A Touch of Haute Couture

Making **CHEMICAL PROTECTIVE SUITS** involves a kind of high-end tailoring, or, in French, ‘haute couture’. These suits allow you to work in places where hazardous gases, chemicals, and bacteria are causing trouble.

If you see someone coming along in this suit, you should run in the other direction,” advises Marco Lange, pointing at a chemical protective suit (CPS) which has been pumped up for testing. Lange is a team coordinator at Dräger and responsible for the production of several thousand of these high-tech garments yearly. The suits enable people to work in adverse atmospheres. Wherever the suits are, the danger of gas, chemicals, and bacteria will not be far away – which is why he recommends fleeing in the opposite direction if you are not involved. But if you happen to be hurrying towards a hazard wearing one of these suits, then you will be protected by the latest technology. This can be seen most clearly by following the production of the top models, CPS 7800 and 7900, step by step.

**Five protective layers**

The two suits differ in one key point: with the CPS 7800, a SCBA is worn outside the chemical protective suit, whereas it is worn inside the CPS 7900. The latter is immediately recognizable by its large visor, whereas the 7800 is closed off to the outside world by a breathing mask or face cuff. Both suits are made of the same material, which was developed with Dräger’s help and is now manufactured exclusively for the company.

This material, known as *D-mex*, is symmetrically built up around a tear-resistant fabric, encased on both sides by a chemical-resistant film. The material is then sealed off outside and inside by an elastomer layer which is self-extinguishing and highly flame-retardant, and which also offers protection against cuts and punctures. It may sound simple at first, but it is not. “The material has to be lightweight, yet strong,” says Lange, “and it has to feel good and accommodate all of its wearer’s movements without difficulty.” The suit – which in its lightest form weighs 3,500 grams – also stands up to the cold produced by liquid gases, which can be as low as -80° Celsius. The material is supplied on rolls in various colors, and it feels very similar to outdoor clothing fabric. Chemical protective suits are made only to order. The variations are too diverse, and the possible combinations produced by customized features are immense. “There are more than a million possible combinations for the CPS 7900 alone,” interjects Lange. That is why a chemical protective suit’s life begins with an order, which in turn breaks down into a detailed list of >

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**Outer shield**

Dräger develops, manufactures, and distributes a series of chemical protective suits in various protective categories. The most advanced of them at the moment are the CPS 7800 and 7900. These are reusable and offer protection against industrial chemicals, chemical warfare agents, infectious agents, and radioactive particles, and are suitable for work involving liquid gases (at down to -80° Celsius). With the right accessories they can be adapted to different applications, and they are carefully tailored as well. An ergonomic, body-hugging cut gives more freedom of movement, which can reduce stress and accidents. The lifespan for such a suit is up to 15 years.
If air cannot escape, then it cannot get in: every protective suit is tested for leaks under pressure.
If all you know is your sewing machine at home, then you’re in for a surprise here

> components required for its production, ensuring that further on down the line they are not missing a loop needed for the compressed air cylinder’s manometer, or a D-Connect, which is a shackle for hanging measuring devices onto, which can also be used for crash rescue. Cutting the blanks for the production of such clothing is a considerable challenge. “We position them,” says Lange, pointing to a pattern sheet on the CAD screen, “so that, from size S to XXL, we lose as little material as possible.”

**Sewing, welding, bonding**

Cutting is done automatically using a standing blade which needs replacing after every 1,000 suits. The blanks are marked on the inside for things like loops that need attaching. Then they are printed onto the material. “We use a thermotransfer process to print not only our company logo, but also customer requirements – such as names and numbers – using a very thin and flexible, wear-resistant film.” This allows the people wearing the suits to recognize each other during missions, and also to find their own suits again when they have to put them back on. “These suits need to be professionally cleaned and disinfected after every use, which is done at between 30° and 60° Celsius using a special detergent in an industrial washing machine,” says Lange.

All of the work-stations that follow gradually assemble the blanks to create a gas-proof suit. The main techniques used for this are sewing, welding, and bonding. Each of these technologies has its various secrets which affect the reliability, longevity, and handling of the product. To make a cut piece into an arm, you quilt the sides using a double-stitched seam. Because the material is extremely resilient to physical damage, the industrial sewing machines have their work cut out for them. “If you sew at home and think that our machines do the same thing, then you should think again,” says Marco Lange.

Welding the seams so that they are gas-proof requires a complex combination of technology and skill. The welding tape is brought up against the seam at a certain angle, and welded on by means of a stream of air at over 300° Celsius coming out of a broad nozzle. Bonding is done using a two-component adhesive which is applied beneath special extraction hoods. “Once mixed, this glue can only be used for quarter of an hour.” That is why its components, which are not exactly cheap, are weighed to the nearest gram for work which is about to be done over the next few minutes, so that losses are kept to a minimum. A rolling-on machine applies a constant pressure to ensure that the bonded areas connect properly. By now the suit has begun to look like a suit, yet there are still challenges awaiting the production team on the ‘home straight’, such as fitting the gloves, boots, and visors, all of which also have to be connected to the suit in a gas-proof way. It is all a little reminiscent of changing a bicycle tire, which, once the inner tube has been repaired, has to be eased back into the wheel.

**Don’t slam the door!**

Before the suit can be tested at the end, it has to spend a night in a ‘tempering room’ at around 50° Celsius. “This artificial aging process hardens the adhesive and degases the material,” says team coordinator Lange. After that comes the final and decisive step: is the suit airtight? This they test inversely so to speak, by pumping it up to a pressure of 17 millibar to see if it leaks. “The measuring instruments are so sensitive that they will register it even if you slam a door,” Lange has noticed. When you get into the suit, together with your self-contained breathing apparatus and protective mask, you become the master of a different world. “People normally work in these suits for 20 to 30 minutes,” says Lange’s voice, coming in from the outside. Careful tailoring to the body’s shape, which is one of the things that has been improved upon, pays off when it comes to walking and running, lifting things, and squatting down. The fact that the material is now thinner – yet even more resilient – also makes the suit lighter and makes movement easier. Yet working in a chemical protective suit is still stressful – but it is reassuring to know that its wearer is enjoying the upmost protection.
The zippers have to be gas tight as well – and their metal must not produce sparks.

Fitting in the visors is one of the last stages in production.

Team coordinator Marco Lange; several thousand CPS each year for the global market.

Looks simple but requires a lot of experience: welding the seams.