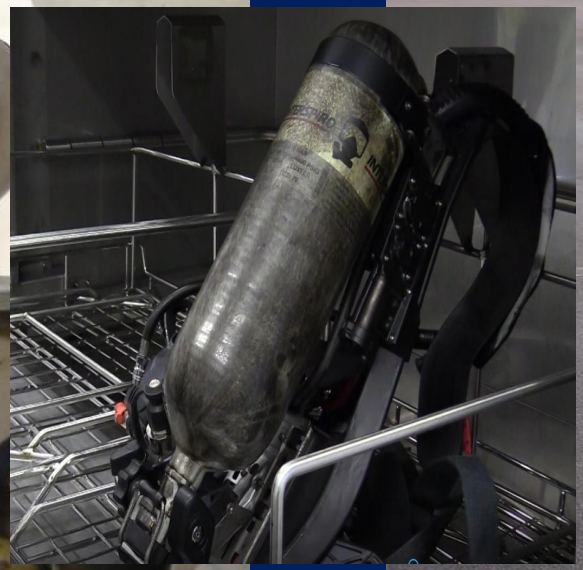
IS IT POSSIBLE TO DECONTAMINATE?



Lejon Kemi AB

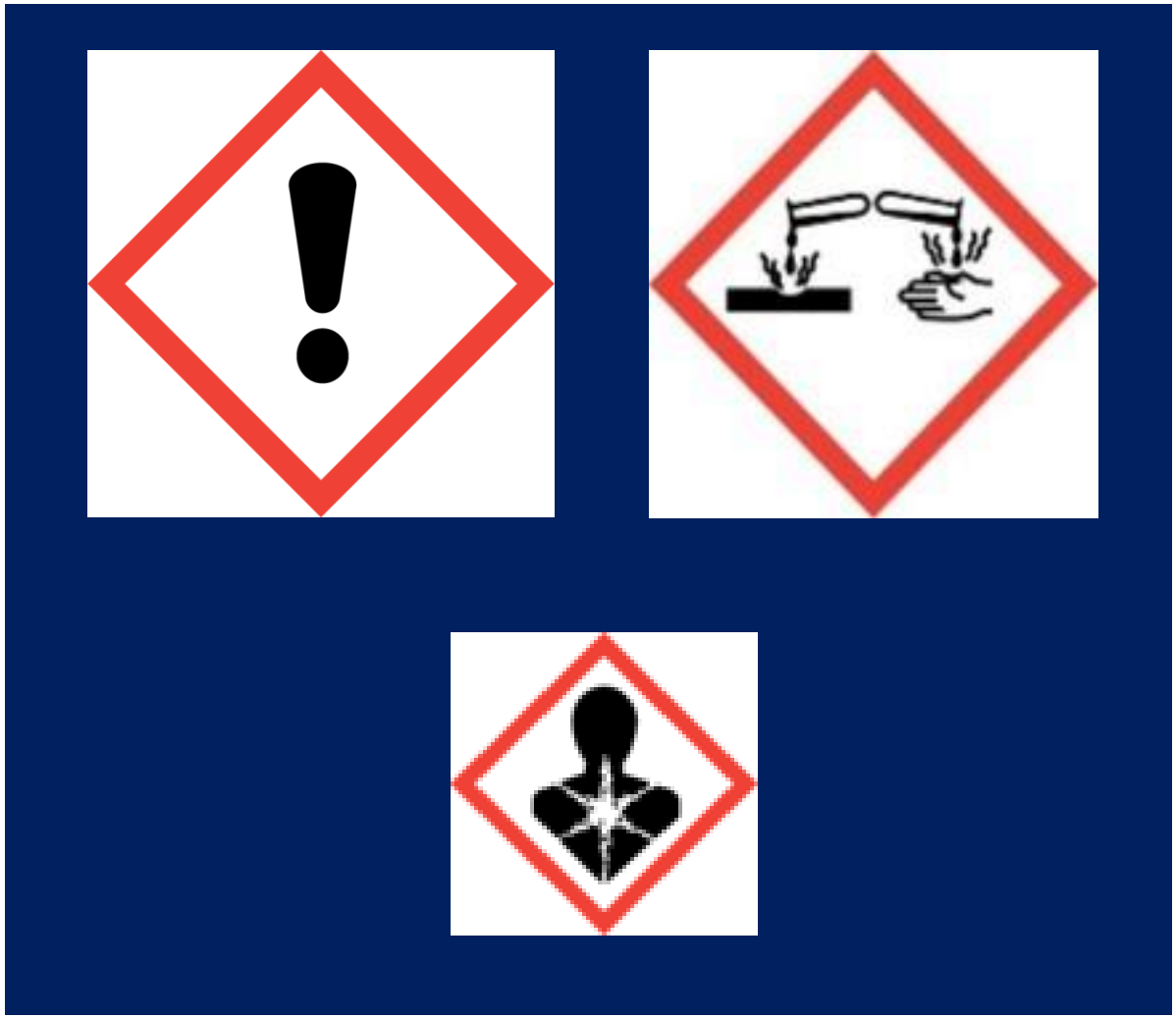
- Swedish company founded in 2008
- Specializes in surface and cleaning chemistry
- 38 years of experience in product development and manufacturing of chem.-technical cleaning products
- Works within a network of partners who manufacture, market and sell products developed by Lejon Kemi
- Over 10 years of experience in the development of cleaning products and methods of cleaning various types of equipment and fire protection clothing used by fire departments
- Lejon Kemi collaborates with leading manufacturers of breathing apparatus, PPE-dishwashers and washing machines, hose washing machines, fire protection clothing and with external analysis laboratories, chemists, toxicologists and rescue services
- Manufacturing in Piteå, Sweden, in a factory with good capacity and quality assurance systems that guarantee high and consistent quality and full traceability throughout the production chain
- Warehouse in Hallstavik, 100 km north of Stockholm
- Retailers in Sweden, Norway, Denmark, Iceland, Germany, Slovenia and the Netherlands. More than 400 fire brigades as customers in the Nordic region.

www.lejonkemi.se
E-mail: info@lejonkem i.se

Soot and gases from fires is a health hazard

Soot and gases from fires can contain 100s of harmful substances, depending on what is burning and under which conditions the combustion takes place.

- Harmful
- Very toxic
- Toxic
- Cancerous
- Mutagenic
- Reproduction disruptors
- Endocrine disruptors
- Corrosive
- Allergenic



Some references

- **Bengtsson and Antonsson (1993).** Firefighter's work environment – Chemical health risks and proposed measures. SRV.
- **Karlsson, B., Quintiere, J.G. (2000**). Enclosure of fire dynamics. CRC Press inc.
- **LeMasters et al. (2006).** Cancer risk among firefighters: A review and meta-analysis of 32 studies. Journal of occupational and environmental medicine. JOM200238.
- **Lidman, U. (2008).** Toxicology: The Study of Poisons. Studentlitteratur AB.
- **Rodriks, J. V. (1992).** Understanding the toxicity and human health risks of chemicals in our environment. Cambridge university press.
- **Straif et al. (2007).** Carcinogenicity of shift-work, painting and firefighting. The Lancet oncology vol. 8 No 12.
- **Svensson, S., Månsson, B. (2009).** Examination of the breathing environment for instructors at the Rescue Department's schools. Swedish Civil Contingencies Agency (MSB).

Exposure to harmful and carcinogenic substances is a problem in the working environment

- **Up to 30% more fire brigade personnel are affected by cancer than the general population due to exposure to harmful and carcinogenic substances in the course of their work.**

- **Fire brigades (emergency services) are therefore investing heavily in reducing exposure through new and remodeled fire stations, new work routines and in PPE dishwashers and washing machines for cleaning (de-contamination) of equipment and fire protection clothing**

- **Decontamination of equipment and protective clothing from soot, as well as oil and grease-soluble contaminants like polycyclic aromatic hydrocarbones (PAH), requires specially developed cleaning agents and methods to be able to provide good cleaning results without damaging the materials.**

- **There are few or no complete, turn key solutions on the market for emergency services from *one* cleaning supplier that include PPE-dishwashers, washing machines, cleaning products, dosing pumps, machine installations, dishwashing and washing programs and the required information and training.**

- **Fire brigades often lack detailed knowledge of de-contamination and are often referred to different manufacturers of PPE dishwashers and washing machines, different dosing pump suppliers, different manufacturers of cleaning products, different service companies that can perform installations, etc.**

- **This lack of knowledge and comprehensive solutions make it difficult and time-consuming for fire brigades to put in place well-functioning, effective and safe solutions for cleaning and decontamination.**

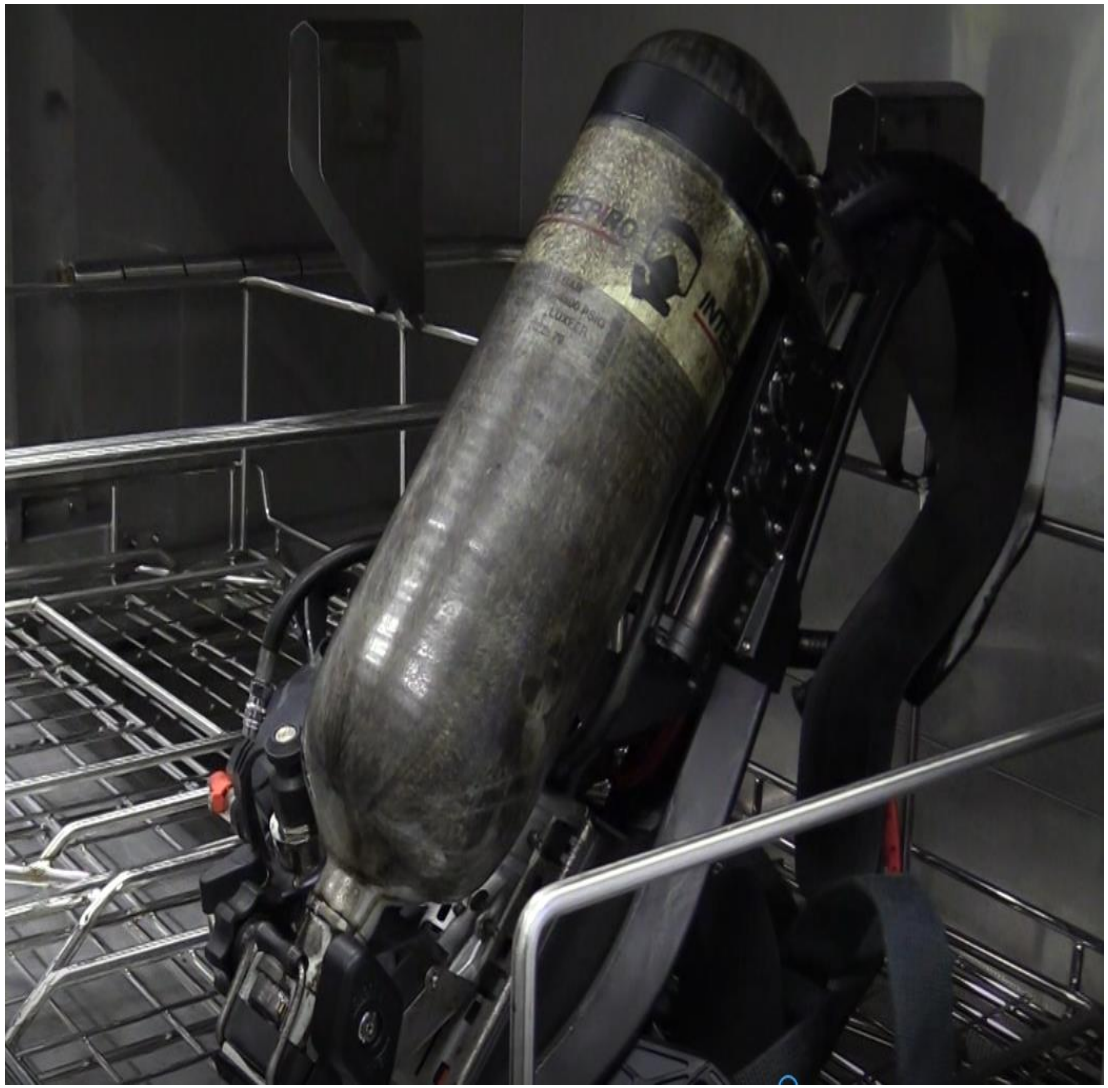
Sooty contaminated parts of breathing apparatus before washing in a PPE-dishwasher

Picture 1. Dirty carrying rack in dishwasher.

Picture 2. Dirty back plate for carrying rack

Sooty contaminated parts of breathing apparatus before washing in PPE-dishwasher

Picture 3. Dirty part of the carrier rack.



Picture 4. Sooty, contaminated breathing apparatus in a PPE-dishwasher

Contaminants from fires are difficult to wash off without damaging materials

Soot, oil and fat-soluble contaminants such as PAHs and dioxins bind to certain plastics, rubbers, painted and varnished surfaces and certain types of textiles and are difficult to wash off without damaging the materials in the equipment and the protective clothing.

- **Solvents – can damage plastics, rubbers, painted and varnished surfaces**
- **Strong alkalis – can cause corrosive damage and especially on metals**
- **Temperatures above 60° C – can cause material damage, especially in the longer term**
- **Excessive flushing pressure (high pressure flushing) – can cause material damage**
- **Only low-foam cleaning substances – can be used in PPE dishwashers**
- **Consideration for the working environment and the external environment – leads to limits when choosing detergents and cleaning methods**

PPE-dishwashers are converted commercial kitchen dishwashers

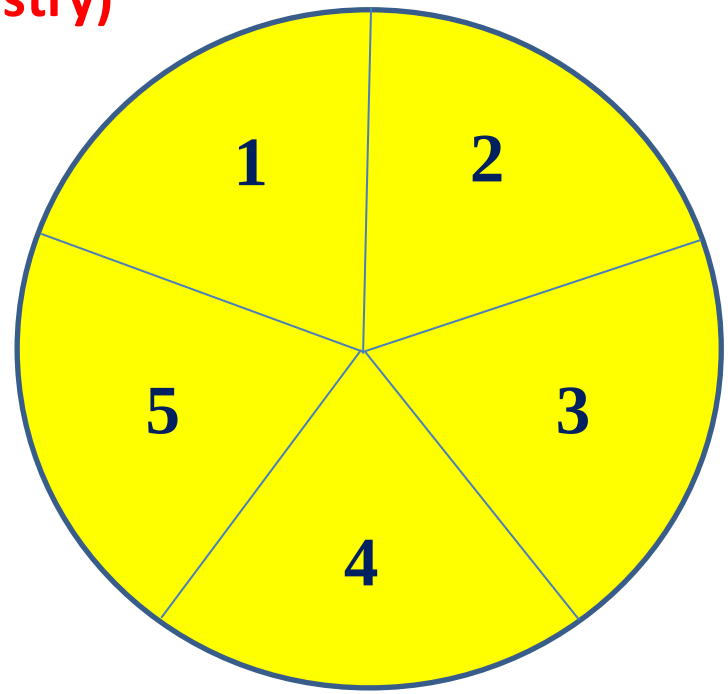
Picture 5. Breathing apparatus is pretreated before washing in PPE-dishwasher of “barrier model” from Wexiödisk AB

Picture 6. Carrier racks for breathing apparatus after pretreatment in a PPE-dishwasher from Electrolux Professional AB

Differences from commercial kitchen dishwashers include the dish space racks, dosing pumps and dishwashing programs and on some models possibility to connect breathing apparatus to compressed air.

The cleaning result is mainly influenced by five parameters

1. Type and content of cleaning agent (chemistry)
2. Washing temperature
3. Washing time
4. Mechanical treatment
5. Rinsing



Factors affecting the cleaning result in PPE dishwashers and washing machines

1. Selection of dishwashing and washing detergents (chemistry)
2. Dosage of dishwashing and washing detergents
3. Water temperature at washing and rinsing
4. Cleaning time
5. Mechanical treatment (e.g. high pressure flushing or rotation of the drum)
6. Rinsing
7. PPE-dishwasher – the location of the items in the dishwasher in relation to the flush nozzles
8. Machine hygiene (especially important in PPE-dishwashers)

Poor machine hygiene as well as foam reduce the cleaning effect in PPE-dishwashers

Picture 7. Sooty, contaminated dishwater in a PPE-dishwasher

Picture 8. Residues after foaming detergents can cause excessive foaming inside a PPE-dishwasher

Detergents – always a compromise between different requirements

- Effective cleaning
- Safe to use on the materials to be cleaned
- Safe at all stages, from a work environmental point of view
- Environmentally friendly (rapidly biodegradable, acceptable low ecotoxicity, non bio-accumulative)
- Acceptable usage cost
- Stability when stored
- Easy to use
- Consistency, color, smell
- Security of supply (availability of raw materials, production, reasonable delivery times, etc.)
- Price

What to consider when choosing a cleaning agent and cleaning method

- Type of material (type of laundry) to be cleaned
- Type of dirt (contaminates)
- Amount of dirt that needs to be washed off
- Desired cleaning results (what is acceptably cleaning level? Below limit values for substances harmful to health?)
- Washing facilities (premises, access to electricity, water, sewage, staff, equipment and time
- Requirements regarding work environment and external environment
- Costs (staff, working hours, water, energy, cleaning products, machines etc.)
- Delivery reliability
- Quality
- Service
- Availability
- Regulatory requirements
- Permission from authorities, etc.

Cleaning results in PPE-dishwashers with cleaners and programs developed by Lejon Kemi

Picture 9. Breathing apparatus after pretreatment with concentrated FFE Cleaner, which was sprayed on and allowed to act for about 3 minutes before cleaning in a PPE-dishwasher for 20 minutes at 60° C and with 1 % FFE Cleaner.

.

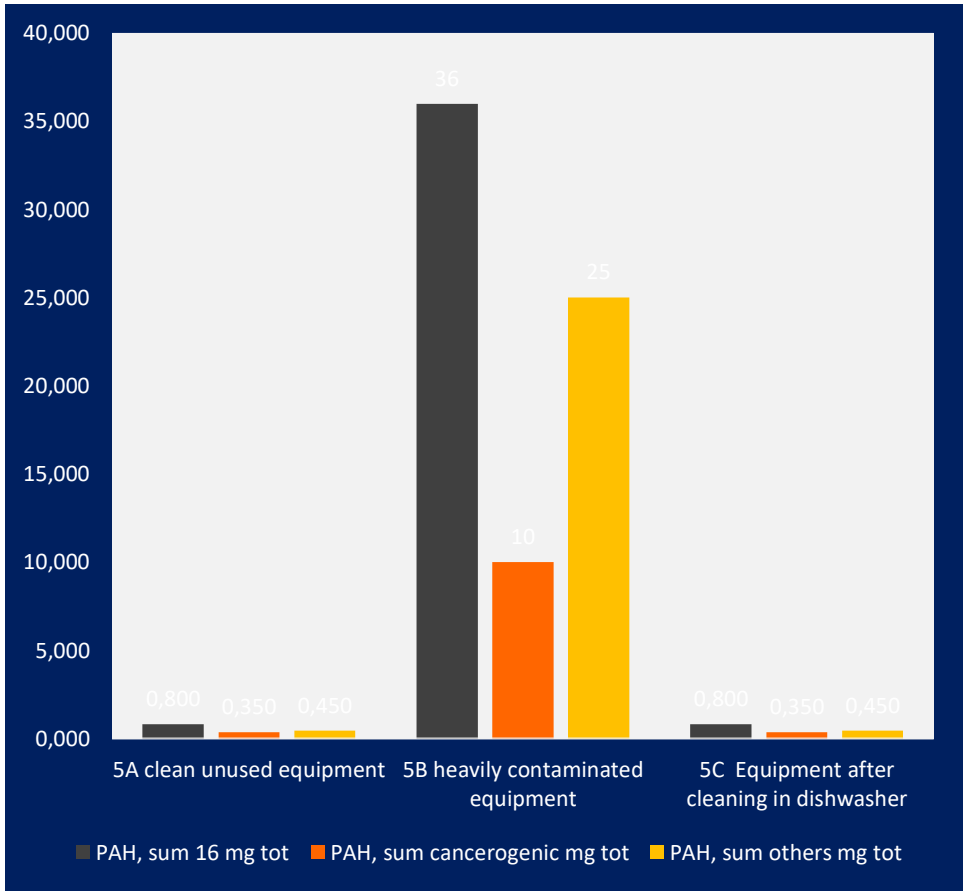


Diagram 1. Levels of PAHs on unused breathing apparatus, on contaminated breathing apparatus and on a breathing apparatus that has been pretreated and then washed in PPE-dishwasher at 60° C for 20 minutes, with 1% FFE Cleaner.

Cleaning results on carrier racks with cleaners and programs developed by Lejon Kemi

Figure 10. Breathing apparatus after pretreatment with concentrated FFE Cleaner, which was sprayed on and allowed to act for about 3 minutes before cleaning in PPE-dishwasher for 20 minutes at 60° C, with 1 % FFE Cleaner.

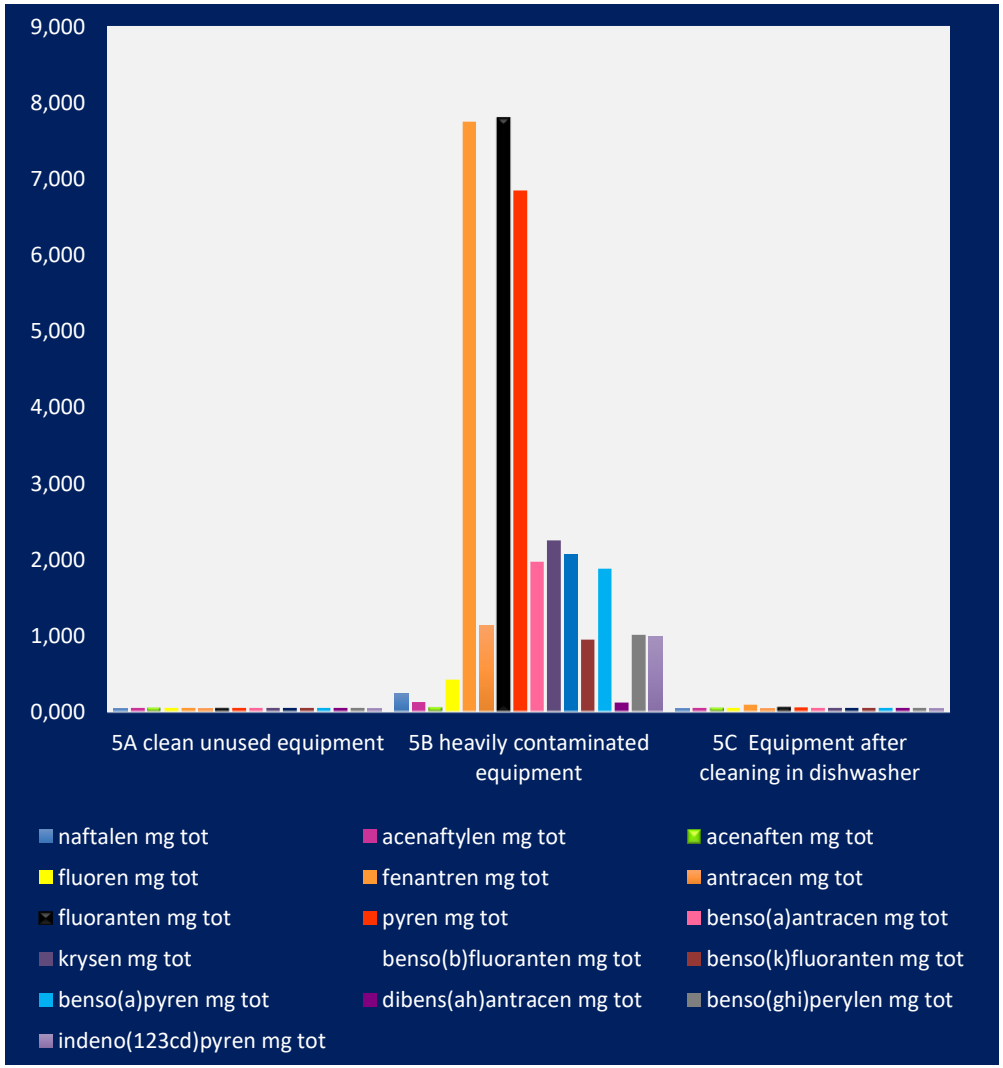


Diagram 2. Levels of PAHs on unused breathing apparatus, on FFE contaminated breathing apparatus and on a breathing apparatus that has been pretreated and in PPE dishwasher at 60° C for 20 minutes, with 1% FFE Cleaner.

Washing respiratory masks in washing machines

- Effective
- Safe
- Easy
- Practical
- Labour-saving
- Timesaving
- Gentle

Picture 11 and 12. Examples of barrier washing machines that can be programmed with the Lejon Kemi washing program for breathing masks with or without disinfection steps.

Machine wash with detergents, microfiber bags and mask-wash program developed by Lejon Kemi

Picture 13. Microfiber laundry bag

Picture 14. Laundry bag and breathing mask

Picture 15. Laundry bag and breathing mask

Picture 16. Breathing mask inside a laundry bag from Lejon Kemi

- Protective laundry bag made from micro-fiber that contributes to cleaning
- Detergent specially developed for washing breathing masks
- Washing program developed for washing breathing masks, with or without disinfection steps
- Washing time about 1 hour 15 minutes
- Washing temperature 50° C
- 4 - 5 rinses in plenty of water
- Drying in drying cabinet at 50° – 55°C

Results after washing sooty contaminated breathing masks in washing machine

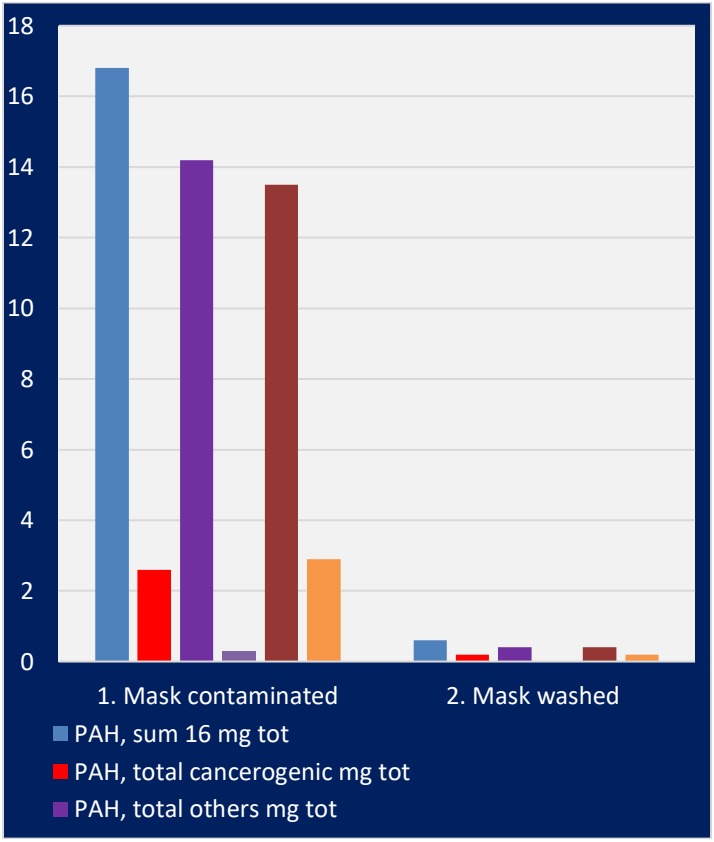
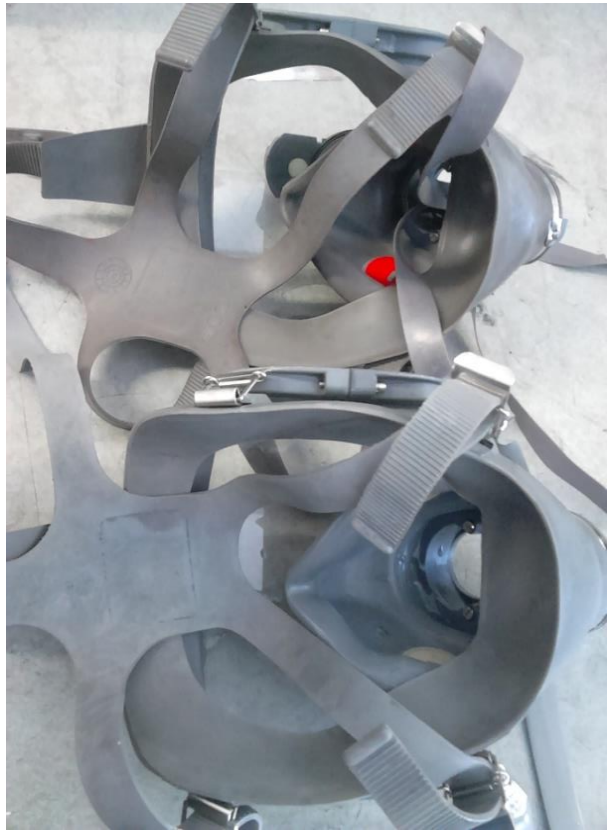


Figure 3. Analysis of PAHs in mg/dm^2 on contaminated Breathing masks and washed breathing masks.

Picture 17. Sooty breathing masks before washing.



Picture 18. Breathing masks from picture No 17 after washing.

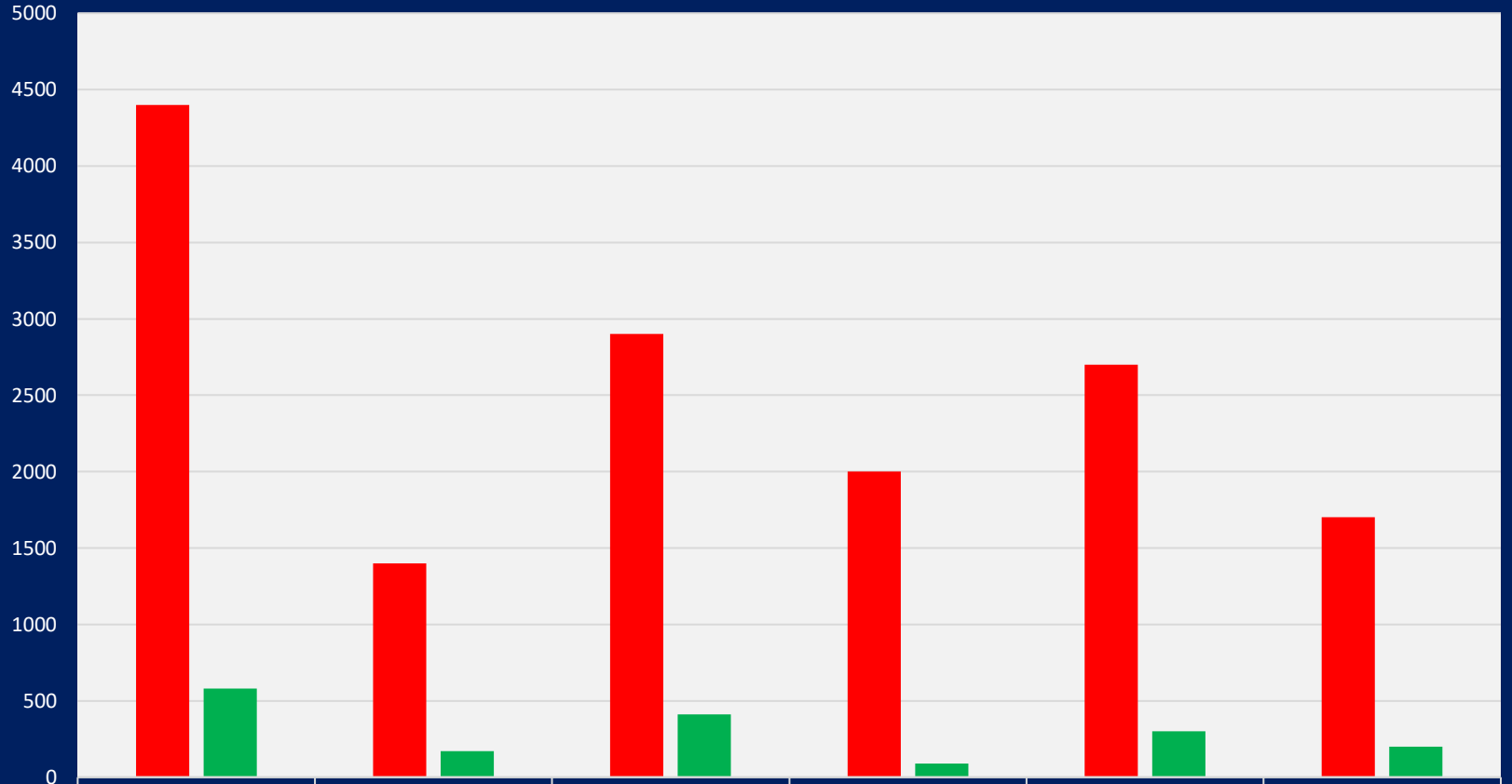
Washing of fire protective clothing with FPG Wash and further developed washing program

Picture 19. Firefighter after practice in Oskarshamn, Sweden.

- **Laundry with Lejon Kemi liquid detergent developed for washing breathing masks and fire protective clothing**
- **Further developed washing programme for washing heavily contaminated fire-retardant clothing**
- **Washing at 60° C**
- **Slightly longer washing time**
- **Rinsing with warm water (60° C) in the first rinse stage**
- **High water level at rinsing for at least 4 rounds, with short spins between rinses**

= Clearly better cleaning results

Levels of 16 different PAHs on alarm racks, before and after washing



	PAH, sum 16	PAH, sum carcinogenic	PAH, sum others	PAH, sum L	PAH, sum M	PAH, sum H
Contaminated	4400	1400	2900	2000	2700	1700
Washed	580	170	410	90	300	200

Diagram 4. Nanogram/g (ng/g) concentrations of 16 different harmful and carcinogenic polycyclic aromatic hydrocarbons (PAHs) on fire protective clothing, before and after washing. Please note that most levels of PAH after washing are less than the values given in the table. Note that the specified values after washing are the upper limit of the sensitivity of this analytical method (GC-MS). The values should therefore be interpreted as meaning that they may amount to a maximum of the specified values but may also be lower than the specified values for the samples from the washed garment. Analysis laboratory: ALS Scandinavia AB in Danderyd, Sweden.

Washing fire hoses in hose washing machine after soaking in Lejon Kemi hose detergent

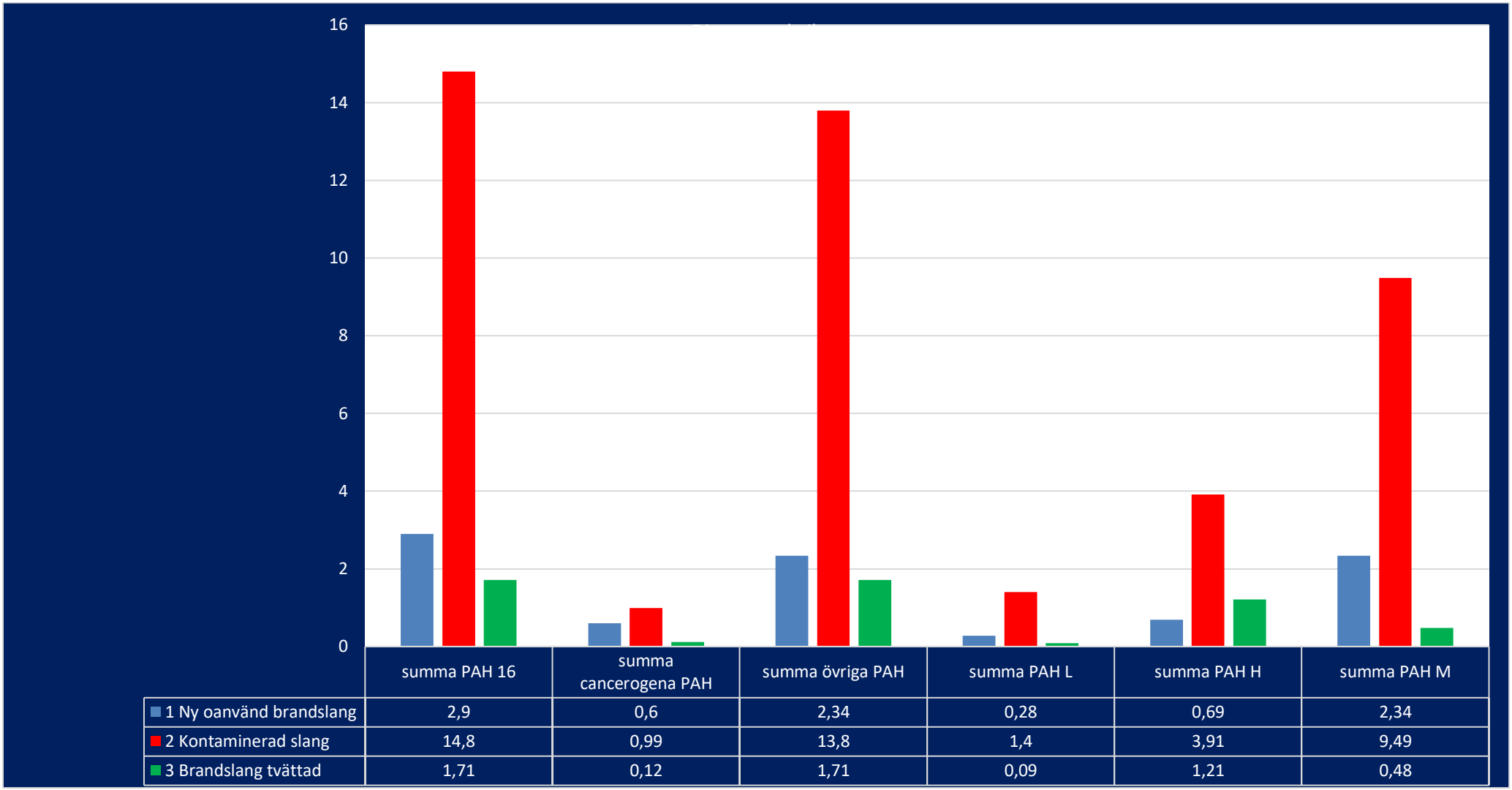
Contaminated fire hose before and after washing

Enlarged image of sooty fire hose

Enlarged image of a cleaned fire hose

Fire hoses are soaked in a water bath at 60° C with 3% Lejon Kemi fire hose detergent for at least 30 minutes, then washed in a hose washing machine with brushes and high-pressure flushing with hot water 50° C – max 60° C. Hot water is important to effectively wash away oil and grease-soluble dirt such as PAH and dioxins.

Levels of PAH on fire hoses soaked in hot water with Lejon Kemi hose detergent



	summa PAH 16	summa cancerogena PAH	summa övriga PAH	summa PAH L	summa PAH H	summa PAH M
1 Ny oanvänd brandslang	2,9	0,6	2,34	0,28	0,69	2,34
2 Kontaminerad slang	14,8	0,99	13,8	1,4	3,91	9,49
3 Brandslang tvättad	1,71	0,12	1,71	0,09	1,21	0,48

Diagram 5. Total micrograms/gram concentrations of 16 different polycyclic aromatic hydrocarbons (PAHs) on a new, unused fire hose, on contaminated fire hose and on a fire hose soaked in water bath at starting temperature of about 60° C with 3 % Lejon Kemi Hose detergent, then washed in hose washing machine with high pressure flush at 160 bar. Result: The total content of analyzed PAHs decreased by 88.4% and the level of analyzed cancerous PAHs by 87.9%. If warm water (60° C) is used in the hose washing machine the cleaning result can be further improved.

It is possible to get good cleaning results by using:

1. Professional PPE-dishwashers, Washing machines, drying cabinets, hose cleaning machines, high pressure cleaners etc.
2. Cleaning products that are developed and tested for effective and safe washing of breathing apparatus, respiratory masks, fire protection clothing, fire hoses and other equipment used by fire brigades
3. Specially developed and optimized:
    - Dosage of detergents
    - Washing and rinsing water temperature
    - Washing times
    - Water levels
    - Rinsing
4. Regular service of PPE-dishwashers, dosing pumps, washing machines etc.
5. Provide training to affected personnel at the fire stations

Complete solutions for cleaning and de-contamination

Lejon Kemi's stated goal is, together with its partners, to be able to offer complete solutions for decontamination for the rescue services, including:

- **Cleaning products, detergents for PPE-dishwashers, washing machines, hose cleaning machines, for manual cleaning and for high pressure cleaning**
- **PPE-dishwashers**
- **Washing-machines**
- **Dishwashing and washing programs**
- **Dosing pumps**
- **Installation of machines, dosing pumps and programmes**
- **Information and training of fire brigade personnel**

Lejon Kemi's product range includes detergents and methods for cleaning of:

- Breathing apparatus
- Breathing masks
- Fire protective clothing
- Fire hoses
- Tools
- Machinery
- Workbenches
- Vehicles

Lejon Kemi has in its range dosing pumps for PPE dishwashers as well as dosing and foaming equipment for vehicle cleaning.

Lejon Kemi AB. Customer contact: Tel.nr: + 46 (0)76 827 00 96. E-mail: info@lejonkemi.se Website: www.lejonkemi.se

Lejon Kemi AB / I.L 2022-09-14 SE.

Exposure for hazardous and carcinogenic substances is global

The problems with exposure for hazardous and carcinogenic substances that fire fighters are exposed for are global

- **Within EU there are more than 100 000 fire stations with more than 1 million fire fighters. 20 000 fire stations are considered to be large.**

- **In USA there are more than 58 000 fire stations with more than 800 000 fire fighters.**

Sourse: www.CTIF.org