HANDBOOKS & REPORTS

PWR AND VVER SECONDARY SYSTEM WATER CHEMISTRY

(SSWC)

Objective

The objective of the Stand Alone Report (SAR) PWR and VVER secondary system water chemistry is to:

- provide guidance for those needing to get an introduction to and an initial understanding of fundamentals of secondary water chemistry or,
- to update and refresh the memory of those with secondary water chemistry background or
- provide deep information on all aspects related to chemistry and corrosion of the entire secondary system, for those who already have a good knowledge.

The 350 pages book is properly arranged in Chapter and sub-chapters allowing to extremely easily finding the relevant information on design, R&D results, operation rationale and options.

The SAR Report covers the range from basic information to current knowledge.

Contents:

5) ENCOUNTERED SG DEGRADATION AND INFLUENCE OF VARIOUS IMPURITIES ON SG PERFORMANCE

5.1 SG degradation problems
- *Wastage*
- *Denting*
- *Pitting*
- *IGA / SCC*
- *Flow induced vibration*

5.2 Influence of various impurities and parameters on SG performance
- *Sulphate and sulphur compounds*
- *Lead*

6) ADEQUATE WATER CHEMISTRY FOR IMPROVED SG PERFORMANCE

6.1 Flow Accelerated Corrosion (FAC)
- *Thermo-hydrodynamic parameters*
- *Alloy composition*
- *Water chemistry*

6.2 Corrosion product control
- *High ammonia concentrations*
- *Alternative (advanced) amines*
- *Support by oxygen*

6.3 Impurity control
- *Make-up water*
- *Condenser leaks*
- *Pollution from other systems*
- *Ion Exchange Resins*
- *Regeneration*
- *Consumables*
- *Manufacturing and maintenance activities*

6.4 Oxygen control

7) DIFFERENT WATER CHEMISTRY STRATEGIES (STATE OF ART)

7.1 High pH operation (High-AVT)

7.2 Alternative amines
- *Various additives and objectives*
- *Amines properties*

7.3 Oxygen injections / oxygenated water chemistry
- *German experience*
- *Japanese experience*

7.4 Dispersants

7.5 Various options and rationale for selection
- *Materials compatibility*
- *Relation with low and high temperature pH*
- *Relation purification means, liquid wastes and costs*
- *Rationale for treatment selections*

8) DIFFERENT STRATEGIES OF USING PURIFICATION SYSTEMS

8.1 Condensate polishing system: Various options and rationale for selection

8.2 SG blow-down demineraliser: Various options and rationale for selection

8.3 Possible recovery of condenser effluents

9) DIFFERENT MAINTENANCE STRATEGIES IN RELATION WITH CHEMISTRY (STATE OF ART), COSTS CONTROL

9.1 Chemical cleaning processes
- *Hard chemical cleaning processes*
- *Maintenance chemical cleaning processes*

9.2 Mechanical cleaning processes
- *Tube sheet lancing (hydraulic cleaning)*
- *Upper bundle hydraulic cleaning*
- *SG Tube scale removal by thermo-hydraulic effects*

9.3 Rationale for selection of cleaning technologies

10) CHEMISTRY CONTROL AND MONITORING

10.1 Purpose of on line monitoring and grab sampling

10.2 Criteria for representative sampling

10.3 Rationale for selection of each type, number of control points

10.4 Relation between pH, conductivity versus reagent content and some ions

11) APPLICATION OF WATER CHEMISTRY CONTROL PROGRAMS

11.1 Power operation
- *EPRI guidelines*
- *EdF guidelines*
- *VGB guidelines*
- *VVER guidelines*
- *Discussion on various parameters*
- *Comparison of various guidelines*
- *Possible evolution of guidelines*

11.2 Plant start-up and shutdown

11.3 Plant lay-up

12) CONCLUSIVE SUMMARY AND RECOMMENDATIONS

12.1 Overall objectives

12.2 Impurities behaviour

12.3 SG degradation evolution

12.4 Impurities mitigation and impact

12.5 Corrosion product and FAC mitigation

12.6 Treatment options and selection

12.7 Purification options

12.8 SG cleaning options

12.9 Chemistry monitoring and guidelines

12.10 Shutdown and lay-up

The Authors

Dr. Francis Nordmann has over 48 years of experience in power plant chemistry. He is retired from Électricité de France (the French Utility) in 2007, where he was an international expert in charge of chemistry and corrosion in the corporate offices. He was in charge of managing the engineering studies for the French fleet of 58 PWR units and of several international programmes. His Ph. D degree was obtained at the French Atomic Energy Commission, in connection with the University of Mulhouse in 1973. He also worked for 8 years within the French manufacturer Framatome.

He has been active for example in the following areas:

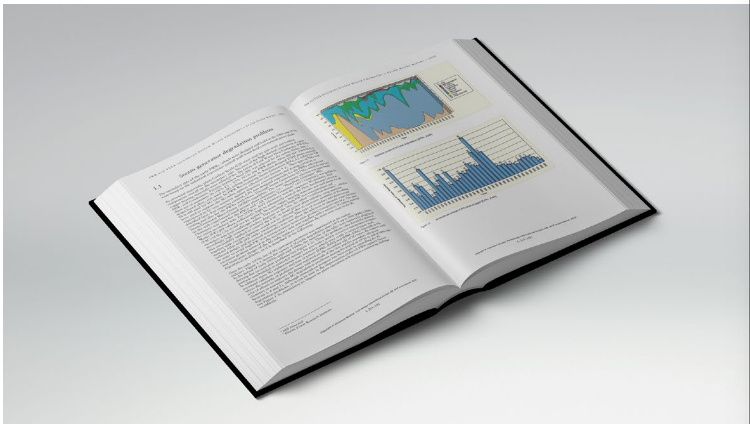
- Water Chemistry evolution and studies for the various systems (primary coolant, secondary steam-water system, condenser cooling systems, and intermediate circuits)
- Developing the Chemistry Specifications for the French NPP and some others
- Interface with Manufacturers and Regulatory Body
- Chemistry and corrosion training
- Steam Generator blowdown and condensate polishers strategy
- Optimisation of secondary water chemistry for various objectives
- Steam Generator experience feedback and relation with chemistry
- Tutorial sessions and workshops for various organisms (France, IAEA)
- International projects with various countries and organisations: IAEA, USA, EPRI, Japan, South Africa, China, Germany, Sweden, Spain, Russia, Ukraine, Bulgaria, Hungary, etc.
- Organising committee of several International Conferences on Chemistry for Nuclear Reactors. He was Chairman of this Conference in Avignon, France

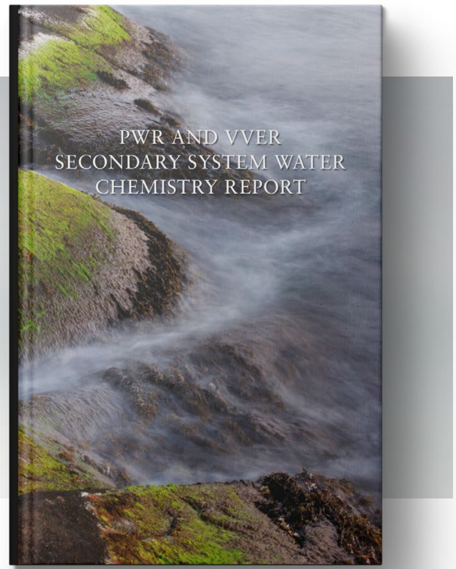
Dr. Suat Odar has 48 years of experience in power plant chemistry. He retired from AREVA NP GmbH (Former Siemens and KWU) in February 2008, where he has held since mid of eighties various service and managerial positions for power plant chemistry. In the last seven years he was responsible for the water chemistry of the nuclear power plants in his company. His degree as Ph.D. in Physical Inorganic Chemistry was obtained from the Technical University of Darmstadt, Germany, in 1970.

He has been active for example in the following areas:

- Water Radiolysis and Post LOCA Hydrogen Control in PWR Containment
- Commissioning of PWR plants
- Developing Chemistry Control concepts for PWRs
- Water Chemistry Guidelines
- Consulting in Power Plant Operation (Chemistry part)
- Improvement of Steam Generator Performance
- Man-Rem-Reduction
- Plant Life Extension (Chemistry measures)

- Steam Generator Chemical Cleaning
- Plant Chemistry Training Programs
- Secondary Side System Design & Material Review to improve Steam Generator Performance





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