



Thought of everything? –  
Expert tips for working safely  
in confined spaces

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Little space, lack of oxygen, and hazardous substances: Workers in the water treatment industry who enter the confined spaces of ducts, manholes and vaults need to trust that they can also get back out again safely.



## Danger lurks in confined spaces

Clogs, caused by sludge, deposits and objects; damage to the structures and technical systems caused by aggressive substances and garbage. The cleaning, maintenance and repair of canals and shafts is a common task in the wastewater treatment industry, yet it is anything but routine. This is because the necessary entering of these “confined spaces” is one of the most dangerous tasks faced by the workers. But when is a confined space defined as such and thus deemed to be particularly dangerous?

Although the definition of a confined space varies between jurisdictions, which leads to numerous local regulations, it is generally recognized as

- a space that is mostly covered by permanent walls,
- a space with typically little air exchange,
- a space where hazards due to substances, contamination or compounds which exceed the normal danger level can occur.

Many workplaces contain areas that are considered “confined spaces” because while they are not necessarily designed for people, they are large enough for workers to enter and perform certain jobs. A confined space also has limited or restricted means for entry or exit and is not designed for continuous occupancy.

Confined spaces include, but are not limited to, tanks, vessels, silos, storage bins, hoppers, vaults, pits, manholes, tunnels, equipment housings, ductwork, pipelines, etc.<sup>1</sup>

Working within confined spaces not only requires an experienced team and practice, but also the necessary technical equipment. Only then is it possible to measure the rooms to exclude toxic or explosive substances and to initiate any required rescue measures. In many countries, employees who perform confined space entry work have to present appropriate training certificates. This includes the use of gas measurement devices and full knowledge of personal protective equipment.

## 200 confined space entry-related deaths annually around the world

The International Labour Organization (ILO) of the UN and the Occupational Safety and Health Administration (OSHA), USA, estimates that worldwide around 200 people die each year due to accidents in confined spaces in industry, agriculture, and private households.<sup>2</sup>

Approximately two thirds of these accidents were caused by toxic atmospheres, which in 70 percent of the cases had prevailed there even before entering the spaces.

<sup>1</sup> Source: <https://www.osha.gov/SLTC/confinedspaces/>

<sup>2</sup> Source: [http://www.hsimagazine.com/article.php?article\\_id=507](http://www.hsimagazine.com/article.php?article_id=507)



Official national statistics rarely contain all accidents and the precise extent of its consequences (type of injury, severity of the injury, deaths). According to a study performed by the University of Berkeley, California/USA, the situations with the highest accident rates are: Repair and maintenance work (24 percent of recorded cases), followed by cleaning work (12 percent) and inspections (11 percent).<sup>3</sup>

### What are the most common causes of accidents?

The causes of accidents which occur during confined space entry work in the wastewater treatment industry vary: They include a lack of or insufficient assessment of the danger, underestimating the danger, or the use of personnel which doesn't have training for confined space entry work, despite all of the regulations. Other potential causes include underestimating the concentration of gases inside the canal or structure (oxygen content – OX, explosion risk – EX, toxicity – TOX) or unexpected biological processes such as rotting and fermenting processes.

There is a risk of losing consciousness due to a lack of oxygen and suffocating, or absorbing poisonous bacteria or viruses through the skin, mouth, and respiratory systems. Falls can occur as well, due for example to faulty crampons or accidents resulting from increased material wear due to aggressive substances in the work environment. Introducing ignition sources, such as electrical machines which can spark, is dangerous as well.

Entering confined spaces will always pose risks, however, since the conditions inside cannot be predicted with one-hundred percent certainty despite all safety precautions. So before work is performed in confined spaces, it is imperative to always check whether it can be performed just as well from outside the space in order to help prevent accidents.

### Taking correct clearance measurements – but how?

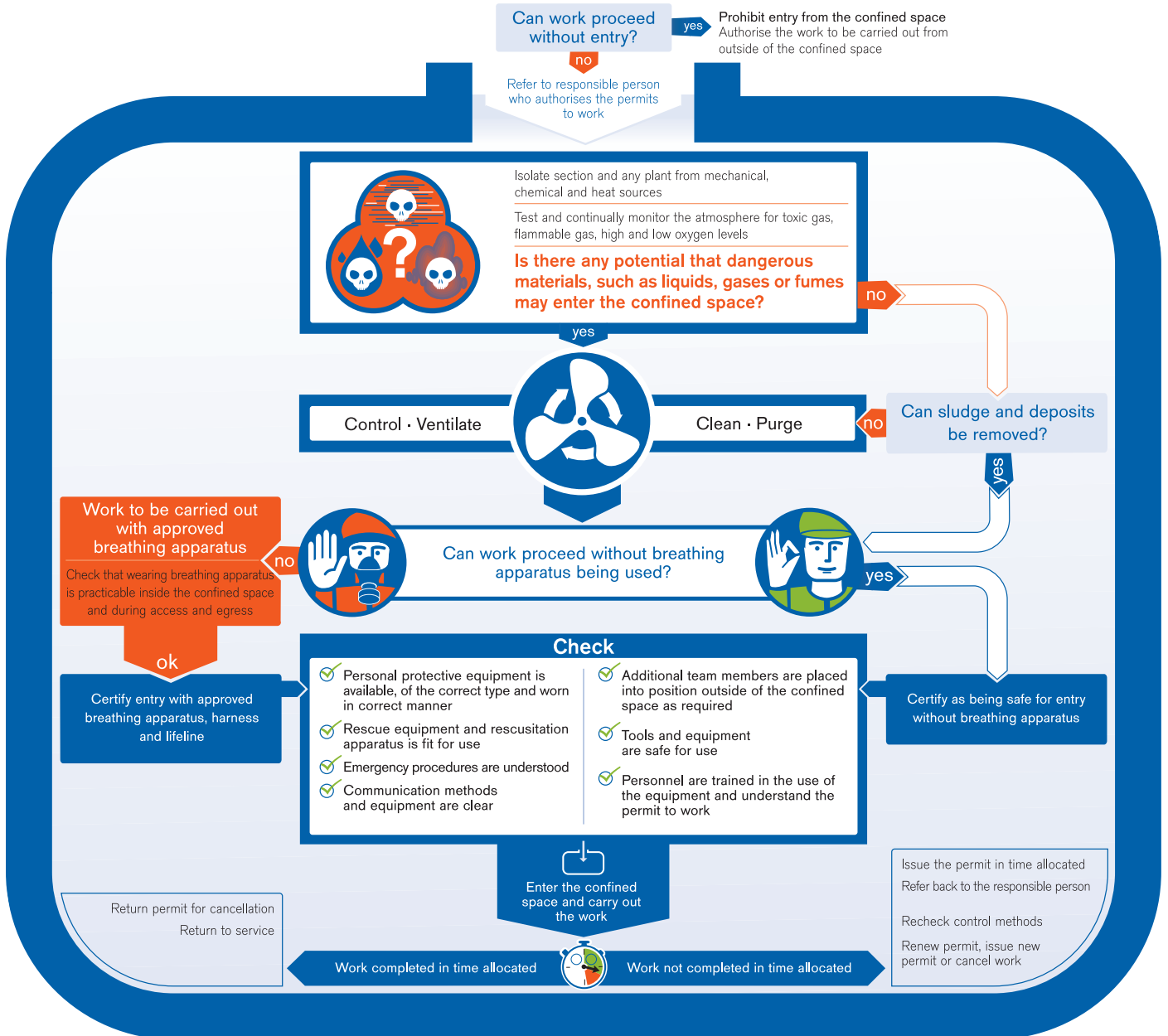
Workers and/or supervisors may have received training on how to behave in confined spaces, but they may have insufficient knowledge of how to use gas measurement and breathing protection equipment. Knowledge, skill and experience are often lacking even when it comes to checking the atmosphere inside a space immediately before the start of work. Errors in judgement often result because the measurement is taken at the wrong location: During entry into a shaft, it is possible for CO<sub>2</sub> or digester gas (a mixture including CH<sub>4</sub>, CO<sub>2</sub>, H<sub>2</sub>S, O<sub>2</sub>, and H<sub>2</sub>) to have formed and settled at different heights. This means that the atmosphere can appear safe when measuring from a safe position, while dangerous gas concentrations are present when the person bends down into the shaft.

So it is important for workers in these areas to always carry a mobile gas measurement device and emergency escape equipment directly on their bodies. In addition to digester gases, the gases which are flammable and/or poisonous at certain concentrations and are typically found in wastewater treatment facilities include CH<sub>4</sub>, CO<sub>2</sub>, H<sub>2</sub>S, O<sub>3</sub>, CL<sub>2</sub>, NH<sub>3</sub> and VOC's. The formation of digester gas can also result in a lack of oxygen. An elevated oxygen concentration, due for example to leaking lines on welding equipment, can lead to the spontaneous combustion of oils and fats and to explosions. To make sure that the workers while working in confined space are protected when gases are present they should use breathing protection.



<sup>3</sup> <http://www.healthresearchforaction.org/sph/occupational-health-and-safety-worker-hazards-confined-spaces>

## Request for work to be carried out in confined space



Accidents can potentially also happen if the wrong sensors are used – an explosion sensor, for example, only detects whether an explosive concentration of a gas is present. Some toxic concentrations are so low that they aren't detected by an explosion sensor, even though a risk of poisoning already exists. This is because an explosion sensor normally only measures the volume percentile in order to detect the risk of an explosion. It doesn't indicate the risk of poisoning which can exist even in the ppm (parts per million) range.

### Why are rescue attempts so risky?

A majority of CSE-related deaths occur during rescue attempts: Colleagues often act on impulse without carefully assessing the situation first. Rescuers often die for the same reason which endangered their colleague in the first place—for example due to losing consciousness as a result of gas, which also affects the rescuer if he undertakes the rescue attempt without adequate breathing protection.<sup>4</sup>

Once an accident has occurred, the confined space entry-related restrictions such as a small access opening, reduced visibility, and often also insufficient equipment hamper the rescue efforts. And every second counts when it comes to rescuing victims in confined spaces, especially in toxic or oxygen-poor atmospheres.<sup>5</sup>

### How can accidents be better avoided?

Training is an important prerequisite for accident prevention in confined space work areas. This training should preferably include both theory and practice and simulate a typical situation at work. The training should start with taking the necessary clearance measurements and putting on PPE (personal protective equipment), followed by entry and exit exercises. The participants also receive training on the correct behaviour under stress and in case of poor visibility inside the space, as well as the evacuation of unconscious and injured persons. Knowledge of the ideal typical confined space entry procedure plan shown here is also helpful in order to thoroughly prepare for a safe deployment.



### A rescue plan must always be prepared

Furthermore, specific emergency plans often don't exist in practice, or the workers are unfamiliar with the plans. Outside rescuers may have insufficient training in confined space rescue, so they have to make time-consuming preparations in light of the high risks associated with these rescue attempts. This can significantly delay the start of rescue measures, with potentially fatal results since saving lives requires a fast response. So developing a “what-if” plan ahead of time is extremely important for this type of work. And just in case, it is necessary to have a trained rescue team at the ready, which can show up with breathing protection and other equipment.

As a rule, the in-house occupational health and safety staff is responsible for discussing and practicing specific rescue scenarios with the team on site before starting the work. Therefore this sort of rescue plan is always specific to the situation. In order to support plant operators and the occupational health and safety staff in this challenging task, the Dräger Academy has added the “Safety and Emergency Management” program to its portfolio.

<sup>4</sup> “[...] 60 percent of deaths in confined spaces result from would-be rescuers entering to help a fallen buddy.” [http://www.huffingtonpost.com/2012/05/24/ca-workplace-fatalities\\_n\\_1542829.html?goback=.gmp\\_2246751.gde\\_2246751\\_member\\_260516403#!](http://www.huffingtonpost.com/2012/05/24/ca-workplace-fatalities_n_1542829.html?goback=.gmp_2246751.gde_2246751_member_260516403#!)

<sup>5</sup> Source: Case-Report of the University of Berkeley/California/USA, page 4, [http://coeh.berkeley.edu/docs/news/08\\_uch\\_confined\\_space\\_rpt.pdf](http://coeh.berkeley.edu/docs/news/08_uch_confined_space_rpt.pdf)

## 5 TIPS FOR CONFINED SPACE ACCIDENT PREVENTION

- 1) Advance check: Have the nationally applicable standards for confined space entry been met?
- 2) Does an alarm and rescue plan exist? Are the measures it describes fully thought out?
- 3) Are the responsibilities clear? Who does what? Is there a supervisor, and does everyone know who this contact for all safety-related questions is?
- 4) Have the employees received training for the particular job? Can they show all necessary certificates? Are the employees trained in the use of PPE, rescue belts, rescue hoist? Is training repeated regularly? Is the training realistic and does it reflect the actual circumstances?
- 5) With regard to clearance gas measurement: Is the necessary work instruction for this available as well? Are appropriately certified employees and the appropriate equipment available?

It should be possible to permanently reduce the number of life-threatening and deadly accidents during work in confined spaces in wastewater treatment facilities. The way to achieve this is by observing the applicable occupational health and safety guidelines, the list of hazards and measures within the plant, individual work instructions, and the necessary training certificates. Because: Whoever goes into these spaces must really have the confidence that they can get back out again safely.



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