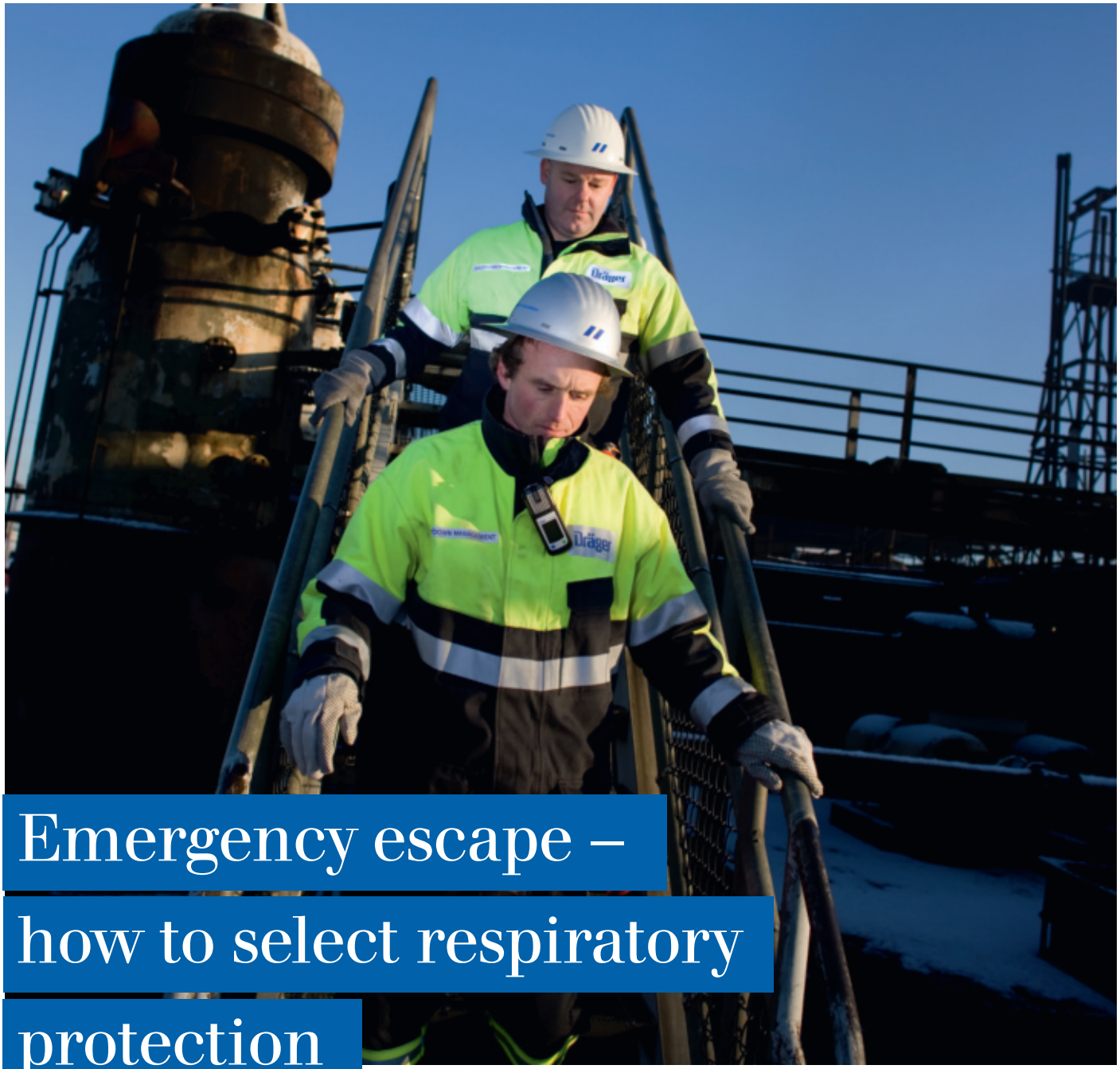

Emergency escape – how to select respiratory protection

Companies in the process industry have the primary safety goal of preventing the release of hazardous substances. Despite all regulations and preventative measures, dangerous situations can still occur. Employees must be protected from exposure to hazardous substances, in case all other safety measures and equipment fail.

HAZMAT risk management

Work on oil and gas exploration sites, refineries or on chemical plants always poses the risk of exposure to hazardous substances, with severe impacts on life and health. Industrial plants are therefore subject to strict safety requirements.

Official bodies such as the Health and Safety Executive (HSE) in the UK and legislative frameworks like the Chemical Agents Directive for the EU and the OSHA 29 CFR 1910.110 Appendix C (Compliance Guidelines and Recommendations for Process Safety Management) for the US are examples of regional standards that have been established to protect workers.

Risk assessments must be carried out and counter measures must be implemented to comply with these regulations. Identified risks should at least be kept as low as reasonably practicable – this is the ALARP Principle. As stated by the HSE: "Reasonably practicable involves weighing a risk against the trouble, time and money needed to control it. Thus, ALARP describes the level to which we expect to see workplace risks controlled."[1]

Personnel working with any hazardous process should be protected by several lines of defence which need to operate in unison as an effective hazard control plan:

Containment: Standard Operating Procedures (SOPs) and engineering controls designed to control all hazardous substances, for instance, approved devices, piping, and process design specifications.

Back-up controls: In case of unexpected failure or damage in first-line hazard controls. Examples are relief valves, scrubbers, flares, surge/overflow tanks or fire-suppression systems.

Emergency response: To protect plant and human assets in the event that containment and back-up measures fail. This can range from a simple evacuation plan to a complex emergency response scenario including escape respirators, escape refuge chambers/safe zones, HAZMAT (or fire) control teams, and search and rescue procedures, depending on the risk and hazard

If these three elements are not operating together, then the likelihood of a disaster or fatality is exponentially higher. The third step is neglected in many cases, due to a false sense of security from having established containment and back-up measures.

Escape respirators are sometimes seen as a redundant compliance requirement of the emergency response plan, as they will not actually prevent an emergency situation from occurring. An organisation with good SOPs and "fail-safe plans" might feel it can reduce the risk of incidents sufficiently, and thus believe that investing in quality escape respirators is not necessary. This is a dangerous assumption, however.

Acquiring the correct type and quantity of escape respirators

This is just as important a part of risk management as the measures to prevent a release of the hazard in the first place. It is the key focus of this paper

1. Process Hazard Analysis (PHA)

The initial step of an emergency response plan is to identify the risks in the workplace – and the consequences that will result if both the containment and back-up measures malfunction.

There are many industrial hazards and risks, but three most common industrial hazards that present a high risk to the human respiratory system are:

Risk of fire

Fire is a risk in virtually every industrial setting, but the highest risk occurs when personnel are exposed to accumulating smoke. Most fire-related deaths are due to carbon monoxide poisoning, not burns. Any industry using high heat processes or flammable materials should be well prepared for fire hazards.

Release of toxins

This includes the release of a chemical, vapour, or gas from a process or vessel at high concentrations. These toxins are typically known because they are identified by the PHA. For example, hydrogen sulphide could be released from an oil drilling rig or chlorine, phosgene or ammonia can be released from a chemical process. Some substances, such as benzene, are harmful even in low concentrations.

Oxygen deficiency

The third most common risk to the human respiratory system is an atmosphere that is likely to change or become dangerous, such as confined spaces where conditions can change quickly. Here, toxins can accumulate or an oxygen deficiency can occur, causing asphyxiation.

2.Degree of severity of emergency situations

This information is important when it comes to selecting the appropriate escape respirator. The degree of severity is classified according to the definitions of High, Specific, and Low established by, for example, NIOSH in its document **"Concept for CBRN Air-Purifying Escape Respirator Standard".**

The equipment needed depends on answers to questions including:

- Is there a release/existence of unknown toxins in the atmosphere?
- Is the atmosphere oxygen-deficient (<19.5 Vol. %[2])?

If the answer is yes to either or both of these two questions, the severity level of the emergency is high. Risks include loss of consciousness and danger to life. Workers would need immediate respiratory assistance during their escape to an oxygen-sufficient space.

- Can the existence/release of known substances in the atmosphere be identified? If so, are the concentrations known?

If the concentrations can be specified or are low, then there should be sufficient oxygen in the work environment.

Note: The exposure limit values and sometimes the unit of measurement for concentrations vary between countries and standards for specified known substances. It is important to measure according to local regulations.

- What is the distance of the escape route/time needed to reach a safe place?

Knowing the length of time (or distance to cover) during which protection with an escape respirator is needed helps determine the type of technology that will best support workers during the risk of substance exposure or lack of oxygen.

Understanding the type and degree of risk will serve as a good foundation for selecting the respirators that are qualified for your applications. However, just because a respirator offers good protection it doesn't mean that it's the best choice for an application. The evaluation of all relevant factors assists in your decision on a cost efficient and safe solution for your task.

3.Identify the right escape respirator for the application

This is a two-step process:

First, narrow down the options to the escape respirators that will provide effective protection. Second, consider the pros and cons of different respirator types to identify the best option.

Escape respirator technologies include

- Filtering Escape Devices, e.g. Air Purifying Respirator (APR) escape hoods
- Independent Air Supplying Respirators, for instance
  - Self-contained emergency escape breathing apparatus (EEBA)
  - Pressure demand supplied air respirator (SAR) w/ escape cylinder
  - Self-contained breathing apparatus (SCBA)
  - Self-contained self rescuer (SCSR)

Some respirators can be used in multiple applications. Some are designed for single use only whereas others are reusable. The following infographic can help in selecting the appropriate protection solutions for potential hazards in emergency and escape scenarios:

How to choose the right emergency escape devices

Life-threatening emergencies can occur at any moment in the oil and gas industry. Proper risk analysis and safety planning should consider every possible emergency scenario. Criteria including the possible concentration of toxic gases, oxygen deficiency and the distance needed to reach a safe place determine which escape device is the best fit for a given purpose. Use this emergency escape chart to help you plan.

WHAT IS THE POTENTIAL ESCAPE SCENARIO?

1
- Direct escape to a safe haven in max. 15 minutes
- Possible concentration of hazards is known
- Sufficient oxygen in ambient air

2
- Direct escape to a safe haven
- Possible concentration of hazards is high or unknown
- Oxygen deficiency is possible

3
- Escape to breathable atmosphere not possible
- Length of escape route requires several escape stages

POSSIBLE HEALTH HAZARDS
Confusion, Reduced Ability to Move, Respiratory Arrest, Sudden Unconsciousness, Injuries, Suffocation

POSSIBLE EMERGENCY ESCAPE SITUATIONS

Short Escape Path	Short Escape Path	Long Escape Path	Act as a Responder	Long Escape Time or Rescue Needed
Smoke inhalation danger Toxic gases inhalation danger Sufficient oxygen 15-minute max. escape path	High or unknown concentration of toxic gases Insufficient oxygen 15-minute max. escape path	High or unknown concentration of toxic gases Insufficient oxygen 30-to-60-minute escape path	High or unknown concentration of toxic gases Insufficient oxygen Need to act as first responder	Escape to breathable atmosphere not possible immediately Rescue operations required or several escape stages required Escape time to rescue chamber or exchange/refill station max. 15 minutes or 60 minutes

WHAT TYPE OF PROTECTION IS NEEDED?

Filter Escape Device: Filters Toxic Gases in the Air

Dräger Protection Solution 1

Filter Escape Device
e.g. Dräger PARAT 4700 and 7500 Filtering Hoods

Self-contained Breathing Device: Compressed Air Escape Equipment & Oxygen Self-rescuer

Dräger Protection Solution 2

Reusable compressed air escape device
e.g. Dräger SAVER

Dräger Protection Solution 3

Single-use, self-contained self-rescue device (SCSR)
e.g. Oxy 6000 Self-rescuer

Dräger Protection Solution 4

Self-contained breathing apparatus (SCBA) approved as working and escape device
e.g. Dräger PAS Colt

Dräger Protection Solution 5

Refuge and Rescue Chambers

Positive Pressure Escape Shelter or Other Customized Solution: Rescue Chambers and Self-sustaining Atmospheres

Reusable compressed air escape device	Single-use SCSR	Reusable compressed air escape device
e.g. Dräger Saver or SCBA PAS Colt, refillable with a plug-in connection to a charge-air system or connection in a rescue chamber	e.g. Oxy 6000 Self-rescuer for max. 60 minutes, exchange at a cache station	e.g. Dräger Saver or SCBA PAS Colt, refillable with a plug-in connection to a charge-air system or connection in a rescue chamber

Training – a key element of emergency response preparation

No one wants an industrial emergency scenario, but health and safety managers and workers on site must be prepared and equipped in case such events occur.

It is important to realise that panic can easily take over in an emergency. Donning and using the escape equipment needs to be automatic. Even a few seconds of exposure to some toxins can be catastrophic.

Regular and frequent training is an essential part of this. Besides being trained thoroughly with simulations and drills on how to respond to emergencies, workers, including contractors, must be trained by authorised training staff on how to properly don and doff an escape respirator quickly. Reasons why the escape respirator is necessary in the first place must also be clearly explained. A healthy respect for the consequences of exposure to a hazard will increase the likelihood that workers will actually use an escape respirator in an emergency.

Workers must also be trained on PPE doffing to avoid potential contact with hazardous substances even after they have left a hazardous environment or emergency situation.

Summary

Spending time to choose and deploy the best respirator for emergency response applications is an essential part of an Emergency Response Plan. It is a safety measure for the third line of defence to ensure workers are protected as well as possible from exposure to hazardous substances. The selection is therefore an important investment for occupational health and safety.

References:

1. https://www.hse.gov.uk/managing/theory/alarpglance.htm
2. Local regulations must be considered