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The new fire protection system in the Studsvik hot cells

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Abstract

Halon had been used for 20 years in the Studsvik hot cells for fire extinguishing. From January 1, 1998 Halon is no longer allowed because of its effect on the ozone layer. Therefore a new fire protection system with Inergen has been installed.

Inergen is composed of three well known gases from the atmosphere: N_2, Ar and CO_2, and is environmentally acceptable. The Inergen gas is kept in special containers at a pressure of 200 bar. Each container holds a volume of 50 litres and contains 10 m^3 of Inergen gas at atmospheric pressure. Totally 11 containers are connected to our 7 hot cells.

The Inergen system consists of two parts: the extinguishing system and the fire alarm system. When an extinguish impulse goes from the central unit an actuator opens the extinguishing valve and the gas flows through a piping system to the designated hot cell and out through the nozzles. The impulse also stops the ventilation of the hot cells.

The gas mixture that reaches the nozzles is divided into 3 horizontal spray-beams. The gas sprays out just under the ceiling and then uses the walls to change direction. The extinguishing time is 80-120 seconds (when 80 % of the gas is released).

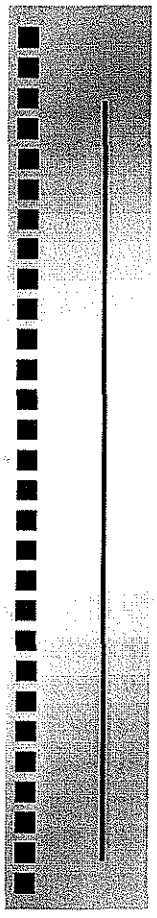
Inergen extinguishes fires in most materials at an oxygen level of 17 %. A full-scale test was performed after installation. The oxygen level at the start of extinguishing was below 17 % after 30 seconds and 14 % after one minute. The lowest concentration was measured after 4 minutes (11 % oxygen) and was then stable as long as the air flow through the hot cells was stopped.

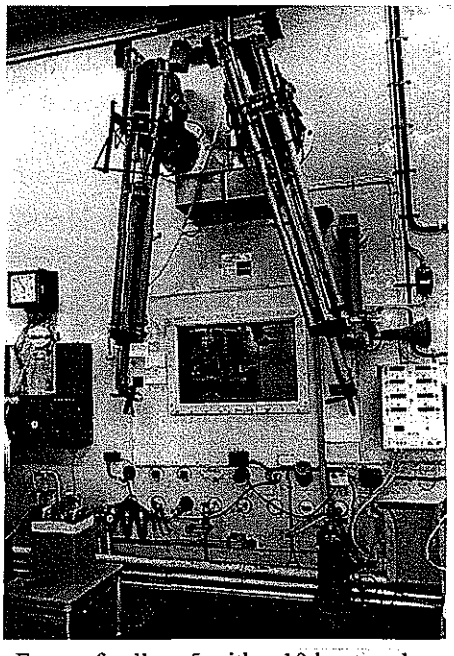
The Inergen system can be initiated either by a heat detector in the hot cell or manually.

Special precautions are observed during operations such as cutting capsules containing NaK and when cutting spent metallic uranium fuel. In these cases inert extinguishing powder is stored closed to the working area in the hot cell.

The first generation fire protection system

In the beginning of the Hot Cell Laboratory history, the personnel had to manually connect a dry powder extinguisher to each individual cell. There was no automatic system or detectors on the inside of the cells and the fan and ventilation system weren't automatically stopped. The fire extinguishers had to be manually activated. As a complement was each cell equipped with small bags containing inert powder. There has never been any incident in our hot cells, that caused the use of powder extinguishers.





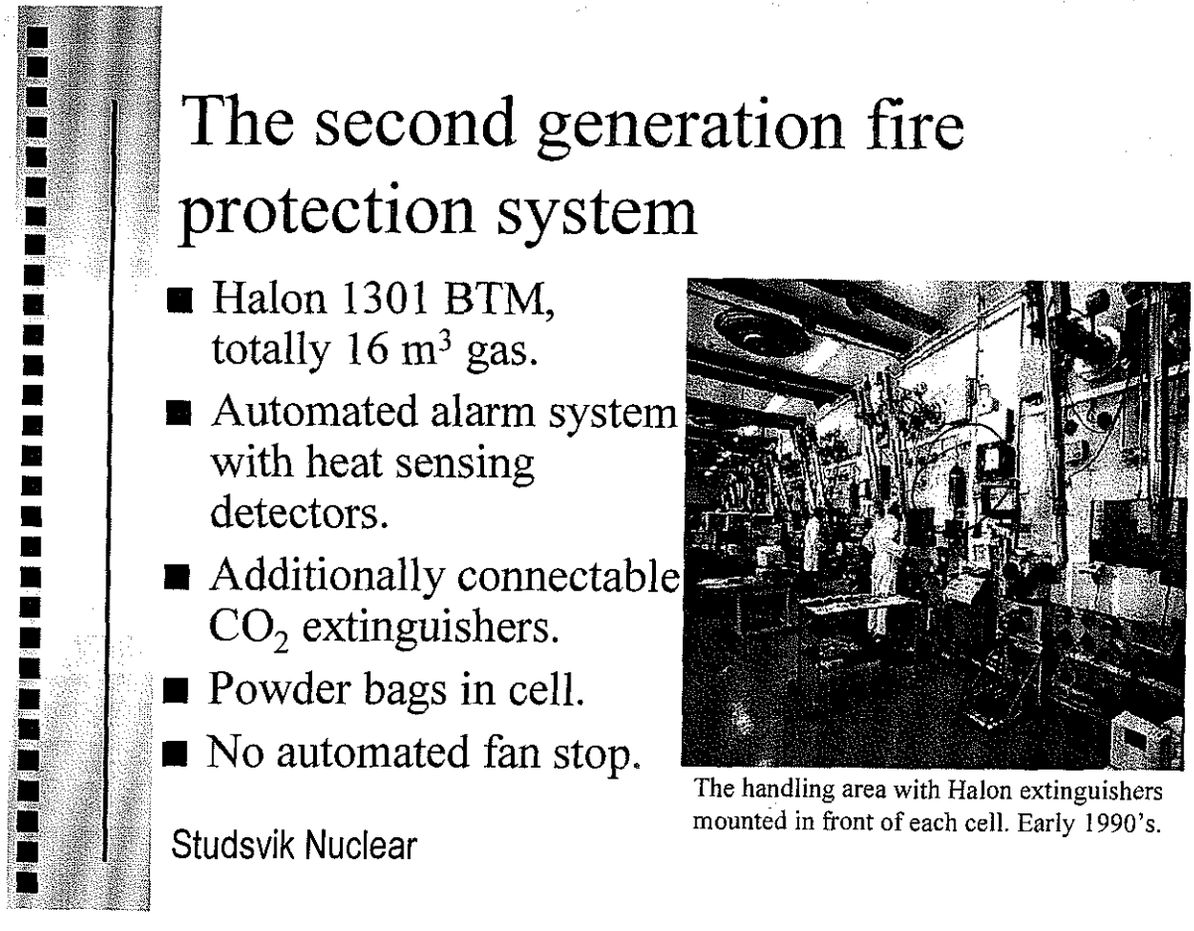
Front of cell no 5 with a 10 kg powder extinguisher connected, October 1977.

The second generation fire protection system

In the middle of the 1970's a process was started that aimed to renew the Hot Cell Laboratory and to install a new automatic fire extinguishing system. At first all dry powder containers were exchanged for carbon dioxide. Then Halon 1301 (bromotrifluoromethane), combined with heat sensing detectors, was chosen as the best alternative.

The second generation fire protection system was commissioned in September 1979. The Halon containers, eleven in all, were mounted at the front of each cell and then connected to the interior through stainless steel pipes. Each tube contained the amount of 1,44 m^3 released gas and was driven inside the cell with pressurized nitrogen. A small cell, with an internal volume of 16 m^3, was connected to one tube. A large cell, with a volume of 40 m^3, had three tubes connected. In case of a fire situation the extinguishers could be manually or automatically discharged. An alarm signal called upon the Studsvik fire brigade and the employees' attention. Carbon dioxide extinguishers and powder bags were situated nearby as a complement.

This system has never been automatically or manually discharged into a cell to stop an ongoing fire during its nearly twenty years of use .



The handling area with Halon extinguishers mounted in front of each cell. Early 1990's.

The new generation fire protection system

In 1992 a new law was passed in Sweden that prohibited any further use of Halon in new installations. The Studsvik Hot Cell Laboratory had to change to another extinguishing agent and finally decided to use Inergen. Inergen is composed of three well known gases from the atmosphere: nitrogen, argon and carbon dioxide. It's environmentally acceptable and multi purpose since it puts out fires by lowering the oxygen level as well as chilling the hot sources. It is kept in cylinders of 50 liters at a pressure of 200 bar and contains 10 m^3 of gas (at atmospheric pressure).

We have eleven cylinders in total connected to our hot cells. They are placed in a room above and away from the cellblock. The gas flow is directed into the cells through stainless steel pipes with a special end nozzle that divides the gas into three spray-beams.

The alarm system has heat sensing detectors. Their signal, if activated, is sent to a central unit that gives an impulse to the valve on top of the Inergen cylinder. The valve opens and releases the gas. The extinguishers can also be manually activated for each cell. The central unit immediately cut the power supply to the main fan, that slows its speed and then finally stops. The stainless steel vent ducts are not closed by a steel-screen so there will still be a small air flow through the cell. That's because we want to prevent back-pressurizing of the contained spaces and back-spreading of contamination to other areas of the building.

The complete alarm system is powered by continuously charged batteries. If the normal power supply is lost, the alarm system will still be operational and maintain its ability to detect and put out fires. Special precautions are taken during operations with pyrophoric materials, such as NaK and metallic uranium fuel. In these cases inert extinguishing powder is stored close to the working area in the cell.

The new generation fire protection system

- Inergen, totally 110 m^3 releasable gas.
- Automated alarm system with heat sensing detectors.
- Automated shut down of fan.
- Additionally connectable CO_2 extinguishers.
- Powder bags in cell.

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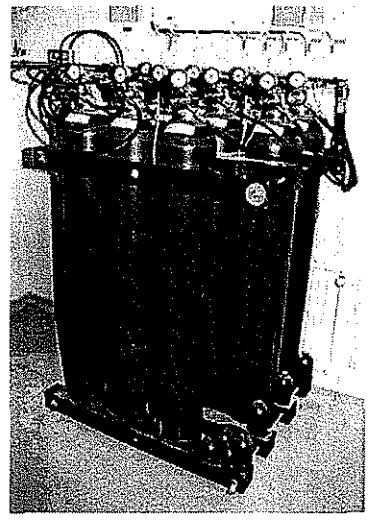
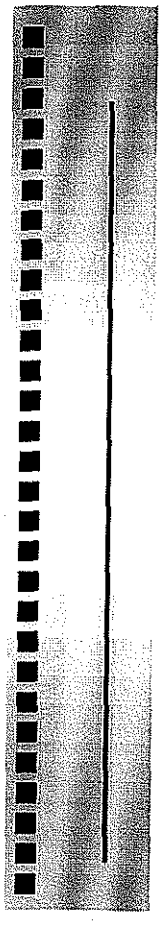


The new Inergen tubes, 1998.

Experience

The Swedish authorities have controlled the complete system and approved it for use. We have done tests, under their supervision, to confirm the oxygen level in a cell after introduction of Inergen. The extinguishing time to release 80 % of the gas, was proved to be less than 2 minutes. After 30 seconds the oxygen level was below 17 %. When 4 minutes had passed, the level was 11 % and stayed at that rate until the experiment was stopped, after 10 minutes.



Experience

- Tests have proven the system to be efficient enough to lower the oxygen level to only 11% and keep it at that rate when the air flow through a cell is stopped.

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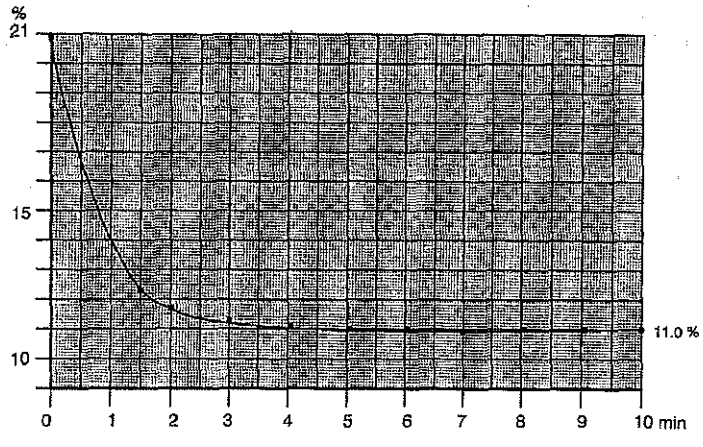
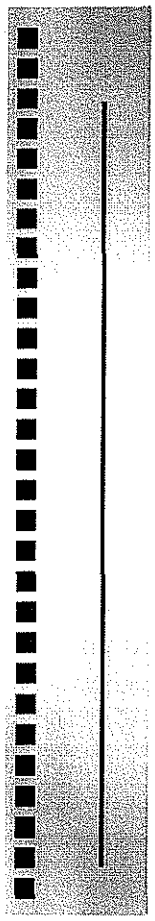


Summary

It is necessary to have a well functioning, and easy to use, fire protection system in almost every facility, but especially in those that handle and maintain nuclear fuel in some form. It is seldom possible to enter such a facility and put out an ongoing fire, without endangering the personnel. The employees must therefore have a high level of awareness so they immediately can identify an emergency situation. In a hot cell the handled material and its behavior, should be well known and documented before being taken inside. Preventive measures are always the best way to minimize the consequences of incidents that still may occur.

The fire protection system ought to have detectors. They can be of various types, heat, light, pressure, smoke or others, or combinations of them. The preferred extinguishing agent should fulfill its purpose in every possible situation, unless it is not partly complemented by other agents. Procedures for periodic testing should be established and maintained. Training and education of personnel, and their ability to react correctly in a given situation, is a very simple way to keep a high standard. Improvements and innovations in the field of fire protection, ought to be continually evaluated and considered for use in nuclear facilities. One can never settle down and relax when it comes to concern about the prevention and protection systems in ones own hot cell. Be alert, or you may be alerted!



Summary

- Preventive measures are the best protection.
- Use automated alarm systems.
- Use multi-purpose extinguishing agents.
- Implement periodic testing procedures.
- Continually train and educate your personnel.
- Evaluate improvements and innovations in the field of fire protection.
- Be alert, or you may be alerted !

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