



# LCC™

## LWR Chemistry and Component Integrity Programme



*The LCC13 deliverables.*

The annual LCC Programme is focused on reactor coolant, secondary chemistry and material issues and open to nuclear utilities, manufacturers and vendors, research and engineering organisations as well as regulatory agencies. In the LCC11 Programme, currently 17 organisations in North America and Europe, representing 21 nuclear plants, are members. The Programme was started in 2004.

# Deliverables

ANT International will provide the LCC Members with the following:

- Searchable CD-ROM(-s) with the following contents:
  - High-resolution pdf files with the complete LCC Special Topic Report (STR) and the Annual Reports (AR) in colour
    - > The files can be copied to a company server, with full read access for everybody with access to the server.
    - > The contents from the LCC Special Topic Report and the Annual Reports in pdf-format can be printed.  
Also, the contents from the pdf-files can be copied and pasted electronically into other documents, e.g. Word files.

The CD-ROM(-s) of the LCC STR and of the ARs will be provided before the Seminar in March (see below).

- Optional reports printed in four-colour. The printed LCC Special Topic Report and the Annual Reports will be provided as soon as they are printed with the aim of delivery before the Seminar in March.
- A Seminar will be held in Europe to present the results of the LCC Programme. The number of full time employees per Member that may attend meetings is limited to eight (8) people per organisation. The language of the LCC Programme will be English.
- The authors will be available for consulting throughout the year. A few telephone or e-mail consultations requiring no additional work are provided at no additional cost to Members.

Listen to Juan de D. Sanchez Zapata, Iberdrola.



Listen to Niels van Dijke, EPZ



Listen to Ana Isabel Muñoz and Carlos Arias, CNAT



## LCC Programme Content and Description

Nuclear utilities must reduce costs for operation, maintenance and fuel, keep the highest level of safety and lowest possible level of radiation exposure to employees and the public and minimize environmental impact of liquid and solid effluents and wastes.

Emphasis is put on safety, longer fuel cycles, higher burnup of fuel, increased fuel duty with more nucleate boiling in Pressurised Water Reactor (PWR's) and plant power uprates as well as more technical issues like Axial Offset Anomaly (AOA also called Crud Induced Power Shift/CIPS), Stress Corrosion Cracking (SCC) all point to the increased importance of high quality water chemistry and control.

It is our goal that the LCC Programme shall assist the LCC Members in meeting all these water chemistry and material related challenges in a most efficient way. This Programme reviews and evaluates the developments and trends in Light Water Reactor (LWR) primary coolant and secondary side chemistry and structural materials technology (excluding fuel materials). This is accomplished by identification of relevant information and a discussion of its significance for the Programme. The Programme reviews all relevant information through publications and international conferences and, when necessary, comments and background information are added.

Additional benefits for the LCC Members can be seen in the fact that the Members gain an increased understanding of power plant water chemistry and material integrity to facilitate more efficient plant operation. Furthermore, the LCC Members can be assisted in the training and education of a new generation of chemistry and material experts in their organisations.

The overall objectives of the LCC Programme are to enable the LCC Member to:

- Increasing understanding of reactor water chemistry related to a successful plant operation and continued integrity of Reactor Coolant System (RCS) materials while keeping radiation exposure low
- Guiding the plant operators to apply adequate PWR secondary side chemistry for safe, economical and environmentally friendly plant operation with high availability and without significant steam generator degradation or fouling problems or carbon steel Flow Accelerated Corrosion
- Assisting in the training and education of a new generation of chemistry and materials experts
- Establishing an independent meeting point for experts to enable free and critical discussions and experience exchange

These objectives are met through critical review and evaluation of the most recent data related to reactor water and secondary side chemistry, identification of the most important new information, and discussion of its significance in relation to water chemistry now and in the future.

The evaluations are based on the large amount of non-proprietary data presented at technical meetings and published in the literature.

# LCC13 Programme

Annual Reports will be prepared within the LCC13 Programme as follows:

- Key emerging issues and recent progress related to structural materials degradations
- BWR decommissioning General information and experiences
- Dose rate mitigation. New information
- Use of film forming amines (FFA) in nuclear power plants for lay-up and power operation
- The underestimated role of the oxygen on RCS components failures

Presentations without Reports will be prepared within the LCC13 Programme as follows:

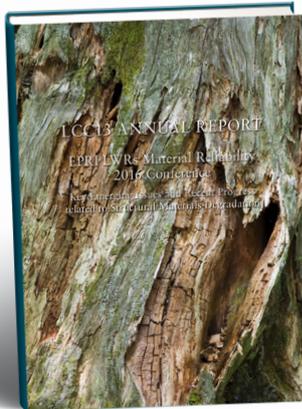
- Specification and guidelines evolution, proposals Secondary and Auxiliary Systems, PWRs and VVERs.
- Hydrazine and possible Alternatives
- Reduction of Activity and Dose Rate by Use of Low Co or Co Free Materials in Light Water Reactors
- BWR Dose Rates and Dose Rate Mitigation

At the LCC13 Seminar, the Annual Reports will be presented, described more in the following.

## LCC13 Reports

The EPRI conference - August 2016 in Chicago:

### International Light Water Reactors Material Reliability Conference



Since many years, EPRI has been organizing conferences on light water reactors materials reliability. Given, there was neither environmental degradation nor Fontevraud conferences in 2016, EPRI took advantage of the available spot this year.

Traditionally, EPRI conferences target Utility people as EPRI is a Utility sponsored organization. However, very few Utilities people attended this conference. A reason for that is opposite to the similar EPRI conferences organized about 10 years ago, (in Santa Ana Pueblo in 2005, in Atlanta in 2007...) most of the

papers concerned laboratory research whereas operational experience was predominant previously. In fact, this is a rather good news as it shows that materials issues are under a much better control than 10 years ago. However, with the plants ageing and the use of new materials, there is still room for materials issues and questions.

The first day of the conference was dedicated to 3 workshops held in parallel: Reactor Pressure Vessel Integrity Workshop, BWR/PWR In-Vessel Inspection Workshop and Fatigue Management Training Workshop.

During days 2 to 4, 104 series of slides were presented in 3 parallel sessions which covered:

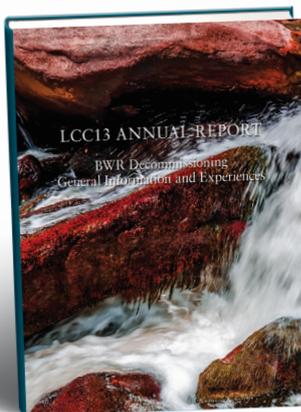
- PWR chemistry,
- PWR Reactor Internals and Aging Management,
- PWR Nickel-Based Alloys,
- PWR Stainless Steel and Modeling,

- BWR Major Component issues,
- BWR Water Chemistry and Mitigation,
- BWR Assessment,
- BWR Inspection/Operating Experience/Non-Destructive Examination,
- Probabilistic Fracture Mechanics,
- Long Term Operation,
- Nondestructive Examination Techniques,
- Reactor Pressure Vessel Integrity,
- Peening and Surface Mitigation,
- Cast Austenitic Stainless Steel,
- Thermal and Environmentally Assisted Fatigue,
- Welding Techniques & Residual Stress Modeling,
- Operational Experience & Plant Component Research,
- Steam Generator.

No papers were given at this conference, the proceedings contain only the slides that have been presented. Thus, the ANT document reporting the conference is a summary of some of the most important slides, with little text added. The report contains a summary and a chapter dedicated to the relevance of some results presented for the Industry.

As the conference is covering the whole range of issues and topics of concern of LWRs, every single engineer working in a nuclear power plant should be interested by at least one of the presentations given over the 4 days. Whatever one's field of expertise, materials, chemistry, non-destructive testing, fracture mechanics, corrosion, irradiation effects, degradations' mitigation, modeling..., this conference brings you up-to-date information regarding the latest research, plant experiences, analyses, planning and solutions for increased materials reliability in BWR and PWR power plant components.

## BWR Decommissioning General Information and Experiences



Many BWR nuclear power plants have begun decommissioning activities recently after completing the licensed operating period of 30 to 40 years, with the final goal of obtaining license termination and getting the property released based on the regulator's decommissioning regulations and guidelines. The power plants use a variety of strategies for dismantling systems, structures, and components, waste management, and deciding on the future use of the site. Typical activities include safely decommissioning of the plant, minimizing radioactive waste generation, fuel removal and storage, license termination and getting the site

restored and released. In the US, it is expected that decommissioning be completed within a period of 60 years.

Radioactive waste management is a major part of the decommissioning cost; however, the experience shows that this cost is much less than the staffing costs. This fact is an incentive for management to optimize the length of the decommissioning period to lower and control costs.

During decommissioning, plant sites typically use one of three approaches, Immediate Dismantling (Dcon), Safe Enclosure (Safstor) or Entombment (Entomb). Each approach has its benefits and disadvantages while most plants have used the SAFSTOR approach.

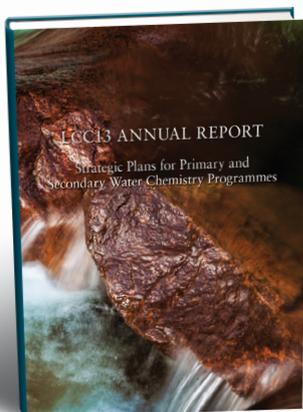
During DCON, equipment, buildings and parts of the facility and site that contain radioac-

tive contaminants are decontaminated to a level that permits removal of regulatory control and are dismantled shortly after the cessation of operations.

During SAFSTOR, a facility is left intact with fuel being removed and radioactive liquids have been drained from systems and components and then processed. Radionuclide decay occurs during the period of safe storage, thus reducing the quantity of contaminated and radioactive material.

During ENTOMB, radioactive structures, systems, and components are encased in a structurally stable material like concrete. The entombed structure is appropriately maintained and continuous surveillance is performed until the radionuclides decay to a level that meets regulatory requirements.

The report and the presentation will summarize the publicly available BWR decommissioning general information and experiences with salient features and practices employed in the decommissioning activity including potential costs involved.



## Strategic Plans for Primary and Secondary Water Chemistry Programs

The U.S. requirements for a Strategic Water Chemistry Plan, despite the additional work for plants, has been a benefit to U.S. nuclear utilities. The reasons for this are that it requires plants to consider the balance of plant components and their chemistry considerations to the overall integrity of the steam generator integrity, primary system pressure boundary and the fuel cladding integrity. This not to imply that either U.S. utilities or non-U.S. utilities would not consider these issues in developing their own water chemistry plans. However, these voluntary commitments

by the U.S. nuclear utilities has probably reduced the regulatory requirements imposed by the NRC, although this is not known for certain.

This document explains the Objective and Optimisation Methodology of this Strategic Water Chemistry Plan. For the Primary Coolant, it includes the Parameters Impacting or not the Pressure Boundary or Fuel Cladding Integrity. For the Secondary System, it includes the key elements and the components susceptibility and reliability. The report is of benefit to those non-U.S. utilities in developing their own water chemistry programs, both primary and secondary side.



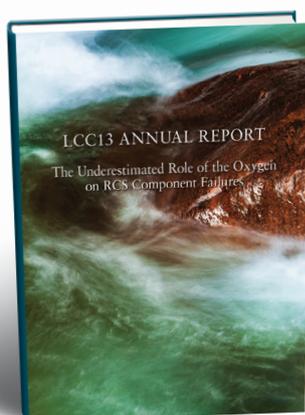
## Use of film forming amines (FFA) in nuclear power plants for lay-up and power operation

This report presents a new corrosion inhibitor based on film forming amines (FFA). The film forming amines (FFA), which are often referred to as fatty amines or polyamines, can form a mono-molecular hydrophobic film or layer adsorbed on the metal surfaces, that constitutes a homogeneous protective barrier against corrosion by its water-repellent behavior. FFA belongs to chemical substances of the class of oligo alkylamino fatty amines, the simplest representative being the well-known Octa-

decylamine (ODA). They show a high affinity to metal surfaces via the free electron pair of the amine functionality. The film established on the metal surface acts as a barrier for corrosive agents like oxygen and carbon dioxide (carbonic acid). According to lab and pilot plant studies, FFA based corrosion inhibitors provide a very high level of corrosion protection for carbon steels that are used in steam-water cycle of nuclear power plants (also in conventional auxiliary systems). Due to the volatility of the film forming amine, not only the steam generator (boiler) section but also the whole steam water cycle of the power plants, for example the condensate system, can be protected. The high affinity to surfaces can lead to a slow removal of surface deposits such as loose magnetite and impurities.

The film forming amines are successfully used as water treatment additives since several decades. Especially in the field of industrial plants but also in steam water cycle of nuclear power plants of VVER type in Eastern Germany and Russia they have shown positive treatment results. However, although steam water cycle including the steam generators of numerous VVER plants are operated since many years with FFA treatment, this technology was not applied in western nuclear power plants due to lack of knowledge and experience. Since several years, AREVA started to very successfully apply this treatment with a specific procedure in several PWR plants with the purpose to control the corrosion product transport into steam generators during the power operation and for long time lay-up of whole steam water cycle without using hydrazine. Even in a BWR plant this FFA treatment was applied in several parts of steam water cycle with success. The achieved results in several PWR, CANDU and BWR plants were excellent. Accordingly, based on the strong interest of the US nuclear industry, EPRI contracted AREVA to start with qualification program for US nuclear power plants.

This report explains the mechanism of the FFA chemistry treatment and summarizes the published information regarding the application results achieved in western nuclear plants.



## The underestimated role of the oxygen on RCS components failures

Any PWR chemist will tell you that there is no oxygen in the Reactor Cooling System because hydrogen injection suppresses the oxidizing species generated by radiolysis. This is why the RCS has no oxygen monitoring. In fact, this assessment is true only if free flowing conditions are considered. But the RCS contains many flow-restricted or occluded zones where some chemistry deviations can occur, one being oxygen presence. Typically, a good many of these areas is known from the corrosion that has been observed, the best example being the canopy seals. There is no reliable inventory of such flow-restricted or occluded zones; all we know is that the list is getting longer over the years; in fact, any time new oxygen induced corrosion is discovered. It is very likely that we do not know all the RCS areas where oxygen can be present.

This report aims at keeping plant chemist staying alert regarding oxygen tracking, ingress, venting, scavenging, monitoring... It also shows some examples of field failures that occurred because oxygen presence was not anticipated in the environment.

In the introduction of the report, it is reminded why the presence of oxygen into the RCS of PWRs has been banished; historically, it is mainly because of the risk of corrosion of

stainless steels.

Then, the deleterious action of oxygen on stainless steels is detailed. Basically, the main risk is intergranular corrosion. The intergranular corrosion is a localized corrosion with a preferential attack of grain boundaries of sensitized stainless steel. The origin of the mechanism is a chromium depletion of the grain boundaries which induces a loss of corrosion resistance when the material is exposed to a harsh environment.

After that, the behavior of oxygen in the RCS is explained. The role of the hydrogen injection is also presented.

There are many ways for oxygen to enter the RCS, so the sources of oxygen ingress into the RCS are listed. Oxygen can be present in the RCS: 1) in outage (because the RCS is open to the atmosphere), 2) during start-up (when the temperature is less than 120°C), 3) in operation in flow-restricted or occluded areas (in some locations, the oxygen results from air being dissolved in water during start-up) and 4) during shutdown (when H<sub>2</sub>O<sub>2</sub> is injected and/or when the Reactor Heat Removal System is connected to the RCS). The main chapter reports some examples of components and materials failures induced by the presence of oxygen in the RCS. Several field examples are detailed coming from French, US or German PWRs. Destructive examinations are presented illustrated with many pictures and sketches.

This report aims at helping plant engineers understanding why they should stay alert regarding oxygen control. The report shows there are several ways to limit oxygen ingress or to scavenge oxygen into the RCS. The oxygen specification may seem too stringent, however the failures presented in this report support a non-deviation application of the RCS oxygen specification.

## LCC13 Presentations without Reports

Additional presentations will be given on the following topics.

### Specification and guidelines evolution, proposals Secondary and Auxiliary Systems, PWRs and VVERs.

After the presentation at LCC 12 (2017) of guidelines specification and evolution for primary coolant for PWRs and for BWRs, a similar presentation will be given at LCC 13 on secondary system of PWRs and VVERs and for some auxiliary systems.

The presentation will include the main guidelines or specification (EPRI, EDF, VGB, VVER) applied in the world. These guidelines or specification are of high importance in the secondary system since they are the documents at the origin of the most likely occurrence of plant operation limitation, with potential shutdown.

The rationale for the various specifications or guidelines will be explained, together with their evolution, the link with materials sensitivity to various types of degradation, the related events and any other reason for differences from one to another guidelines or speci-

*“The long experience of the LCC Expert Team provides useful information for ‘sunny and cloudy days’ of a chemist’s job!”*

MICHAEL BOLZ  
NPP Philippsburg

cation.

The guideline is the background document from a main organism (EPRI, VGB) while the specification is the document applied in a nuclear power plant (EDF). The information given in this presentation will help Manufacturers, Utilities, Researchers and Regulators at understanding the differences in various documents and their practical efficiency for degradation mitigation, keeping a high level of safety and mitigating operating and maintenance costs as well and wastes releases into the environment.

## Hydrazine and possible alternatives

Hydrazine is used worldwide as reducing agent and corrosion inhibitor in the Steam-Water Cycle (Secondary side) and in the auxiliary systems of some PWR and BWR plants. It is also used in the Reactor Coolant System during plant start-up operations to remove oxygen.

However, since 1990s hydrazine is identified as carcinogenic chemical and due to this hazardous behavior of hydrazine there exists worldwide concern for its use because of its effect on human body and on environment. Although, as of today there is no prohibition by regulations for the use of hydrazine in PWR plants, in many countries there are restrictions for the release of hydrazine containing wastewater into the environment. Therefore, there exist concerns within the PWR Utilities worldwide that regulators may authorize such restrictions, limit or prohibit the use of hydrazine in the near future. That is the reason why, several organizations in USA and European countries started mainly in 1990s and in the first half of 2000s, but in few cases still up to present, to perform research work to find acceptable alternative products for the use in PWR plants.

This presentation summarizes the result of such investigations that includes not only the laboratory/loop tests but also the Plant trials performed worldwide and discusses the situation with respect to application of hydrazine and/or its alternatives in PWR plants.

## Reduction of Activity and Dose Rate by Use of Low Cobalt or Cobalt-free Materials in Light Water Reactors

The free activity inventory in LWR's is a result mainly from corrosion products dissolved in the reactor water. The dominant radionuclide is Co-60 which is formed by a neutron reaction from Co-59 mainly determined by Co containing structural parts especially from the core region. To reduce the activity the specific sources of Co-60 must be considered, such as hard facing alloys from stellite 6 (62.5 % Co) in valves, Co impurities in structural parts made from stainless steel (e.g. cladding of components, pipes, steam generator tubes) or e.g. stellite rollers in BWR control rods. Already during the design stage of NPP's the requirements concerning Co content of structural parts must be limited to the lowest level as possible.

Using the example of a Convoy plant (PWR) different measures to reduce Co content of structural parts in the core region as well in areas outside are presented. Beside of this the pH value of the primary water was increased from 6.9 to 7.4. As a result of all the dose rate was reduced by a factor of about 10 compared with plants from the first generation.

Renewal of first core control rod (CR) in BWR with a modern design by use of low Co blade material without pin and rollers was also very effective. Within a 10 year period after

the first CR replacement lot from the core the Co-60 activity in the reactor coolant dropped more than a factor of 3. The radiological improvements in NPP's from the measures taken above play an important role regarding the dose rate of the staff during operation. Nevertheless the measures presented act as advance payments in case of decommissioning.

## BWR Dose Rates and Dose Rate Mitigation

Typically, there are two types of dose rates or radiation fields generated in the BWR. Dose rate generated during BWR operation is called the operating dose rate, and the dose rate or radiation field generated when the plant is shutdown is called the shutdown or drywell dose rate.

The operating dose rate arises from the main steam line activity due to N-16 generation from the transmutation of O-16 to N-16. In the late 80's to mid 90's many BWRs in the US employed hydrogen water chemistry (HWC) to mitigate IGSCC of reactor internal materials. This required moderately high levels of hydrogen in the feedwater up to 2 ppm, in some instances, consequently increasing the reducing conditions in the reactor water resulting in enhanced N-16 activity in main steam lines. This type of operating radiation fields was mitigated in the later years by employing noble metal additions like NMCA or On-line NMCA. The use of these latter technologies allowed BWRs to operate with the same degree of IGSCC mitigation achieved with HWC, but with the addition of low levels of hydrogen (0.2 to 0.35ppm) into the feedwater which consequently greatly reduced the operating radiation fields. Some data will be presented on this development which has been in use for almost 2 decades.

The drywell radiation field increase is primarily due to the transport and deposition of Co-60 on out of core surfaces which is responsible for more than 90% of the outage personnel exposure. Co-60 is generated by the activation of elemental Co-59 on fuel surfaces. Thus, the radiation fields generated at each plant varies depending on the source term. Utilities have employed depleted zinc oxide (DZO) addition to control existing drywell radiation fields. Some Utilities have taken the more proactive approach of replacing cobalt containing materials with low cobalt materials to lower the source term to lowest possible levels.

Many US BWRs have also employed feedwater iron reduction using better filtration technologies to minimize cobalt transport. As an example, in the early 2000's there were only three BWRs that had feedwater iron levels of < 0.3 ppb while by 2014 there were 19 BWRs that had feedwater iron levels of < 0.2 ppb, of which 10 BWRs had feedwater iron levels of < 0.1 ppb. In addition to mitigating cobalt transport through the BWR heat transport circuit, low feedwater iron levels have also resulted in low feedwater zinc demands to achieve low radiation fields lowering plant operational costs and depositing less zinc on fuel crud that has become a recent concern in regard to fuel crud spallation. More recently, resin technologies have also been developed to specifically capture Co-60 species as a means of lowering Co-60 transport.

Data will be presented on the above technologies and any new technologies that may emerge over the course of the year.

## Invited presentation

(To be defined later)

## LCC13 Experts

The experts are: Dr. Francis Nordmann, formerly at Électricité de France, Mr. Peter Rudling, president of ANT International, Dr. Samson Hettiarachchi, formerly at GE Hitachi, Dr. Suat Odar formely at AREVA, Mr. Dewey Rochester, formerly at Duke Energy, Mr. François Cattant, formerly at Électricité de France and Dr. Ulf Ilg, formerly at EnBW.



*Dr. Francis Nordmann* has over 47 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 (now Areva). 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
- International projects with various countries and organisations
- Organising committee of several International Conferences on Chemistry for Nuclear Reactors



*Mr. Peter Rudling* is the President of ANT International, managing the ZIRAT/IZNA/LCC Programmes as well as providing seminars and Handbooks on various fuel related topics to the nuclear industry. Peter was a senior consulting scientist at Vattenfall, the largest Swedish power company. Earlier he has also been a Specialist of Fuel Materials at ABB Atom (now Westinghouse) and a Project Manager at EPRI.



*Dr. Samson Hettiarachchi* has 40 years of experience as a college lecturer, researcher, innovator and a technologist. He has held a variety of technical positions at GE Nuclear Energy as Chief Engineer/Physical Sciences, Chief Technologist/Chemistry, Engineering Fellow and Principal Engineer prior to his retirement from GE in February 2011. Prior to joining GE, he held the position of Electrochemist/Senior Electrochemist at SRI International (formerly Stanford Research Institute)

and the position of Lecturer/Senior Lecturer in Chemistry at the University of Colombo,

Sri Lanka. Two of his innovations at GE Nuclear Energy, NobleChem™ and On-Line NobleChem are widely used in the US, Japan, Spain and Switzerland to extend the life of Boiling Water Nuclear Reactors. Dr. Hettiarachchi's research experiences include Physical Chemistry, Electrochemistry, Surface Chemistry, Catalysis, Corrosion and Mitigation of materials, Battery Technology, Sensor Technology, and In-situ Generation of Nano-particles. He has worked in the nuclear power industry related work for about 25 years. His specific experiences in the nuclear industry include, Development of ECP sensors, ECP monitoring, High Temperature pH Measurements, Zeta Potential Measurements, HWC Benchmark Tests, Water Chemistry Guidelines, Dose Reduction, Fuel Corrosion, SCC Mitigation, NobleChem Applications, On-Line NobleChem Applications, Inspection Relief Criteria Development, and Plant Chemistry/Materials Education and Training. For many years he has participated in EPRI BWRVIP Mitigation Committee Meetings and several IAEA Meetings. He has over 100 publications in International Journals and International Conference Proceedings and holds 27 issued US patents. He has been a peer reviewer for the Corrosion Journal and the Journal of Nuclear Science and Engineering.



*Dr. Suat Odar* has 42 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



*Mr. Dewey Rochester* retired from Duke Energy Carolinas LLC in June 2010 after working for thirty six years in the field of nuclear power plant chemistry. He began his career in May 1974 at Duke's Oconee Nuclear Station as a Junior Chemist. He was promoted to site Chemistry Manager in February 1978. In September 1984 he transferred to the corporate office to lead the process qualification programme for the steam generator chemical cleaning at Oconee. From 1989 until 2003

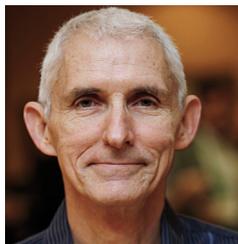
he worked on a variety of projects dealing with primary and secondary water chemistry,

and steam generator corrosion issues as well as performing assessments of plant chemistry performance. In February 2003 he was promoted to Duke Energy's Corporate Nuclear Chemistry Manager, where he led the group responsible for the development of the site chemistry programmes at Duke's three nuclear sites. During his career he has worked in all phases of nuclear power plant chemistry including makeup water production, primary and secondary chemistry, radwaste processing and steam generator chemical cleaning and corrosion. He has authored and co-authored several papers on steam generator chemical cleaning, radwaste processing, steam generator corrosion issues, and the use of dispersants to mitigate steam generator deposition. He also made numerous presentations at various conferences and seminars.

Some of his interests include:

- Chemical cleaning processes and corrosion monitoring
- Core design impact on corrosion product releases
- The use of dispersants for steam generator deposition mitigation
- Post-accident sampling systems
- Steam generator corrosion issues
- Primary and secondary water chemistry guidelines
- Zinc addition to mitigate plant dose rates

He served twice as Chairman of the Babcock & Wilcox Steam Generators Owner's Group, Chairman of the EPRI Chemistry Subcommittee and a member EPRI Steam Generator Owner's Group Technical Support Subcommittee and Integration Committee.



*Mr. François Cattant* graduated in chemical engineering in 1974 and joined Electricity of France (EDF) in 1975 as chemist engineer at the chemical department of the corporate laboratories (Plants Operation Division). At that time, he was involved in power plants water and steam conditioning. Up to 1995 he worked in the following technical fields as an expert:

- Failure root cause analysis of gas-cooled reactors components, including fuel
- Water & steam chemistry, chemical cleaning and NDE for fossil fired stations
- Failure root cause analysis of nuclear power plants irradiated or contaminated parts & components and reactor pressure vessel (RPV) irradiation programs monitoring
- Examination of Dampierre 1 retired steam generator, to the examination of RPV head penetrations, to the study of thermal embrittlement, to the analysis of wear

Between 1995 and 1998 he was loan-in to the Nuclear Maintenance Application Center at EPRI Charlotte (NC, USA). He was involved in various maintenance guides such as those of pumps or diesel generators. He also acted as EPRI expert for the examination of Ringhals 3 retired steam generator.

In 1998 he moved back to France, at the R&D Materials and Mechanics of Components department where he stayed until his retirement in 2009. He served there as scientific advisor and senior engineer. His area of expertise was again chemistry, corrosion, and metallurgy, with special attention to primary water chemistry, source term reduction, primary water corrosion (Alloys 600/182/82, SSs), PWSCC mitigation and repair, fuel cleaning, innovation strategy. He also served as the EDF representative to the EPRI Materials Reliability program. During this period:

- he was under contract with EPRI, being EPRI technical expert regarding several destructive examinations such as North Anna 2 RPV head penetrations, South Texas Project 1 Bottom Mounted Instrumentation, Braidwood 1 pressurizer heater #52, San Onofre 3 CEDM #64...

- he was the President of the "Materials, Non Destructive Testing and Chemistry" section of the "French Nuclear Energy Society" (from 2004 to 2008);
  - he was also the Materials Ageing Institute (MAI) International Partnership Manager.
- During his career he made many presentations and papers in international conferences and scientific journals.

In 2010, he was sponsored by the MAI to write a "Handbook of Destructive Assays", a 1100 pages' document putting together extended summaries of hundreds of destructive examinations performed on LWRs' NSSSs, in France, US, Japan and Sweden.



*Dr. Ulf Ilg* received his first degree as "Diplom-Ingenieur" in Mechanical Engineering from the Technical University Karlsruhe (today KIT), Germany. His Ph.D was obtained at the same university after a scientific research period of 5 years in the field of microstructure and residual stress alteration due to rolling contact fatigue. Since 1981 he was in charge of the German utility EnBW. At that time his major activities had been project engineering for fossil, hydroelectric and new

nuclear power plants. Later he was responsible for reactor engineering materials, structural integrity and ageing management at the nuclear power plant Philippsburg (one BWR and one PWR), EnBW Kernkraft (Germany).

His special areas of activities implied:

- Quality assurance during construction of the Siemens Convoy Plant Philippsburg 2
- Welding technology
- Mechanical stress and lifetime analysis
- Corrosion-assisted cracking phenomena of nuclear materials
- Failure analysis of reactor components
- Materials degradation and ageing
- Evolution and realisation of backfitting strategies
- Zircaloy cladding and fuel technology for reloads (BWR as well as PWR)
- R&D-projects dealing with fuel, corrosion, integrity and fracture mechanics

For a long time he was member in several national and international technical committees and chairman of the VGB working group "Materials and Integrity of Nuclear Components" of the German utilities. As author and co-author he published more than 50 papers on Nuclear Engineering and gave more than 100 lectures in this field. He is co-author of the Physical-Technical Book "Reaktortechnik", SpringerVieweg, 2nd issue, 2013 and is till today lecturer for welding technology at the Cooperative State University Karlsruhe. In March 2014 he retired from EnBW.

## Price and Terms of Payment

The fixed nominal price for the LCC Membership appears in the associated Proposal.

## Terms and Conditions

The term of LCC13 Programme starts from the date of the purchase order and lasts 12 months onwards.

ANT International shall exercise its best efforts to meet the objectives in this assignment and shall apply to the work professional personnel having the required skills, experience and competence. If the assignment is found to be significantly deficient by the customer within 6 months of its completion, ANT International shall modify the work done within this assignment in such a way that it will become satisfactory to the customer. This modification shall be done without incurring any additional costs to the customer. The total amount of such additional costs due to the modification shall be limited to be less or equal to the amount originally paid to ANT International for this assignment.

It is understood that ANT International is not responsible for any damage, incurred to the customer, their employees, or their plants or to a third party due to the use of the information or the recommendations given within this assignment.

The compiled information and the conclusions, as a result of this work, may be used by the purchasing party for its own use for any purpose provided that the source is given. ANT International retains the rights to the compiled information and the conclusions for other uses.

## Nuclear Liability

ANT International and its sub-suppliers, including also suppliers of information and services, of every tier and kind, and everyone engaged by any of them, shall have no liability whatsoever (irrespective of negligence or gross negligence) for any damage or loss whatsoever (including also consequential and indirect loss) resulting from a nuclear incident (as such term is defined in the Paris Convention on third party liability in the field of nuclear energy, as amended from time to time). This shall apply for damage or loss suffered by third parties or the owner and for damage and loss to the nuclear installation, on site property and any other property of any kind, and until the nuclear installation has been decommissioned and irrespective of any termination or cancellation of the proposed work.

Insurances of the owner and of others in respect of a nuclear incident shall exclude any right of recourse against the supplier and his sub-suppliers of every tier and kind.

## Contact

For more information and/or an offer welcome to contact us at [sales@antinternational.com](mailto:sales@antinternational.com)

Please also visit our website for the latest updated information, [www.antinternational.com](http://www.antinternational.com)



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