Confined Space Course – 16h

Falck
Safety Services

NR-33 – CONFINED SPACE (16h)

Macaé/RJ

Falck
Safety Services

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RULES

FALCK RULES

Respect all warning signs, safety notices and instructions;

Loose clothing, jewels, piercings etc. should not be worn during practical activities;

Wearing no-sleeve shirt, "shorts" or mini-skirts is not allowed, being mandatory the use of long trousers and closed shoes;

Instructors and assistants will have priority to access the dining hall;

Do not walk through the training areas without prior authorization. Use the PPE at the recommended areas;

The trainees are responsible for their assets. Lockers with lock and keys are available and their use will be informed. Falck Safety Services shall not be held liable for any losses or damages;

Smoking is not healthy. Only smoke in the smoking areas;

Individuals under the effect of alcohol consumption or illegal drugs will be dismissed from training and sent back to their employer;

During instructions, mobiles should be turned off;

Women are advised not to wear high heels;

No inconvenient jokes are allowed, as well as pushing, discussions and discrimination of any nature;

The trainees should follow instructions of Falck employees during all the time;

Every trainee shall assure the training safety within the best conditions possible. Unsafe conditions or acts should be immediately informed to the instructors;

Pictures, footage or any company-owned image may only be obtained upon prior authorization;

Pregnant women may not carry out the trainings due to hands-on practices;

If, for any reason, being absent from training is required, request the specific form for absence authorization. Your absence period shall be informed to your employer and if it surpasses the limit of 10% of the Discipline hours, it shall be reason for dismissal;

Falck Safety Services assures safety of trainees' transportation during permanence at the Company in vehicles assigned by it, and may not be held liable in case of transportation in private vehicle;

The Certificates/Cards will be delivered to the contracting Company. Delivery to the trainee will only be made upon prior authorization of the contracting Company. Private students shall wait for the result of the Assessments and, when approved, will receive the Training Card;

People who act in non-compliance with these rules or who intentionally subtract or damage equipment shall be held liable and the required measures for the case shall be taken.

GENERAL COURSE GUIDELINES

- **As to course structure**

Structure of this course is in compliance with the Regulatory norm 10 (NR-10) approved through the ordinance of the Ministry of Labor and employment, MTE no. 598, dated 12/07/2004 and published at the Brazilian Official Gazette dated 12/08/2004.

- **As to attendance to classes**

Attendance to classes and practical activities is mandatory.

The student is to obtain the minimum 90% of attendance in total classes given at the course.

For the purpose of the aforementioned letters, absence shall be deemed as: failure to attend classes, delay greater than 10 minutes in relation to beginning of any scheduled activity or unauthorized leaving during their development.

- **As to approval at the course**

The following students shall be deemed as approved:

a) The student who gets grade equal to or greater than six (6,0) in a scale from 0 to 10 (zero to ten) in the theoretical assessment and reach the satisfactory concept in the hands-on activities;
b) The student who has minimum attendance required (90%).

If the student fails to comply with the conditions described in the letters above, he shall be deemed as not approved.

OBJECTIVES

Once finished with the training, the candidate will be able to identify the confined spaces, carry out risk control measures in order to ensure the work team safety and health and be part of a confined space entry for the service execution.

1. **NORMALIZATION AND LEGISLATION**

The cares with prevention and administration of fatal incidents in confined spaces built in the whole world several technical standards and regulations, some of them even containing legal strength, others, only recommendable. Among the main ones, we may highlight:

ORDINANCE No. 202/2006 – NR33; SAFETY AND HEALTH IN CONFINED WORKS.

This standard edited by the Labor and Employment Department is aimed at establishing the minimum requirements for identification of confined space and acknowledgment, assessment, monitoring and control of the existing risks, so as to permanently assure safety and health of the workers who directly or indirectly interact in these spaces.

ABNT NBR 14.606 DATED OCTOBER 2000: SERVICE STATIONS – ENTRY INTO CONFINED SPACE

This standard edited by ABNT – Technical Standard Association, national standardization forum, establishes the safety procedures for entry into confined spaces in service stations. Today, it is only restricted to entries and cleaning of underground tanks.

ABNT NBR 16.577 DATED MARCH 2017: CONFINED SPACE – ACCIDENTS PREVENTION, PROTECTION PROCEDURES AND MEASUREMENTS

This standard edited by ABNT – Brazilian Technical Standard Association, national standardization forum, establishes the minimum requirements for protection of the workers of the work site against the risks of entry into confined spaces. Currently, it is deemed as the major standard available in Brazil for the purpose of providing for every kind of works in confined spaces.

OSHAS 29 CRF PART 1910.146: OCCUPATIONAL SAFETY AND HEALTH STANDARD – PERMIT-REQUIRED CONFINED SPACES

This standard edited by OSHA – Occupational Safety & Health Administration, agency of the Labor Department of the US-Government contains the requirements for practice and procedures for protection of the workers of the general industries against risks of permitted entry into confined spaces

NIOSH PUBLICATION No. 80-106: CRITERIA FOR RECOMMENDED STANDARD – WORKING IN CONFINED SPACES

This publication edited by NIOSH – National Institute for Occupational Safety and Health of the US-department of Health, Education and Welfare also edits recommended criteria for working procedures in confined spaces.

2. **TERMS AND DEFINITIONS**

In the several types of maritime units (Jack up, semi-submersible, stationary, etc.) and vessels (sea gauge, FPSO, FSU, etc.) we can verify many similarities to the land industrial facilities (refineries, chemical, petrochemical, metallurgical, food, etc.) and the other public utilities (water, sewage, telephony, gas, cable TV, etc.) as concerns recognition of confined sites.

However, the accident risk increases in a large number when taking into consideration the limited space of vessels and the hostile environment the sea offers to human presence.

At the maritime environment, the following are examples of identified confined spaces, but not limited to, warehouse tanks, fuel tanks, vessel cargo cellars, galleries, boilers, platform feet, etc. Although the works developed there may expose the workers to some risk, sometimes execution of this work is extremely necessary and, therefore, inevitable, such as for example:

Cleaning to remove some waste or leftover of material;

Inspection in structures and equipment;

Maintenance such as application of coating or jetting;

Installation, repairs, inspections and replacements of cables, connections, valves, piping, flanges, pumps and engines in deep sites;

Repairs with welds and adjustments in equipment;

Alignments and adjustments in components and mechanical devices;

Checking and reading of manometers, readers, displays and other indicators;

Rescuing of injured workers or workers trapped in confined spaces.

3. **WHAT IS A CONFINED SPACE**

NR-33 defines the confined space as follows:

"33.1.2 – Confined space is any area or environment not designed for continuous human occupation, they have limited means for entry and exit, existing ventilation is insufficient to remove contaminants or where there may be deficiency or enrichment of oxygen".

For OSHA 1910.146 confined space is defined as being "a space:

Large enough and thus configured in which a worker may physically enter and carry out an assigned work;

With limited or restricted entry or exit resources;

Not designed for continuous human occupation."

Thus, we define confined space as any and all site not designed for continuous human occupation, but large enough for permanence of authorized workers, with limited access both for entry and exit, few or no ventilation, having an oxygen-enriched or deficient, contaminated or explosive atmosphere and that may also expose the worker to some kind of different risk.

3.1. **DEFINITIONS**

Find below some definitions related to NR-33.

Entry

The understanding of our NBR 16577 is the same followed by OSHA, i.e., the action which by the worker goes through the opening towards inside a confined space, considering the entry as occurred as soon as any part of the worker's body crosses the opening limit of the confined space. Both standards add the definition of entry condition as being those "environmental conditions which should allow for entry into a confined space where there are technical protection criteria for atmospheric, physical, chemical, biological and/or mechanical risks which ensure safety of the workers", and prohibitive entry condition as "any risk condition which does not allow for entry into a confined space".

Authorized Worker

For NR-33 it is the "worker qualified to enter the confined space, aware of his rights and duties and aware of the existing risks and control measures".

Watchman

For NR-33 it is the "worker assigned to remain out of the confined space and who's responsible for monitoring, communicating and ordering abandonment for the workers".

Entry supervisor

For NR-33 it is the "person qualified to operate the entry permit with responsibility to fill in and sign the Entry and Work Permit (EWP) for development of safe entry and work inside confined spaces".

Rescue team

According to the definition of NBR 16.577 it is the "Rescue personnel "regularly trained to Emergency situation, able to carry out the first aid, in good physical and menthal condition compatible with the rescue activity to remove injured workers from confined spaces.

Expert in charge

In the definition of NR-33 it is the professional qualified to identify the existing confined spaces at the company and design the engineering, administrative, personal and emergency and rescuing measures.

Safety and health management

According to NR-33 it is the "set of administrative, personal and collective measures required to ensure safe work in confined spaces". The same standard still adds that the safety and health management in confined spaces "should be planned, scheduled, implemented and assessed, including engineering, administrative and personal measures and qualification for work in confined space".

Technical basis

According to NR-33 it is the "set of standards, articles, books, work safety procedures, and other technical documents used to implement the Entry and Work Permit in confined space system".

Entry and Work Permit – EWP

NR-33 now defines the former entry permit as the "written document containing the set of control measures aimed at entry and development of safe work in addition to emergency measures and rescue in confined spaces".

Special control measures

In complement to the permit system, NR-33 defines as being the "additional control measures required to allow for entry and work in confined spaces in specific situations, such as hot works, IDLH atmospheres or others."

3.2. ATMOSPHERE IMMEDIATELY DANGEROUS TO LIFE OR HEALTH

Also known by OSHA through the English acronym IDLH, which is Portuguese correspondents to IPVS, and defined according to NR-33 as "any atmosphere having immediate risk to life or producing immediate debilitating effect to health".

Condition Immediately Dangerous to Life or Health

In the view of the law, the IDLH concept has a quite greater scope.

For NR-33 it is "any condition with an immediate risk of death or that may result in eye damage, irritation or other conditions that may prevent exit from a confined space".

Hazard Atmosphere

- NBR 16577 defines as "condition in which it is an atmosphere in a confined space, can offer hazards to the place and expose workers to the danger of death, incapacitation, restraint of the ability to self-rescue, injury or acute illness caused by one or more of these as situations:
  a) Gas / vapor or flammable mist in concentrations greater than 10% of the lower explosion limit (LEL) of the material (s) previously identified;
  b) Dust in a concentration in the working environment that exceeds the lower explosion limit (LEL);

  NOTE 1: Blends of combustible dust with air may ignite within their respective ranges of explosivity, which are defined by lower explosion limit (LEL) and upper explosion limit (UEL). The LEL is generally between 20 g / m³ and 60 g / m³ (under normal conditions of temperature and pressure (NCTP), while the LSE is between 2 kg / m³ and 6 kg / m³ (in the same NCTP). If dust concentrations can be kept outside their explosive limits, explosions will be avoided.

  NOTE 2: The following factors influence the combustion / explosion process:
  - • particulate matter in air;
  - • particles of the size appropriate to the combustion process;
  - • air (oxygen) present in the environment;
  - • adequate ignition source to start the combustion process;
  - • relative humidity;
  - • confined space geometry.

  NOTE 3: The layers of dust, differently of the gases and vapors, are not diluted by general diluting ventilation after the leak has ceased. Insuffling air increases the dispersion of dust in the environment, enhancing the suspension of the material and, consequently, propitiating its combustion process.
  NOTE 4: Dust layers may suffer inadvertent turbulence and spread through the movement of transport equipment, people displacement, air insufflation, machine operation, etc.
  NOTE 5: Local exhaust ventilation (LEV) for the removal of contaminants within confined space is recommended for activities that can generate dust, mists, gases, vapors, fumes etc., and at the point of origin, before they reach The respiratory tract of the worker.

c) oxygen-poor atmosphere, where the oxygen concentration is below 19.5% to 23% (v / v);

d) oxygen rich atmosphere where the oxygen concentration is above 23% (v / v);

NOTE 6: The percentage of acceptable oxygen in confined spaces is 19.5% to 23% of VOL, provided that the cause of reduction or enrichment of O2 is known. It is important to note that the presence of other toxic or inert gases at low but dangerous concentrations may not significantly alter the oxygen sensor reading.

e) tolerance limit - defined as the atmospheric concentration of any substance whose maximum value is determined in the Ministry of Labor's NR-15 or more restrictive recommendation (ACGIH - American Conference of Governmental Industrial Hygienists), and which may result in worker exposure above the tolerance limit.

Preliminary Risk Analysis – PRA

The industrial safety technical study tool called Preliminary Risk Analysis is defined by NR-33 as the "Initial assessment of the potential risks, their causes, consequences and control measures."

Near Miss

According to NR-33 it is "any non-scheduled event that may indicate possibility of occurrence of accident."

Hazardous Area

The NR-33 is objective by simply defining it as a "potentially explosive or with explosion risk area". NBR 16577 completes defining as "area in which there is an explosive atmosphere, or probability of occurrence, caused by the presence of a mixture of flammable materials in the form of gas, vapor, mist, dust or fibers, requiring special precautions for construction, Maintenance, inspection and use of equipment, instruments and applications in electrical units".

Emergency

NBR 16577 explains that it is an "unplanned event that represents a danger to the workers or the population and that can cause significant damages to the patrimony and to the environment, generating economic losses, loss of human life or interruption of the productive process".

e) In an emergency situation, two immediate measures may be adopted by the supervision. Blocking Order that NR-33 defines as "order for suspension of standard operation of the confined space", and Release Order that the same standard defines as "order for reactivation of standard operation of the confined space".

Rescue

NR-33 defines as being the "standardized operating procedure, carried out by a team with specialized technical knowledge, to rescue and provide the first-aid to workers in case of emergency".

Safe operation

NR-33 defines as being the feature in which "the equipment may not release electric or thermal power enough to, in normal or abnormal conditions, cause ignition of a given explosive atmosphere, as expressed in the equipment compliance certificate".

Line opening

According to NR-33 it is the "intentional opening of a duct, tube, line, piping which is being used or was used to transport toxic, flammable, corrosive materials, gas, or any fluid in pressures or temperatures able to cause material or personal damages aimed at removing hazardous powers for the safe work in confined spaces".

Imprisonment

NBR 16577 defines as "the condition of retention of the worker within the confined space, which prevents its exit from the premises by normal means of escape and can cause injury or death."

Immersion

Definition of NR-33 is quite simple, "it is the involvement and capture of a person by finely divided liquids or solids". For OSHA " it means the effective and involving capture of a person by a finely divided liquid or substance (floating) that may be aspired and cause death by filling or obstructing the respiratory system or exercising sufficient strength over the body to cause death by choke, constriction or crushing".

Self-rescue

The definition of the Brazilian standard is that was set-out in the "Capacity developed by the worker through training, which makes possible for his escaping with safety from a confined environment in which he entered in IDLH".

4. SAFETY AND HEALTH MANAGEMENT AT THE WORKERS IN CONFINED SPACES

The company shall make available work procedures for all its employees and collaborators of contracted companies involved in operations in confined space. It is essential that the company carries out analyses that must be used as support to draw up and adopt express, formal, mandatory and always revised procedures, so that all risk situations identified in the services to be performed inside such spaces may be avoided, minimized and controlled.

NR-33 as to the work procedure in confined space that the companies shall develop shall comprise, at least: goal, application field, technical basis, responsibilities, competencies, preparation, issuance, use and cancellation of the Entry and Work Permit, qualification for the workers, risk analysis and control measures.

This set of systematized procedures is a requirement by the standard Safety and health management in the Work in Confined spaces which shall be planned, scheduled, implemented and assessed, including engineering, administrative and personal measures and qualification for work in confined spaces.

An important standard innovation is that the procedures for work in confined spaces and the EWP shall be assessed at least once a year and revised whenever there is risk change, now the mandatory participation of the SESMT and CIPA.

Among the main engineering, administrative, personal measures and qualification required by the safety management for these works required by NR-33, we highlight:

- Identify, isolate and signalize the confined spaces in order to avoid entry of unauthorized people;
- Keep updated enrollments of all confined spaces, including the ones out of use, and respective risks;
- Advance and recognize the risks in the confined spaces;
- Proceed to assessment and control of the physical, chemical, biological, ergonomic and mechanic risks;
- Foresee implementation of locks, blocking, relieve, seal and tagging;
- Assess the confined space atmosphere to check whether the entry conditions are safe;
- Keep acceptable atmospheric conditions upon entry and during the entire accomplishment of the works, monitoring, ventilated, purging, washing or turning inert the confined space;
- Continuously monitor the atmosphere in the confined spaces in the areas where the authorized workers are performing their tasks, to check whether the access and permanence conditions are safe;
- Test the gas detector equipment prior to each use;
- Use direct reading equipment, intrinsically safe, provided with alarm, calibrated and protected against electromagnetic emissions or radiofrequency interferences;

- The stationary and portable equipment, including the communication and vertical or horizontal handling ones, should be appropriate to the risks of the confined spaces;
- In rated areas, the equipment should be certified or have a document comprised within the scope of the Brazilian Compliance Appraisal System – INMETRO;
- Adopt measures to remove or control the risks of fire or explosion in hot works, such as welding, heating, grinding, cutting or others which release open flame, sparkles or heat;
- Keep permanent signalization at the entry of the confined space, as per Attachment I of NR-33;
- Implement procedure for work in confined space;
- Adapt the Entry and Work Permit model outlined in Attachment II of NR, to the specificities of the company and its confined spaces;
- Have a control system allowing for traceability of the Entry and Work Permit;
- Make available the procedures and Entry and Work Permit for knowledge of the authorized workers, their representatives and inspection of the work;
- Assign the people to take part of the entry operations, identifying the duties of each worker and providing the qualification required;
- Establish procedures for supervision of the works outside and inside the confined spaces;
- Assure that access to the confined space is only initiated with monitoring and authorization of qualified supervision;
- Assure that all workers are informed of the risks and control measures existing at the work site;
- Implement a Respiratory Protection Program in accordance with the risk analysis, considering the site, complexity and type of work to be developed.

We'll go deeper on the personal procedures when we comment on the responsibilities and rights of the work team;

4.1. **QUALIFICATION**

According to NR-33, the designation of any worker without prior qualification for any work in confined spaces is not allowed. It is mandatory for the companies to set a periodical qualification program of its entire personnel for acquisition of abilities and technical knowledge for supervision, entry, watchman and emergency services, at all times any of the following situations occur:

- Change to the procedures, conditions or work operations;
- Any event indicating the need for new training;
- When there is reason to believe that there are flaws at the use or entry procedures of the confined spaces or that the knowledge is not appropriate.

All authorized workers and watchmen shall receive qualification periodically, with 16 hours at the initial training, and every twelve months, with a recycling course of 8 hours. The entry supervisors, in turn, shall also receive specific qualification, with

minimum 40 hours, and every twelve months, with a recycling course of 8 hours. Upon conclusion of the training, one should issue a certificate containing the worker's name, program content, hours, specification of the type of work and confined space, date and site for holding of the training with the signatures of the instructors and the expert in charge. A copy of the certificate should be delivered to the worker and the other copy should be filed at the company.

4.2. **SPECIFIC MEDICAL EXAMS**

Upon absence of any normative forecast, a medical procedure of the worker one minute before beginning of each work became a recent common practice. A simple blood pressure exam is done, but, it revealed to be the only a procedure of certain efficiency.

In all companies the PCMSO works as a program of periodical occupational exams for all workers, regardless of their assignments. However, for the workers who were designated to enter in confined spaces we always reserved greater attention, because in some situations, assessing whether they had ideal physical conditions for accessing to those sites was required taking into consideration their weight, height, different phobias and perfect health conditions for carrying out their services in those risky environments. And the way they were carried out and the interval between periodical exams prevented the confirmation that the worker would be fully prepared and healthy to face a hard task of entering the confined space for execution of services.

Today, NR-33 goes further. Every worker assigned for works in confined spaces should be submitted to specific medical exams in order to work with in it, as established by the NR's 07 and 31, including the psycho-social risk factors with issuance of the respective Occupational Health Certificate (ASO).

Claustrophobia, acrophobia, fatigue and noise are some of the situations that may generate an emotional stress to which the worker or rescuer may be exposed during long-term entries in confined spaces. The workers are to be submitted to psychological assessments so that the supervisors of works in confined spaces are sure they can count on workers having emotional balance to carry out services in such extremely hazardous sites. Remember that even the use of respiratory protection equipment may be an adversity.

4.3. **RESPIRATORY PROTECTION PROGRAM**

According to NR-33, the respiratory protection program is one of the new obligations of the companies related to entries in confined spaces. Those companies having their general program should also add to their procedures the respiratory risks of the confined space in use, in accordance with the risk analysis considering the site, complexity and type of work to be developed.

The NR defines this program as the set of practical and administrative procedures required to protect the worker's health by proper selection and use of the respirators.

In case of IDLH atmospheres, NR-33 specify that the confined space may only be entered upon use of demand mask with positive pressure or with line respirator of compressed air with ancillary cylinder for escape) or with SCBA.

The most used equipment of respiratory protection that the workers usually deal will be approached in the further chapter concerning equipment for confined spaces.

5. **WORKING METHODOLOGY IN CONFINED SPACE**

The entry into a confined space may be summarized in 3 stages: entry – work – exit. The procedure for a safe work focuses at a planning developed with stages in the management program of works in confined space. This methodology also comprises 3 preparatory moments to develop a scheduled entry in confined space: recognition, Assessment and Control.

5.1. **RECOGNITION**

The companies must identify the confined spaces existing in their organizations, registering and signalizing them. All risks existing at the site should be recognized as well as how they are produced prior to the entry for checking the environmental conditions that may allow for safe entry of the workers.

5.2. **ASSESSMENT**

Monitor means following up and assessing data provided by some device or method. At this stage, we analyze the environmental conditions of the confined space. All companies shall qualitatively and quantitatively test the conditions inside such site as to presence and severity of the existing physical, chemical, biological, mechanic or ergonomic risks, so as to assure that the entry conditions are safe. The atmosphere inside the confined space shall be assessed to verify the presence of toxic gases or steam, oxygen concentration and presence of any other potentially toxic air contaminant.

5.3. **CONTROL**

Monitoring is not limited to the time of site assessment; it is extended in order to ensure control of a safe environment during work. The companies shall adopt measures aimed at elimination or mitigation of the risks found in confined spaces.

The access to any environment that may place risk to the physical integrity of the worker shall be restricted. Even with the place being fully signalized, insulated and ready for work, the permanence of all unauthorized individuals must be prohibited. The data gathered during assessment of the conditions at the site will serve as support in the verification of the confined space during execution of the services and will be registered at the Permit and placed at disposal of the authorized workers preventing measures such as, for example, constant atmospheric metering, ventilation, lighting, respiratory protection, PPE, etc.

5.4. **WORK ENTRY PERMIT – EWP**

Each company must have a standardized document, built in accordance with the general procedures of work permit. This is another innovation by NR-33. Within the scope of NBR 14787 (canceled on July 07th, 2015) and replaced by NBR 16577 (March 28th, 2017), we had the Entry Permit form. The current standard modernized such form by calling it EWP (PET in Portuguese) – Entry and Work Permit, to be in accordance with the procedures as contained in the safety and health management program specific of the companies, being based on the model contained in the standard. It is a written authorization system for execution of any work to be carried out in the industrial areas (land or sea), aimed at offering the safest working conditions in that site for the workers and preserving the best conditions of the equipment, environment and continuity of the main operations.

The companies are obliged to ensure that access to the confined space occurs only after the EWP is issued. It is to be filled in, signed and dated, in three copies: One copy for the issuer (entry supervisor), one copy for the Watchman and another one for the authorized workers. If the entry involves collaborators from other contracted companies or subcontractors, the company shall make available the EWP issuance procedures not only for their own employees, but also the others.

The EWP will be specific for only a certain work and restricted to a single equipment, system or site, perfectly defined and limited, also identifying the authorized worker for service execution.

The permits are to be required by the supervisor of the team to carry out the work or worker or responsible for the area, equipment or system where the work is to be carried out, and shall be issued by employees previously assigned and instructed as to their correct filling and application.

The minimum information contained in the EWP is:

- The confined space to be entered (physical features);
- Objective of entry;
- Date and duration of the permit;
- List of authorized workers, watchman and rescue team;
- Signature and identification of the supervisor who authorized the entry;
- Risks in the confined space to be entered;
- Procedures used to isolate, remove or control the risks prior to the entry.

Certain occurrences during the entries in confined spaces may reveal some failures existing in the permit system. NR-33 mentions the circumstances requiring revision of the permit, but not limited to the following:

- Unauthorized entry into a confined space;
- Identification of the risks not described in the EWP;
- Accident, incident or condition not foreseen during the entry;
- Any change to the activity developed or the setting of the confined space;
- Request of SESMT or CIPA;
- Identification of safer working condition.

The EWP model with its minimum information required proposed by NR-33 is available at the end of our manual.

5.5. DUTIES OF THE AUTHORIZED WORKERS

All authorized workers shall:

- Collaborate with the company in the compliance with NR;
- Appropriately use the means and equipment provided by the company;
- Communicate to the Watchman and the Entry Supervisor the risk situations for their safety and health or that of third parties, which are known by them;
- Comply with the procedures and guidelines received in the trainings in relation to the confined spaces.

5.6. DUTIES OF THE WATCHMAN

The watchman shall:

- Keep continuity of the accurate counting of the number of authorized workers in the confined space and assure that everyone leaves upon conclusion of the activity;
- Remain out of the confined space, at the entry, in permanent contact with the authorized workers;
- Adopt the emergency procedures, activating the rescuing team, public or private, as required;
- Operate the winch;
- Not carry out other tasks that may compromise the main duty which is monitoring and protecting the authorized workers;
- Order abandonment of the confined space whenever he recognizes any sign of alarm, danger, symptom, complaint, prohibited condition, accident, unforeseen situation or when he cannot effectively perform his tasks, or be replaced with another watchman.

The watchman shall also, in existence of traffic of unauthorized people near the site where an entry is occurring or attempts to enter the site without permission, take the following measures:

- Advise the unauthorized people to remain distant from the confined space;
- Warn the unauthorized people to immediately leave the confined space;
- Inform the authorized workers and entry supervisors if unauthorized people are present in the confined space.

5.7. DUTIES OF THE SUPERVISORS

The supervision procedures should be established outside and inside the confined spaces. The entry will only start upon follow-up and authorization of qualified supervision. The supervisors shall:

- Issue the EWP prior to beginning the activities;
- Carry out the tests, check the equipment and procedures contained in the EWP;

- Assure that the emergency and rescuing services are available and that the means to activate them are operating;
- Cancel the entry and work procedures as required;
- Close the EWP after conclusion of the services.

The Supervisors must also:

- Check that entries are made strictly in accordance with the statements of PET and that all pieces of equipment are activated at the site prior to signing the permit;
- Verify, in case of changing the watchman shift, that the responsibility for continuing the operation is transferred to the next watchman; and
- Remove unauthorized people who are next or try to enter the confined space during the operations.

6. IDENTIFICATION OF THE TYPES OF RISKS

The main risks found and analyzed in the confined spaces are:

- Physical Risks
- Mechanic Risks
- Atmospheric Risks (chemical or flammable atmospheres)
- Biological Risks
- Ergonomic Risks
- Psychological Risks

6.1. PHYSICAL RISKS

The physical risks are associated with agents that have the ability to change the physical features existing in the environment. Therefore, the noise caused by a machinery or tool (sander) is able to produce sound waves that may cause some distress to the worker's physical integrity. Common examples of physical risks may be found below:

- Extreme heat or cold;
- Noises;
- Vibration;
- Fatigue;
- Abnormal pressure;
- Lighting; and
- Ionizing or non-ionizing radiations.

The injuries caused by these physical agents may be: burns, dehydration and instability in the cardio-circulatory system, blockage of the thermal regular system (hypothermia and hyperthermia), hearing loss, blurred vision, loss of balance, etc.

6.2. MECHANICAL RISKS

The mechanical risks are related to direct physical contact with the victim to produce the damaging mechanism of injury. Therefore, the worker when handling a tool or being exposed to some unprotected system may be the victim of severe injuries, incapacitating or leading to death. Mechanical risks are:

- Power discharge (energized, heated, pneumatic or hydraulic equipment);
- Liquid spilling;
- Perforating or cutting materials;
- Equipment or materials (cargo) in movement;
- Chemical products;
- Falls, slips or stumbles.

The injuries caused by these mechanic agents may be: immersions, shocks, amputations, perforations, crushing, etc.

6.3. **ATMOSPHERIC RISKS**

OSHA estimates that 90% of accidents and deaths in confined spaces take place as a result of a hazardous atmosphere that may expose the employees to a risk of death, disqualification, loss of self-rescue ability, damage or acute disease of one or more of the following causes:

- Deficiency or enrichment of oxygen;
- Explosive atmospheres;
- Toxic atmospheres.

The injuries caused by these agents may be: asphyxia, intoxications or explosions.

6.4. **COMBINED RISKS**

During prior analysis, we should identify all risks that are originated at the work, as well as the possible combination of risks developed. Such combination may result in another different and/or unforeseen risk, such as for example, a short circuit that may cause flicker and thus serve as ignition source for an explosion or a large fire which, in turn, may cause deficiency of oxygen in the environment.

6.5. **BIOLOGICAL RISKS**

These are those deriving from the so-called biological agents introduced in the work processes as part of the productive process;

- Sewage;
- Contaminated water;
- Animals;
- Biological vectors (mosquitoes, beetles, flies, etc.).

The injuries caused by these mechanical agents may be diseases or miscellaneous contaminations.

6.6. **ERGONOMIC RISKS**

The ergonomic risks are those introduced in the work environments and inappropriate to the limitations of their users. Their situation is characterized by solely reaching the workers. They may cause chronic injuries.

Ergonomic risks are:

- Narrow ellipses;
- Limited accesses;
- Excess equipment, tool or PPE weight.

7. **RISK ASSESSMENT**

We should never trust only our senses to determine quality of the air in a confined space. Many toxic or flammable gases or steam don't have color or smell. It is also impossible for someone to determine the oxygen level present or the environment temperature using only his senses.

7.1. **MONITORING**

Usually, the industrial safety shall be in charge of conducting the tests and the results shall be recorded and compared to the limits set forth by the health and safety standards adopted. The following procedures shall be abided by, at least:

- Select the most appropriate instruments;
- Check and test the instruments as to their data reading;
- When using the instruments, ensure that the atmosphere was accurately assessed; and
- Correct interpretation of the results measured.

7.2. **TYPES OF GASES**

The initial test is carried out outside the confined space. The assessor should wait for the time required to allow for the instrument to provide the answer. If safe conditions are found, the results should be recorded in the entry permit so that it may be authorized. The site should be assessed throughout its major points, at top, in the middle and bottom, due to stratification of the gases and steam.

Type	Example	Effect
Asphyxiant	Nitrogen – N2 Carbon Dioxide CO2 Argon Air	Take the place of O2 taking the oxygen-deficient atmosphere
Flammables	Methane – CH4 Hydrogen	When exposed and mixed to air, when receiving a suitable heat source may be combusted.
	Carbon CO2 Argon Air	
Toxic	Carbon Monoxide – CO	Extremely detrimental to human health and may cause countless reversible or irreversible effects or even take to death depending on concentration of the exposure time.

Falck Safety Services

The space should be immediately tested prior to any entry and monitoring throughout the entry for three possible hazards (in the following order):

- Lack of Oxygen or Enrichment;
- Flammability;
- Toxic atmospheres (CO and H2S)

7.3. PROPERTIES OF THE GASES AND STEAM

Density

When we talk about density, in thesis, we are talking about its weight. The reference is the atmospheric air and for it we assign a value equal to 1. The gases with density greater than 1 are heavier than the air; therefore, they tend to decrease, for example, the Sulphidic Gas (1,19), Propane (1,56), Butane (2,05).

The gases with density lower than 1 are lighter than the air; therefore, they tend to elevate. They are deemed as less dangerous, such as for example, Methane (0,55) Ammonia (0,59) and Carbon Monoxide (0,97).

Flash point

The lowest temperature in which a fuel releases steam in amount sufficient to form a flammable mixture. For the purpose of classification, the flammable liquids having flash point <60° C are identified.

- Gasoline: - 38 °C
- Alcohol: + 22 °C
- Diesel: + 43,3 °C

In general, products having a low flash point have a potential to generate an explosive atmosphere easily.

Tolerance limit

NR-15 Hazardous Activities and Operations defines the LT – Tolerance limit as being the maximum or minimum concentration or intensity, related to the nature and time of explosion to the agent, which will not cause damage to the worker's health, during his labor life.

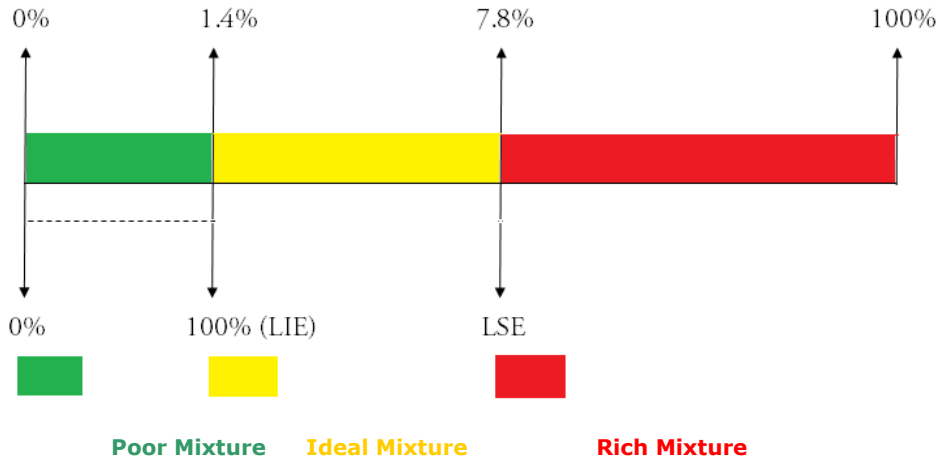
Explosivity range

For a fire or an explosion to occur, three elements should be present: oxygen, fuel and ignition source.

The mixture between the oxygen and the combustible gases or steam should be within the ideal proportion. Such mixture, different for each substance, is expressed by the Explosivity Limit which measures its ideal minimum or maximum concentration to create an explosive atmosphere. Supplying one of these elements the risk of fire will be removed.

NBR 16577 classifies as a hazardous atmosphere the condition in which the atmosphere presents a mixture of gas, vapor or flammable mist in concentrations greater than 10% of its LEL, of the previously defined material (s), or dust in one Concentration in the work environment that exceeds your LIE.

The highest percentage of gases and steam a mixture is concentrated, so that the amount of oxygen is so low that an eventual ignition cannot propagate through the confined space is called UEL – Upper Explosivity Limit.



OSHA and NBR 16577 require that reading of a flammable gas is below 10% of the LEL for entry, but in fact, the ideal is to obtain is reading of flammable gas of 0% for permissions of entry and hot works in confined spaces.

7.4. **ATMOSPHERES LACKING OXYGEN**

Considering the most common risk in confined spaces, because the normal is that we have little or no knowledge of such risk and its effects may be sudden and irreversible. There are three forms of making an atmosphere deficient in oxygen:

- CONSUMPTION
  - ✓ Metal oxidation;
  - ✓ Combustion (welds);
  - ✓ Drying of paints and coating;
  - ✓ Decomposition of organic matter (ironing);

- REPLACEMENT
  - ✓ Introduction of any inert gas (nitrogen, carbon dioxide, helium, etc.). These are rated as Simple Asphyxiants and leave the atmosphere with 0% oxygen;
  - ✓ Issue of steam of some volatile substance;

- ADSORPTION
  - ✓ Activated coal inside columns, chambers or reactors;

The only method accepted to determine the amount of oxygen existing in a confined space is testing its atmosphere with a gas detector. considers an atmosphere deficient in oxygen that containing less than 19.5% oxygen. However, NR-33 is stricter, it considers an atmosphere poor in oxygen that with less than 20.9% of oxygen. However, NR allows for the works in atmosphere with less than 20.9% oxygen to be performed, provided that it is constantly monitored and controlled.

Oxygen Level	Effects in the Human Being
23%	Extreme Risk of Fire
20.90%	Normal concentration
19.50%	Safe minimum level of "normal air"
16%	Disorientation, difficulty to breathe and deficient reasoning.
14%	Fatigue, reduction of the motor capacity
8%	Mental breakdown, weakness
6%	Extreme difficulty to breathe, death in a few minutes.

7.5. **ATMOSPHERES ENRICHED IN OXYGEN**

Flammable materials that may exist in the confined spaces may easily ignite in oxygen-enriched atmospheres, such as for example, leakage of a cylinder or an air-line, or inappropriate ventilation of the site while welding with oxyacetylene is performed . NR-33 defines an oxygen-enriched atmosphere that containing a concentration above 23%.

The excess oxygen in our organism is also responsible for severe injuries. The way of breathing oxygen in excess is called Hyperoxia. Its effects are:

- Brain dilation vein (edema);
- Bronchio dysplasia (lung inflammation and thickening);
- Increase of oxygen free radicals in the blood having as a consequence injuries in the central nervous system aggravating even more an edema.

The risk of an explosion should consider the atmospheric conditions inside the confined space and existence of wastes (gases, steam or dusts) that may be present or have been produced by the work under execution. Some of the most known conditions that may produce an explosive atmosphere during the works are:

- Cargo remaining inside the confined space;
- Flow of cargo or canalization of fuel;
- Coatings and preservatives of tanks;
- Leakage of flammable materials in the vicinities of the confined space;
- Decomposition of organic matter inside the confined space;
- Materials existing inside capable of igniting in the presence of hot works (rags, wood, paper, ropes, etc.).

7.6. **IGNITION SOURCES**

When there is a flammable atmosphere in a confined space, we may find several ignition sources possible to cause a fire or explosion:

- Open flames – welds, heaters;
- Electric arcs – broken wire, terminals, relays, switches;
- Flickers – steel tools in friction with metal.

The static power is a significant source of ignition, especially in loading and unloading services, painting, cleaning in confined spaces. Four cases are required for occurring an ignition by static discharge:

- It is generated by two substances, of separate surfaces, moving one in contact with the other (attrition);
- A static accumulator or collector of such charge appropriate to accumulate sufficient power for ignition;
- A means to discharge the energy rapidly and that can create a spark;
- There should be a mixture of flammable steam near the flicker outlet.

7.7. **TOXIC ATMOSPHERES**

They cause serious health problems for the workers or even their death. The physical effects of intoxication may occur immediately or later throughout the worker's labor life.

The toxic agents may be presented in different states: solid, liquid or gas.

They are also presented in the form of air suspended particles, whether solid (dusts and smokes) or liquid (mist and fogs), which are constituted in the called aerodispersoids. The presence of these agents is almost always resulting from the leftover of substances that were stored in the confined spaces, or by the use of coatings, solvents or preservatives in these sites.

It is also possible that toxic gases are present during an entry due to incorrect insulation procedures.

If the substance present during execution of the services is toxic, knowing its MSDS – Material Safety Data Sheet is required.

Based on the information contained in the record, the appropriate procedures to ensure health and safety of its employees shall be adopted. The records should be mainly adopted when the contaminant is not too known.

The most common toxic gases are presented as follows:

Carbon Monoxide – CO

Its presence in a confined space is resulted from incomplete combustion, weld, engines, or coming from sites adjacent to the confined space. It does not have color or smell, with the risk of not perceiving its presence thus eluding the need to carry out site ventilation.

Limit	Concentration
LT	39 pmm
LIE	12% (=12.000ppm)
LSE	75%

Our organism (lung) has the behavior to absorb the CO up to 300 times faster than the O_2.

Exposure X Time	Effect
200ppm x 3hs	Slight headache and discomfort
600ppm x 1h	Headache
1000ppm to 2000ppm x 2hs	Confusion
1000ppm to 2000ppm x 1,5hs	Disorientation, tending to stumble
1000ppm to 2000ppm x 30min	Slight pulsation
2000 to 5000ppm	Unconsciousness

Sulphydric Gas – H_2S

Considered as one of the most aggressive substances to the human being. Its presence in a confined space is resulted from any process developed inside the confined space such as bacteriological formation and sewage or coming from sites adjacent to the site.

It does not have color, and in small concentrations it smells like rotten egg, and in high concentrations it inhibits the smell after exposure.

Limit	Concentration
LT	8 ppm
LIE	4.30%
LSE	46%

7.8. **MONITORING DURING THE ENTRY**

Although the prior assessment indicates that atmosphere inside the confined space is safe to authorize the entry, the most important is that the monitoring is continuous, because the concentrations may change at any time as a result of the activities which are being carried out inside or in the vicinities of the site. A sudden entry of oxygen enriching the atmosphere or a leakage of inert or toxic gases are some reasons for a continuous or periodical monitoring carried out during the works.

8. ENGINEERING MEASURES FOR RISK CONTROL

The control procedures not being an administrative control, shall be taken into consideration the measures adopted by the engineering, the devices to be used and selection of the required PPE for the worker applicable to the assessed condition. For such, we should have as much knowledge as possible of the work area where the entry is to be made and the processes developed in such work unit to combine them with a work supervision that may provide suitable selection of risk control procedures. NR-33 foresees that should be removed or controlled all risks, including flooding, immersion, fire, electric shocks, static electricity, burns, falls, slips, impacts, crushes, amputations and others that may affect safety and health of the workers.

Any and all sector of the unit that may be directly or indirectly affected by execution of any work in confined space shall also be communicated. Therefore, the companies have the Permit system. Some essential service sectors to be communicated are: Stability, Perforation, Exploitation, Refinement, Storage, Electricity, Mechanics.

8.1. BARRER / SIGNALIZATION

Physical separation of the confined space from other activities developed in relation to the contact with some source of energy potentially hazardous or in relation to traffic of people not involved with that hazardous area. The isolated site will be safe from any danger while the isolation measures are kept. Once isolated, the entry of people without permission shall not be permitted.

8.2. LOCKING / BLOCKING / SEALING

Technique applied to avoid hazardous power discharge or valve opening.

It ensures the execution of the services in intentionally interdicted equipment, which was isolated. A lock or special lock is placed in a switch, breaker, key, valve or any other device so that the equipment is always prevented from being operated.

8.3. **TAGGING**

Placement of tags to the equipment. Tailor-made cards are attached at the equipment locks or sites which needs, and will be placed for accomplishment of that service scheduled in a confined space.

Some companies require interdiction, locking and tagging to be used jointly, corresponding to one of the most effective control methods.

While isolation makes it difficult for entry of any unauthorized person, at the same time the locks prevent handling of the equipment and inform the workers concerned to the activity or not the purposes of those safety measures.

8.4. **DISCONNECTION OF THE EQUIPMENT**

There may be an electric discharge or even the undue operation by blocked equipment. All operators of such equipment are responsible for compliance with the isolation, interdiction and disconnection procedures required by the company, when necessary for execution of any type of work in confined spaces. We're presenting below some measures that may be adopted:

- Prepare for stoppage;
- Disconnect the equipment;
- Isolate the equipment;
- Provide locking and tagging of the equipment;
- Control the stored power;
- Check isolation of the equipment;
- Removal of the locks and notices.

When the services are concluded, we should be aware as to the following:

- Inform all individuals concerned that the locks and tags will be soon removed;

Certify that everyone left that area;

- Remove locks, causing each assigned worker to be responsible for removal of their own locks;
- The warnings and tags should also be removed with the EWP;
- Notify everyone directly or indirectly concerned with the system that interdiction is concluded;
- In relation to the electrostatic power production control we present some general procedures;
- Remove the flammable steams inside the space prior to beginning the works;
- Remove loose objects inside the tanks;
- Ground the mechanic, electric or pneumatic metallic devices to remove production of load or difference of load in objects that may discharge when flicker is produced;
- Wait for atmospheric assessment to introduce objects inside the tanks;
- Inspect the collectors and ducts that may become an ignition source by means of a discharge.

8.5. **PURGING / INERTIZATION**

The process of dispersing hazardous substances of a confined space through the cleaning method that takes internal atmosphere of the confined space free from gases, steams and other undesirable impurities through ventilation or washing with water or steam.

We call attention to the fact that when the purge is used to reduce the risks associated with the flammable or hazardous substance existing in the site, it may also produce new risks, such as for example, deficiency of oxygen. It is the case of inertization that NR-33 defines as displacement of the atmosphere existing in a confined space by an inert gas, resulting in a non-combustible atmosphere and with deficiency of oxygen. For such reason, it should be followed by ventilation. The inert gas most applied in this process is nitrogen, but Argon or CO2 can be used.

8.6. **VENTILATION**

The process of continuous movement of fresh air and removal of contaminants from inside the confined space. Suitable ventilation should reach the following goals:

- Replace the contaminated air with breathable air;
- Reduce the possibility of explosion keeping the atmosphere always below the LEL;
- Reduce or remove toxicity of the environment through decrease of the contaminant;
- Increase the chances of survival of some victim imprisoned by formation of a breathable atmosphere;
- Cooling of the confined space.

There are two methods used for mechanic ventilation to be dealt with as follows.

Insufflation

Positive pressure ventilation introducing the air towards inside the space, forcing expulsion of contaminated air through any outlet. It is the most common method indicated for oxygen-deficient atmospheres.

Exhaustion

Suction ducts that pull the contaminated air out of the space. The fresh air naturally penetrating through an opening is dragged by the inside of the space by the force of exhaustion. It is considered as the best process for explosive or toxic atmospheres produced by the activities in operation inside the space. Use it for hot works, grinding operations or cleaning with solvents.

Choice of the method to be used will depend on the features of the confined space, type of work, contaminants, flammable gas or steam concentrations, etc.

However, we may also combine both systems to increase efficiency of the control system used. In such case, first the contaminated air is diluted through injection of fresh air, then it is expelled by exhaust already in less toxic concentrations. The problem of such method is that it may require a large number of pieces of equipment and that maybe they may not be used due to the limitations of the own site.

8.7. **SPECIAL EQUIPMENT / TOOL**

We should recognize that not always obtaining or keeping the atmosphere in a safe level will be possible. Therefore, for safety of the workers, appropriate equipment for hazardous areas shall be available, as well as due training for correct handling.

8.8. **ANTI-SPARKLING TOOL**

Special tools made of brass or beryllium. In fact, these tools may produce sparks when used against other surfaces. However, the energy generated by the spark is so small that it shall not be able to produce ignition.

Equipment Intrinsically Safe – Exi

Designed in such a way that in case of any failure, the greater energy (sparks or heat) internally produced of the equipment will not be enough to produce ignitions in the most sensitive concentrations of flammable gases or dust. Most of the portable gas detectors are of such kind. They are limited by a circuit provided with insulators and barriers.

Explosion-Proof Equipment – Exd

Designed to avoid the explosion risk in two ways. First, the equipment is designed to withstand the fosse of an explosion resulted from any internal ignition, ensuring that the flame does not propagate outside the casing.

Second, the equipment is designed for hot combustion gases to be cooled prior to being expelled so that they will not be exposed to ignition in the confined space. The lamps, for example, are designed to be explosion-proof.

8.9. INDIVIDUAL PROTECTION EQUIPMENT (IPE)

When the controls performed by the administrative programs and the engineering do not work, the IPE shall be used. This equipment shall be used solely if there's no other safe means to carry out the work. Incorrect use of the IPE frequently represents an additional risk to the workers in confined spaces.

8.10. EQUIPMENT FOR CONFINED SPACE

As we saw previously, accomplishment of an activity in a confined space, whether for work, or rescue, ends up by becoming a hard task due to the special features of that space. Therefore, as special as the confined sites, the equipment to be used in such activities shall have specific features required as we also saw in the previous chapter. Find below the most used equipment.

8.11. GAS DETECTOR

NR-33 obliges that the gas detectors must be intrinsically safe. They may be stationary or portable and may detect presence of more than one gas / steam (multigas). In case of portable equipment, they should offer direct reading in real time of the existing concentration. The own device collects, analyzes the substances and determines the atmospheric features of the confined space.

Certification of the equipment is mandatory by ordinance no. 176 dated 12/17/2000 of INMETRO. They should be certified, tested as to its performance by a responsible agency and followed by a Compliance Certificate.

RESPONSE TEST

The equipment should have its sensors tested with a standard gas which assures its response due to presence of that gas. It is the only safe way to ensure that its sensors are perfectly operating.

CALIBRATION

Through calibration the equipment is certified as to accuracy of the values measured by the reader, and if they are in compliance with the statements of the manufacturer.

Also, a periodical certificate should be issued for each calibration. Usually, the multigas detectors are prepared for reading as to presence of the Oxygen, Sulphydric gas, Carbon Monoxide and combustible gases.

RESPIRATORY PROTECTION EQUIPMENT

In all places where deficiency of oxygen is detected, as well as an improper state of the breathable air, supply of respiratory protection for those who will enter there shall be provided, so as to avoid any possibility of interference in the respiratory function, injury or death. Special attention should be given for the respiratory protection, because usually it is not used correctly. We suggest the following minimum requirements:

Respiratory protection program;

- Selection of the respirator by means of testing;
- Training for correct use of the equipment;
- Periodical cleaning and hygiene of the equipment and registration after use;
- Appropriate storage of the equipment should be recorded as to conditions;
- Periodical inspection and maintenance of the equipment should be recorded;
- Periodical medical assessment of the workers using this equipment; and
- Equipment use registered at the EWP.

Air Purifying Mask

Only used when:

- The atmosphere contains sufficient oxygen;
- Concentration of the contaminant is known;
- The concentration levels are within the limitations of mask filters;

Respiration Equipment by Line Air

It has the following features:

- It is independent from the contaminant concentration;
- Also indicated for lack of oxygen;
- Great autonomy (cascade system or compressor with air filter);
- Spare cylinder for escape;
- Positive pressure;
- Little weight;
- Limitations of the size of the air hose.

Autonomous Breathing Equipment (SCBA)

It has the following features:

- It is independent from the contaminant concentration;
- Also indicated for lack of oxygen;
- Provides greater mobility to the user;
- Independent compressor supply (power shortage);
- Positive pressure;
- Sound alarm;
- Limited time (about 30 minutes);
- Inconvenient weight.

Fans / Exhausts

Equipment used to remove the contaminated air or supply fresh air, having double function, depending on to which edge the ventilation duct will be connected. The differences between the models are measured by the technical information of each one such as power, outflow, air exchange speed, etc. The flexible ducts are used to direct the air flow of the equipment to the confined space or from the confined space to the atmosphere. For classified areas the model indicated should have explosion-proof engine and the ducts may not produce any static.

8.12. COMMUNICATION EQUIPMENT

Communication in confined spaces is an essential tool.

Fast, clear and safe communications are essential for protection of the authorized workers. It should be made through radios, and may be exceptionally by visual signs, if the worker remains constantly under the visual reach of the guard, also remembering that all electric equipment should be intrinsically safe.

8.13. SAFETY HARNESS

In all entries the worker shall use the complete parachute-type safety harness connected to a cable or rope safely anchored out of the confined space.

The purpose of using this equipment includes:

- Lowering or raising safely with the least effort possible;
- Carry out any work positioned at certain height;
- Making easier recovery of the victim through non-entry;
- Allowing for rescuers a method for locating the victims and removing them as soon as possible;
- Belts for entry into confined space are equipped with hemispheric rings in the shoulders used to raise the set through a separating bar.

They have a D ring cast to the harness and is positioned in the back. However, other belts may be used provided that they have a ring positioned at the back at the height of the shoulder, a D ring in front positioned at the waist. The belt should be certified (CA) by the applicable authority, inspected prior and after each use and cleaned after the work.

8.14. HANDLERS

We present here some of the pieces of equipment used in entries to make handling of the workers or rescuers easier inside a confined space.

Any person assigned for works, mainly in a vertical operation, should have the minimum abilities acquired in training for handling of the equipment. We shall only use equipment manufactured for loading people.

Never use a handler for which you were not trained yet!

Tripods

Tripods are freely positioned and have fitted legs that may be adjusted to offer variation of heights. They are very effective in lowering and raising, but are unstable if the side force is too big. Therefore, we should pay more attention for the equipment not to tumble.

DAVIT (OR MONOPOD)

Another handling equipment, the popular monopod. There are many models available, some permanently assembled, others are disassembled, some have free positioning and others are fixed and immovable, which shows their versatility.

An essential advantage of the Davit Arm in relation to the tripod is a reduced trend to tumble. The cares that should be taken by selecting it are the same as those indicated previously for the tripods.

Fall Arrestor hook

Tripods and monopod are usually equipped with handles which contain a galvanized steel cable of, approximately, ¼ inches of diameter, although greater diameters and stainless steel cables are also used. These handles may be used to raise or lower people where stairs or other access means are not available.

Mechanic hooks are relatively easy to assemble and require little training.

Many fall arrestor devices operates with handles incorporated becoming rescuers, and can be separately used to protect the workers from risks of fall in case of any break in the working cable or defect in the main equipment.

Effort reduction systems

Assembled or pre-assembled pulley systems are also usual and, nowadays maybe considered as the most efficient handling devices due to their countless variations and possibilities of application in the most different configurations of confined spaces.

9. **FIRST-AID**

Even in case of an entry for work it is important that the authorized worker and the other working team members are able to provide the initial service, even if restricted, and in case of an accident.

First-aid is construed as the immediate help provided by one person to an injured, sick, or victim of sudden illness, for the purpose of keeping him with life, until arrival of the doctor. Its main goals are:

- Saving lives;
- Relieving the pain;
- Avoiding later worsening;
- Promoting recovery;
- Serving as link between the time of the accident and arrival of professional help.

In emergency situations, all workers inside confined spaces should initially assure their safety for self-rescue. In case of victims in the site, the authorized workers shall, at least, follow the following guidelines:

- What happened?/ what are the requirements:

a) Observe if the area is safe;
b) Verify the signs of level of conscience (signs, blood, convulsions, etc.);
c) Try to obtain diagnosis;
d) Maximum of information possible (injury, deformities, injury mechanisms, etc.);
e) Request for immediate and appropriate rescue.

- Call the medical assistance

a) Accurate accident location;
b) Indication of the type and severity of the accident;
c) Number of injured people.

9.1. **RESPIRATORY SYSTEM**

The oxygen is the source of life. When inhaling this gas contained in our land atmosphere, our organism will make a series of reactions until transforming it into energy for perfect operation of our body. Among the systems controlling the metabolic functions of our body, the respiratory system is responsible for the gas exchanges involving submission of the oxygen to the lungs.

The respiratory system is comprised of the nasal cavities, mouth, larynx, trachea, bronchia and lungs. For breathing, the thoracic box also contributes, of which the expansion and reduction movements are essential for the air to enter and leave the respiratory routes.

Operation is quite simple, the air enters through the nose, goes through the nasal cavities and the pharynx. Then, it goes down through larynx which is continued by the trachea. This, arriving at the thorax, is bifurcated into two branches, the right and left bronchia which get to the respective lungs.

9.2. **BLOOD SYSTEM**

So that our body may carry out its functions, the blood has to permanently circulate throughout the body. But, why?

The answer is simple. The blood is the means for transportation of the energy required for operation of our organs which was fed by the oxygen processed by the respiratory system. In the blood circulation the blood makes two trips, a short one between the heart and the lungs (the small circulation).

For such circulation, an organ leveraging the blood (heart) and channels (blood vessels), through where the blood flows, are required. Operation of the heart causes the blood to be pumped to all parts of the body.

9.3. **ASSESSMENT OF THE CONSCIOUSNESS LEVEL**

Consciousness is the perception of what is around us. It means that breathing and circulation of the victim are present. Unconsciousness is a damage that may vary from temporary lack of reaction to deep coma. It is the result of interruption of the regular activity of the brain. The consciousness level is measured by testing the victim's response to stimuli such as sound or smell.

Response	Symptom	Level
Alert	Reaction to sound	Normal
	Speaks normally	
Voice	Confusing response	Reduced
	Confusing impression	
Pain	No sound reaction	Unconscious (Partial)
	Some pain reaction	
Unconscious	No sound reaction	Deeply unconscious
	No pain reaction	

9.4. **INJURIES**

Injuries may be internal and external. The internal injuries are complicated, because their treatment is not possible for a rescuer. External injuries may cause complications because the germs (contaminants) may infect the injury.

The injuries may be open or closed. Open injuries are those in which there's loss of surface integrity of the skin. In the closed injuries there is no loss of skin integrity.

9.5. **EXCORIATIONS**

Injuries of the superficial layer of the skin or mucosa having discrete bleeding, but use to be extremely painful. They do not represent risk to the victims when isolated.

9.6. **INCISIONS**

Tissue injuries whose edges are regular, being produced by cutting objects. They may cause bleeding of different degrees and damages to tendons, muscles and nerves.

9.7. **LACERATIONS**

Tissue injuries of irregular edges, produced by objects, leaks through closed trauma over bone surface. The bleeding should be controlled by direct compression and application of dressing and bandages. Immobilize the extremities with deep injuries.

9.8. **PERFORATIONS**

Injuries by perforation of the skin and underlying tissues by an object. The entry hole may not correspond to the injury depth. The thorax penetrating injuries should be concluded as soon as possible, so as to avoid aspiration of air to the pleural space with formation of open pneumothorax. Check presence of outflow hole, but never exploring the injury. Treat the conditions which cause imminent risk of life. victims with penetrating injuries of torso and abdomen should be removed as soon as possible for hospitals having surgical team by the high risk of internal hemorrhage.

9.9. **AVULSIONS**

Injuries with displacement of the skin in relation to the underlying tissue, that may be connected to the healthy tissue or not. They have varied degrees of bleeding, usually hard to control. The most common location occurs in hands and feet. Placing the rag and its normal position is recommended and effecting direct compression of the area, to control the bleeding. If the avulsion is complete, transport the rag to the hospital. Preparation of the rag consists in washing it with saline, avoiding use of direct ice over the tissue.

9.10. **CLOSED INJURIES**

An impact or compression may cause breaking of blood vessels, causing overflow of liquids or blood. These injuries, which are called contusions, may affect only the superficial structures, but, in case of intense force applications, there may be injury to the internal organs. Usually, in case of only superficial affecting the victim has pain and swelling (edema) of the affected area.

In case of hemorrhage, the site acquires dark or bluish color, which is called bruise. In some cases, the bleeding produces a tumor visible under the skin, which is called hematoma. These injuries when superficial are not risky to life, but their visible signs may alert for the possibility of injuries to the internal organs.

9.11. **TRAUMATIC AMPUTATIONS**

Amputations are defined as injuries in which there's separation of a limb or a protuberant structure of the body. They may be caused by cutting objects, crushing or traction forces. They are frequently related to industrial accidents. Their initial

treatment should be fast due to gravity of the injury, which may cause death by hemorrhage, and for the possibility of re-implantation of the amputated limb. Control of the hemorrhage is crucial in the first stage of treatment. The amputated limb should be preserved whenever possible, but the greatest priority is maintenance of life.

- Complete or total amputation: the segment is fully separated from the body;
- Partial amputation: the segment has 50% or more of area of solution of continuity with the body;
- Degloving: when the skin and the fatty tissue are pulled with no injury of the neighboring tissue.

9.12. **CRUSHING**

Common injury in landslides and industrial accidents. May result in open and sealed injuries. There is extensive tissue damage of the underlying structures.

It may be the mechanism of cause of amputation of extremities. Crushing of thorax and abdomen causes severe circulatory and respiratory disorders.

9.13. **HEMORRHAGES**

Severity of the hemorrhage depends on:

- Type of blood vessel involved;
- Amount of blood lost;
- Speed of losing the blood; and/or
- Site of bleeding.

Upon occurrence of accidents involving internal hemorrhages, for an efficient service of the victim the following symptoms should be observed:

- Anxiety;
- Thirst;
- Tachycardia (cardiac pace between 100 and 120/min);
- Weak radial pulse;
- Cold skin;
- Paleness;
- Cold sweat;
- Respiratory frequency greater than 20/min; and/or
- Slow capillary fill (greater than two seconds).
-

The conclusion is:

- Internal bleeding.

The first-aid goal is:

- Avoiding more blood loss.

The action to be taken:

- Leave the victim. Rest of the injured part helps formation of the coagulum;
- If the injured is covered in clothing uncover him (but avoid cooling);
- Avoid state of shock;

Provide urgent transportation to a hospital.

9.14. TAMPONAGE

Dressing or bandages which are used to cover an injury and should only be placed over an injury when sterilized to avoid greater contamination. The bandages may be used to keep the dressing in the place or to press strongly in case of serious bleeding.

In view of an initial help for application of a bandage in an injury, we should proceed as follows:

- Elevate the injured part of the body (if possible);
- Apply the dressing (preferably sterilized);
- Apply a circular layer of synthetic cotton wool;
- Press with a bandage roll or cloth in a narrow triangle format or folded in half. After placing the dressing, you should leave the part of the injury of the body elevated and supported. For an arm, use the sling and for a leg, an elevation.

9.15. BURNS AND SCALDS

The tissues will be damaged when physically exposed to a direct source of heat at a temperature of 45°C or more. When the temperature exceeds 50°C they will be permanently damaged.

Burns may be caused by: dry heat, electricity, chemical products, radiation, friction. Scalds may be caused by hot liquids or steam. We should also be aware of a significant risk of infection with burns because the damaged skin does not offer protection against germs.

The burns may be:

- 1st degree: redness, swelling and pain;
- 2nd degree: vesicles, that may be open and pain;
- 3rd degree: dark or whitish burnt skin, no feeling of pain.

In case of severe injuries caused by burns, proceed as follows:

ACTION

- Immediate cooling: 15 to 20 minutes under tap cold water;
- Small burns such as those of 1st degree should be covered and sterilized;
- Severe burns such as 2nd and 3rd degree should be covered and sterilized;
- Lay the injured down; and
- Provide urgent removal to a hospital.

ATTENTION:

- Do not burst the vesicles or remove loose skin;
- Do not remove anything sticking to the burn; and
- Do not apply lotions, creams or fat to the injury.

9.16. FRACTURES

Breaking of any bone. They may be closed (when the skin remains intact) or exposed (when there is injury to the skin, even if a small hole).

Every injury with a lot of complaining of pain and formation of hematoma (purple), should be treated as a potential fracture.

SYMPTOMS OF AN INTERNAL FRACTURE

- Pain;
- Loss of normal movement;
- Swelling;
- In some cases there's deformity; and/or
- There may be abnormal movements (decontrolled)

CONCLUSION

- Internal fracture.

FIRST-AID GOAL

- Avoid that the injury aggravates and relieve the pain.

ACTION

- Immobilize the joint above and another one below the fractures limb;
- Provide support and trust;
- For the arms, wrists and hands, use a sling;
- For the shoulders, arms and elbows use a piece of triangle cloth folded in half; and
- For lower limbs, use a wrapped quilt.

SYMPTOMS OF AN EXPOSED FRACTURE

- Pain;
- Los of abnormal movements;
- Swelling;
- Small external injury. In some cases, there may be deformity; and/or
- There may be abnormal movements (decontrolled).

CONCLUSION

- Exposed fracture.

FIRST-AID GOALS

- Avoid that the injury aggravates, infection and relieve the pain.

ACTION

- Immobilize the fracture;
- Provide comfort to the victim;
- If the injury is visible, it should be covered with a dressing (bandage); and
- Provide transportation to the hospital.

Sometimes there may be state of shock. Provide treatment of shock. If you're in doubt, always consider that the bone is broken and treat him as if it really were.

10. BASICS OF RESCUING IN CONFINED SPACES

In view of the countless settings possible of accidents, the companies shall implement within their management of works in confined spaces an operating procedure for service of rescues and medical emergencies with specialized and team prepared for the occurrences of removal and ready service of the workers victim of accidents. Every time in which any work in confined space is carried out, regardless of the potential risk for life or health of the worker, the rescuing team shall be, in advance aware of the execution of the services, available and placed with all pieces of equipment required prepared.

10.1. EMERGENCY AND RESCUING SERVICES

NR-33 provides for obligation of the employees to draw up and implement a rescuing procedure which includes, at least, the following:

- Description of the possible settings of accidents, obtained as of Risk Analysis;
- Description of the rescuing and first-aid measures to be carried out in case of an emergency;
- Technical selection of use of the communication, emergency lighting, rescuing search, first-aid and victim transportation equipment;
- Activation of a team responsible, public or private, for execution of the rescuing and first-aid measures for each service to be carried out;
- Annual simulated rescuing exercise in the possible settings of accidents in confined spaces.
- NBR 16577 states that the employer, or his agent, must ensure that each member of the rescue service has personal protective equipment (including breathing protection) and rescue equipment necessary to enter confined spaces, as well as their own gas detectors for classified areas with O2 sensors, flammable and toxic gases potentially present in confined spaces and trained for the proper use of these equipment.
- The following requirements apply to employers who have workers entering confined spaces to perform rescue services:
- a) if a combustible / flammable atmosphere is detected, the crew shall revert the atmosphere with ventilation and tester measurements, gas detectors and electrical / electronic equipment suitable for classified areas, and then proceed with rescue;
- b) each member of the rescue service must possess physical and mental fitness compatible with the activity to be performed;
- c) each member of the rescue service shall be trained to perform work in confined spaces (authorized worker) and to perform the assigned rescue tasks;
- d) the training of the rescue team should include all possible accident scenarios identified in the risk analysis;
- e) the rescue team is exempt from the Entry Work Permit (EWP) issue.

10.2. ARRIVAL OF AN EMERGENCY

Rescues with only one rescuer would be unthinkable. We know that in any activity in confined space, one does not work alone.

The rescue, depending on its complexity, may require a greater number of components, each with its task.

- Call the team;
- Arrange the team;
- Delegate tasks;
- Planning.

10.3. ANALYSIS OF THE RISKS

The rescuer shall receive the initial information on the accident through the guard or individual responsible for the entry, and able to transmit safe information, both in relation to the site setting, as to the control procedures of the activities inherent to him. The rescuer shall monitor presence of the risks related to deficiency of oxygen, exposure to contaminated atmospheres, explosions, fire and for the other mechanical, electric and ergonomic and psychological risks.

- Isolate the area, establish a perimeter;
- Obtain the entry permission;
- Number of victims;
- Conditions and location of the victims;
- Consult the tolerance limits and the MSDS, as required.

10.4. ASSESSMENT OF THE RECOURSES AND RISK CONTROL

We should not enter a confined space until it is safe and assuring that all assistance is present, even if a rescuing operation. After identification of the risks, an assessment will be proceeded that removes the existing risks or that may protect the rescuing team and the victim, if existence of the risks still persist. In this step, we choose the appropriate control measures and the IPE. The speed of the rescue should also be a factor to consider, but always respecting in first place the safety of the own rescuer. Statistical data at NIOSH reveal that 60% of the deaths occurred in confined spaces were the rescuers.

The rescuer shall know and know how to use its IPE correctly and have abilities to deal with possible disturbances caused by the own equipment. Wrong choice or misuse of the IPE may contribute towards failure of the operation.

10.5. SAFETY OF THE RESCUING PROCEDURES DURING THE OPERATION

The essential for every rescuing operation is that it is being developed under the safest control conditions of the risks. If the accident was caused by the presence of any atmospheric risk (presence of a toxic gas), it may be a sign that the control measures of that scheduled entry failed. Therefore, the rescuing team command shall request a new check list as to the valve closing procedures or piping blockage, electric

power cut, use of fans/exhausts, gas metering, respiratory protection etc., always keeping some kind of protection which ensures that no such measure is violated.

10.6. ALTERNATIVE SOLUTIONS

Capacity to improvise by the team. If the standard rescuing procedure is impossible to be applied, the rescuing team shall always have a "Plan B". As mentioned in the prior item, the time of response to the rescue is a very important variable, as soon as the team may not lose any of the scarce minutes when facing difficulties that delay the operation.

10.7. ENTRY FOR RESCUE

It should be preceded of an attempt to rescue using only the handling devices, already assembled and which are still connected to the victim. If it is not possible, entry for rescue is authorized. Therefore, the operation may be summarized in the following sequence:

- Pre-entry

a) First survey yet in the preparation of entry to work;
b) Support ventilation;
c) Begin contact with the victim;
d) Try to determine what was the injury mechanism;
e) Psychological service to the victim.

- Entry

a) Spare team also prepared;
b) Constant communication;
c) Lighting;
d) Locate the victim rapidly;
e) Stabilize the victim, first service;
f) Provide breathable air supply as required;
g) Immobilize the victim if possible;
h) Pack and transport the victim;
i) Remove the victim;
j) Remove the rescuers;
k) Specialized service for victims and, as required, for the rescuers;
l) Disassembly of the systems and collection of the equipment;
m) Cleaning of the equipment and decontamination, as required;
n) Assessment of the physical and mental status of the rescuers;
o) Assessment of the final operation report.

10.8. ATTACHMENT II TO NR-33 – ENTRY AND WORK PERMIT (PET)

Informative model for elaboration of the Entry and Work Permit in Confined space.

Annex II of the NR-33 - Permission of Entry and Work (PET)

Model of character information for the preparation of Entry Permit and Work

Confined space
Company Name:

_____

Location of confined space: _____ Space confined n: _____

Date and time of issue: _____ Date and time of completion: _____

Work to be held: _____

Authorized workers: _____

Watchman: _____ Rescue Team: _____

Entry Supervisor: _____

Procedures that must be completed before entry

- Isolation _____ Y () N ()

- Initial test of the atmosphere: time_____

Oxygen_____% O^2

Flammables_____% LEL

Gases / vapors toxic _____ ppm

Dust / fumes / mists _____ mg/m3

Readable name / signature of the Supervisor of tests: _____

- Locks, locking and labeling _____ N / A () Y () N ()

- Purging and / or washing _____ N / A () Y () N ()

- Ventilation / exhaust - type, equipment and time _____N / A () Y () N ()

- Test after ventilation and isolation: time_____

Oxygen _____% O2> 19.5% or <23.0%

- Flammables _____ LEL% <10%
- Gases / vapors toxic _____ ppm
- Dust / fumes / mists _____ mg/m3
- Readable name / signature of the Supervisor of tests: _____
- General lighting _____ N / A () Y () N ()
- Procedures of communication: _____ N / A () Y () N ()
- Procedures for redemption: _____ N / A () Y () N ()
- Procedures and protection of vertical motion: _____ N / A () Y () N ()
- Training of all workers? It current?_____ Y () N ()

Equipment:

- Equipment for continuous monitoring of gases approved and certified by an Accredited Certification Body (OCC) by INMETRO to work in areas potentially explosive for direct reading with alarm conditions: _____ Y () N ()
- Flashlight/ Torch _____N / A () Y () N ()
- Clothing for protection _____N / A () Y () N ()
- Fire extinguishers _____N / A () Y () N ()
- Helmets, boots, gloves _____ N / A () Y () N ()
- Respiratory protection equipment / or autonomous air-cylinder with warrant escape_____ N / A () Y () N ()
- Safety harness and lines of life for workers authorized _____ Y () N ()
- Safety harness and lines of life for the rescue team _____ N / A () Y () N ()
- Ladder _____N / A () Y () N ()
- Vertical movement of equipment / external media _____N / A () Y () N ()

Electronic communications equipment approved and certified by a body of Accredited Certification (OCC) by INMETRO to work in areas potentially

- explosivas_____ N / A () Y () N ()

- Respiratory protection equipment or system of autonomous air cylinder with escape bottle to rescue team? _____ Y () N ()

- Electrical and electronic equipment approved and certified by a body of Accredited Certification (OCC) by INMETRO to work in areas potentially explosive _____ N / A () Y () N ()

- **Procedures to be completed during the development of business**

- 14. Permission for Hot Work _____ N / A () Y () N ()

Procedures for Emergency and Rescue:

Phones and contacts: Ambulance: _____ Fire: _____ Security: _____

Legend: N/A - "not applicable" N - "no"; S - "yes."
- The entry cannot be allowed if a field is not filled or contains the mark in column "No."
- The lack of continuous monitoring of the atmosphere inside the confined space, alarm, agenda

Watch any situation or risk the safety of employees, involves the immediate cessation of area.

- Any removal of all team for any reason involves the issue of permission for new entry. This permission of entry should be exposed at work until it ends. After the work, this permission should be archived.

REFERENCE DOCUMENTS

The following documents were used as source of information during preparation of this reference manual.

- Labor and Employment Department – NR-33: Safety and health in Works in Confined spaces.
- Brazilian Association of Technical Standards - NBR 16577: 2017: Confined Space Prevention of Accidents, Procedures and Protection Measures.
- Brazilian Association of Technical Standards - NBR 14.606: Service Stations - Confined Space Entry
- Labor and Employment Department – NR-15: Hazardous Activities and Operations.
- OSHA – REGULATIONS (Standards – 29 CRF) Permit-Required Confined Spaces-1910.146.
- NIOSH – Working in Confined Spaces, December 1979. (Publication n°80-106).

NIOSH – A Guide to Safety in Confined Spaces, July 1987. (Publication n°87-113).