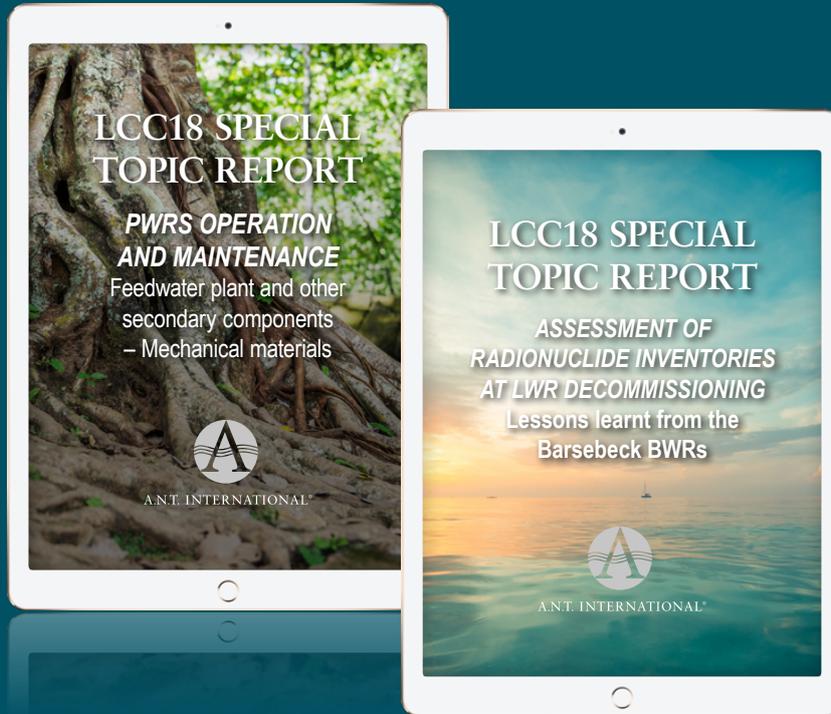




A.N.T. INTERNATIONAL®

Boosting your Excellence through Knowledge and Training



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LCC™

LWR Chemistry and Component Integrity Programme

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 LCC16 Programme, currently 19 organisations in North America and Europe are members.

The Programme was started in 2004.

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 burn up of fuel, increased fuel duty with more nucleate boiling in Pressurised Water Reactor (PWR's). Plant power up rates 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 and safe long term operation of the Nuclear Power Plants.

It is our goal that the LCC Programme shall assist the LCC Members in meeting all these water chemistry and material related challenges in the most efficient way. This Programme reviews and evaluates the developments and trends in the 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 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 organizations.



[Listen to Mr Juan De Dios Sánchez, Zapata](#)

[Listen to Mr. Niels Van Dijke, EPZ](#)

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

Increase 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

Guide 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.

Improve plant operation and chemistry control and monitoring

Assist in the training and education of a new generation of chemistry and materials experts.

Establish 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 with added point of view of LCC experts

“One of the main advantages with these seminars is the contacts you can make with the experts”

JOLANDA CAPPAERT-DE VOS
EPZ

”Excellent presentation material given in a thoroughly professional manner. Excellent interaction with regard to answering the questions raised by the audience.

CHRISTOPHER SMITH
Rolls-Royce

LCC18 Reports

PWRs operation and maintenance - Feedwater plant and other secondary components – Mechanical materials

At LCC17, a report entitled “The condenser: a key player for a good feedwater chemistry” was presented. This document was reporting a rather comprehensive experience of operating and maintaining PWRs’ condensers. In the balance of plant, condenser and feedwater plant go together like horse and carriage. Therefore, it makes sense proposing at LCC18 reporting the operation and maintenance of the feedwater plant. In fact, the LCC18 report, entitled “PWRs operation and maintenance - Feedwater plant and other secondary components – Mechanical materials”, as its title says, covers more than just the feedwater plant section.

The first section of the LCC18 report is dedicated to the feedwater plant and other secondary system components, i.e.: feedwater plant reheaters, moisture separator re-heaters, feedwater plant pumps and steam generator turbine driven auxiliary feedwater pumps; whereas a second section is dedicated to mechanical materials, i.e.: piping and supports, valves, pumps and bolted connections. given as it also covers other secondary components.

As for the LCC17 report on the condenser, the LCC18 report is also about compiling field operating experience and maintenance as its content shows.

CONTENT

1. Summary
2. Secondary system overview
3. Feedwater plant and other secondary components
 - 3.1 Feedwater plant reheaters
 - 3.2 Moisture separators reheaters
 - 3.3 Extraction pumps
 - 3.4 Feedwater pumps
 - 3.5 Auxiliary feedwater pumps
- 4 Mechanical materials
 - 4.1 Pipes et supports
 - 4.2 Valves
 - 4.3 Pumps
 - 4.4 Bolted connections
- 5 Conclusion
- 6 Industry perspective

Assessment of radionuclide inventories at LWR decommissioning – Lessons learnt from the Barsebeck BWRs

The two Barsebeck BWRs were finally shutdown in 1999 and 2005, respectively, after around 25-30 years of commercial operation. At present the two plants are subject to a decommissioning project. An important part of the project is the assessment of radionuclide inventories to be stored as decommissioning waste. These inventories are determined by a combination of calculation methods and special validation measurements.

The report will describe:

- **Neutron activation products in reactor internals, pressure vessel and biological shield.**
 - » Calculation methods (neutron transport, neutron activation)
 - » Validation data
- **Contamination of different plant system**
 - » Activated corrosion products, fission products, actinides
 - » Used calculation models and performed validation measurements
- **Contamination of different building parts.**

The report will end with a discussion section, where uncertainties are addressed as well as some recommendations for future projects.



“An excellent seminar, it
was very useful for me”

JOLANDA CAPPAERT-DE VOS
EPZ

“I learned a lot of
chemistry in a plant”

MAGDALENA WILZYNSKA
KKL

Deliverables

A.N.T. International will provide the LCC Members with the following:

- A Seminar will be held in Spring 2023 in Europe, most likely in Madrid, Spain, to present the results of the LCC Programme. The number of full-time employees per Member that may attend the seminar is limited to eight (8) people per organization.
- Before the seminar, you will have access to:
 - » High-resolution searchable pdf-files with the complete Reports as well as the presentation material 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 Reports and presentation material 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.
 - » All figures and tables with A.N.T International copyright can be used by the member both internally and externally, provided that the source is stated in the caption.
- 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.
- LCC members have an option to purchase:
 1. [Previous LCC reports](#) at a 50% discount and
 2. 12 months access to [A.N.T. International Online Education Courses](#) at a large discount.
 3. Consulting hours related to large projects for a discounted hourly rate

“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

“A.N.T. International provides excellent material for education, this supports the very important transfer of knowledge in times when alternation of generation becomes a problem in many nuclear power plants.”

BERNT BENGTSSON
Vattenfall

Bios of LCC18 Lecturers



Dr. Jiaxin Chen joined Studsvik in 1997 and currently works as Senior Specialist in fuel crud and oxide characterisation in Studsvik Corrosion and Water Chemistry Laboratory. He was adjunct professor at Department of Physics, during 2014-2016, and now at Department of Chemistry and Chemical Engineering (from 2020), Chalmers University of Technology. His recent research interests include quantum chemistry study on coolant zinc interaction with oxides; microstructural characterization of fuel crud and solids in LWR coolant; corrosion kinetics of reactor material surfaces in LWR primary coolant; characterisation of radioactive deposit on LWR piping surfaces; stability of neutron absorber materials in reactor coolant. In the field of PWR fuel crud, he and his colleagues at Studsvik have made some significant experimental findings that are of high value for the industry.



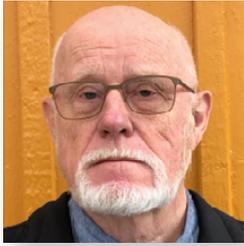
Mr. François Cattant graduated in chemical engineering in 1974 and joined Electricity of France (EDF) in 1975 as chemist engineer at the chemical department of the corporate laboratories (Plants Operation Division). At that time, he was involved in power plants water and steam conditioning. Up to 1995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

- **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. From 2004 to 2008, he was the President of the "Materials, Non Destructive Testing and Chemistry" section of the "French Nuclear Energy Society". 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.



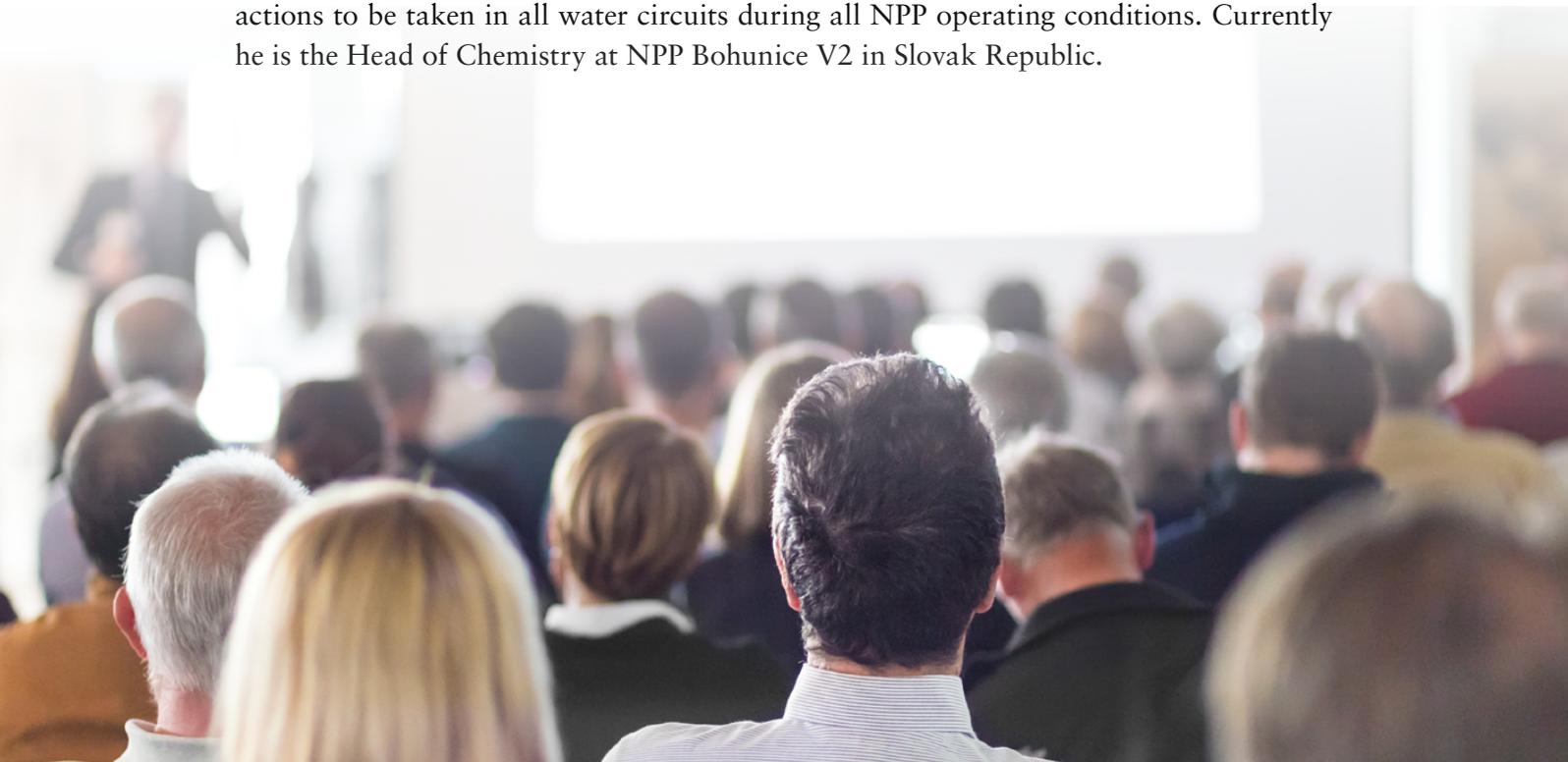
Mr. Klas Lundgren graduated 1973 in M.S Engineering Physics, Chalmers University of Technology, Gothenburg, Sweden. Joined ASEA-ATOM (later ABB Atom) in 1973. Was one of the founders of ALARA Engineering in 1995, which from 2008 was incorporated in Studsvik Nuclear. Klas holds presently, 2021, a position as Senior Specialist in radiation technology at Studsvik Nuclear.

Main areas of interest have been:

- **BWR water chemistry, radiation and materials** - sampling and analysis, cleanup systems, condensate, feed and reactor water chemistry, gamma scanning and radiation measurements, Hydrogen Water Chemistry, radiochemistry evaluations, ALARA reviews in European and US BWRs, computer models for activity buildup in BWRs, post-accident analysis, computerized plant chemistry and activity data systems, radioactivity monitoring systems, radwaste and offgas systems. Plant-Life-Extension (PLEX)
- **PWR water chemistry and radiation** – Radiolysis chemistry, activity build-up, safety analysis and source terms
- **Radiation shielding and radiation technology** - computer code development, shielding design of BWRs and waste handling facilities, neutron transport calculation for activation and criticality analysis, radiation surveillance at power plants, reactor decommissioning analysis, safety analysis reports. shielding and neutron activation calculations of proton cyclotrons.



Mr. Igor Škorvaga (M.S., Organic Chemical Technology, University of Chemistry and Technology, Prague, Czech Republic) has been working for 25 years in seven different work positions in the Chemistry Department of both Nuclear Power Plants (NPPs) in Slovak Republic (four WWER units at Bohunice and Mochovce). He has participated in three International Atomic Energy Agency (IAEA) Chemistry Expert Groups and in eleven World Association of Nuclear Operators (WANO) Peer Reviews as an NPP Chemistry Expert. He has been in charge of NPP Chemistry supervision, evaluation and implementation of corrective actions to be taken in all water circuits during all NPP operating conditions. Currently he is the Head of Chemistry at NPP Bohunice V2 in Slovak Republic.





Professor Was received his ScD from MIT in 1980, after which he joined the Nuclear Engineering Department at the University of Michigan as an Assistant Professor. He became Full Professor in 1990 and was endowed with the Walter J. Weber, Jr. Professor of Sustainable Energy, Environmental and Earth Systems Engineering chair in 2007. He holds appointments in Nuclear Engineering and Radiological Sciences, and Materials Science and Engineering at the University of Michigan and has served as Director of the Michigan Memorial Phoenix Energy Institute, Associate Dean of the College of Engineering and Chair of the Nuclear Engineering and Radiological Sciences Department twice. Professor Was' research is focused on materials for advanced nuclear energy systems and radiation materials science, including environmental effects on materials, radiation effects, ion beam surface modification of materials and nuclear fuels. Most recently his group has led the development of ion irradiation as a surrogate for neutron irradiation in reactor structural materials, and he has utilised that capability to uncover the mechanism of irradiation assisted stress corrosion cracking of reactor core structural materials.



Terms and Conditions

The term of LCC18 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, A.N.T. 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 A.N.T. International for this assignment. It is understood that AN.T. 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. A.N.T. International retains the rights to the compiled information and the conclusions for other uses.

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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.



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