A.N.T. International Academy

Online Education

by A.N.T. International Academy

For nuclear engineers at all levels

for more information visit: www.antinternational.com

Online Education
by A.N.T. International Academy

GENERAL INFORMATION

What is A.N.T. International Online Education Programme?

Our courses provide training and knowledge in the areas of nuclear fuel, structural materials and coolant chemistry. The course material is online based and can be accessed at times convenient for practicing engineers and managers.

Who is the programme suited for?

Nuclear engineers and managers with knowledge ranging from no nuclear experience to expert level. Our clients work for utilities, regulators, fuel/reactor vendors, nuclear laboratories and experimental reactors.

Why is a special online educational programme needed?

The Universities cover the theoretical aspects of nuclear plant operation but not the practical aspects of operational issues and problem solving. These courses will bridge the gap between theoretical and practical aspects that is critically needed at the current juncture where the utilities are hiring new young engineers.

What's the benefit for you as a customer?

Overall, the courses can enhance profitability and nuclear safety. More specifically, the courses cover more practical aspects, problems faced by the industry and solutions, critical thinking, background knowledge, current knowledge updated every year, helps improving safety culture, and ultimately provides a certificate of achievement to the participants on successful completion of the course.

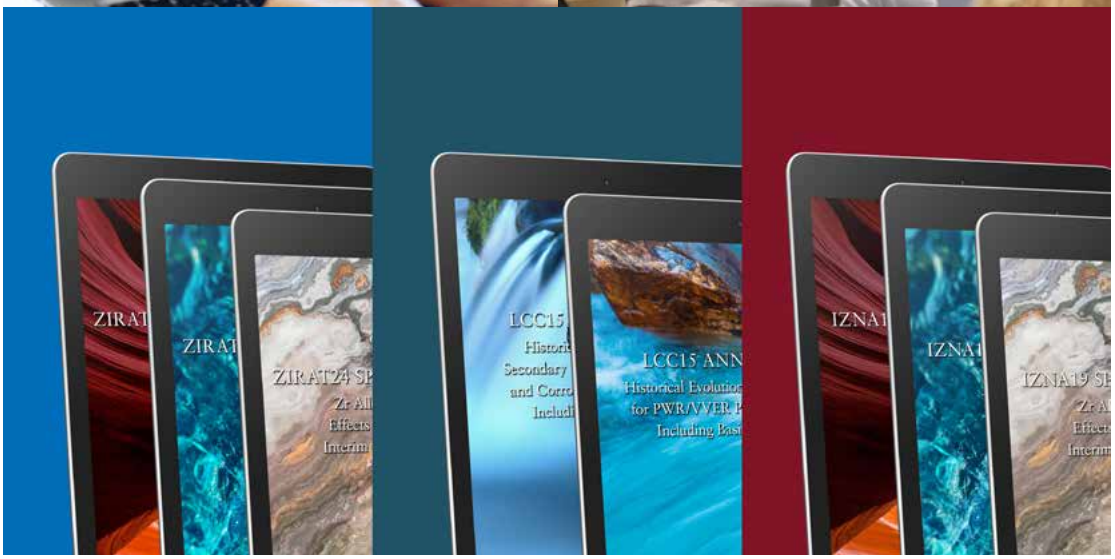
Why online?

The online approach provides the freedom to complete the course at each individual's pace which is highly appreciated by busy professionals and nuclear engineers. Since the training takes place online it is highly cost effective for you as a customer, while still providing a required qualification with up to date nuclear training.

Why A.N.T. International and how are we unique?

Through our independent world class network of experts we can provide unique knowledge and experience in the nuclear field. We do not rely on fuel vendors and the information provided in our products and services is unbiased and analysed with a bird's eye view on the business. The lectures are based on seminars conducted by A.N.T. International's experts. Our seminars are much appreciated by the participants with highest ranks in our evaluations. Please see a few of our average scores in the table below (rating from 1/poor - to 5/excellent):

	Average	Number of Responses
How did the level of the information fit your background?	4.0	524
How well did we meet your expectations with the seminar/course?	4.2	313
How were the speakers?	4.4	322
What is your oppinion of the A.N.T. International reports?	4.3	914
What is your overall opinion of the seminar/course?	4.4	328



OUR EXPERTS, YOUR LECTURERS

Our experts have more than 600 years of cumulative experience working for fuel/reactor vendors and nuclear utilities such as Duke Energy, General Electric, AREVA NP GmbH, AREVA NP, Electricité de France (EDF), EnBW, Harwell Laboratory of the UKAEA, etc.

Of the 18 experts, 14 have a Ph.Ds. Their specialties cover a large spectrum of subjects. During their working careers they have held a large range of responsible positions: Manager of Fuel Channels Components Branch, Chief Technologist/Chemistry, Manager of Safety Analysis Engineering and Fuel Development, Manager of Materials Technology, Manager of the Corrosion Mitigation and Coatings Laboratory, Expert Consultant in corrosion and stress corrosion of materials, Head of the corrosion department of the Technical (R&D) Centre, International expert in charge of chemistry and corrosion in the corporate offices, Chief Physical Sciences, Engineering Fellow, Chief Technologist, Chemistry Manager.

THE NETWORK OF EXPERTS

Fuel Material

Dr. Charles Patterson retired from Global Nuclear Fuel in 2008 as a Consulting Engineer for Fuel Engineering. During 44 years with GE Nuclear Energy/GNF, he was actively engaged in the development of fuel manufacturing processes, fuel materials, thermal-mechanical and fuel performance models and in the improvement of fuel reliability.

Dr. Kit Coleman spent his working career at the Chalk River Laboratories of AECL He worked on several aspects of zirconium metallurgy applied to the components of the CANDU reactor. He retired in 1999 but retains an attachment to AECL as a Researcher Emeritus.

Dr. Sheikh Tahir Mahmood retired from Global Nuclear Fuel in 2012 as a Senior Engineer/ Technologist for fuels Engineering at the Vallecitos Nuclear Center. At GE Nuclear Energy/ GNF, he was actively engaged in fuel performance and materials technology. He has a doctorate in Nuclear Engineering from North Carolina State University. His Post-doctoral work on mechanical anisotropy of zirconium alloys and radiation effects on reactor structural materials was done at NCSU and ORNL, respectively.

Mr. Friedrich Garzarolli retired from Framatome ANP in March 2002, where he has held various managerial and research positions, dealing with fuel rod performance analysis, planning and evaluation of irradiation tests, materials characterisation and evaluation of irradiation effects in materials. His degree as Diplom lngenieur in metallurgy was obtained from the University of Leoben, Austria, in 1963.

Dr. Ron Adamson retired from GE Nuclear Energy in 2000, where he was the manager of Materials Technology. During his 31 years with GE, Dr. Adamson was actively involved with utilities and the technical community worldwide. He has a PhD in Metallurgy and has done post-doctoral work on irradiation effects, conducted at AERE, Harwell, England.

Mr. Kenny Epperson independent consultant, previously a Principal Engineer with Duke Energy, involved in fuel assembly thermal-hydraulic analysis, fuel performance evaluations, and plant support with fuel performance issues. Involved directly in four fuel product transitions for seven units as well as four first of a kind LTA programs for new fuel designs.

Dr. Clément Lemaignan retired from CEA in 2009. He has spent his entire carrier in the field of nuclear materials. Research director he was in charge of basic and applied research on fuel and Zr alloys, with special emphasis on physical mechanisms. For his research and teaching, Prof. Lemaignan has received many distinctions, among them the Kroll award from ASTM in 2001.

Dr. Albert Machiels retired in June 2017 from the Electric Power Research Institute [EPRI] located in Palo Alto, California, he has 50 years of involvement in various fields of nuclear technology R&D, including faculty and program direction positions at several universities and EPRI. In 2012, Dr. Machiels received a Lifetime Achievement Award for his numerous technical contributions to nuclear technology.

Dr. Malcolm Griffiths obtained his PhD in Physical Metallurgy from the University of Birmingham in 1981. After a three-year post-doctoral term working on radiation damage in Ti-alloys he joined AECL at the Chalk River Laboratories in 1984. He has worked on various aspects of materials performance in nuclear reactor cores during his 32 years with AECL.

Mr. Peter Rudling 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 Westing- house) and a Project Manager at EPRI. Peter is the President of A.N.T. International, managing the ZIRAT/IZNA/LCC programs as well as providing seminars and Handbooks on various fuel related topics to the nuclear industry.

Structural Materials Degradation

Mr. François Cattant joined Electricity of France (EDF) in 1975, where he examined failures and did root cause analysis of nuclear reactor components. After a 3 year stay at EPRI in the US, he joined EDF R&D Materials and Mechanics of Components Department, working on primary water chemistry, source term reduction, primary water corrosion, corrosion mitigation and repair and fuel cleaning. From 2004 to 2008, he was the President of the "Materials, Nondestructive Testing and Chemistry" section of the "French Nuclear Energy Society". François retired from EDF in 2009.

Dr. Peter Scott started his career in the nuclear industry in the Materials Development Division at the Harwell Laboratory of the UKAEA in 1971and during 19 years at Harwell became a section head and a recognised expert in corrosion fatigue and stress corrosion cracking of materials in thermal and fast reactor systems. He joined the Framatome Group (now AREVA NP) in 1989 where he was an Expert Consultant for 18 years in corrosion and stress corrosion of materials, mainly in PWRs, until his retirement at the end of January 2008.

Dr. Ulf Ilg received his Ph.D from the Technical University Karlsruhe (today KIT), Germany, after a scientific research period of 5 years in the field of microstructure and residual stress alteration due to rolling contact fatigue. From 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, EnBW Kernkraft, Germany.

Coolant Chemistry and Corrosion

Dr. Francis Nordmann has over 40 years of experience in power plant chemistry. He is retired from Electricite' 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 programs. His Ph. D degree was obtained at the French Atomic Energy Commission, in connection with the University of Mulhouse in 1973.

Dr. Suat Odar has over 35 years of experience in power plant chemistry. He is 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. His degree as Ph.D. in Physical Inorganic Chemistry was obtained from the Technical University of Darmstadt, Germany, in 1970.

Mr. Dewey Rochester, retired from Duke Energy Carolinas LLC in June 2010 after working for thirty six years in the eld of nuclear power plant chemistry. Since February 2003 he was Duke Energy's Corporate Nuclear Chemistry Manager, where he led the group responsible for the development of the site chemistry programs at Duke's three nuclear sites.

Dr. Samson Hettiarachchi has more than 33 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. He obtained his Ph.D. degree in Electrochemistry from the University of Cambridge, UK, in 1976.

Dr. Wilfried Ruhle has been working in nuclear power industry for over 35 years. His degree as Ph.D. in chemistry, physical chemistry and radiation biology he has got from the faculty of natural sciences at Heidelberg University, With a background in chemistry, radio chemistry and radiation biology he joined the German energy supplier EnBW. There he was in charge of the chemistry department for two Nuclear Power Plants (NPP), one BWR and one PWR.

Online Education

by A.N.T. International Academy

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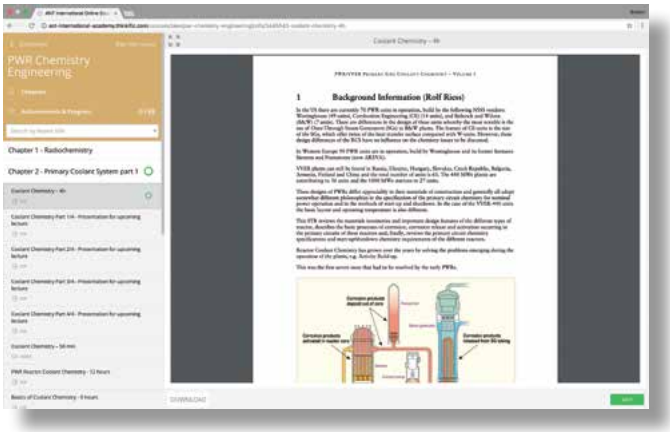

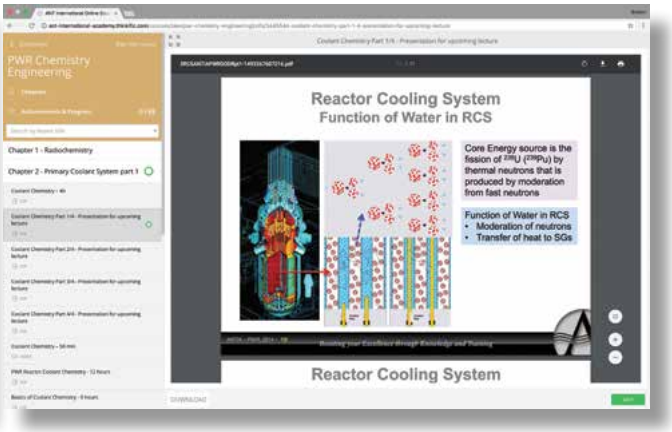

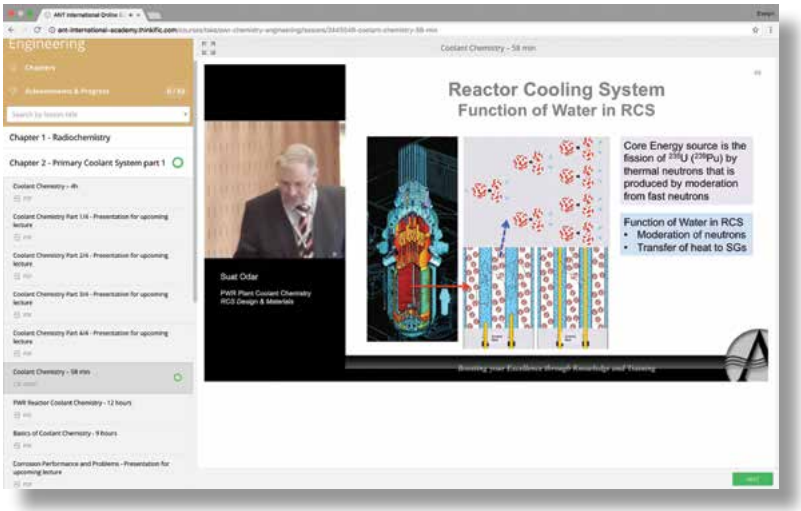

INDIVIDUAL COURSES

A.N.T. International Academy provides a variety of courses in the areas of Fuel Material, Structural Material Degradation and Coolant Chemistry & Corrosion.

BASIC

4 HOURS – 4 DAYS

For Managers and Engineers with no nuclear experience.

INTERMEDIATE

4-6 WEEKS

For Engineers with nuclear experience and Technical Managers.

IN-DEPTH

10-15 WEEKS

For specialists.
(The Intermediate course is required for this course)

EXPERT

1 WEEK

For experienced specialists.

The above listed times are approximations of how long it would take to finish the course when conducting full time studies.

The Basic courses involves watching lectures, while the Intermediate, In-depth and Expert courses also requires reading technical reports. To finish the course, and to be able to proceed to the next level of the more advanced courses, online tests needs to be completed to show an understanding of the current material. The course material, including the online content, can be accessed at times convenient for practicing engineers and managers.

You will automatically receive an email with a certificate that you can print or share on social media. If you need a printed certificate, please don't hesitate to contact us and we can send it to you via regular mail.

You reach us at: *support@antinternational.com*.

FUEL MATERIAL

The following courses are available.

COURSE NAME	DIFFICULTY LEVEL	COURSE LENGHT
Thermal Hydraulics in PWR Fuel	Basic	4 hours
Fuel Introduction	Basic	15 hours
PWR Fuel Engineering	Intermediate	3 weeks
BWR Fuel Engineering	Intermediate	3.5 weeks
PWR Fuel Advanced	In-depth	4.5 weeks
BWR Fuel Advanced	In-depth	5-6 weeks
Irradiation Growth ← NEW COURSE	Expert	10 hours
Zirconium Alloy Manufacturing	Expert	12 hours
Fuel Reliability	Expert	15 hours
Fuel Design Review	Expert	2 weeks
Fuel Fabrication Audit/Review	Expert	2 weeks
Interim Dry Storage	Expert	10 hours
Delayed Hydride Cracking	Expert	1 week

Thermal/Hydraulics in PWR Fuel

Click here to try it for free!

Engineers are taught in school the basic fundamentals of the physical process involved in nuclear power generation. Once employed in the industry, the specific design and requirements of the finished fuel product are observed through day to day activities. Often what is missing is a clear path linking the relationship of the physics to the finished product.

The design of this course is to cover the basic physical laws related to nuclear fuel and show how these directly affect the design, analysis, and operation of both the fuel and related reactor systems. The discussion will show the links from the fundamental equations to the fuel design, through the cycle analyses, and culminating with the operating limits in PWRs. The course will focus mainly on the thermal-hydraulic and neutronics of the fuel but will also include key fuel rod mechanical items. In addition, a short discussion will show real life examples of how application of basic fundamentals can explain observed operating anomalies.

The course material was developed by A.N.T. International and consists of pre-recorded A.N.T. International Seminars.

The authors/lecturers of the reports and lectures, World Class Experts in their fields, are as follows:

- Mr. Kenneth Epperson

Course Appendix

1) NEUTRONICS

FREE PREVIEW

» Basic Relationships, including key assumptions for PWR application

» Relationship of key Components to Reaction Rate Equation

» Safety Criteria for PWR Operation

» Key parameters for Cycle Design and Analyses

2) THERMAL HYDRAULICS

» Basic Equations for PWR application

» Forms of Heat Transfer in PWRs

» Safety Criteria for Cycle Operation

» DNB Protection in Fuel Cycle Designs

3) FUEL ROD MECHANICAL DESIGN

» Basic Equations and Relationships

» Safety Criteria for Cycle Operation

4) APPLICATION OF FUNDAMENTALS TO OPERATING ANOMALIES

Additional Information

COURSE LENGTH:

4 hours

LECTURES:

4 hours

DIFFICULTY LEVEL:

Basic

In addition to seminar footage and their corresponding presentations, courses may include partial reports previously published by A.N.T. International, which you can download to read offline.

TRY THIS COURSE FOR FREE!

All of our currently available courses have selected content you can access completely free of charge such as lectures, and reading materials. For more information, email us at:

sales@antinternational.com

Download the course brochure for detailed information and full Course Appendix.

Fuel Introduction

Click here to try it for free!

This overview course gives an introduction to Fuel Material and will provide engineers/managers with the necessary background information to understand more complicated fuel material information. The course involves watching recorded lectures and participating in an online assessment (test).

The course material was developed by A.N.T. International and consists of pre-recorded A.N.T. International Seminars.

The authors/lecturers of the reports and lectures, World Class Experts in their fields, are as follows:

- Dr. Charles Patterson
- Mr. Peter Rudling

Course Appendix

click here to view full appendix

1) FUEL CYCLE, REACTOR/FUEL DESIGN

- » Introduction — FREE PREVIEW
- » Fuel Cycle
- » Fuel Suppliers — FREE PREVIEW
- » Reactor Design
- » Fuel Assembly Materials
- » PWR, VVER, and BWR Fuel Design Specifics

2) REACTOR SAFETY

- » Reactor Safety and Mechanical Design Criteria

3) FUEL DESIGN AND DESIGN CRITERIA

- » Design Verification, Fuel Performance Codes, Treatment of Uncertainty
- » Thermal-Hydraulic Design Criteria
- » Nuclear Design Criteria

4) FUEL PERFORMANCE DURING NORMAL OPERATION, ACCIDENT CONDITIONS & INTERIM DRY STORAGE

- » Irradiation Effects on Fuel
- » Irradiation Effects on Structural Materials
- » Irradiation Effects in Water — FREE PREVIEW
- » Fuel Performance during NO and AAO
- » Fuel Reliability
- » Design Basis Accidents
- » Dry Storage Requirements

5) CURRENT FUEL PERFORMANCE ISSUES

- » Fuel Performance Issues — FREE PREVIEW

Additional Information

COURSE LENGTH:
15 hours

LECTURES:
14 hours

TESTS:
1 test (1 hour)

DIFFICULTY LEVEL:
Basic

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PWR Fuel Engineering

Click here to try it for free!

The overview provides background information necessary to understand fuel and material behaviour as related to practical design, operational, reliability and safety issues. The course covers the entire lifespan of fuel assemblies from manufacturing, mechanical, T-H and nuclear design as well as performance during operation, design basis accidents and post-irradiation interim dry storage.

The course material was developed by A.N.T. International and consists of pre-recorded seminars and associated reports, all previously published by A.N.T. International.

The authors/lecturers of the reports and lectures, World Class Experts in their fields, are as follows:

- Mr. Alfred Strasser
- Dr. Richard Collingham
- Dr. Charles Patterson
- Mr. Friedrich Garzarolli
- Dr. Ronald Adamson
- Mr. Peter Rudling

Course Appendix

click here to view full appendix

1) FUEL DESIGN AND MANUFACTURING

- » Introduction — FREE PREVIEW
- » Fuel Rod Manufacturing — FREE PREVIEW
- » Fuel Rod Assembly — FREE PREVIEW
- » End Fitting Manufacturing — FREE PREVIEW
- » End Fitting Fabrication & Assembly — FREE PREVIEW

2) FUEL PERFORMANCE DURING NO AND AOO

- » Basic Metallurgy / Microstructure / Effect Of Irradiation
- » Fuel Reliability, Primary Failures and Secondary Degradation
- » Corrosion and HPU /Effects of Coolant Chemistry on Fuel Performance
- » AOA Root Cause and Influence of Coolant Chemistry /Dimensional Stability
- » Irradiation Creep / Irradiation Growth
- » Fuel Assembly Bowing
- » Deformation and Mechanical Properties of Zr Alloys
- » The Effect of Huydrogen on Zr Alloy Properties / Hydrogen and Hydrides
- » Pellet Clading Interactions
- » UO2 and MOX Fuel
- » Performance of NI-base Alloys
- » Fuel Performance Codes

3) PWR CONTROL RODS, FUEL PERFORMANCE DURING ACCIDENT CONDITIONS AND INTERIM DRY STORAGE

- » LOCA
- » RIA — FREE PREVIEW
- » Dry Storage

Additional Information

COURSE LENGTH:
3 weeks (full-time studies)

READING:
90 hours

LECTURES:
25 hours

TESTS:
4 tests (4 hours)

DIFFICULTY LEVEL:
Intermediate

In addition to seminar footage and their corresponding presentations, courses may include partial reports previously published by A.N.T. International, which you can download to read offline.

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sales@antinternational.com

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BWR Fuel Engineering

Click here to try it for free!

This course gives an overview of topics relevant to BWR Fuel Engineers and Technical Managers. The overview provides background information necessary to understand fuel and material behaviour as related to practical design, operational, reliability and safety issues. The course covers the entire lifespan of fuel assemblies from manufacturing, mechanical, T-H and nuclear design as well as performance during operation, design basis accidents and post-irradiation interim dry storage.

The course material was developed by A.N.T. International and consists of pre-recorded seminars and associated reports, all previously published by A.N.T. International.

The authors/lecturers of the reports and lectures, World Class Experts in their fields, are as follows:

- Mr. Alfred Strasser
- Dr. Richard Collingham
- Dr. Charles Patterson
- Mr. Friedrich Garzarolli
- Dr. Ronald Adamson
- Mr. Peter Rudling

Course Appendix

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1) INTRODUCTION

» Introduction — FREE PREVIEW

» Fuel Design and Manufacturing /Structures and Components of the Fuel Assembly

2) MECHANICAL-THERMAL-HYDRAULIC AND NUCLEAR DESIGN

» Mechanical Design / Mechanical Design Review

» Thermal-hydraulic Design — FREE PREVIEW

» Thermal-hydraulic Fuel Design Audit PWRs & BWRs / Nuclear Design Audit

OTHER LECTURES:

» Pellet Fabrication / Zr Alloy Manufacturing, Component Fabrication

» Fuel Rod / Grid-Spacer Manufacturing / Spacers

» End Fitting Manufacturing / Fuel Assembly Manufacturing

» Bundle Assembly / Zr Alloy Materials

» Basic Metallurgy and Microstructure / Fuel Reliability

» Corrosion and HPU / Dimensional Stability

» Irradiation Creep / Irradiation Growth / Fuel Channel Bowing

» Bow of BWR Channels / Deformation and Mechanical Properties of Zr Alloys

» The Effect of Hydrogen on Zr Alloy Properties / Hydrogen and Hydrides

» Pellet Clading Interaction / UO2 and MOX Fuel

» LOCA / LOCA Design Audit

» RIA / RIA Design Audit — FREE PREVIEW

» Dry Storage

Additional Information

COURSE LENGTH:
3.5 weeks (full-time studies)

READING:
100 hours

LECTURES:
25 hours

TESTS:
4 tests (4 hours)

DIFFICULTY LEVEL:
Intermediate

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PWR Fuel Advanced

Click here to try it for free!

This course covers in-depth topics relevant to PWR fuel engineers to become experts in their field. The course focuses on fuel performance during normal operation, AOO, design basis accident, interim dry storage. Further the course covers high burnup issues as well as pool side and hot cell examination of fuel. The course comprises four technical areas: Structural Material Degradation, Coolant Chemistry, Fuel Thermal-Hydraulic and Fuel Materials. The principal focus of this course, fuel materials, covers the entire lifespan of fuel assemblies from design and manufacturing through operation and post-irradiation interim storage. Background information is provided on coolant chemistry and the degradation of plant materials as well as on the nuclear and thermal-hydraulic behaviour of fuel assemblies.

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The authors/lecturers of the reports and lectures, World Class Experts in their fields, are as follows:

- Dr. Peter Ford
- Dr. Pierre Combrade
- Dr. Peter Scott
- Dr. Francis Nordmann
- Dr. Suat Odar
- Mr. Dewey Rochester
- Mr. Kenny Epperson
- Mr. Alfred Strasser
- Dr. Richard Collingham
- Dr. Charles Patterson
- Mr. Friedrich Garzarolli
- Dr. Ronald Adamson
- Mr. Peter Rudling

Course Appendix

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THE COURSE APPENDIX INCLUDES:

» Introduction	FREE PREVIEW
» PWR/VVER Primary Side Coolant Chemistry	FREE PREVIEW
» LWR Design & Material Choices	FREE PREVIEW
» Water Chemistry in LWRs	FREE PREVIEW
» Corrosion Basics, Aqueous Corrosion, Electrochemistry	
» Stress Corrosion Cracking / SCC & IASCC of Stainless Steels in PWRs	
» Thermal-hydraulics – Overview	FREE PREVIEW
» Neutronics / Fuel Rod Mechanical / Fuel Design	
» Fuel Rod Manufacturing	FREE PREVIEW
» Fuel Rod Assembly	FREE PREVIEW
» Grid-spacer Manufacturing / Spacer Grid Assembly	
» End Fitting Manufacturing	FREE PREVIEW
» End Fitting Fabrication & Assembly	FREE PREVIEW
» RIA	FREE PREVIEW

Additional Information

COURSE LENGTH:
180 hours

READING:
145 hours

LECTURES:
36 hours

TESTS:
6 tests (6 hours)

DIFFICULTY LEVEL:
In-depth

In addition to seminar footage and their corresponding presentations, courses may include partial reports previously published by A.N.T. International, which you can download to read offline.

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BWR Fuel Advanced

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This course gives an overview of topics relevant to BWR fuel engineers and technical managers. The overview provides background information necessary to understand fuel and material behaviour as related to practical design, operational, reliability and safety issues. The principal focus of this course, fuel materials, covers the entire lifespan of fuel assemblies from design and manufacturing through operation and post-irradiation interim storage. The course comprises four technical areas: Structural Material Degradation, Coolant Chemistry, Fuel Thermal-Hydraulic and Fuel Materials. Background information is provided on coolant chemistry and the degradation of plant materials as well as on the nuclear and thermal-hydraulic behaviour of fuel assemblies.

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- Dr. Peter Ford
- Dr. Pierre Combrade
- Dr. Peter Scott
- Dr. Samson Hettiarachchi
- Dr. Robert Cowan
- Dr. Wilfried Rühle
- Mr. Alfred Strasser
- Dr. Richard Collingham
- Dr. Charles Patterson
- Mr. Friedrich Garzarolli
- Dr. Ronald Adamson
- Mr. Peter Rudling

Course Appendix

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THE COURSE APPENDIX INCLUDES:

» Introduction	FREE PREVIEW
» Background to Material Degradation	FREE PREVIEW
» LWR Water Chemistry / Physical Metallurgy	
» Corrosion Basics - Localised Corrosion and MIC	FREE PREVIEW
» SCC General Phenomenology and Mechanisms / EAC of Stainless Steel in BWRs	
» History of Design and Development of BWRs / IGSCC Mitigation Technologies	
» Water Radiolysis / Dose Rate Mitigation Technologies	
» Activation Corrosion Products and Fission Products	
» Fuel Design and Manufacturing	
» Thermal-Hydraulic Design	FREE PREVIEW
» Nuclear Design Audit / Zr Alloy Manufacturing / Pellet Production	
» Zr Alloy Materials / Basic Metallurgy and Microstructure	
» Irradiation Creep / Irradiation Growth / Fuel Channel Bowing	
» Hydrogen & Hydrides / UO2 and MOX Fuel	FREE PREVIEW
» RIA	
» RIA Design Audit	

Additional Information

COURSE LENGTH:
200 hours

READING:
140 hours

LECTURES:
60 hours

TESTS:
6 tests (6 hours)

DIFFICULTY LEVEL:
In-depth

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Irradiation Growth

Click here to try it for free!

Irradiation growth is a change in the dimensions of a zirconium alloy reactor component even though the applied stress is nominally zero. Understanding of the detailed mechanism is still evolving; however, a clear correlation of growth to microstructure evolution exists, and many empirical observations have revealed key mechanistic aspects.

Irradiation growth is involved in:

- Fuel rod length changes
- Bow of a component such as a BWR channel or PWR control rod assembly

This course addresses all data deemed relevant to understanding irradiation growth, broad review and new aspects of growth mechanisms, and a summary of practical effects of growth on component performance.

The course material was developed by A.N.T. International and consists of pre-recorded seminars and associated reports, all previously published by A.N.T. International.

The authors/lecturers of the reports and lectures, World Class Experts in their fields, are as follows:

- Dr. Ron Adamson
- Dr. Malcolm Griffiths

Course Appendix

- » Welcome Page — FREE PREVIEW
- » Introduction to Irradiation Growth
- » Irradiation Growth Data
- » Irradiation Growth Mechanisms & Modelling (part 1)
- » Irradiation Growth Mechanisms & Modelling (part 2)

Additional Information

COURSE LENGTH:
10 hours

LECTURES:
3 hours

DIFFICULTY LEVEL:
Expert

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Zirconium Alloy Manufacturing

Click here to try it for free!

The purpose of this course is to provide insight how the manufacturing of Zirconium alloy fuel assembly components impact the Pellet Cladding Interaction (PCI) Pellet Cladding Mechanical Interaction (PCMI) corrosion and hydriding properties. Re-opening of the pellet-cladding gap, lift-off, which is partly related to the fuel clad creep properties. Excessive dimensional changes (resulting in e.g. excessive Fuel Assembly (FA) bowing) of fuel components that are a function of creep (including oxide induced and residual stress relaxation creep), irradiation growth, and hydrogen pickup in the components. Loss of Coolant Accident (LOCA) performance that is related to hydrogen pickup both during the base irradiation, before the LOCA event, as well as during the high temperature LOCA oxidation.

The course material was developed by A.N.T. International and consists of pre-recorded seminars and associated reports, all previously published by A.N.T. International.

The authors/lecturers of the reports and lectures, World Class Experts in their fields, are as follows:

- Mr. Peter Rudling
- Mr. Friedrich Garzarolli

Course Appendix

- » Introduction — FREE PREVIEW
- » Reactor Characteristics and Fuel Design
- » Irradiation Effects
- » Microstructure, Sponge and Ingot Fabrication
- » Effect of Impurities and Alloying Elements part 1
- » Effect of Impurities and Alloying Elements part 2
- » Secondary Degradation
- » Tube, Sheet Bar Manufacturing part 1
- » Tube, Sheet Bar Manufacturing part 2
- » Microstructure and Texture Consequences on Performance part 1
- » Microstructure and Texture Consequences on Performance part 2

Additional Information

COURSE LENGTH:
12 hours

LECTURES:
5 hours

DIFFICULTY LEVEL:
Expert

In addition to seminar footage and their corresponding presentations, courses may include partial reports previously published by A.N.T. International, which you can download to read offline.

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Fuel Reliability

Click here to try it for free!

The cost per failure typically ranges from $1 500 000 to approximately $15 000 000 depending upon the type of reactor, the need for power suppression or a mid-cycle outage, reduced cycle length, the cost of replacement energy and the impact of the leaking fuel on subsequent core designs, operation and post-irradiation handling.

Maintaining and improving fuel reliability requires an understanding of the behaviour of fuel and materials as related to in-reactor conditions and the mechanisms that have been observed to cause fuel failures. With such an understanding, fuel investigation and development programs can be focused on the likely causes of failure or degradation, while unnecessary costly and time consuming work can be minimised. One of the objectives of this course is to provide such an understanding.

The course material was developed by A.N.T. International and consists of pre-recorded seminars and associated reports, all previously published by A.N.T. International.

The authors/lecturers of the reports and lectures, World Class Experts in their fields, are as follows:

- Dr. Charles Patterson
- Mr. Peter Rudling

Course Appendix

- » Introduction — FREE PREVIEW
- » Complementary Reading - Fuel Reliability
- » Primary Failure Causes (Corrosion & HPU)
- » Monitoring Fuel Reliability
- » Secondary Degradation
- » Poolside Techniques (Fuel Sipping)
- » Poolside Techniques (Hot Cell Examinations & Means to Improve Fuel Reliability
- » Summary and Discussions

Additional Information

COURSE LENGTH:
15 hours

LECTURES:
14 hours

DIFFICULTY LEVEL:
Expert

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Fuel Design Review

Click here to try it for free!

This course intends to provide a guide to the items that have the greatest influence on fuel performance and prioritise the audits that are recommended. A review of all aspects of the fuel design is not feasible or necessary within the time constraints of the utility and the vendor. The objective is to do the most effective audit in the shortest time period. The course provides the "what, why and how" for the audits by describing the design criteria, their influence on performance and the approach to reviewing the associated design features for the three distinct technical areas of nuclear, thermal/hydraulic, and mechanical/materials design, each written by experts in their eld. A guide for design tool verification is included as well as a guide to auditing the vendor design QA system.

The course material was developed by A.N.T. International and consists of pre-recorded seminars and associated reports, all previously published by A.N.T. International.

The authors/lecturers of the reports and lectures, World Class Experts in their fields, are as follows:

- Mr. Alfred Strasser
- Dr. Richard Collingham
- Mr. Kenny Epperson
- Mr. Jerald Holm
- Mr. Sten Lundberg
- Mr. Peter Rudling

Course Appendix

click here to view full appendix

1) INTRODUCTION

» Introduction	FREE PREVIEW
» Fuel Suppliers, Structures and Components	FREE PREVIEW
» Introduction to Structure and Components	FREE PREVIEW

2) AUDIT PROCEDURES

» Audit Procedures	FREE PREVIEW
» Utility Audit Procedures	FREE PREVIEW
» Design Method Qualification	
» US Standards / Design QA System Audit	
» QA System and Standards, Mechanical Design Review, Pellets	

OTHER TOPICS

- » Mechanical Design Review/Audit, Rod, Cladding, Grid
- » Thermal-hydraulic Design Review/Audit, Thermal-hydraulic Fuel Design
- » LOCA/RIA Fuel Design Audit
- » Appendix A – Margins
- » Appendix B – Treatments of Uncertainties
- » Appendix C – PCI Operation Restrictions

Additional Information

COURSE LENGTH:
70 hours

READING:
60 hours

LECTURES:
7 hours

TESTS:
2 tests (2 hours)

DIFFICULTY LEVEL:
Expert

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Fuel Fabrication Audit/Review

Click here to try it for free!

This course intends to provide a guide to the items that have the greatest influence on fuel performance and prioritise the audits that are recommended. A review of all aspects of the fuel design is not feasible or necessary within the time constraints of the utility and the vendor. The objective is to do the most effective audit in the shortest time period. A guide for design tool verification is included as well as a guide to auditing the vendor design QA system.

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- Mr. Alfred Strasser
- Dr. Charles Patterson
- Mr. Peter Rudling
- Mr. Kenny Epperson
- Dr. Graham Walker

Course Appendix

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THE COURSE APPENDIX INCLUDES:

- » Introduction — FREE PREVIEW
- » Introduction to Fuel Fabrication Process — FREE PREVIEW
- » Fuel Fabricators/ Structure and Components of the Fuel Assembly
- » Audit Procedures — FREE PREVIEW
- » Quality Assurance Systems
- » Qualification Programmes
- » Fuel Pellet Manufacturing/Fabrication
- » Pellet Cladding Interaction
- » Zr Alloy Component Manufacturing
- » Fuel Rod Assembly
- » Spacer Grid Assembly
- » End Fitting Fabrication
- » Fuel Bundle Assembly
- » BWR Channel Assembly/Bowing
- » Dimensional Stability
- » BWR Channel Bowing
- » Statistical Quality Control
- » Software Quality Assurance Process

Additional Information

COURSE LENGTH:
2 weeks (full-time studies)

READING:
23 hours

LECTURES:
9 hours

TESTS:
2 tests (2 hours)

DIFFICULTY LEVEL:
Expert

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Interim Dry Storage

Click here to try it for free!

Interim storage of spent fuel will be required until there is sufficient capacity in permanent geologic repositories or until more advanced technology options become available. Spent fuel is first stored in pools (ponds) located within the nuclear power plant facilities. Given the limited capacity of these installations, additional storage capacity located at either centralised or reactor site facilities are required. In this seminar, the focus will be on the performance of commercial LWR fuel assembly components, with emphasis on Zircaloy-based alloy cladding, during long-term storage of the spent fuel in a dry, inert environment such as helium. Potential degradation mechanisms of cladding alloys will be examined under normal and offset conditions of storage. Changes in cladding mechanical properties will be reviewed in order to properly assess the impact of interim storage upon subsequent spent-fuel management activities, such as transportation.

The course material was developed by A.N.T. International and consists of pre-recorded A.N.T. International Seminars.

The authors/lecturers of the reports and lectures, World Class Experts in their fields, are as follows:

- Mr. Alfred Strasser
- Dr. Charles Patterson
- Mr. Peter Rudling

Course Appendix

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THE COURSE APPENDIX INCLUDES:

- » Introduction
- » Managed Storage – A Global Perspective — FREE PREVIEW
- » Interim Storage Options – Consequences for Transportation
- » Radiological Risks
- » Zr-based Alloy Technology
- » Oxidation and Hydriding
- » Cladding Degradation Mechanisms
- » Thermal Creep
- » Hydrogen Mitigation
- » Laboratory Vs. Deployment Conditions
- » Transportation
- » Selected R&D Topics

Additional Information

COURSE LENGTH:
10 hours

LECTURES:
10 hours

DIFFICULTY LEVEL:
Expert

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Delayed Hydride Cracking

Click here to try it for free!

This course gives an overview of Delayed Hydride Cracking (DHC) in zirconium alloys and will provide engineers and technical managers at utilities, reactor vendors and regulators who would like to get a deeper knowledge of DHC in Zr alloys.

Some fuel cladding and structural components made from zirconium alloys have failed by DHC in nuclear reactors and chemical plants. This course will tackle the circumstances of the failures so that plant designers and operators can avoid such failures over the whole lifetime of their components, including post-operation storage, for example, dry storage of spent nuclear fuel. The approach is to avoid exceeding at least one limiting condition. The effect on DHC of other variables will also be discussed.

The course material was developed by A.N.T. International and consists of pre-recorded A.N.T. International Seminars.

The authors/lecturers of the reports and lectures, World Class Experts in their fields, are as follows:

- Dr. Kit Coleman

Course Appendix

THE COURSE APPENDIX INCLUDES:

» Introduction to Delayed Hydride Cracking (DHC) — FREE PREVIEW

» Component failure by DHC

» Hydrogen in zirconium alloys:

(a) Solubility limits and (b) Diffusivity

» Hydride properties:

(a) Crystallography and (b) Mechanical properties

» Basic mechanism of DHC — FREE PREVIEW

» Implications of mechanism for behaviour of a crack

» Experimental methods

» Phenomenology and dependencies on:

(a) Time, Stress and stress intensity factor,

(b) Temperature history and distribution, (c) Microstructure, and Strength

» Models of crack growth by DHC

» Implications for structural integrity:

(a) During operation - Leak-before-break and

(b) During storage of spent nuclear fuel

Additional Information

COURSE LENGTH:

1 week

LECTURES:

6 hours

DIFFICULTY LEVEL:

Expert

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STRUCTURAL MATERIAL DEGRADATION

The following courses are available.

MATERIAL GENERAL BASICS

COURSE LENGTH:
11 hours
DIFFICULTY LEVEL:
Basic

PWR MATERIAL INTRODUCTION

COURSE LENGTH:
20 hours
DIFFICULTY LEVEL:
Basic

BWR MATERIAL INTRODUCTION

COURSE LENGTH:
20 hours
DIFFICULTY LEVEL:
Basic

BWR & PWR MATERIAL ENGINEERING

COURSE LENGTH:
20 hours
DIFFICULTY LEVEL:
Intermediate

BWR MATERIAL ADVANCED

COURSE LENGTH:
5 weeks
DIFFICULTY LEVEL:
Intermediate

Material General Basics

Click here to try it for free!

The objective of the Material General Basics course is to provide new BWR Engineers, BWR Plants Chemists and BWR Managers with no or little background in Material Degradation in LWRs with the necessary background information to understand more complicated plant corrosion and metallurgical information. Not only presently inexperienced engineers working on structural materials but also plant chemists, engineers working on nuclear fuel, as well as high level managers could benefit from this course.

The course material was developed by A.N.T. International and consists of pre-recorded A.N.T. International Seminars.

The authors/lecturers of the reports and lectures, World Class Experts in their fields, are as follows:

- Dr. Peter Ford
- Dr. Pierre Combrade
- Dr. Peter Scott

Course Appendix

click here to view full appendix

CHAPTERS 1-3

» Introduction and Background to Material Degradation — FREE PREVIEW

» LWR Water Chemistry

» Materials Physical Metallurgy

CHAPTERS 4-6

» Corrosion Basics – Aqueous Corrosion

» Corrosion Basics and Electrochemistry

» Corrosion Basics Localised Corrosion and MIC

CHAPTERS 7-10

» SCC General Phenomenology and Mechanisms

» Low Temperature SCC Processes in LWRs — FREE PREVIEW

» Corrosion Rates and Cation Release

» FAC and BAC

Additional Information

COURSE LENGTH:
11 hours

LECTURES:
10 hours

TESTS:
1 test (1 hour)

DIFFICULTY LEVEL:
Basic

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Try this course for free!

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PWR Material Introduction

Click here to try it for free!

The objective of the PWR Material Introduction is to provide engineers/managers with no or little background in PWR Material degradation in LWRs with the necessary background information to understand more complicated plant corrosion and metallurgical information. Not only presently inexperienced engineers working on structural materials but also plant chemists, engineers working on nuclear fuel, as well as high level managers could benefit from this course.

The course material was developed by A.N.T. International and consists of pre-recorded A.N.T. International Seminars.

The authors/lecturers of the reports and lectures, World Class Experts in their fields, are as follows:

- Dr. Peter Ford
- Dr. Pierre Combrade
- Dr. Peter Scott

Course Appendix

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CHAPTERS 1-3

» SCC Stainless Steel in PWR — FREE PREVIEW

» IASCC of SS PWR

» EAC SG Secondary Side IGA IGSCC

» PWSCC Ni Alloys

CHAPTERS 4-6

» High Strength Alloys PWR

» PWSCC Mechanisms

» EAC Carbon and LAS PWR

CHAPTERS 7-9

» Corrosion Fatigue — FREE PREVIEW

» Corrosion Tests

» Mitigation PWRs and LTCP

Additional Information

COURSE LENGTH:
20 hours

LECTURES:
18 hours

TESTS:
1 test (1 hour)

DIFFICULTY LEVEL:
Basic

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BWR Material Introduction

Click here to try it for free!

The objective of the BWR Material Introduction is to provide engineers/managers with no or little background in BWR Material degradation in LWRs with the necessary background information to understand more complicated plant corrosion and metallurgical information. Not only presently inexperienced engineers working on structural materials but also plant chemists, engineers working on nuclear fuel, as well as high level managers could benefit from this course.

The course material was developed by A.N.T. International and consists of pre-recorded A.N.T. International Seminars.

The authors/lecturers of the reports and lectures, World Class Experts in their fields, are as follows:

- Dr. Peter Ford
- Dr. Pierre Combrade
- Dr. Peter Scott

Course Appendix

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CHAPTERS 1-4

» EAC Stainless Steel

» EAC of Ni-base Alloys

» EAC of High Strength Alloys in BWRs

» EAC of Carbon and LAS

CHAPTERS 5-7

» Corrosion Fatigue — FREE PREVIEW

» Corrosion Tests

» Corrosion Mitigation

Additional Information

COURSE LENGTH:
20 hours

LECTURES:
18 hours

TESTS:
1 test (1 hour)

DIFFICULTY LEVEL:
Basic

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BWR & PWR Material Engineering

Click here to try it for free!

This course is the complete and full course combining all our courses on Material Introduction. It both holds the introductory sections as well as information about both BWR and PWR.

The objective of the course is to provide Engineers/Managers with the necessary background information to understand more complicated plant corrosion and metallurgical information. Not only presently inexperienced Engineers working on structural materials but also Plant chemists, Engineers working on nuclear fuel, as well as high level Managers could benefit from this course.

The course material was developed by A.N.T. International and consists of pre-recorded A.N.T. International Seminars.

The authors/lecturers of the reports and lectures, World Class Experts in their fields, are as follows:

- Dr. Peter Ford
- Dr. Pierre Combrade
- Dr. Peter Scott

Course Appendix

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CHAPTERS 1-6

- » Introduction and Background to Material Degradation — FREE PREVIEW
- » LWR Chemistry / Materials Physical Metallurgy
- » Corrosion Basics: Aqueous Corrosion / Electrochemistry
- » Localised Corrosion and MIC

CHAPTERS 7-11

- » SCC General Phenomenology and Mechanisms
- » Low Temperature SCC Processes in LWRs — FREE PREVIEW
- » Corrosion Rates and Cation Release / FAC and BAC
- » EAC Stainless Steel in BWRs / EAC of Ni-base Alloys in BWRs
- » EAC of High Strength Alloys in BWRs / EAC of Carbon and LAS in BWRs

CHAPTERS 12-14

- » SCC Stainless Steel PWR — FREE PREVIEW
- » IASCC of SS PWR / EAC SG Secondary Slide IGA IGSCC
- » PWSCC Ni Alloys / High Strength Alloys PWR
- » PWSCC Mechanisms / EAC C and LAS PWR
- » Corrosion Fatigue — FREE PREVIEW
- » Corrosion Tests / Mitigation PWRs and LTCP
- » Corrosion Mitigation in BWRs

Additional Information

COURSE LENGTH:
20 hours

LECTURES:
18 hours

TESTS:
1 test (1 hour)

DIFFICULTY LEVEL:
Intermediate

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BWR Material Advanced

Click here to try it for free!

The objective of the BWR Material Degradation Advanced course is to provide Engineers and Technical Managers with a background in Structural Material Degradation in LWRs with the necessary background information to understand more complicated plant corrosion and metallurgical information.

The course material was developed by A.N.T. International and consists of pre-recorded A.N.T. International Seminars.

The authors/lecturers of the reports and lectures, World Class Experts in their fields, are as follows:

- Dr. Peter Ford
- Dr. Pierre Combrade
- Dr. Peter Scott

Course Appendix

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THE COURSE APPENDIX INCLUDES:

» Introduction	FREE PREVIEW
» History of Design and Development	FREE PREVIEW
» BWR Waterchem, Electrochem and Corrosion Fundamentals	FREE PREVIEW
» BWRs Shutdown Dose Rates and Injecting Zinc	
» Stress Corrosion Cracking Mitigation	
» Water Chemistry Related Systems	
» Waterchem Impacts on Fuel Performance	FREE PREVIEW
» BWR Water Treatment / Off-Gas Treatment	
» Water Chemistry Guidelines and Technical Basis	
» Fuel Cycle, Reactor/Fuel Design	FREE PREVIEW
» Fuel Cycle	FREE PREVIEW
» Rod Mechanical Design	
» Thermal Hydraulics Design	
» RIA	FREE PREVIEW
» Reactor Safety and Mechanical Design Criteria	
» Fuel Performance During Normal Operation and AOO	
» Fuel Performance Issues	
» Reactor Designs & Material Choices	
» Physical Metallurgy of Structural Alloys	
» Low Temperature EAC in LWRs	FREE PREVIEW
» Low Temperature SCC processes in LWRs	FREE PREVIEW
» Environmentally Assisted Cracking in Boiling Water Reactors	
» EAC Stainless Steel in BWRs	

Additional Information

COURSE LENGTH:
5 weeks (full-time studies)

READING:
90 hours

LECTURES:
85 hours

TESTS:
4 tests (4 hour)

DIFFICULTY LEVEL:
Intermediate

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COOLANT CHEMISTRY AND CORROSION

The following courses are available.

PWR CHEMISTRY INTRODUCTION

COURSE LENGTH:
24 hours
DIFFICULTY LEVEL:
Basic

BWR CHEMISTRY INTRODUCTION

COURSE LENGTH:
25 hours
DIFFICULTY LEVEL:
Basic

PWR CHEMISTRY ENGINEERING

COURSE LENGTH:
3 weeks
DIFFICULTY LEVEL:
Intermediate

PWR CHEMISTRY ADVANCED

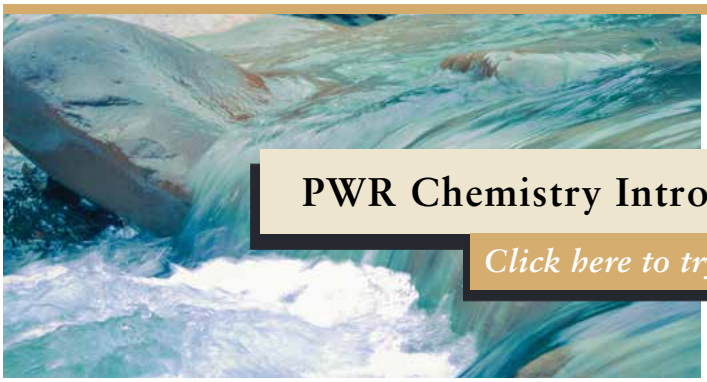
COURSE LENGTH:
6 weeks
DIFFICULTY LEVEL:
Intermediate

CRUD IN PWR/VVER COOLANT – VOL I

COURSE LENGTH:
8 hours
DIFFICULTY LEVEL:
Expert

CRUD IN PWR/VVER COOLANT – VOL II

COURSE LENGTH:
8 hours
DIFFICULTY LEVEL:
Expert



PWR Chemistry Introduction

Click here to try it for free!

This course gives an overview of topics relevant to PWR plant chemists with little experience, but also engineers working on fuel and structural material as well as high level chemistry managers.

The course material was developed by A.N.T. International and consists of pre-recorded A.N.T. International Seminars.

The authors/lecturers of the reports and lectures, World Class Experts in their fields, are as follows:

- Dr. Francis Nordmann
- Dr. Suat Odar
- Mr. Dewey Rochester

Course Appendix

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1) RADIOCHEMISTRY

- » Introduction — FREE PREVIEW
- » Radiochemistry

2) PRIMARY COOLANT SYSTEM

- » RCS Design and Materials
- » Corrosion Performance, Concerns and Problems — FREE PREVIEW
- » Chemical Additives in Primary System (Objectives, History)
- » Fuel Deposits, Cladding Corrosion & Evolution, AOA
- » Hot Functional Testing / Materials Selection and pH Optimisation
- » RCS Startup and Shutdown Practices
- » RCS Chemical Guidelines — FREE PREVIEW

3) SECONDARY COOLANT SYSTEM

- » Introduction, Design and Materials
- » Chemical Additives in Secondary System and Lay-ups
- » Various Types of Corrosion / Flow Accelerated Corrosion
- » Impurities Behaviour and Hideout
- » Secondary System Chemical Monitoring and Guidelines

4) AUXILIARY SYSTEMS, MAINTENANCE, OTHER SYSTEMS

- » Chemical & Volume Control System — FREE PREVIEW
- » Make-up Water Systems
- » Decontamination
- » Wastes
- » Fouling; SG Cleaning
- » Laboratory Quality Control
- » Chemicals & Ion Exchange Resins Specifications

Additional Information

COURSE LENGTH:
24 hours

LECTURES:
23 hours

TESTS:
1 test (1 hour)

DIFFICULTY LEVEL:
Basic

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BWR Chemistry Introduction

Click here to try it for free!

This course gives an overview of topics relevant to BWR plant chemists with little experience, but also engineers working on fuel and structural material as well as high level chemistry managers.

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The authors/lecturers of the reports and lectures, World Class Experts in their fields, are as follows:

- Dr. Samson Hettiarachchi
- Dr. Wilfried Rühle

Course Appendix

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1) BWR DESIGNS AND MATERIALS SELECTION

- » Introduction — FREE PREVIEW
- » History of Design and Development of BWRs — FREE PREVIEW
- » BWR Design and Materials Selection
- » Basic Knowledge About Reactor Structural Materials

2) BWR WATER CHEMISTRY, ELECTROCHEMISTRY AND CORROSION FUNDAMENTALS

- » BWR Water Chem, Eletrochem and Corrosion Fundamentals — FREE PREVIEW
- » Normal Water Chemistry
- » Water Radiolysis and Radiolysis Gas
- » Overview of Radiochemistry

3) DOSE RATE MITIGATION TECHNOLOGIES

- » Dose Rate Mitigation Technologies

4) IGSCC MITIGATION TECHNOLOGIES

- » IGSCC Mitigation Technologies

5) PLANT OPERATIONAL CHEMISTRY AND CONTROLS

- » Startup and Shutdown Procedures — FREE PREVIEW
- » Activation Corrosion Products and Fission Products
- » Water Chem Impacts on Fuel Performance
- » BWR Water Treatment / Off-gas Treatment

6) WATER CHEM SPEC, GUIDELINES AND ACTION LEVEL

- » Water Chem Spec, Guidelines and Action Level

Additional Information

COURSE LENGTH:
25 hours

LECTURES:
24 hours

TESTS:
1 test (1 hour)

DIFFICULTY LEVEL:
Basic

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PWR Chemistry Engineering

Click here to try it for free!

The principal focus of this course covers both primary and secondary side coolant chemistry. Background information is provided on fuel and degradation of plant materials because the primary coolant chemistry affects fuel performance but is generally targeted towards minimising corrosion of structural materials and minimising the buildup of plant activity. Information is provided on the nuclear and thermal-hydraulic behaviour of fuel assemblies because irradiation and temperature are primary factors in the behaviour of fuel materials.

The course material was developed by A.N.T. International and consists of pre-recorded seminars and associated reports, all previously published by A.N.T. International.

The authors/lecturers of the reports and lectures, World Class Experts in their fields, are as follows:

- Dr. Francis Nordmann
- Dr. Suat Odar
- Mr. Dewey Rochester

Course Appendix

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THE COURSE APPENDIX INCLUDES:

- » Introduction — FREE PREVIEW
- » Radiochemistry
- » Coolant Chemistry / PWR Reactor Coolant Chemistry
- » Basics of Coolant Chemistry
- » Corrosion Performance and Problems — FREE PREVIEW
- » Chemical Additives
- » Formation of Protective Layers and Formation of Crud
- » Crud Behaviour in the Coolant
- » Fuel Depots, Cladding Corrosion, AOA
- » Hot Functional Testing — FREE PREVIEW
- » RCP Startup and Shutdown Practices
- » Coolant Monitoring Concept
- » RCS Chemistry Guidelines / Auxiliary System
- » Chemical and Volume Control System
- » Radioactive Waste Processing / Decontamination / Chemical Additives
- » Various Types of Corrosion in Secondary Systems
- » Flow Accelerated Corrosion
- » Impurities Behaviour / Chemical Monitoring
- » Make up Water Systems / Fouling
- » Laboratory Quality Control
- » Chemical & Ion Exchange Resins Spec

Additional Information

COURSE LENGTH:
3 weeks (full-time studies)

READING:
90 hours

LECTURES:
15 hours

TESTS:
2 tests (2 hours)

DIFFICULTY LEVEL:
Intermediate

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PWR Chemistry Advanced

Click here to try it for free!

The course comprises four technical areas: Structural material degradation, fuel materials, fuel thermal-hydraulic and coolant chemistry. The principal focus of this course, coolant chemistry, covers both primary and secondary side. Background information is provided on fuel and degradation of plant materials because the primary coolant chemistry affects fuel performance, but is generally targeted towards minimising corrosion of structural materials and minimising the buildup of plant activity. Information is provided on the nuclear and thermal-hydraulic behaviour of fuel assemblies.

The course material was developed by A.N.T. International and consists of pre-recorded seminars and associated reports, all previously published by A.N.T. International.

The authors/lecturers of the reports and lectures, World Class Experts in their fields, are as follows:

- Dr. Peter Ford
- Dr. Pierre Combrade
- Dr. Peter Scott
- Mr. Alfred Strasser
- Dr. Richard Collingham
- Dr. Charles Patterson
- Mr. Friedrich Garzarolli
- Dr. Ronald Adamson
- Mr. Peter Rudling
- Dr. Francis Nordmann
- Dr. Suat Odar
- Mr. Dewey Rochester

Course Appendix

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THE COURSE APPENDIX INCLUDES:

» Introduction	FREE PREVIEW
» Water Chemistry in LWRs	FREE PREVIEW
» Nuclear Fuel Cycle	FREE PREVIEW
» Fuel Cycle	FREE PREVIEW
» PWR Reactor Design / Reactor Design	
» Nuclear Design Review & Criteria	
» Thermal-Hydraulic Design	
» Irradiation Effects in Water	FREE PREVIEW
» Dry Storage Requirements / Cladding Performance under Accident Conditions	
» Fuel Performance Issues	FREE PREVIEW
» Radiochemistry	
» Coolant Chemistry / PWR Reactor Coolant Chemistry	
» Crud Behaviour in the Coolant / Enriched Boric Acid	
» Fuel Deposits, Cladding Corrosion, AOA	
» RCS Chemistry Guidelines / Auxiliary System	
» Radioactive Waste Processing / Decontamination	
» Various Types of Corrosion in Secondary Systems	
» Make up Water Systems / Fouling	
» Laboratory Quality Control / Chemical & Ion Exchange Resins Spec	

Additional Information

COURSE LENGTH:
6 weeks (full-time studies)

READING:
125 hours

LECTURES:
85 hours

TESTS:
4 tests (4 hours)

DIFFICULTY LEVEL:
In-depth

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CRUD in PWR/VVER Coolant – Volume I

Click here to try it for free!

The purpose of this course is to provide insight into different types of phenomena, like solubility, transportation, deposition and release of crud that helps to better understand the crud behaviour under PWR/VVER/CANDU operating conditions. There is an associated course which describes in detail the mitigation tools for adequate crud control. The information given in this and the associated course:

- Can support the plant chemists to establish their coolant chemistry strategy to achieve the plant specific goals.
- Is valuable for fuel vendors and plant fuel engineers to understand the influence of coolant chemistry on fuel performance.

The course material was developed by A.N.T. International and consists of pre-recorded A.N.T. International Seminars.

The authors/lecturers of the reports and lectures, World Class Experts in their fields, are as follows:

- Dr. Suat Odar

Course Appendix

1) SOURCES OF CRUD

FREE PREVIEW

» Composition and thickness of the oxide layers

» Influence of design and structural materials (PWR, VVER and CANDU plants)

2) RELEASE AND TRANSPORTATION OF CRUD IN THE COOLANT

» Interaction of oxide layers with coolant

» Particulate, colloidal and dissolved

» Distribution, composition

3) FUEL DEPOSITION

» Mechanism

» Composition, morphology and distribution on fuel assemblies

» Consequences of fuel crud deposits (cladding corrosion, AOA)

4) CORE CRUD RELEASE AND RADIATION BUILD-UP

Additional Information

COURSE LENGTH:

8 hours

LECTURES:

5 hours

READING:

3 hours

DIFFICULTY LEVEL:

Expert

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CRUD in PWR/VVER Coolant – Volume II

Click here to try it for free!

The purpose of this course is to describe the tools and their application to adequately control the coolant crud in order to improve the fuel and out-core radiation performance. There is an associated course which describes solubility, transportation, deposition and release of crud that helps to better understand the crud behaviour under PWR/VVER/CANDU operating conditions. The information given in this and the associated course:

- Can support the plant chemists to establish their coolant chemistry strategy to achieve the plant specific goals.
- Is valuable for fuel vendors and plant fuel engineers to understand the influence of coolant chemistry on fuel performance.

The course material was developed by A.N.T. International and consists of pre-recorded A.N.T. International Seminars.

The authors/lecturers of the reports and lectures, World Class Experts in their fields, are as follows:

- Dr. Suat Odar

Course Appendix

1) COOLANT CRUD BEHAVIOUR

FREE PREVIEW

» CRUD sources

» CRUD release, transportation and in-core deposition

» Core CRUD release & radiation field build-up

2) PREVENTIVE TOOLS FOR CRUD & RADIATION FIELD CONTROL

» Plant design phase

» Hot Functional Tests

3) MITIGATING TOOLS FOR CRUD & RADIATION FIELD CONTROL

» Power operation by coolant chemistry

» Plant shutdown operation

4) ACTIVE CLEANINGS FOR CRUD & RADIATION FIELD CONTROL

» High temperature mechanical filtration (VVER 1000 strategy)

» Chemical & mechanical decontaminations

» Fuel CRUD removal

5) CONCLUSIONS

Additional Information

COURSE LENGTH:

8 hours

LECTURES:

5 hours

READING:

3 hours

DIFFICULTY LEVEL:

Expert

In addition to seminar footage and their corresponding presentations, courses may include partial reports previously published by A.N.T. International, which you can download to read offline.

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