10 things you need to know about chemical protection suits
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Dangerous gases, explosive mixtures, confined spaces: Industry requirements

Dangerous substances may escape during normal operations, particularly during shut downs or maintenance, making it necessary to wear a chemical protection suit. Employees often have to remove residues of various materials and protect their skin from direct contact while cleaning. It is also impossible to completely prevent hazardous fluids or gases from escaping.

One typical use involves work carried out in confined spaces and containers (CSE): The danger in pipes and tanks is particularly high due to the limited space for movement, poor ventilation and the substances found there. So the safety protection equipment needs to be meet tougher requirements. Depending on the use, a splash protection suit or gas-tight model with anti-static properties may be needed. The cut and fit of the suit need to take the breathing apparatus solutions into account whenever possible.

This guide shows what needs to be kept in mind when selecting a suitable protective suit. It is not intended to replace individual specialist advice.

Safety in the jungle of hazardous substances.
www.draeger.com/jungle
Typical hazardous materials in the chemical industry

Working in the chemical industry means to work with hazardous material: organic and inorganic substances are processed to get specific chemical products. Some of them are toxic for humans. Inter alia they can lead to skin irritation or chemical burn if direct contact to unprotected skin occurs.
Hydrogen sulphide (H₂S)
- Colourless, flammable gas, heavier than air
- Unpleasant odour at low concentrations but from approximately 200 ppm Human olfactory nerves no longer perceive it
- Deadly from 1,000 ppm
- Causes irritation upon contact with mucous membranes and tissue fluids in the eye, nose, throat or lungs

Hydrofluoric acid (HF)
- Clear fluid
- Strong odour
- Corrosive to skin, mucous membranes and the conjunctiva

Sulphur dioxide (SO₂)
- Poisonous, clear, non-flammable gas with strong odour
- Irritates the eye and the upper respiratory tract (throat irritation, coughing)
- Can cause asthmatic reactions in poorly ventilated areas, danger of suffocation in low lying or closed spaces
Nitrogen dioxide (NO₂)
- Poisonous gas that smells strongly of chlorine
- Causes headaches and dizziness
- Shortness of breath and pulmonary oedema at high concentrations
- Suffocation danger in poorly ventilated, low-ceiling or closed rooms

Ammonia (NH₃)
- Colourless
- Poisonous
- Extreme irritant both as gas or solution, even when highly diluted
- Strong odour
- Liquefies under pressure or at temperatures of less than -33°C
- Can cause chemical burns on eyes and skin

Methanol (CH₃OH)
- Poisonous, colourless liquid
- Highly flammable, explosive when mixed with air
- Heavier than air
- Light irritant upon contact with eyes, skin and the upper respiratory tract
- Suffocation danger in poorly ventilated, low-ceiling or closed rooms
Danger also comes from aromatics such as xylene, toluene and benzene, which can form explosive mixtures.
Hazardous material information with a single click

You can find this and other information in Dräger VOICE:
The hazardous materials database is constantly updated and contains information about more than 1,700 hazardous materials and 11,500 synonyms.

**For each substance VOICE provides**
- Current national and international limits
- Chemical-physical information (e.g. formula, vapour pressure, melting and boiling point)
- Fire protection information (e.g. UEG, OEG, flash point, ignition point) and
- ID numbers (e.g. CAS no., UN no., EC no.).

In addition to material-specific information VOICE contains recommendations for measurement and personal safety technology that you can order from Dräger.
You can find VOICE at www.draeger.com/voice.
10 things you need to know about chemical protection suits
1. What requirements do chemical protection suits need to meet?

Mechanically, chemical protection suits need to be anti-abrasive, crack proof and puncture proof. Chemically they need to be resistant against the penetration of hazardous materials.
The essential difference can be found in mechanical resistance and chemical resistance as protection from the penetration of hazardous materials. Various suit types are available depending on the protection level:

<table>
<thead>
<tr>
<th>Suit type</th>
<th>Property</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type 1</td>
<td>Gas tight</td>
</tr>
<tr>
<td>Type 1a</td>
<td>Gas tight</td>
</tr>
<tr>
<td>Type 1b</td>
<td>Gas tight</td>
</tr>
<tr>
<td>Type 1c</td>
<td>Gas tight</td>
</tr>
<tr>
<td>Type 2</td>
<td>not gas tight</td>
</tr>
<tr>
<td>Type 3</td>
<td>Protects against fluids</td>
</tr>
<tr>
<td>Type 4</td>
<td>Protects against spray</td>
</tr>
<tr>
<td>Type 5</td>
<td>Particle protection</td>
</tr>
<tr>
<td>Type 6</td>
<td>Limited protection against spray</td>
</tr>
</tbody>
</table>

The rule of thumb: The longer a chemical needs to penetrate a material, the more effective the protection offered by the material. So, resistance to permeation is an important test criteria in EN 943-1 and EN 943-2.

To find out how long a material can resist penetration from a certain chemical, test procedures have been defined in DIN-EN ISO 6529. The breakthrough time is clocked, indicating how long it takes for a certain concentration of a chemical to penetrate from outside to inside. The breakthrough time is a core factor in determining the protection offered by a chemical suit.

The chemical protection suits include six different classes based on the protection offered:

<table>
<thead>
<tr>
<th>Suit class</th>
<th>Breakthrough time</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>&gt; 10 min</td>
</tr>
<tr>
<td>2</td>
<td>&gt; 30 min</td>
</tr>
<tr>
<td>3</td>
<td>&gt; 60 min</td>
</tr>
<tr>
<td>4</td>
<td>&gt; 120 min</td>
</tr>
<tr>
<td>5</td>
<td>&gt; 240 min</td>
</tr>
<tr>
<td>6</td>
<td>&gt; 480 min</td>
</tr>
</tbody>
</table>
3. 5 steps to finding the right protective suit

Every task presents various challenges. The challenges can be determined in five steps.

**Step 1: What work needs to be performed?**
Chemical facilities include numerous applications and tasks where employees need to wear chemical protection suits. Typical examples include pre-entry measurements, the transfer of substances (filling, transferring or emptying containers), service and maintenance work, tank and other cleaning work as well as responding to emergencies. The type and duration of the application determine the necessary protection.

If the hazardous material is very cold, such as liquefied gas, the suit material must not become brittle or break when exposed to the cold.

**Step 2: What are the risks associated with the hazardous materials?**
Hazardous materials may take many forms, which then determines the risk: Whether a material is in a gaseous or liquid state is decisive as to whether splash protection is sufficient or gas protection is needed.

Should the hazardous material be flammable at room temperature, the protective suit needs to be flame resistant.

If there is a danger of explosion from the hazardous material, the suit needs to have the appropriate electro-static properties.

Protective suits are available in various materials. They are characterised by their various protection levels against hazardous materials. In this case the best selection needs to be made to counter the potential danger. The materials have various breakthrough times depending on the hazardous material. The Dräger VOICE hazardous materials database can help you select the right protective outfit (www.draeger.com/voice). Should the hazardous material or the relevant concentration not be known, you should always assume the worst and select the next highest protection level.
Step 3: Where will the work be performed?
For mechanical work or jobs in unknown environments it is often necessary to manoeuvre between sharp surfaces. The protective suit needs to have robust mechanical properties, such as a reusable model for example.

Should damage be unlikely, a protective suit with limited re-use may also be used. A tight fitting protective suit with an external compressed air breathing apparatus is best for working in restricted spaces, such as tanks with manholes. This means that the breathing apparatus can be easily placed to one side making it easy to move through the restricted space.

Step 4: Is a breathing apparatus needed?
Should no breathing apparatus be required, simple overalls or other protective clothing should be sufficient to protect against chemical damage.

If you have to work with a filter apparatus, it is best to take a suit with a full mask or facial mask.

Step 5: How can hazardous materials contamination be removed? (Decontamination)
Should the hazardous material permanently settle on the surface of the suit, a protective suit where the breathing apparatus is worn on the inside will be needed. You are then protected from contamination. If the suit is so contaminated that it probably cannot be cleaned, then a disposable suit should be used.
A practical example illustrates what it is actually like at a chemical plant

**Step 1: What work needs to be performed?**
The tanks need to be cleaned. A two-man team will perform the work. One person does the cleaning while the second monitors the work and provides support as needed. The tanks can be entered through a manhole. The deployment will not take any longer than 90 minutes. Measurements are taken by gas analysts to determine the concentration of certain hazardous materials.

**Step 2: What are the risks associated with the hazardous materials?**
The tanks contain slag residue. Gas Contamination is existent. The material is not flammable. There is no acute danger of explosion. The hazardous material concentrations still need to be constantly monitored by the second person during the deployment. The special requirements for working in containers and confined spaces need to be complied with.
**Step 3: Where will the work be performed?**

Entry is through a restricted opening. The container is also not very large. The risk of mechanical damage caused by sharp objects is seen as relatively low. Abrasion or pulling on the material may occur but would not present a real and immediate danger to the wearer.

**Step 4: Is a breathing apparatus needed?**

A self-contained breathing apparatus is needed as the ambient atmospheric composition may deteriorate and the oxygen concentration may fall below the permitted minimum (in many countries 17% by volume). A filtering breathing apparatus is not allowed in this case.

**Step 5: How can contamination from the hazardous materials be removed?**

The cleaning work will most likely produce severe contamination of the suit.

**What are the final requirements?**

A type 1 suit is needed. The suit material needs to have medium mechanical robustness as the risk in our example can be seen as limited. A precise description of how well a suit protects against various types of mechanical damage can be found in the instructions for the suit.

Due to the space, the suit needs to be as tight fitting as possible. A compressed air breathing apparatus is needed as it is light and self-contained.

As the cleaning of the chemical protection suit cannot be performed independently at the plant, it may be more economical to use a disposable protective suit and simply dispose of it afterwards.
4. What standards apply to chemical protection suits?

Chemical protection suits need to meet varying requirements that differ according to their protection level. They are set in the following European standards:

<table>
<thead>
<tr>
<th>Standard</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>EN 943-1: Type 1a, 1b, 1c and 2</td>
<td>Protective clothing against liquid and gaseous chemicals, including liquid aerosols and solid particles – Part 1: Performance requirements for ventilated and non-ventilated ‘gas-tight’ (type 1) and ‘non-gas-tight’ (type 2) chemical protection suits.</td>
</tr>
<tr>
<td>EN 943-2: Type 1a ET and type 1b ET (for emergency teams)</td>
<td>Protective clothing against liquid and gaseous chemicals, including liquid aerosols and solid particles – Part 2: performance requirements for gas-tight (type 1) chemical protective suits for emergency teams (ET)</td>
</tr>
<tr>
<td>EN 14605: Type 3 and 4</td>
<td>Protective clothing against liquid chemicals – performance requirements for clothing with liquid-tight (type 3) or spray-tight (type 4) connections, including items providing protection to parts of the body only (types PB [3] and PB [4])</td>
</tr>
<tr>
<td>EN ISO 13 982-1:2005</td>
<td>Protective clothing for use against solid particulates – Part 1: performance requirements for chemical protective clothing providing protection to the full body against airborne solid particulates (type 5 clothing)</td>
</tr>
<tr>
<td>EN 13 034:2005: Type 6</td>
<td>Protective clothing against liquid chemicals – performance requirements for chemical protective clothing offering limited protective performance against liquid chemicals (type 6 and type PB [6] equipment)</td>
</tr>
</tbody>
</table>
Test methods


EN 1149-1  |  Protective clothing – electrostatic properties

American standards:  

ASTM F739: 2012  |  American society testing & materials test method for the permeation of liquids and gases through protective clothing materials under conditions of continuous contact.

International chemical protection suit requirements  

EN ISO 16602:2007  |  Protective clothing for protection against chemicals – classification, labelling and performance requirements
5. What other quality criteria are there?

In addition to the materials, the quality of the work is decisive for chemical protection suits, particularly in places where the hazardous material may penetrate such as seams, weld seams and zippers. Another quality aspect is fit: The more precise the size and fit of a suit and the accessories (shoes, gloves, etc.) are configured to the relevant requirements, the more comfortable the user.

Some activities, such as working with pressurised cleaners will leave traces of the hazardous materials on the front of the worker. A model with a closed front and a zipper on the rear protects the wearer from coming into contact with the hazardous materials when removing the suit. In addition, having a partner available when putting on or taking off a suit provides additional monitoring to assure the suit is handled properly.
6. How can I be sure that the chemical protection suit will guard against a specific hazardous material?

Prior to use, always check to make sure that the selected suit provides sufficient resistance to the hazardous material in question. The manufacturer will provide a chemical resistance list. The list includes the test requirements used to create the chemical resistance list, which are far tougher than conditions found in practice. The test concentrations of hazardous materials in the tests are far higher than those found in practice. The hazardous material data base Dräger VOICE (www.draeger.com/voice) provides detailed information about chemical resistance.

The icons have the following meaning:

- Clothing for protection against radioactive contamination.
- Clothing for protection against infectious agents.
- Protection against build up of electrostatic according to EN 1149-1:1995
- Clothing for protection against chemicals.
- Caution! Strictly follow the Instructions for Use.
- Do not wash!
- Do not bleach!
- Do not iron!
- Do not tumble dry!
- Do not dry clean!
- Avoid naked flames!
7. What materials are gas tight (type 1)?

**D-MEX™®**
- Maximum protection under the toughest conditions
- Re-usable
- Very robust mechanically while remaining light and flexible
- High breakthrough periods for industrial chemicals, munitions etc.
- Does not become brittle when in contact with very cold substances
- Flame retardant and self-extinguishing even with flashes

**Symex**
- Good protection against acids, lyes and oils
- Re-usable
- Light material
- High abrasion resistance and flexibility

**Umex**
- Specifically suitable for work with chlorine and ammonia
- Re-usable
- Light and soft material
- Does not become brittle when in contact with very cold substances

*D-MEX™® is a registered trademark of Dräger.*
**Zytron® 500**
- High protection against various hazardous materials
- Disposable material for work with low mechanical loads
- Very comfortable, flexible and very light
- Long breakthrough periods for industrial chemicals and munitions

**Tychem® F**
- Excellent for handling fluids and solids
- Disposable material for work with low mechanical loads
- Good protection from organic and highly concentrated inorganic hazardous materials
- Particularly low weight

**Tychem® C**
- Particularly good for uses involving infectious agents and acids
- Disposable material for work with low mechanical loads
- Particularly low weight

*Zytron® is a registered trademark of Kappler. Tychem® is a registered trademark of DuPont. Tyvek® is a registered trademark of DuPont.*
8. What materials are impervious to fluids (type 3)?

**PVC**

- Good protection against low concentrations of acids and lyes
- Re-usable
- High tear resistance and flexibility
- Fluid resistant even with strong fluid jets (e.g. high pressure cleaner)
9. What materials are impervious to spray (type 4)?

**Flexothane®**
- Good protection against crude oil, machine oil, petroleum, dyes and dusts
- Re-usable
- Light and flexible
- Water vapour permeable

*Flexothane (Registerzeichen) is a registered Trademark of Sioen.*
10. What accessories do I need for a chemical protection suit?

**Protective boots and gloves**
Should they not be integrated in the protective suit, keep the following in mind when making a selection:
- Suitability of protective class for handling the chemicals
- Ease of putting on and removing
Cotton gloves are not recommended for hygienic reasons. Outer gloves protect the actual protective gloves from mechanical damage.

**Cooling**
Working in a protective suit is tough manual labour. The temperature and humidity in the suit increase rapidly. This increases the risk of cardiovascular failure. Some suits have ventilation systems in order to keep the temperature in the suit down: A flow of fresh air from an external air supply is produced through high pressure in the suit. An over-pressure valve pushes the moist, warm air out of the suit. The accelerated evaporation keeps the wearer comfortably cool.

Another means of regulating the climate in the suit includes re-usable cooling elements placed in a comfort vest. Depending on the level of physical exertion they lower the skin temperature by 3 to 4°C for up to four hours and are suitable for longer jobs.
All the information was compiled to the best of our knowledge. However, no liability can be accepted for the information. The information and data are subject to technical changes and may not always be up to date.

The user instructions included in the products only apply to the use of Dräger products. They need to be read closely and complied with prior to use of the product.

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