Risk Assessment Information for Safe Systems of Work

Communication During Confined Space Entry

Contents

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1.0 Introduction

Safe Systems of work, made safer with good communication…

Communication methods between workers inside and outside confined spaces can often be relegated to the bottom of the heap when initially designing a safe system of work for confined space entry. In many instances communication in confined spaces gets no more consideration than ticking a box on an entry permit or risk assessment form.
It is the purpose of this paper to highlight various communication issues specifically for confined space applications for both emergency and day-to-day work situations.
Also to raise the profile of good communication and how it fits into the overall confined space risk assessment process.

2.0 Regulations

This report makes reference to the following regulations

- **Confined Space Regulations 1997 (S.I.1997 No 1713)**
- **Confined Spaces Regulations (N. Ireland) 1999 Stat Rule 1999 No. 13**
- **The Dangerous Substances and Explosive Atmospheres Regulations 2002(S.I. 2002 no. 2776)**
- **Health Safety at Work Act 1974**
- **Management of Health & Safety at Work Regulations 1999**

Approved Code of Practice [1]

Paragraph 39 An adequate communication system will be needed and should enable communication:

- Between those inside the confined space;
- Between those inside the confined space and those outside; and
- To summon help in case of an emergency.

Whatever System is used, and it can be based on speech, tugs on a rope, the telephone, radio etc, it is important that all messages can be communicated easily, rapidly and unambiguously between relevant people. Consider whether the communication methods are appropriate for any workers wearing breathing apparatus. The communications system should cover the need of those outside the space to raise the alarm and set in motion emergency rescue procedures. Equipment such as telephones and radios should be specially protected so they do not present a source of ignition where there is a risk of flammable or potentially explosive atmospheres.

Health Safety at Work Act[2]

2. (1) It shall be the duty of every employer to ensure, so far as is reasonably practicable, the health, safety and welfare at work of all his employees.

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[1] Excerpt Health Safety Commission's "Safe Work in Confined Spaces" "Approved Code of Practice (ACOP), Regulations and Guidance Document" which includes the Confined Spaces Regulations 1997(S.I. 1997 No 1713).

2 Excerpt Health and Safety at Work Act 1974. (Elizabeth II 1974. Chapter 37)

Management of Health & Safety at Work Regulations 1999[3]

Risk assessment

3. - (1) Every employer shall make a suitable and sufficient assessment of (a) the risks to the health and safety of his employees to which they are exposed whilst they are at work; and(b) the risks to the health and safety of persons not in his employment arising out of or in connection with the conduct by him of his undertaking,…

3.0 Work Environment

Confined space work environments can by the very nature of their make up impede effective communication. An effective assessment must begin by first looking at the type of Space, its physical make up, its location and surrounding environment. This is where the experience of the competent person [4] creating the safe system of work is very important. As working environments vary considerably it would be impossible to go into the detail needed for complete assessment of each space, so in the interest of brevity included below are some general questions and comments that should provide enough scope to provide a starting point for any assessment:

- Where is the space Located? (Consider the physical location is it underground, next to running equipment)
- What is the space normally used for? What contents (if any) are commonly found in the space?
- What is the interior make up of the space? (i.e. does the space contain structures such as baffles, trays, vaults that can impede communication or visual contact)
- How far from the point of entry will work be carried out? (How far does voice have to travel or ropes have to be run)
- Is the point of work on the same plane as the point of entry? (Either horizontally or vertically)
- Is the entrant while at the point of work, clearly visible at all times from the point of entry? (Visual contact alone does not meet the regulatory requirement that all messages can be communicated easily, rapidly and unambiguously between relevant people)
- What is the noise level on the outside of the space? (This can affect the ability of the Safety Attendant outside the space from hearing communication from inside the space i.e. traffic noise, machinery, pumps, etc)
- Is the point of entrance exposed? (If the point of entry is on a free standing tower or tank, wind noise, weather conditions and ambient noise can interfere with communication)
- What are the general acoustic properties of the space? (Some materials or linings have a deadening affect on sound while the absence of a coating, as in a metal

3 Statutory Instrument 1999 No. 3242 The Management of Health and Safety at Work Regulations 1999

4 A competent person for these purposes will be someone with sufficient experience of, and familiarity with, the relevant processes, plant and equipment so that they understand the risks involved and can devise necessary Precautions to meet the requirements of the Confined Space Regulations….

tank promotes echo and reverberation that can confuse or cancel out direct voice communication with the outside)

- What type of process equipment will be running adjacent to the space? (Is it intermittent or constant source)

- What type of work is being conducted? (In addition to ambient noise consideration needs to be given to the type of work being conducted… will it create its own noise i.e. welding, jack hammering, riveting etc.)

- What is the ambient noise level inside the space? (This can vary… allow for fluctuation… see above)

- Is Hearing protection required? (Hearing protection equipment can impair the ability of user to communicate effectively with a safety attendant on the outside of the space or with a co-worker inside a space. Additionally, Hearing protection gives user's a sense of speaking louder than they actually are in a noisy environment)

- Is the space made of a material or situated in an area that is subject to Electromagnetic Interference (EMI), Radio Frequency Interference (RFI) or a Faraday Shielding affect? (If your chosen method of communication relies on a wireless communication device (i.e. Radio or Mobile phone) determine the level of functionality by testing it in the space… works all the time, works some of the time, never works)

- Is there a potential for Electro Static build up? (a risk assessment of operations taking place within the potentially explosive atmospheres must include to possibility of Electro Static Discharge (ESD).

4.0 The Impact of Protective Equipment on Communication

Personal Protective Equipment and Work Equipment such as, Breathing Apparatus, Gas Detection, Fall Protection/Retrieval and Ventilation equipment are commonplace in Confined space entry. Workers who make safe entry and meet regulatory requirements utilize some or all of the above equipment. A Reliable means of effective communication is typically the final piece of the confined space safety puzzle. It can tie a whole operation together and not only provide a safer workplace but a more productive one.

The following section looks at the affect various pieces of personal protection equipment can have on effective communication …

4.1 Breathing Apparatus and Respiratory Protection Equipment

Confined Space entry often requires the use of breathing apparatus or respiratory protection equipment. By its very nature this equipment obstructs speech and creates a barrier to effective communication. Even though many Facemasks incorporate voice diaphragms that improve the passage of speech through the mask wall there is a marked reduction in both volume and intelligibility. Additionally some breathing systems create inherent noise during inhalation or exhalation and can create a feeling of isolation in confined space workers. In some instances users have become so frustrated with the limitations on verbal communication when wearing facemasks they

remove them temporarily to communicate with a co-worker, then put them back on (a very dangerous and prohibited practice).

Reliable communication can also provide a valuable link if there is a problem with breathing apparatus and/or an alarm sounds. Any one who has ever experienced a loss of breathing air can tell you the immediate reaction is one of panic and confusion. Being able to immediately call for help or just having a voice in your ear can do a lot to calm these fears and reduce the possibility of mistakes made during a period of confusion or panic. A safety attendant can talk the entrant through a problem and or notify entrant(s) before it occurs. If the problem is only momentary, communication can be used to coordinate between the use of emergency air and the regular air supply.

What type of breathing apparatus is being used? (If any)

- Self contained breathing apparatus
- Supplied air breathing apparatus (Airline)
- Blasting Helmets/ Hoods
- Powered Air Respirators
- Full Face Respirators
- Half mask respirators
- Escape Sets

Questions:

- How is Verbal Communication affected by Respiratory Protective equipment?
- Describe the level of verbal and aural intelligibility when respiratory protective equipment is used? (Both speaking and listening)
- Are there instances where masks are removed to communicate…even temporarily?
- Are there instances where messages need repeating? How often?
- Would the ability to easily communicate with co-workers or the safety attendant make entries less stressful?
- Would the ability to easily communicate with co-workers or the safety attendant make you more productive?
- Would communication make the task safer?

4.2 Fall Protection/Retrieval Equipment

Tripods, Davits and Winches are arguably the most common piece of equipment for confined space entry these days. This equipment is a common sight on streets and in facilities throughout the country. The irony is that the best retrieval device in the world is useless until the attendant recognizes a problem with the entrant or the entrant requests the attendant to get them out…now! Continuous communication can save valuable time in the recognition of a problem and could mean the difference between "retrieving" or "recovering" a worker from a Confined Space.

4.3 Gas Monitoring Equipment

Monitoring for explosive, poisonous or oxygen deficient atmospheres is essential practice, prior to and during Confined Space entry operations. Some entries require gas-monitoring equipment that stays with the safety attendant on the outside of a space (probe or tube going into space). When an alarm sounds the possibility exists that entrant might not hear it. It is then up to the attendant to notify the entrant of the

problem. When entrants are working in high noise, at a distance or out of sight, the attendant must have a means to tell the entrant of the alarm and to evacuate the space immediately.

On the other hand, some operations require portable gas monitors that are carried by entrants and sample gases in the environment they are actually working in. Often personal monitors are used to compliment monitoring at the point of entry. For this type of system to work effectively and keep permit documentation current the attendant should have a means of receiving periodic readings from the entrant's monitor and note them on the entry log or permit. If the personal monitor sounds an alarm and the distance is significant and or noise levels are high, entrant(s) must have a means of immediately notifying the safety attendant of the change in atmosphere and coordinating corrective ventilation and/or retreat from the space.

Note: In some instances, RF transmissions from a portable radio when in close proximity to a portable gas monitor can have adverse affects on the circuitry resulting in false alarms or powering down the monitor. Special care must be taken when using radios with gas monitors. Be certain to check your equipment, prior to entry and in a non-hazardous environment.

4.4 Ventilation Equipment

Portable Ventilation equipment is widely used for Confined Space work. These products are powered by electric motors, petrol engines or pneumatically powered. The noise produced by the petrol and pneumatic blowers can be considerable and can negatively impact communication between workers.

Also, if a problem occurs with the flow of fresh air or some airborne hazard like vehicle exhaust, is introduced into a space. Real time communication would allow entrants to easily make a comment of a smell or symptom and give the attendant immediate feedback regarding conditions in the space. Alternatively the Attendant could easily notify the entrants if conditions changed outside of the space that might affect the atmosphere being provided them via the ventilation system.

Note: When ventilating confined spaces be mindful that in general the dryer the environment the higher the potential for static charge. Humidity (moisture) in the air can significantly lower the potential for static)

4.5 Personal Protective Equipment

The wearing of protective hoods, helmets with earflaps, protective suits (in some cases fully encapsulated) can obstruct verbal communication.

- What type of PPE is commonly used during operations?
- What is its effect on communication?
- Also consider the time of year and climate changes? (In the winter workers might modify their PPE for warmth i.e. addition of earmuffs, hat that covers ears etc.)

4.5.1 Special note on Hearing Protection

Hearing protection equipment – ear plugs or ear defenders can impair the ability of user to communicate effectively with a safety attendant on the outside of the space or with a co-worker inside a space. Additionally, Hearing protection gives users a sense of speaking louder than they actually are in a noisy environment

- Is Hearing protection required?

- What is the affect on Verbal communication with Co- workers?…Inside the space? …Outside the space?

5.0 Rescue Communication

5.1 Summoning help summon in an emergency.
This is a task that must be preplanned, written down and clearly understood by all members of the confined space entry team. It is extremely important that the safety attendant contact the rescue team as soon as a problem is recognized.

Common methods of communication for this task include: Portable Radios, Mobile Phones, Landline Telephones or Intercoms, Sirens, Flashing lights or Horns etc. As this communication typically occurs outside the space it is not normally given the same level of consideration as equipment used in the space. However it should be looked at and evaluated in the same way with consideration being given to the safety aspects and the necessity of messages being communicated easily, rapidly and unambiguously between relevant people. Factors such as the environment, location, noise, dead spots, interference, potentially explosive atmospheres, etc must be considered.

5.2 Rescue Response Time
A confined space rescue begins with the discovery that an Entrant is in trouble and ends when the Entrant is safely out of the space and in the care of medical personnel. Effective means of communication can impact many of the steps in a rescue chain of events…
As an example, consider the following: An entrant goes down or indicates that there is a problem and cannot self rescue, the Safety Attendant should be the first person to know and with a minimum of elapsed time should be able to summon a Rescue Team or begin an assisted rescue. Raising an alarm, by radio, by telephone or by word of mouth, can alert an on-site Rescue Team. An off-site Rescue Team can be alerted by radio or by telephone and must then respond as quickly as possible. Once at the scene the Rescue Teams, whether from on-site or off-site, must assess the problem, prepare for the rescue and then execute the rescue to its completion.

The time frame for any rescue is therefore made up of several very specific blocks of time:

1. Reaction time: Time taken by the Safety Attendant to recognize a problem with the entrant. (Having an open method of communication between Entrant and Safety attendant can reduce this time considerably)
2. Contact Time: Time taken by the Safety Attendant to actually contact the Rescue Team. (Preplanned and correctly implemented communication between attendant and rescue team can reduce overall response time)
3. Response Time: The time taken for a Rescue Team to arrive at the scene of the rescue.(if not already on standby)
4. Assessment Time: Time taken by a Rescue Team to assess the problem and determine what preparations are needed to perform a safe but efficient rescue. (If an open method of communication is in place between the attendant and the entrant it can be used by the rescue team for victim contact prior to entry)
5. Preparation Time: Time taken by a Rescue Team to set up for the rescue.
6. Rescue Time: Time taken for the actual rescue and get the victim to medical help. (Reliable effective communication between members of a confined space rescue team has been proven to save time during rescue operations)

The “Golden Hour” concept (i.e. from step1 to step 6 should take no longer than one

hour) is a widely held goal for rescue teams; anything that helps achieve this goal is beneficial to the survival rate of victims. However in most confined space incidents -1 hour is to long and overall rescue time must be minimized where possible.

6.0 Methods of Communication

6.1 Visual Contact

It is a common misconception the visual contact with entrants during a Confined Space entry constitutes effective communication as set out in the regulation. An example might be a scenario like this…. I can see the entrant the whole time therefore the entry is safe and compliant….what might not be apparent until questions are asked, is that the worker is 60 feet down a pipe, in a dark, noisy environment, the normal working position for the job is laying flat on the floor, and all that is visible from the point of entry is a pair of work boots and the dim light of a torch.
In reality, if the entrant passed out due to an atmospheric hazard or had a head injury it could be a long time before the Attendant would even recognize a problem exists and contact help or begin retrieving the entrant from the space. As most deaths in Confined Space are due to bad atmospheres any delay in recognizing that the entrant was in trouble could cost a life. (The brain can suffer serious damage or die if deprived of oxygen for approximately 4 minutes).

Hand signals and other means of Visual communication (sign boards, flags etc) can provide acceptable communication if used as a backup to some form of verbal communication.

6.2 Direct Speech

Direct Verbal contact with entrants is the easiest and most desirable for confined space entry work. However to be effective it relies on a few things; a direct path for voice, relatively short distances, medium to low noise conditions (shouting for a long period of time is very tiring), unobstructed ears, unobstructed mouth (minimal PPE).

Additionally, some entries utilize additional personnel staged at various locations within the space simply to pass communication along and/or keep sight of the entrant. This puts additional personnel needlessly at risk. It can also be a costly solution when you consider additional manpower, equipment and the loss of efficiency and increased risk.

If voice communication is desirable but the work environment, protective equipment and the scope of work make direct speech difficult or impossible powered options are available and should be considered (see Sections 6.4 & 6.5)

6.3 Rope Tugs

Anyone who has ever tried to decipher how many "tugs" from the end of a 30 meter rope that goes around a corner or two, will tell you it is almost impossible. Yet for many workers this is the primary method of Communication for "regulatory compliance". The "OATH"[5] method common in the Fire Rescue service but in industry a variety of "home grown" systems are in use. The number of tugs (or blasts on an air horn) can have decidedly different meanings from company to company.

[5] OATH Method for rope communication is the standard for rope commuication

O = 1 pull on the rope	-	Okay
A = 2 Pulls on Rope	-	Advance line
T = 3 Pulls on Rope	-	Take Up Line
H = 4 Pulls on Rope	-	Help

There is no standardized practice or method for this type of “coded” communication in industry. Special Note; Airhorns using this method i.e. Short blasts for contact and a long blast for evacuation …users run the risk of not having enough pressure in the cylinder left for the “long blast” (ensure this risk is covered in your assessment).

Although this method may meet the minimum requirements for compliance, it should be put back into the context for which it was intended, "When all else fails” not as a primary method of communication. In this day and age, when the technology and the equipment for safe and reliable voice communication is commercially available, it is a needless risk to send someone into a space without the ability to simply ask for help.

6.4 Portable Radios / Mobile phones

Probably the most common piece of communication equipment used in industry is a portable two-way radio or mobile phone. The obvious benefit of any wireless system is that there is no connecting cable and they can accommodate an unlimited number of users. In addition, they are available with many options and accessories, which makes communication possible with a wide variety of personal protective equipment. Portable radios and mobile phones are typically lightweight and use rechargeable batteries. Other desirable features available include prioritised channels, programmable frequencies and intrinsic safe approvals. Radio/ Mobile equipment functions best when it is out in the open, in line of sight of a radio antenna, or repeater. It can also perform well in areas that have openings allowing signals to “bounce” to or from another radio or repeater, etc. Operations requiring users to have freedom of movement or those that are carried out in the open are best suited to wireless equipment.

Some of the negative aspects of this equipment may not be readily apparent. For instance, wireless equipment does not function reliably in enclosed spaces constructed of metal or using stealth technology for example, aircraft fuel cells, shipboard void spaces, water tanks, fuel tanks, towers, vessels, etc. In these work environments, radio communication is unreliable and subject to dead spots, fading and weak signals, similar to what happens to car radios when driving through an underground parking lot or tunnel. In addition, radios and mobile phones can be extremely hazardous in and around fuel tanks and explosive ordinance due primarily to Effective Isotropic Radiated Power (EIRP). This is the reason Mobile phones are prohibited at petrol stations and the Aircraft Maintenance and the Petro-chemical industry have strict regulations must be observed when using radios or transmission equipment.

Another aspect of wireless equipment commonly overlooked is that radio frequency allocation is become more difficult and transmissions over public bands are subject to unwanted or outside monitoring and/or interruption from other radio users on the same channel(s). During operations of a sensitive nature such as a rescue or during work inside classified areas, it is important to be aware that transmissions can be monitored. Additionally a channel or frequency allocation from regulatory bodies in over crowded frequency bands is also an area that is commonly overlooked. As a final note, handsets are subject to considerable abuse in the work place and maintenance and replacement costs can be high (especially true with Intrinsic Safe versions) and should be factored into the decision process.

6.4.1 Wireless Accessories

Portable radios (and some mobiles) operate on a “Push-To-Talk” basis, requiring workers to stop what they are doing or take their hands off what they are doing in order to communicate. Radio accessories are available that incorporate large body

worn Push-To-Talk switches or remote finger switches so that users do not have to actually activate the PTT on the side of the radio.

To address the PTT issue some users have turned to “hands-free" or “voice activated”(VOX) accessories. These accessories work best in Low to Medium noise environments. In High noise areas VOX accessories are plagued by false activation due to high ambient noise picked up by the microphone. High noise triggers the *electronic* Push-To-Talk switch and can inadvertently lock a radio into transmit mode cutting off all communication on a particular channel. VOX radio accessories typically have a PTT override in addition to some kind of microphone sensitivity adjustment to accommodate different ambient noise levels. Difficulties arise when workers move from low to high noise locations (or visa versa) and do not re-adjust the microphone sensitivity. Mobile phones operating in a full duplex mode tend to pick up ambient noise and make communication difficult.

In cases where users position the handsets or radio equipment inside their protective clothing (i.e. encapsulated suit) the adjustment becomes difficult if not impossible to reach. In this writer's opinion, a good rule of thumb is to use only PTT activation for radio accessories in extremely dangerous environments. This helps to prevent any accidental lock out of your communication system due to ambient noise levels or if someone gets hurt and is screaming in pain.

One of the most common problems for radio users is how to effectively communicate when wearing a facemask respirator or breathing apparatus. Many different accessories are available and include; Throat Microphones, Bone Conduction Microphones, Integrated Mask Microphones, Ear Microphones that work in conjunction with a variety of speaker or earphone options for listening. All of these accessories have their own positives and negatives that must be assessed in terms of a particular work environment or task. When assessing accessory equipment look for flexibility or adaptability in the equipment design to get the best value for your money.

Some questions you might ask when evaluating accessories for handsets or radios include:

- Can I use the accessory with or without a facemask?
- Can I use the accessory with an encapsulated suit?
- What radios are compatible with the unit?
- How does the equipment function in a High Noise Environment?
- Does the equipment require batteries? How many? What type? Battery life?
- Is the equipment waterproof?
- Is the equipment Spark Proof, Intrinsically Safe of Explosion Proof? (See Appendix A)
- Does wireless communications present a possible risk due to Electrostatic Discharge (similar to mobile phones on a petrol station forecourt)
- Is the product Voice Activated? Push to Talk? Both? How big is the PTT Switch?
- Can the PTT be activated through a suit? How tactile is the switch?
- What receiver options are available?
- Can the unit be decontaminated?
- Does other protective equipment affect the clarity of communication?
- Will communication capability be affected by the removal or addition of any PPE?
- Is the equipment ruggedly constructed? What is the warranty period?
- Who uses the product now? Where? For what applications?
- How much does a complete unit with radio interface cable cost?

- What is the cost of ownership over time? I.e. batteries, additional components, etc.

6.5 Hardwired Communication Equipment

Portable hardwired communication systems are not as common as two-way radios but are growing in popularity for work in and around Confined Space, Gas Free, Explosive Ordinance, and Sensitive applications. At first glance, the biggest drawback to this method of communication is the cable itself. That said the cable is also one of this equipment's greatest assets as hardwired systems typically excel in areas where radios fail. Aircraft fuel cells and underground storage tanks, pipes and tunnels are good examples of areas where radios become unreliable due to the shielding effect of the surrounding metal or composites. Workers in these environments can benefit greatly through the use of a hardwired communication system. The continuous communication that is offered by this type of equipment allows the monitoring of entrants by a safety attendant as required by Confined Space entry safety regulations. Passing signals through a correctly shielded cable facilitates communication without the worry of interference, dead spots, or the radiation of potentially dangerous or destructive radio signals. Portable hardwired systems provide two-way communication between all users entrants and attendants. Full duplex systems are completely hands-free and provide a dedicated and private network for workers doing a specific job. During jobs where supplied air breathing apparatus is required, the communication cable can be "piggybacked" onto a breathing air line, making a single umbilical, that is easily managed by the entrant. Accessories for portable hardwired systems include pass through connectors for chemical suits, face mask communication accessories, high noise headsets, alarm options, and two-way hands free talk boxes. The units are typically battery powered and able to deploy anywhere that work must be done. Systems are available with high level Intrinsic Safe Approvals for use in explosive environments. One advantage to a wired communication is that it physically ties people together with a tangible link and prevents entrants and particularly attendants from simply walking away.

Negative aspects of a portable, hardwired communication systems are: the number of users per operation, physical attachment by cable and distance limitations.

Note:
It is important to note that *sound powered* phones are not the same as a powered hardwired communication system. This is a common mistake, but the differences make comparison almost impossible. The sound powered phone systems are temperamental, cumbersome, and the volume and clarity is inadequate for confined space entry/gas free operations. Current sound powered phone headsets do not couple with standard breathing equipment and require one hand to operate and provide no means of emergency alarm notification.

- I the equipment portable?
- Is voice communication continuous?
- Does the equipment meet ATEX requirements?
- Approved for what environments? (See Appendix A)
- What materials are used in the construction of the equipment?
- What is the chemical resistance of the equipment?
- Is the equipment Waterproof? Immersion Proof?
- What is the power source? Batteries (type)? Other?
- What is the battery life? Is there a low Battery warning?
- Can it be used while wearing Breathing Apparatus?

- What accessories are available for the equipment?
- Are system components and accessories interchangeable?
- How quickly can the equipment be set up?
- Is the equipment shielded against RF or Electro magnetic interference?
- How easy is it to use? How much training is required?
- How many people can be on the communication system at once?
- What type of warranty does it come with?
- Is the equipment built to a quality standard? What standard?

Special Note: The question lists included herein are meant as a starting point only, add anything you feel pertinent to your particular application(s)

7.0 Human Factors of Communication in Confined Spaces

While it is a requirement that workers are medically and physically fit to undertake the work operations required of them. In critical or dangerous environments it is not enough to take the word of the worker that they are fit. Their fitness should be properly determined and certified by an appropriate medical examiner that assesses their fitness for the specific work operations they will undertake.

Workers who suffer from claustrophobia or has a propensity for panic attacks would not be considered fit for entry to confined spaces. However, even with experienced workers, entering an unknown Confined Space environment can stir feelings of claustrophobia or in some cases even panic. We tend to forget that the space they enter is harsh and unfriendly and was designed by engineers for a specific task, not for human occupancy. Therefore, workers cannot rely on the surroundings for their psychological well being and must depend on what can be taken into the space with them.

The well being of entrants determines how well they will function at any given moment. The study of ergonomics basically tells us that the better people feel, the better they perform their job. In critical situations adrenaline and emotions can create a very stressful atmosphere. Personnel working outside their own comfort zone are considerably more prone to errors through poor decision-making and bad judgement due to stress. Workers, no matter how experienced, are still human beings and while an error due to stress outside a space may be easily corrected, the same error made inside a space could be their last.

The human voice has been proven to have a calming effect on people in isolation. Therefore, reliable, continuous voice communication can help to provide Confined Space entrants with the level of comfort needed to relieve the fears of entry, maintain an acceptable comfort zone for the duration of the entry and help to keep feelings of claustrophobia and panic in check. Industrial workers who routinely utilise a voice communication system for Confined Space work confirm this. They report feeling safer, more at ease, and less stressful. They also say that, as a result, they work better, are more efficient, and are much happier in their work. As an added benefit, safety attendants also report favourably on being able to communicate with entrants. Their job is less boring and they feel more useful by being able to monitor entrants at all times. Close teamwork between entrants and their safety attendant is possible with little or no effort.

8.0 Intrinsically Safe Equipment

When selecting any electrically powered communication equipment destined for use in a hazardous or potentially hazardous environment, it is important to choose equipment that has been designed and approved to be spark proof, explosion proof or intrinsically safe. To do this properly you must have an understanding of the **CE Marking and the 94/9/EC ATEX Directive** on equipment and protective systems intended for use in potentially explosive atmospheres (note: in the U.K. 94/9/EC is implemented under **Statutory Instrument 2001 No 3776**, The equipment and protective systems intended for use in potentially explosive atmospheres (amendment) 2001). Also an understanding of **99/92/EC ATEX (Workplace) Directive** on minimum requirements for improving the safety and health protection of workers potentially at risk from explosive atmospheres (note: in the U.K. 99/92/EC is implemented as **The Dangerous Substances and Explosive Atmospheres Regulations 2002 (DSEAR)**.

On July 1st 2003 existing Explosive Atmosphere and Gassy Mines Directives were officially replaced with the ATEX Directives. After that date only equipment and systems 'CE' marked as compliant with ATEX Directives can be put on the market within the EU. Equipment purchased prior to 30 June 2003 and currently in use, does not have to necessarily be replaced with equipment compliant with ATEX 94/9/EC. However, this is provided that the equipment is still safe for use in the environment in which it will be utilized. A new risk assessment under DSEAR (Workplace directive ATEX 99/92/EC) should be undertaken as it relates to equipment certified under the old system. Any equipment found to be non compliant with the requirements of the risk assessment should be replaced. (Example: changes in electrostatic dissipative materials for equipment enclosures etc. were new to ATEX equipment testing)

In Appendix A is an abbreviated list of the different classifications and what they mean and well as general guide on the category of equipment that equipment must meet for use in various Zones. If there is any doubt about the approval rating on a particular piece of equipment…"Check the Label". In Europe, all products destined for use in potentially explosive environments must carry a label that lays out the type of environments the equipment has been tested and approved for**. Simply put, if it doesn't say it on the label, it's not approved for that location and if there is no label, the equipment is not approved.** In instances where physical size prohibits a listing of approved locations, the equipment will have, as a minimum requirement, the File number, which will contain reference to the ID Number of the Notified Body who did the testing. If there is any doubt about the approval status for a piece of electrical equipment, request a copy of the certificate of conformance which will describe the level of approval and which Notified Body completed the testing (a complete listing of Notified Bodies with contact details is available on the web at http://europa.eu.int/comm/enterprise/atex/nb/nblist.htm).

9.0 Conclusion

This paper was written to give safety professionals a better understanding of the issues as well as an appreciation for the "safety dividend" that a properly selected and applied method of communication in confined space work environments can provide. It is common for organizations implementing a system of reliable two-way voice communication for purely *safety* reasons to quickly notice the positive affect in other areas such as worker moral, productivity and efficiency.

The importance of a correctly assessed work environment is central to the concept of a Safe System of Work for Confined Spaces. Confined Space Risk Assessments are without doubt one of the most important responsibilities put on the shoulders of Safety Managers and Professionals in industry today. Workers rely on the accuracy of a comprehensive assessment and entry plan to ensure their safety in these dangerous workplaces, so at the end of the day they can go home safely to their families. Company Director's rely on these assessments to protect their employees and keep them out of trouble when things go horribly wrong.

It is my hope that a better understanding of communication and where it fits in the jigsaw of confined space work will help the *competent person*, designing the system of work; the *worker*, doing the entry; and the *manager*, signing it off feel much more confident the next time they put a tick box beside "communication" on a permit or risk assessment form.

Author's Note:
The excerpts of regulatory information included herein should not be construed as substitute for the complete regulations or applicable standards. They have been included in an effort to help those individuals responsible more easily understand the broad range of issues involved. I recognize that radio types, styles and manufacturers are varied and that more elaborate radio systems can overcome some of the difficulties described above. However, for the purposes of this paper I have limited comments to common, simplex portable radio systems and accessories widely used in industry. The information and opinions expressed herein are entirely those of the author. This paper has been written without prejudice or copyright, and may be copied and/or distributed as required.

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Appendix A - ATEX Marking

0359

II 1 G D

CE Mark	Notified Body ID	Mark for ex	Equipment Group	Equipment Category	G= Gases D= D usts

 – the CE Mark is the manufacturer's declaration that the equipment complies with relevant EU Directives. The number beneath the CE Mark is the identifier number for the Notified body responsible for monitoring production quality and EC compliance.

 Mark denotes explosion protection

Equipment groups and categories

Equipment Groups and categories identify areas in which equipment can be used safety. Each group is further broken down into categories as follows.

Equipment Group I - (Mining) applies to equipment intended for use in Mines or the surface installation at a mine, liable to be endangered by fire damp and/or combustible dust.

Equipment Group I – Categories:

Category M1- Equipment designed using various protection techniques that meets a very high level of protection and will allow the equipment to function safely even with an explosive atmosphere present.

Category M2 - - Equipment designed using various protection techniques that meets a high level of protection but is intended to be de-energized in eth event of an explosive atmosphere.

Equipment Group II - (Industrial) applies to equipment intended for use in areas (other than Mines) liable to be endangered by explosive atmospheres

Equipment Group II – Categories:

Category 1 - Equipment in this category meets a "very high level" of protection and is intended for use in areas where explosive atmospheres are present continuously, for long periods of time or frequently.

Category 2 - Equipment in this Category meets a "high level" of Protection and is designed to be used in areas where explosive atmospheres are likely to occur but are not present under normal conditions

Category 3 – Equipment in this category conforms to a "normal level" of Protection and is intended for use in areas where explosive atmospheres are unlikely to occur but if they do occur it will be for a short period and very infrequently

Gases and Dusts

In addition to the equipment group and category in Group II (Industrial) equipment must be marked "G" noting that the equipment is suitable for use in explosive atmospheres caused by Gases vapours or mists AND/OR marked "D" noting that the equipment is suitable for use in explosive atmospheres caused by combustible or conductive dusts.

Special Note: Equipment and protective systems may be designed and purpose built for a specific explosive atmosphere and not classified under an equipment group… However in this case the equipment must be marked accordingly.

APPENDIX A - CENELEC / IEC MARKING

E	EX	ia	IIc	T4
Conforms with European Standards	Explosion Protected	Protection Concept	Gas Group	Temperature Class

"E EX" – E Prefix notes that the equipment is in compliance with CENELEC standards in the EN50014 series – EX denotes Explosion protected equipment

"ia" or "ib"- Protection Concept (i) denotes Intrinsic Safety meaning that energy in the circuit is limited so as to prevent sparks, arcs or high temperatures. Other protection techniques may be employed in the design of the product to render it safe. (O) Oil immersion, (p) Pressurized Enclosure, (q) Sand Filled, (d) Flame Proof Enclosure, (e) Increased Safety, (n) Non-incendive, (m) Encapsulation.

Gas Groups

Group	Hazard types –(typical)
I	Methane
IIA	Propane
IIB	Ethylene
IIC	Hydrogen/ Acetylene
II	All Gases

Temperature Class

The Temperature class relates the maximum surface temperature the equipment can reach under fault conditions. Under certain conditions gases can be ignited when they come in contact with equipment that has a surface temperature above their Auto ignition temperature.

Temperature class	Auto Ignition temperature range	Allowable surface temperature of electrical equipment
T1	> 450 °C	450 °C
T2	> 300 ... ≥450 °C	300 °C
T3	> 200 ... ≥300 °C	200 °C
T4	> 135 ... ≥200 °C	135 °C
T5	> 100 ... ≥135 °C	100 °C
T6	> 85 ... ≥100 °C	85 °C

Appendix A - HAZARDOUS LOCATION CLASSIFICATIONS

Zones

Classification of hazardous locations

Zone 0	A location where an explosive atmosphere consisting of a mixture with air of flammable substances in the form of gas, vapour or mist is present continuously or for long periods or frequently.
Zone 1	A location where an explosive atmosphere consisting of a mixture with air of flammable substances in the form of gas, vapour or mist is likely to occur in normal operation occasionally.
Zone 2	A location where an explosive atmosphere consisting of a mixture with air of flammable substances in the form of gas, vapour or mist is not likely to occur in normal operation but, if it does occur, will persist for a short period only.
Zone 20	A location where an explosive atmosphere in the form of a cloud of combustible dust in air is present continuously, or for long periods or frequently.
Zone 21	A location where an explosive atmosphere in the form of a cloud of combustible dust in air is likely to occur in normal operation occasionally.
Zone 22	A location where an explosive atmosphere in the form of a cloud of combustible dust in air is not likely to occur in normal operation but if it does occur, will be only for a short period.

Notes: 1. Layers, Deposits and heaps of combustible dust may be considered as any other source which can form an explosive atmosphere
2.Normal operation means a situation when installations are used in there normal parameters.

Criteria for the selection of equipment for selected hazardous location zones

The following table gives a general guideline on the category that equipment must meet so that it would be considered safe for use according to regulations. Of course if an explosion protection document is based on a professional risk assessment that does not state otherwise, the following categories of equipment must be used in the zones indicated, provided they are suitable for gases vapours or mists and/or dusts as appropriate.

Hazardous Location Classification	Equipment Category
Zone 0 or Zone 20	Category 1 Equipment
Zone 1 or Zone 21	Category 1 or 2 Equipment
Zone 2 or Zone 22	Category 1, 2 or 3 Equipment

As you can see from the above table equipment in category 1 offers the widest range of applications. When selecting equipment it is important to have a good overall picture where you intend to utilize the equipment and the types of environments it will be exposed to. Consideration of this issue during the selection of equipment can save a considerable amount of money, if done before the equipment is purchased.

Rescue equipment: Special consideration must be given to equipment that is destined for use in by rescue personnel as conditions during an emergency could result in a sudden change of atmospheric conditions or concentration of potentially explosive gases or particles. Equipment should be rated in the highest category possible so that additional risks to rescue personnel are minimized. If equipment is not suitable for a particular environment it should be identified and included in the rescue plan.

Appendix B

The following is an example of an actual communication assessment and some of the issues that were dealt with during the selection process.

EXAMPLE

Task: Tank Entry for cleaning & painting

Number of Workers: 1 Safety Attendant, 2-4 worker/entrants

Work Environment:
- Steel Enclosed Space
- Restricted Entry and Exit
- High Noise Area
- Water, Debris, grit
- Chemicals, Vapours
- Potential oxygen deficient, explosive or hazardous atmosphere.

Equipment used during the operation:
- Supplied Air Breathing Apparatus integrated into blast helmets
- Protective clothing, gloves, hearing protection (plugs)
- Atmospheric monitoring equipment
- Retrieval/fall protection equipment (depending on the space)
- Ventilation equipment
- Sand Blasting equipment
- Spray Painting equipment
- Explosion Proof lighting

Current method of communication:
- Exiting the space to verbally communicate with personnel outside the space.
- Communication using hand signals or shouting between personnel working inside the space.
- Shouting

Drawbacks to Current Method of Communication:
- Must stop work to communicate resulting in decreased efficiency and lower productivity.
- Mistakes are made due to misunderstandings.
- Cannot make visual or audible contact during Blasting
- Does not measure up to the intent of the safety regulations for Confined Space Entry.
- Blasting Helmet hinders verbal communication

Appendix B continued…

Benefits of Improved Communication:

- Workers would not have to stop work to communicate with the outside.
- If workers need something, they just ask for it increasing efficiency and productivity.
- Communication between workers will make the attendant/observer a useful member of the team.
- He/she can enter data into a computer or fill in inspection sheets while the entrant calls out findings.
- Meets the intent of applicable safety regulations
- Attendant maintains continuous hands-free two-way communication with entrant(s).
- Single attendant could monitor multiple entrants.
- Workers could talk to each other and co-ordinate operations even in high noise environments.
- Does away with misunderstandings due to complicated hand signals, etc.

Safety Concerns:

- Must comply with Confined Space safety regulations and protocols.
- Intrinsically Safe / Spark Proof or Explosive Proof equipment

Criteria for a Tank Communication System:

- A Hardwired Communication System that will function reliably in a heavily shielded enclosed steel space.
- A fully open system that allows for hands-free operation.
- The equipment must be Spark Free (Intrinsically Safe) and third party certified by a Notified body and compliant with ATEX Directive
- Interchangeable accessories to allow for a variety of different spaces and applications.
- The user communication accessories that interface with the system will perform well in High Noise environments and must function with or without a facemask.
- The system will be portable and waterproof.
- The hardwire should be shielded against Electro magnetic and radio frequency interference.
- The unit will not emit a signal that could affect the readings of atmospheric monitoring equipment.
- The construction of the equipment should be such that it will withstand harsh work environments and rough handling by users.
- The communication cable must be flexible, resistant to chemicals, lightweight and rugged.