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AREVA Liner Repair Strategy Based on Adhesive Technology

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ABSTRACT

Over long experience, the global nuclear power industry has relied on AREVA NP strengths in developing rapid, safe, and effective solutions to nuclear power plant operating problems. Over the entire spectrum of nuclear plant operations, we partner with utilities to keep plants running, keep generating capacity up, and keep the world powered.

AREVA NP has developed a repair method for sealing leakages in austenitic stainless steel liners, especially in nuclear power plants. This technology is either a repair, when applied after failures already occurred, or a prophylaxis, when applied before such failures occur.

An important new area of AREVA NP's armament of nuclear services for the nuclear industry has been perfected over the past 20 years in more than 35 sites worldwide. AREVA NP's process for detecting, coating, and sealing liner leaks offers a safe, effective, responsible, and highly economical way to repair and prevent leakage.

1. INTRODUCTION

Leakages of stainless steel pool liners can be classified into basically four mechanisms:

Mechanical impact, mechanical stress, weld failures and corrosion.

Damage from mechanical impact like dropping tools or equipment can be usually recognized and localized immediately. In such situations no extensive leak detection needs to be performed.

Contrary to the mechanical damage, it is more difficult to localize damages due to mechanical stress, such as load changes or thermal stress. Load changes occur when a stainless steel pool is repeatedly filled and drained, thermal stress occurs when a pool is exposed to temperature gradients. Those two prerequisites are given in reactor cavities (RC). Mechanical stress usually promotes other pre-existing defects.

According to the experience of AREVA the weld failures found after several years of operation are seldom a cause for leakages. This is due to the standard testing procedure in which all weld seams are checked (by Penetrant Testing (PT) for example). If failures are detected, they are repaired during the commissioning.

The main root cause for leakages found after several years of operation is corrosion. Corrosion failures themselves are mainly caused by stress corrosion cracking (SCC). SCC needs certain prerequisites to occur:

- Stress, either mechanical or heat influenced
- A corrosion initiating element (e.g. chlorine) above a limiting concentration in the crevices is necessary

- Heat Affected Zone (HAZ): Exists near weld seams. The microstructure of the stainless steel is changed by the heat generated by the welding process leading to a higher susceptibility to SCC.

Those prerequisites for SCC cannot be found at the front side of the liner (water side), because the water inside the pools in nuclear power plants is pure water which contains no SCC promoting elements, such as chloride. At the concrete side of the liner, all of those prerequisites can be found in some areas. Therefore, the SCC starts from the concrete side and can be detected after penetrating through the liner sheet.

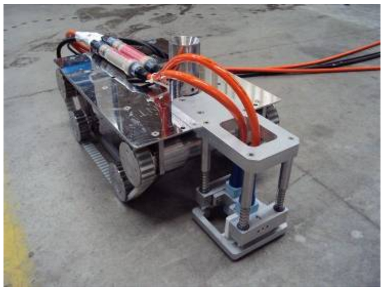
2. DETECTION METHOD

When there are leakages known in a pool, there is either the need to locate those leaks or to carry out a prophylactic coating on all welding joints.

The detection method can be carried out in 2 steps. First, a pre-detection made with cameras for the main parts of the liner (for big impacts) and Alternative Current Field Measurement (ACFM) sensors on each side of the welds to check for crossing cracks in the HAZ.

Then, on the pre-detected areas, the leak detection equipment is placed to identify and also evaluate (if requested) the leaks.

This can be achieved in air or underwater.



ACFM sensors carried out by a crawler

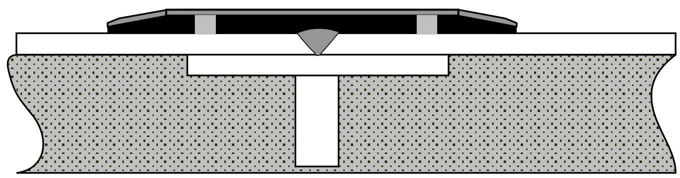
Corner vacuum box

3. REPAIR METHOD

The AREVA repair method can be roughly divided into two principles: Remote controlled application for use under water or in high radiation dose areas and manual application for use in dry and low radiation dose areas.

Depending on the application area a suitable adhesive material is chosen. For dry applications and low dose areas mainly a silicone-based material is applied, for underwater application, e.g. in a spent fuel pool (SFP) mainly an epoxy-based material is applied.

The basic design of the repair method is shown in Fig. 1. In this figure a cross-section of a stainless steel liner welded onto a T-shaped support framework (white) is fixed in concrete (grey). On top of the welding line the elastic repair material (black) seals the HAZ and is protected against mechanical damage with a stainless steel cover (grey). This principle is the most frequently applied design, because it combines the excellent sealing abilities of the elastic coating material with the advantage of mechanical protection. Simultaneously, a minimum surface of coating material is exposed to the water side of the pool.



Basic design of repair method

The design shown in Fig. 1 can be applied manually as well as by remote control.

4. ADVANTAGES OF ADHESIVE & COATING TECHNOLOGY

There are several advantages of this technology compared to repair by welding. The AREVA repair method is substantially faster and, therefore, more cost effective than a usual weld repair. Additionally, the exact localization of the leakages is not necessary if all weld seams in a pool are covered. The base material is neither negatively affected by the adhesive material nor is the liner exposed to additional heat stress, which may cause future leaks. This repair technique has been field proven for more than 20 years.