Film-forming amines (FFA) complement to the existing water chemistry treatment in mitigating corrosion transport into steam generators (SGs). Moreover, they can form part of a feasible strategy for optimizing the layup procedures with respect to the subsequent outages.

**Challenge**

Most of the world’s operating nuclear power plants are more than 25 years old and consequently subject to increasing outage durations, especially due to long-term refurbishments. For reason of plant-specific characteristics (material concept, water-steam cycle design), the scope for improving water chemistry is very limited. In particular, corrosion products, impurities and hardening substances (mainly silicate) carry a high risk of hard sludge formation.

**Solution**

Our patented and field-proven application process of FFA effectively protects the entire water-steam cycle against corrosion.

FFA show a positive impact on hydrodynamic cavitation characteristics within two phase flow areas as well as on heat and mass transfer from and to the inner surfaces of the water–steam cycle.

FFA treatment is applied during full power operation as a complementary but time-limited measure to the existing secondary side water chemistry with the main objectives:

- To minimize corrosion product transport into the SGs during all operating modes
- To reduce wet/dry layup efforts during long-term outages.

**Customer benefits**

- Layup effort is reduced and performance prior to outage optimizes outage schedule
- No environmental hazards of waste water after system layup
- Applicable at full power operation, controlled and time-limited injection of FFA into the water-steam cycle
- Mobilization and removal of impurities from secondary system
- Significant reduction of impurity ingress and smaller particle size
- Protective effect continues after restart
- Minimize consumption of harmful conditioning agent hydrazine during outages and subsequent cycles

**Iron transport reduction into SGs**

**Sludge from SGs during outage**

**Your performance is our everyday commitment**
Technical information

- Applicable at full power operation
- Complementary to adequate pH strategy without influencing plant operation and performance
- Compatible with plant materials and already existing protective oxide layers
- No environmental hazards of waste water after system layup
- Adherent non-wettable film lowers the corrosion rate
- Protective effect continues after restarting the unit
- Minimize consumption of the harmful conditioning agent hydrazine during outage periods and the subsequent fuel cycles
- Mobilization and removal of impurities from secondary system
- Significant reduction of iron ingress in feedwater during transient phase.
- Low iron concentrations (≤ 2µg/kg) during normal power operation
- Successful operating experience in pressurized water reactors (PWRs) and pressurized heavy water reactors (PHWRs) in ten FFA applications worldwide

References

Almaraz Unit 1 and Unit 2 (PWR, Spain), since 2011
Focus on corrosion protection during outage, surface protection continuous after outage
- Inside surface cleaning of the entire water-steam cycle (removal of impurities and loosely bound corrosion products)
- Surface protection in wet steam areas

Embalse (PHWR, Argentina), 2015
Focus on long-term layup

Borssele (PWR, Netherlands), 2017
Focus on corrosion protection during outage, reduction of hydrazine

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