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Cleaning and decontamination of cooling fins on spent fuel transport casks.

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Introduction

In 1985, regular transports of spent fuel from the twelve Swedish nuclear power stations to CLAB, the central interim storage for spent nuclear fuel, started. Until now, Aug 2001, around 3 600 tonnes of spent fuel, corresponding to 1200 casks have been transported to CLAB. The transports have been performed using a purpose built sea transport system where the ship M/S Sigyn is an important and the most well known part.
Yearly, about 200 tonnes of spent fuel are transported to CLAB corresponding to around 15 sea voyages with the ship.
The CLAB facility is owned by SKB but operated by staff from the OKG AB, which owns and operates the three nuclear power plants at site. OKG AB is also one of the owners of SKB.

SKB operates 10 transport casks for spent fuel of the French design TN 17/2. This cask is made of forged steel and has a length of about 6 meters and a diameter of about 2 meters. Its weight is 80 tonnes and the loading capacity is about 3 tonnes of spent fuel. The transports are performed under dry conditions and the cask is cooled by natural air circulation around the 40 000 cooling fins. The fin area is roughly 4 meters long with a diameter of about 2 meters. During loading and unloading operations at the power plants and CLAB a metallic skirt protects the fin area by circulation of clean water which also cools down the cask. Under normal road transports the cask is covered by a canapé preventing the fins from dirt and dust. Despite these protection measurements it is almost impossible to keep the cask and the fins completely clean during all transport and loading operations.

As a consequence of the problems with contaminated transport casks experienced in Europe in 1998, SKB, the Swedish Nuclear Fuel and Waste Management Co, checked all transport documents since the start of the spent fuel transports in 1985. About 20% of the casks received at CLAB had one or more spots of loose contamination in excess of the regulatory limit 4 Bq/cm^2. In a few cases contamination was found as “ spots” among the cooling fins on the outside of the transport cask.

The fin area has earlier been manually cleaned. This meant very time consuming cleaning operations, by hand, by the CLAB personnel. Therefore, in 1999, a project was started to design and manufacture new equipment for cleaning and decontamination of the cooling fin area of the cask.

Maintenance.

The maintenance of the transport cask follows the requirements stipulated in the Safety Analysis Report for the cask and schedule that was earlier known as “Green Book”.
This stipulates periodicity and level of maintenance for different periods of the transport cycle.
The main maintenance is carried out in our workshop at CLAB. One type of maintenance is done after every 15 transports or 3 years and a more rigorous one after 60 transports or 6 years.
The 15- transport cycle maintenance is mostly concerned with keeping all surfaces in good condition, replacing o-rings and leak testing all orifices and making sure that lifting trunnions are in good condition.
At the 60- transport maintenance additional operations are carried out such as removing all lifting trunnions and after re-assembly performing an overload test.
Maintaining a good surface finish on the outside of the transport cask is very important in order to avoid decontamination of these surfaces. This means that plenty of time is spent in grinding and polishing of these surfaces.

Handling at reactor site.

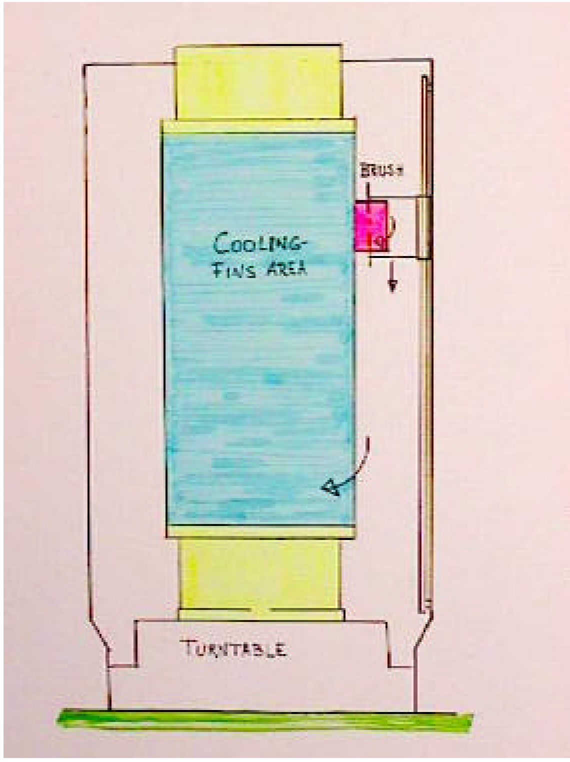
During loading at the power stations the cask is lowered into the fuel-loading pond and thereby exposed to contaminated water. Before the cask is lowered into the water, a protective skirt covers the cooling fin area. This metal cooling skirt is circulated by clean water. This arrangement should protect the cooling fins to come in contact whit contaminated water.
After the cask has been loaded with fuel elements and the inner lid put in place, the cask is lifted out of the pond and placed at the floor. Water is drained from the cask and all orifices are closed and leak tested. The cooling skirt is then removed and all accessible outside surfaces are carefully cleaned to remove any traces of contamination. Checks for radiation and contamination are performed on the outside of the transport cask and after satisfactory results are achieved the cask is lowered down on its transport frame and transported out of the plant.

Handling at CLAB.

When the transport cask is taken in to the CLAB plant, its put in a preparation cell and a metal cooling skirt is mounted over the cooling fins. Cooling water is then run on the outside of the cask. Hoses are connected to orifices communicating to the inside of the cask and it’s filled with water. This water is circulated in a closed system with heat exchangers and filters until the fuel is cooled down.
The cask is lowered into the unloading pool system, which consists of two different pools.
The two pools are sealed off from each other to make sure no contaminated water is in contact with the outside of the transport cask.
When the fuel has been unloaded the cask is brought back to the preparation cell. Water is drained, the cooling skirt is removed and all orifices are closed and leak tested.
After cleaning, checks for radiation and contamination are performed.

New cleaning equipment.

In view of the problem with contamination on the cooling fins, it was decided in the beginning of 1999, to investigate the possibility of constructing a device for cleaning the fins. Considering the difficulties with cleaning by hand this was a venue well worth exploring.
The cooling fins are made of copper with a chromed surface. On the topside of the fins there is normally a brown coloured layer of oxides stemming from the cooling water. This layer has been analysed and proved to consist of 55% Fe and 40% Cu plus traces of Cr and Ni.
At the CLAB plant a decontamination cell with equipment for cleaning the outside of the transport cask with high-pressure water is used. The cooling skirt is normally mounted to protect the silicon-layer between the fins.
This cleaning device is designed as a big drum with a turntable in the bottom and drainage to a system for contaminated water. The transport cask is placed at the turntable and rotates slowly while it is sprayed with high-pressure water.
After a series of experiments we found that a rotating brush was the best way to remove the oxide layer on the cooling-fins.
Using the existing cleaning tank we designed an apparatus with a rotating brush that follows the side of the transport cask as it rotates in the cleaning tank.
The brush is driven by a hydraulic motor and is mounted on an arm that can be moved in and out from the side of the tank. This is done with a hydraulic cylinder that will press the brush against the cask so that two support wheels rests against the fins and follows the perimeter of the fin area. As the cask slowly rotates one turn on the turntable, an area all around the perimeter of the cask is brushed. After each turn the brush is moved axially along the cask and a new section is brushed. The axial movement is done with a hydraulic motor driving a sprocket and chain that pulls the brushing arm up and down.

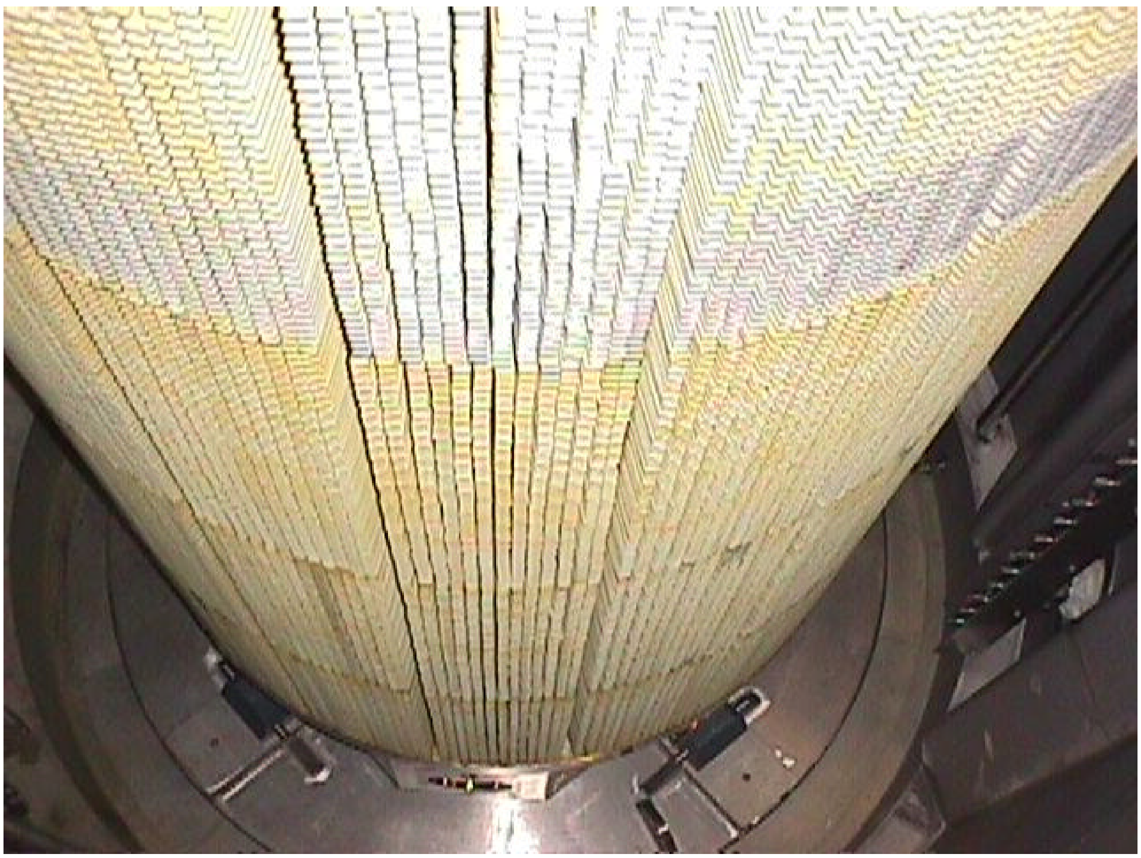


The hydraulic unit is placed beside the cleaning tank and uses de-ionised. This eliminates the risk of oil getting into the drain system.

The system consists of a dr um with axial slots where the brushes are fixed, which makes it easy to change brushes. Two different types of brushes have been used. One is made from artificial fibres with an abrasive the other is a nylon brush without abrasive.

Results.

The equipment was ready for use at the end of the last year, 2000. To get rid of the oxide layer on the cooling fins we selected a brush made from artificial fiber with an abrasive mixed into the material. This type of brush should remove the oxides. It proved to be effective and we were successful in removing this layer of oxide and greatly improve the surface appearance of the fins.



Picture 1

Picture 1 shows a cask standing in the cleaning equipment with the top section brushed. One can see the difference between brushed and non-brushed area clearly enough.


Picture 2

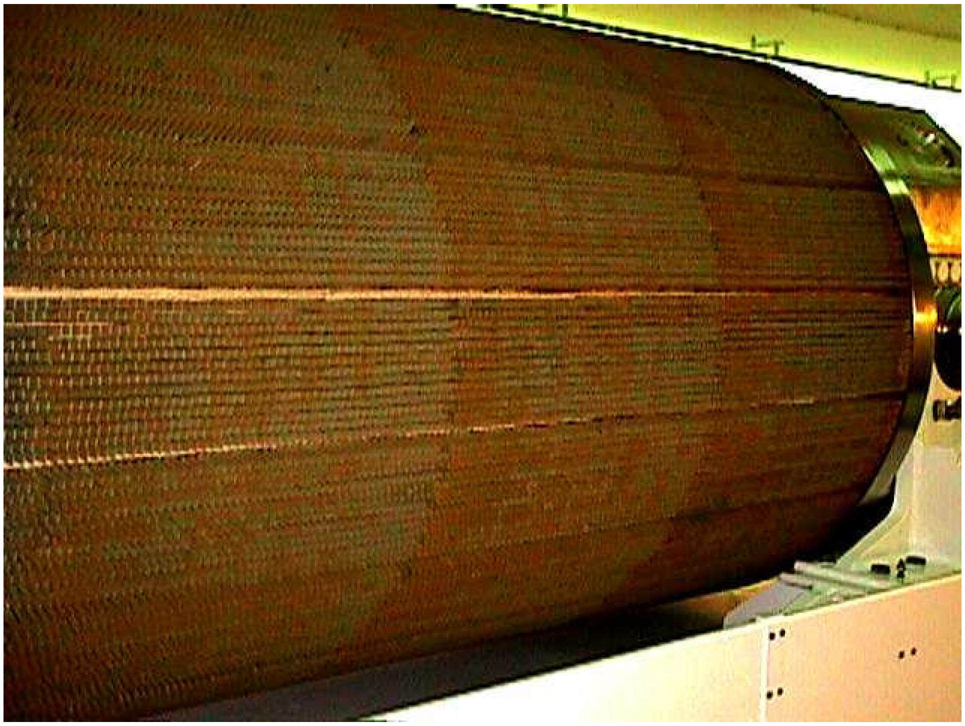
In picture 2 the brushing apparatus can be seen in operation with about half the transport cask finished and the bottom half still not brushed.

Up to date we have used the equipment eleven times with good result. Four of these occasions to remove the oxide layer. On the other 7 occasions brushing has been initiated because contamination has been found among the cooling fins. This has been effective as well, but to make the cleaning more adapted to only removing contamination a couple of modifications will be done.

First a different type of brush should be used. We have chosen a fairly soft nylon brush that wont wear on the fin surface. This is to eliminate the risk, with frequent brushing, of wearing through the chrome surface on the cooling fin. This chrome layer is very thin.

Secondly an extra water supply should be arranged to be able to flush the fins with water after brushing to rinse off any particles that has come loose during brushing.

In conclusion it has been shown that the equipment is working well. We will continue to improve the equipment and expect to use it frequently in the cleaning process at CLAB.



Picture 3

Picture 4