# WORKING IN EXPLOSIVE ATMOSPHERES

## WHAT ARE THEY AND HOW DO WE WORK SAFELY IN THEM?

**Explosives falling under the Hazard Class 1 category are substances that cause a sudden, virtually instantaneous release of pressure, gas, and heat when subjected to sudden shock, pressure, or high temperature. An explosive atmosphere is a perfect mixture of air under atmospheric conditions, and combustible substances in the form of dust or gas in which the combustion, after ignition, propagates throughout the unused mixture.**

The consequence of an explosion can have a very serious impact on a human, environment, and business' ability to continue to operate due to loss of premises and equipment. It can also have serious consequences for a business' reputation, as incidents become permanent statistics (history) associated with the organisation.

Working in explosive atmospheres entails high risks, which require important safety measures and the use of specialised safety tools by trained and experienced professionals.

Method Statement, Task Risk Assessment, and Permit to Work are some of the major tools that define the controlled working environment for the successful execution of tasks with mutually beneficial conditions in hazardous or explosive atmospheres.

## Method Statement

A comprehensive method statement needs to be developed that considers the scope of the task, dividing the task into small steps and establishing an adequate sequence. Key personnel roles and responsibilities with minimum competency criteria, authorities, and areas of accountability need to be defined in the Method Statement (MS), such as:

- Defining the required tools and equipment (according to zone 1 classification) by considering all needs throughout an entire activity.
- Describing types, quality and quantity of materials and substances required to be used during the task.
- Occupational Health, Safety and Quality requirements, including personal protective gear, gas testing and monitoring equipment, and safety and quality hold points.
- Emergency response details with contact persons, rescue equipment, medical and first aid facilities and liaison external support services.

- A Task Risk Assessment covering all steps (activities) of the scope.

## Task risk assessment

Risk assessment is a key process in evaluating potential risks; respective consequences and probabilities; control measures by considering local and international legal regulations; best industrial practices; organisational plans, and procedures; monitoring and supervision; assigning responsibilities, and completion target dates (and time where applicable).

The risk assessment session should be conducted including all stakeholders, area authorities, senior members of the workforce, process/task supervisors, health and safety representatives and a member of the emergency response team. Findings of the risk assessment session must be documented and endorsed by all participants. Control measures should be appropriate to bring the risk at as low as reasonably practicable (ALARP) by implementing all defined steps. However, some scenarios may require a business to impose additional control measures where they were not defined earlier.

The following need to be considered with regards to explosive atmosphere risk assessment as a minimum:

- The hazardous properties of the material to be used during the task.
- The workforce likely to be affected and the severity of the consequences on them, other workers, and the public.
- Information on safety provided by the manufacturer, including information contained in any relevant material safety data sheet.
- The work involved including the work process, type and amount of hazardous material used, and if the work involves more than one substance. Furthermore, would the risk increase if they interact?
- Safe handling, storage, and transport of hazardous material and of waste containing dangerous substances.
- Potentially high-risk activities to be executed during the entire task.
- The effectiveness of control measures that have or will be taken to protect people, assets, and the environment.
- The likelihood of an explosive atmosphere occurring and its persistence.
- The likelihood of ignition.
- The scale of the fire or explosion and its effects and impacts.
- Damage to adjacent equipment, process, plant, and premises.
- Any additional safety information required.

## Permit to Work

Permits to work are used to define the category of activity; cold or hot work; requirement of isolations (mechanical, and or electrical); consideration of confined space if working in tanks, vessels, or enclosed environments; and electric power (low or high voltage).

A Permit to Work must be issued, and control measures need to be implemented accordingly. The permit has to be issued and closed by the area authority on the request of the task performer, after ensuring the competency and ability to safely execute that task. All associated isolations can only be cleared to normal operation after the successful closure of a Permit to Work.

## Management commitment and competency

The Management needs to provide all required resources; plans and procedures; appropriate tools and equipment; training and awareness; and monitoring and supervision other than their moral and technical support.

The workforce needs to be qualified, experienced, and have attained a competency certification (where required), with the ability to understand Risk Assessment and Permit to Work defined hazards, and successfully implement control measures. They are also required to effectively communicate the recommended actions to all team members involved, who must be physically and mentally fit.

## Training and awareness

The entire task team has to undertake a comprehensive training and awareness session and have a complete briefing on the sequence of the task; its associated risk and potential threats; control measures with appropriate resources; procedures, tools and equipment, and personal protective equipment. This training should include:

- The characteristics of hazardous material and substances – ignition sources and causes, may lead to explosive atmospheres.
- Transportation, storage and safe use of the task's hazardous substance, precautions, and protection.
- Working combinations, selection of tools and equipment, and call and support during a threat or emergency situation.
- An understanding of equipment readings, warning and alarms, and immediate protection measures e.g. force ventilation, emergency shutdown and power cut offs.
- Briefing on entire Task Risk Assessment, Work Method Statement, and types of Permit to Work and certificates to be used, their precautions, and mandatory requirements.
- Defining the role and responsibilities of each category of workforce, their authorities, and accountabilities.

## Eliminating the risk

First priority should be given to execute the task during the complete shutdown or when entirely disconnected from the process or from the explosive zone. If deemed extremely necessary, try to eliminate risks involved with humans by introducing robots, drones and other mechanical or technological means.

## Minimising the severity of risk

In order to minimise the potential risk and consequences of severity, you can:

- Reduce your workforce to the minimum acceptable number needed for the task and keep rotating their exposure to the explosive atmosphere.
- Choose low voltage power equipment, lights, and appliances.
- Organise hydraulic and pneumatic equipment instead of mechanical to avoid friction and hammering impacts.
- Select the less hazardous substances or chemicals required and reduce the quantity to a minimum.
- Avoid or minimise releases of dangerous substances – controlling release of dangerous substances at source will support prevention of the formation of an explosive atmosphere.
- Secure adjacent equipment and processes by shielding the area with explosive proof screens or walls.

## Access control and free egresses

The area in use should be restricted with controlled access and egresses. The workforce assigned for the task should be issued with specific identity badges. No unauthorised personnel should be allowed to enter this restricted area. Logging of workforce inside the area has to be maintained on a separate log sheet with names, time in and out, and task category. More than one egress (if possible), free from any obstruction, has to be established considering the emergency evacuation situation. Access and egresses need to be maintained clear from any obstruction, be bright enough, and supported with necessary signs and guide marks. All other escape means and measures should be available near each exit with adequate support and resources.

## Availability of task documents

Method Statement, Permit to Work, Task Risk Assessment, facility layout, P&IDs, Material Safety Data Sheets, and other necessary documents have to be available at the entrance of the work area. This allows guidelines, controls measures, material specifications, safety requirements or any other help from these documents to be obtained from time to time or as and when needed.

No one should be allowed to remove or replace any of these documents, instructions/requirements, procedures/ work instructions, or safety and quality protocols under any circumstances until the task is completed and all work permits and isolation certificates are closed successfully.

## Checks and inspection

Prior to starting any activity, all equipment, tool and gears, and instruments have to be visually inspected and checked to confirm their accuracy. This is usually done by performing test runs in accordance with calibration and certifications requirements. The equipment fulfilling the inspection criteria can only then be selected for the specific task to be executed in an explosive atmosphere.

## Isolation from energy and process sources

Appropriate and adequate measures need to be taken to isolate the working equipment/objects from all kinds of electrical, mechanical and process sources and to ensure that no stored energy is available.

The most appropriate isolation method is to remove the energy connection (flow line, power, process), then block and bleed. A Lock out/Tag out (LOTO) system should then be applied by involving process and execution parties with separate tags, locks, and keys.

All isolation is only to be removed after successful closure of all work permits issued for the entire task. No partial isolation should be energised under any circumstances.

## Sources of ignition

Nine potential sources of ignition can, and should, be considered:

1) Hot surfaces

2) Flames and hot gases or particles

3) Mechanical sparks

4) Electrical system

5) Cathodic protection

6) Static electricity

7) Lightning

8) Electric-overload

9) Heating cables

For each source of ignition, the likelihood of ignition should be calculated using historical and fault tree analysis or, sometimes, specific calculation procedures. Subsequently, for each source of a potential explosion, the effects of an explosion under the presence of all possible sources of ignition has to be calculated.

## Unique characteristics

Some substances may be dangerous when wet, as compounds react violently with water to form toxic vapours and/or flammable gases that can ignite and cause a fire or explosion.

Always keep flammable liquids stored away from oxidisers and away from heat or ignition sources such as radiators, electric power panels, etc. All containers have to be closed tightly to avoid developing any vapour or gas clouds. All possible discharges of processes have to be monitored regularly to evade any potential explosive environment. There must be adequate arrangements organised to dilute or eliminate developing hazardous clouds or atmosphere.

## Safety tools

When it comes to the provision of high-quality safety tools, it is vital that an exact material composition of the alloy is used for the safety tool, as production must be attained with precision since even slight deviations can significantly impact the tool's properties in a negative way.

Tools recommended for use in explosive environments should be made from aluminum-bronze and copper-beryllium alloys, which offer a great mix of safety and usefulness. The smelting process must be executed with care as the tool should not only look great on the outside, but its core should be strong and stable. A range of Intrinsically Safe pneumatic tools including, drills, saws, impact wrenches, mag-drills, grinding and cutting tools that are designed for use in explosive atmospheres can be selected and safely used.

## Non-hazardous lighting

Explosion proof lighting fixtures, switches, plugs, distribution boxes, and accessories that prevent produced sparks from igniting the flammable and explosive gases in the atmosphere have to be carefully considered.

Explosion proof lights are available in various forms to suit an explosive atmosphere's area lighting needs. Explosion proof LED lights generally have built-in LED lights that are long lasting. Explosion proof light fixtures are designed to safely contain a halide light element, and also come in the form of explosion proof fluorescent light fixtures.

It must be ensured that all electrical equipment fulfills the criteria to work in explosive atmospheres and that they are properly earthed (grounded).

## Ventilation

This includes mechanical extraction for all sources of vapour and ventilation to a safe area to maintain temperature and pressure. The collection, containment, and removal of releases to a safe place; the quantity of substances released; and the probability of the formation of an explosive atmosphere need to be calculated. Adverse conditions such as exceeding pressure/temperature limits have to be avoided that could lead to an explosive atmosphere being created.

## Equipment requirements

Where equipment is required to be located or used in an explosive atmosphere – e.g. mixers and stirrers, pumps, control systems, forklift trucks, detectors, torches, etc. – these items must be designed so that they cannot release energy within the area that is sufficient enough to cause an ignition.

## General safety requirements

Adequate housekeeping, material/hose/cable management, storage and labeling, spill containments, and waste management need to be considered as potential factors to reduce the probability of developing an explosive atmosphere. This includes waste products, materials used for cleaning or maintenance, and any materials used as fuel.

## Personal Protective Equipment (PPE)

Personal Protective Equipment must be supplied and adequately utilised according to the risk evaluation of each activity. Workforces have to be effectively trained in how to use and maintain their respective PPEs. Garments should meet the NFPA 2112, 2113, 2014/34/EU and the NFPA 70E standard, which means garments must resist flash fire and arc flash.

Any PPE that are intended for use in explosive atmospheres, must be designed and manufactured so that they cannot be the source of an electric, electrostatic, or impact-induced arc or spark, that would likely cause an explosive mixture to ignite.

## Activity management

The supervision and close monitoring to observe findings, atmospheric conditions, and changes in environment (temperature/pressure) rely on specialist

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instruments. Thermal and gas detectors, and other instruments, are vital apparatus in the implementation of adequate and effective control measures. Other things to observe and manage are security and safety movements through CCTV, the emergency and rescue watch, and any progress made at each stage of the tasks (activity).

After the successful completion of a task, closing and demobilisation are other important factors that need to be considered seriously. All temporary arrangements have to be restored according to the defined controls in the Task Risk Assessment and as described in the Work Method Statement.

## Emergency response

This includes the provision of explosion suppression or explosion relief equipment; the installation of emergency detection, protection and management tools and equipment; an establishment of emergency response and support teams including firefighting, first-aid and medical support teams; measures to control or minimise the spread of fire or explosion; auto-shutdown equipment from supplies and energy sources; rescue and medical treatment arrangements and facilities; contact details of third party emergency support and management agencies; well-maintained auto and manual firefighting equipment, and professionally trained staff.

## In conclusion

In the Oil, Gas, and Petrochemical industries, explosive atmospheres are unavoidable. But by identifying potential sources of danger, executing risk assessments, and doing regular maintenance, along with implementing and using the appropriate equipment, the potential for explosions and accidents while working in explosive atmospheres can be minimised. ■

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