that any electrical equipment, which is used by a rescue team, be designed for use in a possible flammable or explosive atmosphere. This type of equipment is called explosion proof or intrinsically safe.

Explosion proof equipment is designed to have it possible ignition source contained in a special enclosure within the equipment. Gases that may enter the equipment are cooled before existing.

Intrinsically safe equipment use insulating material to prevent arcing or an ignition source.

General types of flammable or explosive atmospheres are:

- flammable vapors and gases,
- ignitable fibers, and
- dust.

Flammable environments have been explained in detail in Chapter 2 of this manual.

Hand or Power Tools

Whenever there is the possibility of an explosive atmosphere in a confined space non-sparking tools are required. When using any form of tool in a confined space rescue, a non-sparking form of the tool shall be used. Many hazardous material clean up team have non-sparking hand tool.

Whenever an electrical power supply is needed, a ground fault circuit interrupter (GFCI) should be used. Ground fault circuit interrupters are used when wet conditions are present. They may also come with circuit monitors, which prevent accidental startup after a power interruption.

Lockout Equipment

Serious injury can be caused by the unexpected startup of machinery or equipment, release of stored energy, or contact with electrical energy. This unexpected startup can be done by other works in the area, or through an automatic device, without warning. OSHA estimates that failure to control hazardous energy sources results in:

- 10% of serious industrial accidents,
- 28,000 lost work days per year, and
- approximately 120 deaths per year.

These hazards can be avoided through the use of lockout/tagout procedures. Lockout procedures isolate energy and control equipment, to protect workers servicing the equipment and protecting any bystanders.

With hazardous energy sources resulting in 10% of all industrial accidents, a rescue team must be able to isolate the energy source, because they will be called to these type of accidents. To rescue a victim and protect the rescue personnel, all energy sources must be isolated and controlled.

Before any rescue team personnel can perform lockout/tagout procedures they are required to:

- identify hazardous energy sources that the team may encounter,
- develop a written energy control program, and
- all members must be trained in lockout/tagout procedures.

UNDERSTANDING ENERGY SOURCES

Energy sources can take many forms, including:

- ***Electrical Energy*** - the flow of electrons through a conductor.
- * (i.e.: lighting, motors, etc.)
- ***Hydraulic Energy*** - The force caused by a pressurized fluid.
- * (i.e.: Hi-Lows, stabling machinery)
- ***Kinetic (Moving) Energy*** - the force caused by an object's motion.
- (i.e.: energy released by a spinning shaft)
- ***Pneumatic Energy*** - the force caused by compressed air.
- * (i.e.: any supplied by an air compressor)
- ***Potential (Storied) Energy*** - the force stored in an object that isn't moving.
- (i.e.: a suspended load that is not moving but in under tension)
- ***Thermal Energy*** - increased heat of a fluid or object.
  * (i.e.: steam heating)

It is important to identify and isolate all types of energy. Equipment must be both shut off and prevented from releasing stored energy. If the energy source is not isolated, a release of energy can occur, causing unexpected start-up, movement caused by the release of stored energy, or electrical shock.

By understanding and identifying the type and amount of energy source, employees can make sure that equipment or machinery has no kinetic or potential energy that could cause injury. The use of engineered safety devices isolates these energy sources. Examples of engineered safety devices are machine guards, electrical disconnects, mechanical stops and point-of-operation guards. All of these devices are designed to provide additional safety to employees working on a piece of equipment or machinery, in addition to power shut-off.

However, no safety device is 100% safe, when someone wants to bypass the device.

Lock-out/Tag-out Procedures

A rescue team must perform Lockout/tagout whenever operations are being performed on or around any energy source, where injury could result from unexpected start-up or release of stored energy. Lockout must also be performed when a guard or other safety device must be bypassed or removed, or when a victim or rescue team member must place any part of their body where it could be caught by moving machinery.

Before an energy source can be isolated, the following questions must be answered:

- What is the type of energy source?
- What are the potential hazards, related to the energy source?
- What steps are necessary to control the energy source?

All of the energy sources identified in this chapter are commonly found in confined spaces. Also, many confined spaces will have a secondary or multiple sources of energy present that will have to be shut down.

After all energy sources have been positively identified, the isolation of these sources must occur. This is usually accomplished by placing a lock or isolating device to physically block energy to the equipment or area being shut down.

Common examples of energy isolating devices are:

- Electrical disconnects
- Blanks, slide gates or slip lines used in pipelines to isolate chemical energy when it cannot be closed off or controlled by valves.
- Blocks and pins used to prevent the movement of machine parts caused by pressure from hydraulic or pneumatic energy or gravity.

Once the identification and isolation of all energy sources has occurred, the locking and tagging of all isolating devices is the next step. Safety equipment suppliers manufacture lock-out supplies for every type of isolating requirement imaginable. Most industrial setting will have these lock-out devices on hand, but do not use them.

OSHA requires that a rescue team have their own lock-out devices. This is to ensure the safety of the rescue team members. Only the rescue team member that lock-out an isolating device can have the key to remove that lock. If an existing industrial lock-out device is used, then the key is possibly available to any worker on the site. A lock-out kit containing a basic assortment of these items must be carried by the fire department with the potential for confined space emergency.

Once you are certain that lock-out has occurred, tags may now be installed in all areas required. These tags serve as a warning to anyone approaching the site that rescue work is going on, and under no circumstances should energy be restarted to the affected area. This is an effective communication to subsequently arriving fire department or rescue personnel, or for civilian workers on the site.

A final check and inspection of all the controls involved should now be accomplished. This final check will ensure that you have shut down the right machine or affected area and that any stored energy involved will be released. Only now will it be safe to proceed with the remainder of the rescue operation.

Extreme caution is the rule when performing lock-out/tag-out procedures. Assume the worst case scenario, and never proceed until you are completely satisfied that the system cannot be operated and the space is neutralized from all energy sources.

Start up of energy sources, after the confined space incident has been resolved, is just as important as the original lock-out procedure. Because of the potential dangers, under no circumstance should fire department personnel restore and start-up machinery, equipment, or energy sources.

Respiratory Equipment

There are many types of respiratory equipment on the market but only two types that are recommended for rescue team use, SCBA and SABA. All the others are not designed for use in an oxygen deficient atmosphere.

Self-Contained Breathing Apparatus (SCBA) are used daily in the fire service and in an industrial setting. An SCBA is a totally independent supplied-air respirator. This means that it provides breathing air and maintains a positive pressure to keep the unsafe atmosphere of the confined space outside of the mask. SCBA's can only be used by trained personnel and are designed to provide the user within positive pressure atmosphere. While SCBA's are the respiratory equipment of choice in the fire service, they do have limitation when used in a confined space:

- may have to remove to make entry,
- limited air supply,
- limited maneuverability,
- weight, and
- no back-up air supply.

While many training manuals (i.e.: IFSTA, Essentials) support the removal of an SCBA, when moving through a tight space, it is not recommended when operating or entering into a confined space. The unit is heavy and may fall, causing the mask to be removed from the users' face or cause the user to be pulled down with the falling unit.

Supplied Air Breathing Apparatus (SABA) use a central source of breathing air that is delivered to the wearer through an air supply line or hose. The hose lengths vary but can not exceed 300 feet. A confined space rescuers' SABA is required to have an added compressed air cylinder (minimum of five minutes/ten minutes when operating in a sewer). Combination units are used are generally designed for emergency entry operations like rescue. The self-contained part of the device is used only when the air line part fails and the wearer must escape.

There are advantages when using SABA:

- allows entry into areas prohibited by SCBA's,
- compact design,
- light weight,
- unlimited air supply, and

- back-up air supplies and escape system.

The use of a SCBA or SABA unit can cause anxiety and stress to an individual. Then add the acute stress of a possible rescue in a small, unfamiliar, confined, and limited access area, like a confined space, can cause panic to a rescuer. A panic and excess anxiety can only cause confusion and danger to an rescue operation. The need to understand and control these natural human responses, is essential for all rescue personnel.

CASE STUDY
"This Could Be You"
by
Michael G. Brown, Virginia Beach Fire Department

This was not a typical emergency call. I had second thoughts as I peered into a 24-inch in diameter culvert pipe. It looked more like a funnel than a tube. I felt the anticipation eating at my stomach, the sweat soaked into my helmet liner, and I realized that time was of the essence. I wondered, how could a five year old boy have gotten stuck so far inside a culvert? I hope he's okay, his whimpers and moans seem to have gotten quieter.

The last thing I saw before I began my slithery journey was the colorful Tasmanian Devil on the side of the big, heavy rescue truck. I felt some confidence knowing the specialized equipment and a cascade air system were available.

My entry into the tube was relatively uneventful, I quickly became accustomed to the dark and acclimated to the cold slime that coated the bottom of the tube. After all, being a macho firefighter, I could handle just about anything.

I became conscious of my labored breathing after about 50 feet of inch-worm like crawling. The air was dank and stale. I wanted fresh air, to expand my chest and to breathe comfortably.

Over the hump, I could see my victim some distance away. At this point I became anxious to end this uncomfortable situation. My back became wedged against the top of the totally inflexible corrugated pipe. An immediate and over whelming anxiety swept over me as if someone had just flushed the tube with warm blood.

My anxiety began to increase dramatically. I began to see shapes and images that would not go away. Suddenly, my victim became the Tasmanian Devil, the same colorful Tasmanian Devil that was on the side of the rescue truck outside. Reality had become a thing of the past. I wanted out!

CONTRIBUTING CAUSES

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Anxiety is a natural defensive response that the human body uses when it is exposed to a new, different, or frightening situation. When this feeling of anxiety over comes you, a sense of urgency comes over you. Your mind is telling you that you are in danger. This is similar to a firefighters' first really hot fire, or a police officers' first armed confrontation.
Anxiety is a totally natural emotion and like other emotions, must be controlled. The only method of truly controlling the type of anxiety experienced in a confined space, is to train. OSHA mandates that all rescue team

members must be exposed to and train in each permit-required confined space, or one similar use and design, so that rescue personnel will be familiar to each space. When a person is familiar with their surroundings or environment, anxiety is limited or quickly controlled.

Claustrophobia is a morbid fear of small, confined, closed spaces. The word can be broken down into two parts, "claustro", small or confined spaces, and "phobia", morbid, recurring fear that appears to be unwarranted.

Many first time fire cadets have had this feeling when they first place a face piece, from a SCBA, over their face. This was a real fear that all fire fighters have to learn to overcome and control, to do their job.

This reaction, claustrophobia, is a natural human response to entering a confined space. In addition to the design of the space add a heightened sense of urgency, a rescue, and you may have morbid fear that comes over a rescuer quickly (See the Case Study, "This could be you").

The only recognized method of overcoming claustrophobia is training and exposure. Training on the use of all equipment necessary to do your assigned job. This may include many repetitive hours of practice with an SCBA or SABA unit until your mind is convinced that this equipment will not harm you or fail. The next step is the training within a confined space, similar to any that you may have to perform a rescue in. As mandate in the OSHA standard 29 CFR 1910.146, all rescue personnel must have prior training and knowledge of all confined spaces they may be called to. This training must be practiced annually (minimum) for each type of space you may be called to. The last step is exposure. This too is spelled out in the current OSHA standard when its mandates that all rescue teams must perform simulated rescue maneuvers annually, at each type of confined space that they may be called to. This repeated exposure will reassure all personnel of the knowledge, equipment, and personnel capabilities when performing a rescue.

Stress will always have a direct affect, positive or negative, on a person involved in confined space rescue. Stress has been seen by many as a motivator. It is the stress that causes them to "raise up" to the challenge.

Stress has also been seen as having a negative affect on personnel. Stress can have an immediate affect or build up over time. In either case, stress can cause panic and depression to over come a rescuer, which has a direct effect on the job performance.
Training is again used to help relieve stress. The team building and support the team gives each member help defuse stress. The physical demands of training also help relieve stress, but stress affects everyone and must be monitored.

Structured training will help alleviate much of the anxiety and internal influences that operating in a confined space will have on a rescue team member. If a rescue team member avoids training situations, it may be caused from stress, anxiety, or many other internal mental influence. Avoidance reinforces and justifies ones fears.

Atmospheric Monitoring Equipment

"In all cases atmospheric monitoring shall be done before entry and rescue operations and in no case less than hourly during the operation, or at more frequently intervals dependent on changing conditions."

Atmospheric monitoring equipment are used to monitor the immediate atmosphere that an entrant is being exposed too. OSHA standards require that a three function monitor be used to measure a variety of parameters. At a minimum you must monitor for:

- Oxygen levels
  - Oxygen deficiency < 19.5%
  - Oxygen enriched > 23.5%

- Toxicity levels;
  - Parts Per Million (PPM) that exceed Permissible Exposure Limits (PEL)

- Flammability
  - Lower Explosive Limit (LEL) $\geq$ 10%

(Atmospheric Hazards are explained in greater detail in Chapter 2 of this manual)

An atmospheric monitor uses sensors to measure the amount of oxygen in a given environment. These sensors use an electrochemical cell to determine the oxygen concentration. These sensors can located internally or externally, depending on the manufacturer.

Toxic level sensors are used to detect and measure the presence of specific gases. Two common gases are hydrogen sulfide and carbon monoxide. These gases are measured in Parts Per Million (PPM) and alarms are set to the specific gases Permissible Exposure Limit (PEL). In any case, in order to correctly qualify a reading, the operator must know the PEL and not rely on the alarm. In some cases it takes very few PPM to kill.

Toxic meters should be used whenever the presence of a specific gas is suspected, but before entering atmospheres with possible toxic gases present, positive pressure self-contained breathing apparatus must be worn by all entrants.

Parts Per Million (PPM):

1.28 oz of liquid in 10,000 gallons is equal to 1 PPM, or fill an entire room with white ping pong balls and one with orange on it represents 1 PPM.

Flammability is measured as the percentage of the Lower Explosive Limit (LEL). This value is obtained from the gas to which the monitor was calibrated. In most monitors are calibrated using Methane, Pentane, or Hexane. There are two forms of testing are used to measure LEL, Catalytic and Electrochemical.

Catalytic devices allow a sample to pass across a heated filament. This type of sensor can be permanent damaged by contaminants, such as sulfur compounds, heavy metals, and silicon compounds. With a sensor that uses the combustion process to make accurate readings also relies on sufficient oxygen level to be present. Insufficient oxygen level will give false reading.

Electrochemical devices pass a sample across a semi permeable membrane. This type of sensor is commonly found in a three function monitor.

The alarm setting should be calibrated to 10% of the LEL. In other words, when an atmosphere as reach 1/10th of the calibrated gases LEL, the alarm will sound (i.e.: LEL for methane is 5%, so alarm sounds a 0.5%). While not all gases have identical LEL's, a response curve or graph can be used to assist in detecting and measuring for other gases, other than the one the instrument was calibrated too. Each reference chart is manufacture specific and are not interchangeable.

The personal monitoring equipment are carried by one of the entry rescue team members, once in the confined space.

Head Protection

Head protection is one of the fundamental requirements when entering into any construction or work site. When called to a confined space rescue, normally it is because a worker is the victim. This means that work was being preformed at the site and head protection is mandatory.

All fire fighters, whether volunteer, career, or public safety, have been issued head protection in the form of a fire helmet. This helmet can be come more or a endurance than an assist when used in small tubes or tunnels. A more stream lined helmet may be required.

Eye and Face Protection

The use of eye and face protection reduces injuries. Common equipment used are safety glasses, goggles, face

shields, and SCBA or SABA face piece.

Hearing Protection

Excessive noise can cause noise-induced hearing loss. You should wear hearing protection if there is excessive noise. A good rule of thumb is, "If you can't verbally communicate within three feet, then some kind of hear protection should be used. For rescue teams, this may interfere with communication between rescuers and attendants and between the rescuers themselves. Other forms of communications must be used.

Other forms of communications may include:

- two-way radio head sets
- use of air horn, and
- use of rope pulls.

Hand, Foot, and Full Body Protection

The use of Personal Protective Equipment (PPE) with includes hand, foot, and full body protection, id dependent on the hazards you will encounter. Pre-plans and the written plan should address the use of special PPE.

Rescue personnel should aware of all hazards before exposing themselves. If the hazards have not been recognized, then rescue team members should wear the highest level of protection available, until all hazards have been recognized.

RESCUE EQUIPMENT

As a fire responding unit to most emergency situations, a fire engine has been equipped with a great deal of tools. These tools can be used and are used in confined space rescue operations. Examples are: SCBA's, radios, ropes, ladders, backboards or rescue stretchers, air monitors, and first aid equipment. This equipment has been used by fire fighters, to perform rescue, for years. It can still be used for confined space rescue.

Most fire departments are using kernmantle rope. With this change has come expanded the use of ropes in all areas the fire service. Kernmantle rope needs supporting associated equipment to use it to it fullest potential. Webbing, locking carabineers, prussic cord are commonly found on today's fire engine. This equipment will be used in confined space rescue operations. Additional rope related equipment needed, if not already available, is 2 - 2" pulleys and at least 8 large locking carabineers.

Air monitors have become common within most fire departments. While they may not be placed on every fire engine, they are available and should be dispatched to any suspected confined space incident. The use of air monitoring is critical to any confined space rescue operation.

OSHA requires that each rescue team have a pair of rescue hand-cuffs or wristlets. These can be made with webbing or commercially purchased. The are made out of a webbing material and placed over the wrists of the victim, to assist in removal.

Ladders or tripod can be used as anchor points to raise and lower equipment and personnel as needed. While few rescue rated tripods are available to fire departments, ladder are very common and easily accessible to fire fighters.

Forcible entry equipment, portable lights and other equipment available on a fire engine, will be used in a confined space rescue operation.

PRACTICE EXERCISE

1. List three types of confined space safety equipment needed when performing a rescue.

2. What advantages does mechanical positive ventilation provide, when entering a confined space?

   Help prevent to collection of hazards atmospheric vapors
   May provide a clean atmospheric environment for entrants
   Does not need an outside power source
   All of the above

3. Why is a supplied air source (SCBA) necessary, when entering a confined space, during a rescue operation?

   Because it apart of the fire service
   All worker wear them
   It provide a safe air supply in an unknown atmosphere

4. List the possible personal affects a confined space may have on you, especially when wearing a Self-Contained Breathing Apparatus.

5. Describe the need for continuous air monitoring, during a confined space rescue operations.

6. List five personal protective clothing items necessary to wear, when entering a confined space.

7. Describe the five pieces of equipment, normal found on a fire engine, at can be used for confined space rescue operations.

RESCUE PRINCIPLES

CHAPTER OBJECTIVES:

- Explain a Rescue Action Plan.
- Explain the differences between different types of rescue equipment.
- Demonstrate the safe and proper use and care of fundamental rescue tools and equipment.
- Explain the elements of a Rescue Action Plan.
- Describe the implementation of the Rescue Action Plan.
- Explain some of the considerations involved in working with a trapped victim.
- Describe the steps necessary to complete a confined space rescue operations.
- Explain the steps in terminating a confined space rescue operation.

Rescue Action Plan

Every rescue operation performed by a fire department should be pre-planned prior to arriving at the incident scene. The Rescue Action Plan, is a suggested operational plan for a response to a confined space incident. The components of this plan are very similar to any other Standard Operating Procedure or Guideline.

To properly develop a Rescue Action Plan, the fire department or other first responding personnel must first survey their jurisdiction for all possible confined space location in their community. While the location is important it is just the first step.

The next step is to survey each space for known hazards associated with that confined space. The design, configuration, and environment must be taken into consideration.

OSHA requires that an employer must allow access to each type of confined space, to it designated rescue team, for annual training. This access is mandated if the company has selected the fire department as their rescue team. If the fire department has not been designated as their rescue team, then no access is required. But you are guaranteed to respond if there is a problem because who do they always call when some one is ill, injured, or trapped? It is a good idea to survey all the businesses, industry, and institutional buildings in your community to see what you may have to deal with.

Once the determination of the type, design, and hazards that the confined spaces present in your jurisdiction, then the written action plan can be developed. The components of the written action plan are:

- Organizational operating system (Incident Command System)
- Training and qualifications for members.
- Monitoring and ventilation procedures.
- Entry procedures and considerations.
- Rescue procedures and considerations.
- Debriefing and incident review procedures.
- Annual review and update.

Organizational Operating System (Incident Command System)

Every fire department that responds to any hazardous material incident must operate under an Incident Command System (ICS). Confined space operations must be managed by an Incident Command System.

Each team is required to train and evaluate in each type of confined space response that they are designated as the Rescue Team. It is recommended that each rescue team annually train in every type of confined space available to the team. This will help prepare the team for any situation and will allow for the Rescue Action Plan to directly address the unique design or hazardous associated with each type of confined space in your jurisdiction.

Rescue Action Plan: Rescue Operations

The Rescue Action Plan must be unique and tailored to the specific needs of that jurisdiction, the resources available to them, the type of confined spaces, and the hazards associated with these spaces. Many fire department refer to their Rescue Action Plan as a Standard Operation Procedure or Guideline (SOP or SOG).

The operational section must address the pre-entry procedures, the entry procedures, and the post-entry procedures. All of these operations must the spelled out in the Rescue Action Plan, and be trained on prior to any member performing a rescue.
The use of specific equipment (air monitor, ventilation, rigging, air supply) must be clearly address in the plan.

Rescue Action Plan: Debriefing and Annual Review

These plans should have provisions for reviewing and debriefing after each training exercise and each incident. This process should be spelled out in the plan, and should include an open exchange of information. All actions during the training exercise, or incident should be documented and filed for the annual review of Rescue Action Plan. These records are required to be keep on file for one year.

Every operational plan, in the fire service, should be reviewed annually. The Rescue Action Plan should also be reviewed. During this review, every entry in a confined space should be reviewed for:

- current operational procedures effectiveness,
- ICS effectiveness,
- every confined space must be checked for changing, and/or recognizable hazards,
- safety and injury reports.

By addressing each of these areas, the plan can be measured for its true effectiveness on the incident scene. Each incident debriefing should be reviewed for needed changes. Changes to the Rescue Action Plan should not wait for the annual review. Changes in the plan must be address as quickly as possible, for the protection of the team members, and any change must be reviewed and understood by all members before implemented.

RESCUE EQUIPMENT

Manufactures are making and have designed specific equipment used for confined space entry and rescue. Most of the equipment sold to industry is the same, or very similar to the equipment carried on a fire engine.

SCBA
- Ropes and Rigging
- First Aid and Extrication/Removal Devices
- Portable Lighting
- Portable Radios

In addition to this equipment, manufactures have available other equipment to add in operations in a confined space.

- Continuous Air Supply - SABA
- Ropes with hard-line Radio Communication
- Mechanical Advantage, retrieval systems

All of this equipment is helpful, but may not be needed in the majority of confined space rescue incidents. The

equipment carried on a fire engine, with possibly a few minor modifications, will surface. This programs is designed to use the equipment on a fire engine, or available with a fire department, for the specific use during confined space rescue operations.

The use of the equipment available is critical in this type of operations.

Ropes

During every firefighters training, ropes were introduced and understood. Ropes are playing a must larger role in fire ground operations, so it should come as no surprise that ropes will play a major role in confined space rescue operations.

The ropes to be used in a confined space operations must meet NFPA 1983. The type of rope used in rescue operations should be kernmantle - lifeline. The use of smaller diameter kernmantle rope for prussic is recommended.

Webbing is used in confined space rescue operations. While most fire departments may not have this available, many are starting to. Webbing will be used for many applications, from the rescuer harness to anchor points.

The knots used in conjunction with webbing and kernmantle rope, are the same knots used in confined space rescue operations.

- Figure eight
- Figure eight follow through
- Figure eight loop
- Double figure eight loop
- Water knot
- Fisherman's knot
- Prussic
- Clove Hitch

All of these knots, except the webbing knots, are required training to all firefighters in the State of Michigan. The expansion of their use will be explained and demonstrated in the field exercises.

Ropes allow for the use of mechanical advantage systems. Mechanical advantage systems transfer the weight of an object through the use of pulleys and anchor points. These systems can be made, by using ropes and pulleys, or can by per designed by a manufacturer.

Confined space harnesses must be constructed to be full body harnesses. Rappelling harnesses will not work for this purpose. All harnesses used, should be rated for rescue purposes. Ropes and webbing will be used to create harnesses for all entrant into a confined space. The use of manufactured harnesses, for confined space rescue are recommended, but the use of webbing devise can be used.

Ladders

Ladders have been used in the fire service since its beginning. They have been used to allow firefighters quick means of access to an area. This is still true in many confined spaces. Placing a ladder into a confined space, will allow for quick and safety access to that area. But what must be done when a ladder and a firefighter will not fit into and area at the same time? An example of this may be a sewer or manhole.

OSHA mandates that fall protection be applied to any individual that may have a vertical fall over or five feet. This too must be accomplished, when entering a vertical opening, during a confined space operation. Ladders can many times still be used in both cases.

Through the use of A-Frames and Ladder Gin Pole, fire service ladders can be used to aid in the entry of a vertical

confined space opening, while also supplying vertical fail protection. Examples of this use of ladders will be demonstrated during practice exercises.

Tripods may be available to some fire departments and will probably be at the incident scene when entry into a confined space uses a vertical opening. Most of the tripods in use, in the industrial setting are not rated for rescue use. If the tripod is not rated for rescue operations, it must not be used. It is not designed to support the weight necessary during this type of operation and the possibility of failure in great. Only rescue rated tripods should be used during rescue operations.

The advantage of using a tripods is speed. It is must quicker to setup and comes with pre-established anchor points. Rescue rated tripods can be an advantage to any confined space rescue operation, but they too have their limits. Because of their design, they will not work over a large vertical opening. The also allow for limited working area in and around them. Tripods are not the only answer to a vertical opening.

SCBA - SABA

The use of respiratory protection in mandatory, when entering any possible hazardous environment and this is especially true in confined spaces. The main hazard associated with confined spaces, is atmospheric hazards. The use of self-contained breathing apparatus (SCBA) is common among firefighter. SCBA's are available on every fire engine, with spare bottles.

The use of positive pressure SCBA unit is mandatory in all confined space environments, which are not confirmed to be clear of any atmospheric hazard. This confirmation must come from rescue team air monitoring, and should not rely on prior reading made by workers on the incident scene.

The use of SCBA, at a confined space, may be limited. The size of the unit, with the size of the entrant, must be taken into consideration. (Try to fix 10 pounds of water in a 5 pound container!)

Size is only one consideration. The use of SCBA, in a confined space, is also limited to the distance and direction an entrant should travel. The entrant should not travel more that 50 feet from an attendant, into a confined space, and should not be out of site of the attendant. This is for the safety of the entrant. Placement of attendant at every turn, and other methods can be used to assist in rescue operations. Use of SCBA units, in a confined space, will be demonstrated during the practical exercises.

Many technical rescue teams have adopted the use of Supplied Air Breathing Apparatus (SABA). SABA units allow for a continuous supply of air. Many of these units are supplied with a five to ten minute escape bottle, to allow the entrant time to leave the confined space when an air supply problem exists. These systems may be identical to supplied air system found in aerial platforms.

Ventilation and Air Monitoring

The use of continuous air monitoring and supply of fresh air is essential for during confined space operations. The process and procedures for use of this type of equipment are manufacture specific and should not be generically addressed. All member of a confined space rescue team shall be trained in the use and operation of this type of equipment.

A recommendation for air monitoring: Personal air monitors should be supplied to the entry team, while air monitoring is continued in and around the space by an air monitoring group. Local Haz-Mat teams may be a good resource for assistance or coordination in this area.

Every level of the confined space must be monitored for hazardous conditions. This is done by monitoring every five to ten feet, using the probe off the monitor. Lower the probe, then wait for a reading. Then continue to lower the probe, as necessary.

Miscellaneous Fire Apparatus Equipment

Most, if not all equipment found on a fire engine, will be used during a confined space incident. Portable lights, forcible entry tools, salvage covers, and radios are but a few of the tools needed for successful operations at a confined space incident.

The use of personal alarm devices, usually connected to fire department SCBA units, is mandatory for use in a confined space.

Scene Protective Equipment

A safe working environment should be established. To protect all rescuers and any workers or bystanders in the area. Barrier tape or ropes can be used to mark off the area. Access to the area should be limited to only those needed in the current operations. All other rescue team member and support members should be clear of the area, in staging (as stated in ICS).

An Incident Command System must be used during a confined space incident. While there are many "modified" versions, of ICS, being used in the fire service, the authority having jurisdiction system will be followed. This is one reason for mandatory training. ICS systems are management systems and not tactical systems. The goals are established by the Incident Commander (IC), the objective are met through the divisions and groups.

The IC must establish control zones in and around the incident. A hot zone, warm zone, and cold zone should be established. The Hot Zone is the area in which the confined space entry and all direct supporting actives, for the entry team, are occurring. Only those personnel necessary for supporting the entry team should be in the hot zone.

The Warm Zone is where all secondary supporting functions are occurring. Primary staging of equipment and manpower to support the entry operations is place in this area.

The Cold Zone is where the command post is located, and all support activities for this operation is located. This area is where the secondary staging maybe located and where other interested parties, that are supporting the operation, can assemble during the rescue operations.

The use of barrier tape or rope can be used to mark off these areas. Any decon activities should take place in the hot zone.

The placement of apparatus should be at least 50 feet from the entry site and not over top of any part of the confined space. The diesel fumes will settle into the area and may compromise entrants and victims. Also, diesel apparatus, as well as gas powered, will vibrate the ground and area around it. This noise will compromise any communication in and around the confined space.

All other entry points into the confined space should be controlled by the IC. Any activity around alternate entry points, must be controlled and monitored.

RESCUE OPERATIONS:

Confined space rescue operations are dangerous. Over 60% of all death associated with confined space incidents are would be rescuers, so care and planning must be done before ever attempting a confined space rescue.

Confined space rescue operations follow a logical, fire service, thinking pattern. The steps involved are:

- Make the general working area safe.
- Make the rescue area safe.
- Entry procedures.
- Rescue the victim.

- Termination of incident.

Make the General Working Area Safe:

The general work area is made safe by establishing a controlled perimeter, establishing atmospheric monitoring of the general area, establishing specific entry points, and eliminating all potential ignition sources. Perimeter control is vital to accountability and coordination at a confined space incident scene. Police and/or other similar agencies can assist in this action.

General area atmospheric monitoring is done to establish if there has been any mitigation of product from the confined space. Ventilation may be necessary, in the general working area to control any mitigation.

The establishment and control of entry and exit points, into a confined space, again is for the rescue teams safety. Accountability of all personnel on the incident scene, as well as control of any work being performed in and around the confined space is vital.

By eliminating any and all potential ignition sources, will limit the possibility of complicating any hazardous atmosphere within the general working area.

Making the Rescue Area Safe:

The confined space must be as safe as possible before any member of a rescue team enters the space. This is achieved by performing specific tasks. Each of these task, like each task performed on a fire ground, must be coordinated and many require a team effort.

- Lock-out, tag-out, and blanking,
- Atmospheric monitoring of the confined space.
- Established ventilation in the confined space.
- Established communication system.
- Established support for entry team.

Lock-out/tag-out is a critical component of this type of operation. Controlling and/or eliminating an energy source will provide a safe working environment for the rescuers.

Atmospheric monitoring, in the confined space, should be performed prior to entry and continued during entry operations. All monitor reading should be documented on a regular basis. Any change in the atmospheric conditions must immediately be reported to the incident commander and the entry team.

Ventilation, prior to entry, is required. Continuous ventilation is necessary to help control the migration and/or accumulation of atmospheric hazards in the rescue operation area. This action may provide enough clean air, to the victim, to support vital signs until rescuers can arrive.

Providing the necessary support activities, is the basis for any emergency operation. All necessary steps must be accomplished prior to entry into the space. Operations like:

- air supply,
- air monitoring,
- communications,
- equipment needed for entry,
- ropes, rigging, anchor points and fail protection (if needed), and
- personal protective equipment for entry team.

All of these tasks, and possibly many more, must be performed and ready for operation to support entry team members.

Entry Operations:

No entry into a confined space should begin until all pre-entry requirements have been completed. This is to insure the safety of all personnel, and especially the entry team members. Entry operations start when a member of the team enters the confined space. (Remember, entry is when any portion of a body breaks the plain of the entry opening.) The entry team is responsible to the Entry Team Supervisor, operating in the Incident Command System.

Prior to entering a confined space, the Entry Team Supervisor will receive a briefing. This briefing should be specific, explaining their expected task. The briefing should also include review of emergency procedures, within the space, in the event of a rescue team problem. Each team member shall be provided with a description of the confined space, if available, any known hazards associated with the space, and any time limit placed upon them in reference to their time in the confined space.

Entry team personnel must be chosen properly, the right person for the job. It becomes very difficult to fit a 5' - 200 pound man into a 23" circular opening. When selecting an entry team and the space is configured so that it has limited mobility, it is best to select the smallest men for this assignment.

While OSHA does not mandate confined space rescue team entry teams to operate in pair, firefighters are trained to operate in pairs. Entry team will always operate in pairs. No personnel should enter and operate in a confined space alone. As discussed earlier, the configuration of a confined space may be such as to limit the entry of members to one at a time. Operations shall wait until both members of the team have entered the space and are ready for assignment. Each member of the entry team will have their own air supply system and tag line. If available, an addition air supply should accompany the entry team for the victim. One patient retrieval system and wristlets shall be carried in with the entry team.

A back up team, suited up and ready to go, shall be staged prior to the entry team entering the confined space. The back up team shall be prepared to enter in the event of an emergency during entry. If the need arises for the back up team to be used, a second back up team should be assembled, suited up and ready for action.

Once in the confined space, entry team members should be aware of their surroundings, the configuration, and any energy sources that are directly involved with the operation. Every energy source in the confined space, should be treated as if still “hot”, if possible.

When the entry team finds the victim, they should immediately answer some questions. How many victims are there? Is this a rescue or a body recovery? Is the victim(s) entrapped within a mechanism that will require additional equipment and time? Is the victim(s) easily removable and quickly accessible to the primary entry team? Will additional manpower be needed to package and remove the patient? How long will this operation take? The answer to each question should be communicated to the Entry Team Supervisor immediately.

With the limited air supply available from SCBA units, the primary task and accomplishment of the first entry team is to locate the victim(s). Once this task has been accomplished, removal and packaging can be done by the next entry team. Whenever possible, the primary entry team should supply the victim with a clean air supply, SCBA.

When it becomes necessary to have multiple crews leave and enter the space, consider the following as critical to the ongoing mission. As each crew exits the space and before the next crew enters the following information should be exchanged between crews, during a quick briefing.

- Any specific hazards directly associated with the operations.
- Location of the victim(s) or areas searched and not found.
- Update a map of the space.
- If decon or specialized PPE is necessary.

Rescue of Victim(s):

If a patient or victim(s) are easily removable by the first entry team, do so. The use of hasty hitch or wristlets can be used for this purpose. They allow for a secure means of removing a victim.

If the victim(s) are not easily removable, then a more extensive operation is required. At this time, all consideration as to the resources immediately available at this incident scene, to determine if the rescue is possible, at this time, or if a specialized technical rescue team is needed. If is always advisable to call a specialized technical rescue team immediately upon determining that a confined space rescue is necessary. Many times these teams are not readily available and need to be assembled.

Speed is important in any rescue operation, but the speed and complexity of the removal process shall not compromise the safety of the entry team. Coordination, through the Entry Team Supervisor and the Operations Officer, of both interior and entry operations will aid in removal process. The removal process:

- The entry team will package and coordinate the interior movements of the victim within the space. This will include rigging within the space or providing information to the Entry Team Supervisor for adequate support system outside of the space.

- The exterior teams will have adequate rigging systems in place to remove the victim from the space. This may include A-frame/ tripods systems, mechanical advantage systems, safety backups and rope systems. This type of operation requires close coordination and communication with the entry team.

When the entry team is packaging a victim for movement, they should consider the following:

- Rescuers should be stationed on the egress side of the patient.
- Avoid being blocked in by the victim during movement activities in the space.
  A) When movement blocks the egress, it must be done quickly and smoothly.
  B) Be sure to communicate with the Entry Team Supervisor, prior to blocking the egress.
- When working in a potentially flammable atmosphere, the use of spark causing metal devises in the rigging system is not recommended.

The exterior operations shall be responsible for the moving of victims. This will require an appropriate rigging system and close coordination. Some of the considerations are:

- The rigging system is appropriate for the weight and size of the victim.
- Mechanical advantage systems are preferred over “brute” strength systems.
- Safety device should be used on all retrieval systems.
- The use of electrical winches or other mechanical systems, is ***not allowed.***

The actual removal of the patient from the space is coordinated through the Entry Team Supervisor. Once the patient is packaged for removal, the Entry Team Supervisor coordinate every movement of the patient. The Entry Team Supervisor must consider:

- The removal of the patient will block the egress opening, so all activities must be done quickly and smoothly for the safety of the entry team.
- Identify how the victim will be removed (head first or feet first). Head first is recommended but not always possible.
- Have the entry team coordinate the lower half of the victim movements.
- Have a medical crew staged and ready for treatment of the victim.

Under no circumstances should the removal team be tied up with patient treatment and care. They have a responsibility to the entry team and must not be used for any other assignments until all members of the entry team have been removed from the space.

CASE STUDY

Source: NIOSH Publication 94-103

At 10 a. m., two sewer workers entered an underground pumping station, 50 feet below the surface. Their job was to inspect a check valve. While attempting to remove the inspection plate, it blew off allowing raw sewage to flood the camber, overwhelming one of the workers. The second worker exited the pumping station and radioed the police department requesting assistance. He again entered the station and was overcome. At 10:10 a. m., two police officers responded to the call and one entered the pumping station. Later the sewage system field manager arrived on the scene and followed the officer into the pumping station. None of the rescuers returned to the top of the sewer opening. A construction worker, who was passing by the site, stopped and entered the station in a rescue attempt. After descending approximately 10 feet into the shaft, he called for help. The second police officer assisted in the construction worker out of the shaft. None of the responding men wore respirators.

Fire department personnel arrived at the accident site at approximately 10:11 a. m. One firefighter, wearing a SCBA entered the shaft, but could not locate the four men. By this time sewage had completely flooded the underground room. The firefighter exited the pumping station. A second firefighter (6' 8", 240 lbs.) entered the shaft wearing a SCBA and a life line. As he began his descent he apparently slipped from the ladder and became wedged in the shaft approximately 20 feet down. His body was folded with his head and feet facing upward. Not being able to breathe, he removed the face mask and lost consciousness. Rescuers at the site extricated the firefighter after a 30 minute effort. No further rescue attempts were made, until professional divers entered the station and removed the bodies.

NIOSH Recommendations:

Recommendation #3: Firefighters, police officers and others responsible for emergency rescue should be trained for confined space rescue.

Discussion: A police officer died in the rescue attempt of the sewer workers. The police officer was not trained in confined space rescue techniques and did not recognize the hazards associated with the confined space. The volunteer firefighter, who attempted the rescue and wedged him in the shaft, should not have been allowed to enter. His size alone created a potential hazard for himself and the incident delayed possible rescue of the victims. Emergency rescue teams must be cognizant of all hazards associated with confined spaces, including rescue hindrances, and they should wear proper personal protection and devices for emergency egress.

CONTRIBUTING CAUSES

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Termination of the Incident:

Once the entry team has exited from the confined space, document their exit time and account for all personnel on the incident scene. Accountability is very important.

All entry team members should be debriefed for critical information they discovered while in the confined space. This may include the location of the victim, the hazards that cause the victims to need rescue, the environment that assisted or compromised the ensuing rescue operations, and any other information that may be useful. The IC should

collect all mapping of the space, as well as any other documentation collected on the incident scene.

All entry personnel should be sent for medical evaluation, through the Rehab Group in the ICS. All rehab information must be documented.

Each Division or Group Officer should inspect the equipment assigned to them for return to service. All equipment should be cleaned before returning it to an apparatus. This may be done at the station, if decon is not necessary. An accounting of all damaged equipment and should be marked or tagged.

The site will be turned over to the owner or contractor, but it is not the Rescue Team responsibility to return the confined space for safe occupancy. This responsibility is that of the owner or contractor.

Because of the uniqueness of this type of operation, it is recommended that a Critical Incident Stress Debriefing be considered for all personnel. A Critical Incident Stress Debriefing should only be performed by trained professionals and all information collected must be confidential.

GLOSSARY

Acceptable Environmental Conditions
The conditions that must exist in a permit space to allow entry and to ensure that employees involved with a permit-required confined space entry can safely enter into and work within the space.

Action Level
A legal exposure level which triggers specified activities in the cases of lead, arsenic, vinyl chloride, and asbestos. Industrial hygienists generally consider the action level to be 50% of the permissible exposure limit. Although actions are not legally mandated for contaminants other than those four listed when exposure exceed the action level, it is a concentration at which controls should be investigated. On a random sampling basis, if an exposure exceeds the action level, it may exceed the permissible exposure level.

Acute (Health Hazard)
Marked by a single dose or exposure, generally having a sudden onset for a course of time (acute toxicity, acute exposure).

Air Horn
See Venturi-type Air Mover.

Asphyxiate
Any vapor or gas that causes unconsciousness or death by suffocation. An asphyxiant can be categorized as simple or chemical. A simple asphyxiant acts on the body by diluting or reducing the oxygen in the air required for normal breathing. Examples include carbon dioxide, nitrogen, and natural gas. A Chemical asphyxiant upsets or disturb the normal body chemistry processes which control respiration. They can range from chemical which inhibit oxygen transfer from the lungs the respiratory system (carbon monoxide) or prevent respiration at the cellular level (hydrogen cyanide) to those which totally paralyze the respiratory system (hydrogen sulfide).

Asphyxiating Atmosphere
An atmosphere related to oxygen deprivation and/or asphyxiation within the body.

Atmospheric Analyzers
Specialized instruments for testing confined space atmosphere.

Attendant
A trained individual stationed outside one or more permit spaces who monitors the authorized entrants and who performs all attendant's duties assigned in the employer written plan.

Authorized Entrant
A trained employee who is authorized by the employer to enter a permit space.

Body Harness
A system of adjustable straps and buckles to remove an entrant from a confined space.

Blanking (Blinding)
The absolute closure of a pipe, line, or duct by the fastening of a solid plate that completely covers the bore and that is capable of withstanding the maximum pressure of the pipe, line, or duct with no leakage beyond the plat.

Blinding
See Blanking.

Calibration
Calibration of gas detectors is done in the laboratory by the manufacturer of the instrument. Certified personnel shall do calibration of gas detectors.

Chemical Asphyxiant
Substance that prevent the body from receiving or utilizing adequate oxygen supply.

Chemical Cartridge Respirator
A respirator that filters out gases and vapor through a cartridge or canister that is specific to the chemical hazard encountered.

Chronic (Health Hazard)
Marked by a long or permanent duration, consistent or continuous (chronic toxicity are usually permanent or irreversible); often occurs from repeated exposures over a period of time.

Combustible Gas Analyzers
Electrical direct-reading instruments for detecting combustible gases, vapors, or mists.

Confined Space Hazards
Hazards of confined spaces result from hazardous atmospheres or displacement of oxygen, lack of identifying confined spaces, and lack of rescue/emergency plans.

Control Operations
All procedures that make a confined space safe after a rescue has been made. Control operations must be completed before a secondary search for victims in a confined space is made.

Direct-reading Instruments
See Atmospheric Analyzers

Double Block and Bleed
Closing a line, duct, or pipe by locking and tagging a drain or vent that is open to the atmosphere. The place of closing is between tow locked-closed valves.

Dust
A solid, mechanically produced particle with a size ranging from submicroscopic to macroscopic.

Emergency
Any occurrence inside or outside of a confined space that could endanger entrants.

Engulfment
Surrounding and capture of a person by liquid or finely divided solid substance. Confined spaces with a risk of engulfment require the presence of an attendant.

Entrant
The person authorized to enter a confined space. Also called the authorized entrant.

Entry
Intentionally passing through an opening into a confined space. This includes working in that space. A worker has entered the space as soon as any part of the worker's body breaks the plane of an opening into the space.

Entry Permit
An entry permit is written authorization to enter a confined space. It is designed as a system under which confined space entry will be authorized, supervised, and terminated.

Entry Permit System
The written procedure for preparing, issuing, and completing permits for confined space entry.

Explosion meters
See combustible gas analyzers.

Explosive Atmosphere
A flammable gas or vapor in a permit-required confined space at a concentration greater than 10 percent of its lower flammable limit or it a combustible dust is present at a concentration greater than or equal to its lower flammable limit.

Exposure Hazard
Hazards existing from the inhalation, ingestion, injection, or skin contact of the material involved.

Face Velocity
The velocity of air at the face of an opening. This is important information when ventilating a confined space.

Field Testing
Testing of atmosphere monitoring equipment by certified calibration gases to ensure proper reading during testing of an atmosphere. This test may be performed by the entry supervisor or by personnel trained to perform the test.

Flammable Atmosphere
A flammable gas or vapor present at a concentration greater than 10 percent of its lower flammable limit or if a combustible dust is present at a concentration greater than or equal to its lower flammable limit.

Fit Testing
Fit testing is concerned with demonstrating the effectiveness of the face seal of a respirator.

Flammable Limits (LFL/UFL)
The lower flammable limit (LFL) is the minimum concentration of gas or vapor in air below which propagation of a flame will not occur in the presence of an ignition source. The upper flammable limit (UFL) is the maximum concentration of gas or vapor in air above which propagation of flame will not occur. If a gas or vapor mixture in air is below the LFL, it is described as being "too lean" to burn. It is above the UFL, it is "too rich" to burn. When the gas or vapor concentration is somewhere between the LFL and UFL, fires and explosions can occur. The mixture is said to be in the flammable range.

Flammable Range
The range of gas or vapor concentration (percentage by volume in air) that will burn or explode if an ignition source is present. Limiting concentrations are commonly called the "lower flammable limit" (LFL) and the "upper flammable limit" (UFL). Below the flammable limit, the mixture is too lean to burn. Above the upper flammable limit, the mixture is too rich to burn.

Flash Point
The lowest temperature at or above the point where a flammable liquid will give off enough vapors to form an ignitable mixture with the air above the surface of the liquid or within its container.

Fume
A solid condensation particulate, usually or a vaporized metal.

Gas
An aeriform fluid that is in a gaseous state at standard temperature and pressure.

Hard Hats
See Protective Helmets.

Hazardous Atmosphere
An atmosphere which exposes employees to a risk of death, incapacitation, injury, or acute illness.

Hot Work
Operations which could provide a source of ignition (riveting, welding, cutting, burning, heating).

Hypothermia
A condition of extreme cold which causes numbness in the extremities. Always remove the entrant to a warmer location and provide first aid if necessary.

Ignition Temperature
The minimum temperature required to initiate or cause self-sustained combustion independent of the heating element.

Immediately Dangerous to Life or Health (IDLH)
Any condition which could impair escape from a confined space. IDLH conditions are those that are immediately life-threatening or result in an acute exposure-related reaction to a chemical within three days of exposure. They also include conditions that may produce eye and lung irritation. Irritation might not be serious in itself, but could delay or impair escape from a confined space.

Immediate-Severe Health Effects
Any acute clinical sign(s) of a serious, exposure-related reaction within 72 hours after exposure.

Incident Commander
The individual in charge of an emergency operation. Responsibilities include developing an effective organizational structure, making appropriate assignments of personnel and equipment, managing information, and continually attempting to achieve the basic command objectives.

Inerting
Making a confined space non-flammable, non-explosive, or otherwise chemically non-reactive.

Ingestion
The introduction of a chemical into the body through the mouth. Inhaled chemicals may be trapped in saliva and swallowed. Exposed workers should be prohibited from smoking, eating, or drinking except in designated rest areas after being decontaminated.

Inhalation
The introduction of chemical vapors or toxic products of combustion into the body by way of the respiratory system. Inhalation is the most common exposure route and often the most damaging.

Injection
Injection of toxic material can result from being cut by a contaminated object or coming in contact with solvents and other materials. Cover any cuts, sores, burns, or scratches before entering a confined space.

In-plant Rescue Service Team
A group designated and trained to perform rescues in confined spaces.

Intrinsically Safe
Equipment, lighting, and tools designed to be used in area that might have, or has potential for, an explosive atmosphere. Intrinsically safe equipment, lighting, and tools can not create a source of ignition when used in the atmosphere for which they are rated or approved.

Irritants
Any gas or vapor which causes an inflammatory reaction.

Isolation
Removal of unwanted forms of energy which could be a serious hazard to an entrant.

Lanyard
A safety line. This can be a lifeline or a retrieval line.

Lifelines
Safety equipment designed to lower and lift workers in and out of a confined space.

Line Breaking
The intentional opening of a pipe, line, or duct that is or has been carrying flammable, corrosive, or toxic material, an inert gas, or any fluid at a pressure or temperature capable of causing injury.

Mechanical Lifting Devices
Hoists or winches for removing entrants from confined spaces.

Medically Qualified
Employees must have a medical evaluation prior to assignment to tasks requiring respirators to determine if they are physically able to perform work while wearing a respirator. A physician may make an objectively based judgment about an employee's ability to physically or psychologically tolerate wearing a respirator based on specific medical history and detection of current health problems may preclude safe use of respirators.

Mists
A liquid condensation particle.

Not-permitted Condition
Any condition or set of conditions where the hazard potential exceeds the limits stated in the entry permit.

Ongoing Work Space
Space modified to permit greater access through widening of openings and/or increased permanent air supply and exhaust ventilation.

Oxygen-deficient Atmosphere
An atmosphere containing less than 19.5% oxygen by volume.

Oxygen-enriched Atmosphere
An atmosphere containing more than 23.5% oxygen by volume.

Particulate Filter Respirator
A respirator that filters out dust, mist, and fumes through a mechanical filter.

Permissible Exposure Limit (PEL)
The airborne concentration of a substance above which exposure is not legally permitted. PELs are established by OSHA or its equivalent state agency. PELS are normally eight-hour time-weighted average values. However, there are also short-term exposure limits (15 minute averages) and ceiling limits (exposure concentrations not to be exceeded at any time).

Personal Alert Safety System (PASS)
Motion detectors to sense body movement and provide a warning if movement stops.

Post-Incident Analysis
The reconstruction of a confined space incident to provide a clear picture of the events that took place. This helps establish the details of the emergency response procedures for further study.

Precautionary Signs
Warn that nearby area is, or may become, hazardous.

Pre-entry Briefing
A meeting during which all employees who will be entering a confined space are informed of the hazards and safety conditions or the particular job by the entry supervisor.

Protective Helmets
A safety item, also called Hard Hats.

Retrieval Line
A line or rope secured to a worker at one end and an anchor or lifting (or retrieval) device at the other end.

SAR
See supplied-air respirator.

SCBA
See Self-contained Breathing Apparatus.

Self-Contained Breathing Apparatus
A totally independent supplied-air respirator.

Short Term Exposure Limit (STEL)
A STEL is defined as a 15 minute TWA exposure which should not be exceeded at any time during a workday even if the 8 hour TWA is within the TLV-TWA.

Simple Asphyxiants
Substances which induce a deficiency in the supply of oxygen to the body tissue by displacing oxygen in the air.

Skin Absorption
The introduction of a chemical or toxic product into the body by way of the skin. Skin absorption can occur with no sensation to the skin itself.

Standby
See attendant.

Suffocation
Lack of oxygen.

Supplied-air respirator
Any of three types of respirator that supplies breathable air for working inside a potentially hazardous confined space.

Threshold Limit Value (TLV)
A term used to express the airborne concentration of a material to which most people can be exposed day after day without adverse effects.

Toxic Atmospheres
Atmospheres containing gases, vapors, or fumes known to have poisonous physiological effects.

Toxicity
Those events related to toxins and poisons. Some chemicals affect the body by causing damage to specific internal organs or body systems.

Vapor
The gaseous form of any substances which is usually a liquid or a solid.

Vapor Density
The weight of a pure vapor or gas compared with the weight of an equal volume of dry air at the same temperature and pressure. If the vapor density is less than one, the material is lighter than air and may rise. If the vapor density is greater than one, the material is heavier than air and will stay low to the ground.

Venturi-type Air Mover
A ventilating unit often called an air-horn.

Warning Properties
Toxic gases and vapors that cause immediate irritation upon contact with the upper respiratory tract. Their presence is noticed immediately so appropriate measures can be taken to control exposure.

Wristlets
Loops of strong strapping material attached to a lifeline or lanyard.

Written Plan
The plan prepared to provide information about a confined space.