Online Education
by A.N.T. International Academy

For nuclear engineers at all levels
for more information visit: www.antinternational.com
CONTENTS

GENERAL INFORMATION ................................................................. 4
OUR EXPERTS, YOUR LECTURES .................................................. 6
INDIVIDUAL COURSES ................................................................. 11

FUEL MATERIAL ........................................................................... 13

FUEL INTRODUCTION ................................................................. 14
PWR FUEL ENGINEERING .......................................................... 15
BWR FUEL ENGINEERING .......................................................... 16
PWR FUEL ADVANCED ............................................................... 17
BWR FUEL ADVANCED ............................................................... 18

FUEL DESIGN REVIEW ............................................................... 19
FUEL FABRICATION AUDIT/REVIEW ......................................... 20
INTERIM DRY STORAGE ............................................................. 21

STRUCTURAL MATERIAL DEGRADATION .................................... 22

MATERIAL INTRODUCTION ......................................................... 23
PWR MATERIAL INTRODUCTION ................................................ 24
BWR MATERIAL INTRODUCTION ................................................ 25

MATERIAL ENGINEERING .......................................................... 26

COOLANT CHEMISTRY & CORROSION ........................................ 27

PWR CHEMISTRY INTRODUCTION .............................................. 28
BWR CHEMISTRY INTRODUCTION .............................................. 29

PWR CHEMISTRY ENGINEERING ............................................... 30
PWR CHEMISTRY ADVANCED ..................................................... 31
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 we are 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 ANT 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):

<table>
<thead>
<tr>
<th>Question</th>
<th>Average</th>
<th>Number of Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>How did the level of the information fit your background?</td>
<td>4.0</td>
<td>524</td>
</tr>
<tr>
<td>How well did we meet your expectations with the seminar/course?</td>
<td>4.2</td>
<td>313</td>
</tr>
<tr>
<td>How were the speakers?</td>
<td>4.4</td>
<td>322</td>
</tr>
<tr>
<td>What is your opinion of the ANT International reports?</td>
<td>4.3</td>
<td>914</td>
</tr>
<tr>
<td>What is your overall opinion of the seminar/course?</td>
<td>4.4</td>
<td>328</td>
</tr>
</tbody>
</table>
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.
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. Richard Collingham retired from AREVA in 2004 where he was manager of Safety Analysis Engineering and fuel Development. His responsibilities included Code Development, fuel Development, nuclear fuel and reload design and LWR Plant Safety Analyses.

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. Alfred Strasser, a material scientist, has more than 50 years of experience in core technology, in the design, fabrication and irradiation of nuclear fuels for LWRS, FBRs and test reactors, for 18 years at NDA and United Nuclear, for 22 years at S.M. Stoller and currently as President of Aquarius Services Corp.
Mr. Friedrich Garzaroli 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 Ingenieur 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.

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 Westinghouse) and a Project Manager at EPRI. Peter is the President of ANT International, managing the ZIRAT/IZNA/LCC programs as well as providing seminars and Handbooks on various fuel related topics to the nuclear industry.

Structural Material Degradation

Dr. Peter Ford worked initially as manager of the corrosion group at the research laboratory of the Central Electricity Generating Board (UK) and then for 23 years with the General Electric Corporate Research and Development Centre (GE-CRD) now the GE Global Research Centre) where he was manager of the Corrosion Mitigation and Coatings Laboratory. He received his bachelors and doctoral degrees from Cambridge University (UK) and a masters degree from RPI (USA), with an emphasis on metallurgical engineering and corrosion science.

Dr. Peter Scott received his Ph.D. in physical chemistry from the University of Sheffield in England in 1968. During the 37+ years he has worked in the nuclear power business, his interests and experience have been in materials selection, analysis of field cracking events, life prediction, preparation of technical reports and presentations to utility clients and Safety Authorities relating to general and localised corrosion, stress corrosion and corrosion fatigue.
Dr. Pierre Combrade earned his doctorate degrees with a thesis on solidification of refractory eutectic alloys for aero engine turbine blades in 1972. He joined Framatome (now AREVA NP) in 1994 as head of the corrosion department of the Technical (R&D) Centre and subsequently became an “AREVA International Expert”. He has been involved in corrosion problems for the nuclear industry since 1972.

Mr. Francois 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). Up to 1995 he worked in the several technical fields as an expert.

Dr. Ulf Ilg earned his Ph.D at 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. 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).

Coolant Chemistry and Corrosion

Dr. Francis Nordmann has over 40 years of experience in power plant chemistry. He is retired from Electricité 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.

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.
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. Robert Cowan, retired Chief Technologist of General Electric’s Nuclear Energy Division, with over 40 years of Boiling Water Reactor chemistry, corrosion, structural material and fuel material experience. He holds a Ph.D. in Metallurgical Engineering from The Ohio State University in Columbus, Ohio.

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

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.

<table>
<thead>
<tr>
<th>Course</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fuel Introduction</td>
</tr>
<tr>
<td>PWR Fuel Engineering</td>
</tr>
<tr>
<td>BWR Fuel Engineering</td>
</tr>
<tr>
<td>PWR Fuel Advanced</td>
</tr>
<tr>
<td>BWR Fuel Advanced</td>
</tr>
<tr>
<td>Fuel Design Review</td>
</tr>
<tr>
<td>Fuel Fabrication Audit Review</td>
</tr>
<tr>
<td>Interim Dry Storage</td>
</tr>
</tbody>
</table>
Fuel Introduction

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).

Course Material

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

Course Appendix

1. Fuel Cycle, Reactor/Fuel Design
2. Reactor Safety
3. Fuel Design and Design Criteria
4. Fuel Performance During Normal Operation, Accident Conditions and Interim Dry Storage
5. Current Fuel Performance Issues

Full appendix and more information on this and other courses can be found at: www.antinternational.com

Authors/Lecturers

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

- Dr. Charles Patterson
- Mr. Peter Rudling.

Additional Information

- Course length: 15 hours
- Lectures: 14 hours
- Tests: 1 tests (1 hour)
- Difficulty level: Basic
- Language: English
PWR Fuel Engineering

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.

Course Material

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

Course Appendix

1. Mechanical Thermal-Hydraulic and Nuclear Design
2. Fabrication and Manufacturing
3. Fuel Rods and Spacers
4. End Fittings, Assembly and More!
5. Zirconium and Basic Metallurgy
6. Fuel Reliability
7. Corrosion and HPU
8. Dimensional Stability
9. Irradiation Creep & Irradiation Growth
10. Fuel Assembly Bowing
11. Deformation and Mechanical Properties
12. Hydrogen
13. PCI
14. UO₂ and MOX
15. Performance
16. LOCA & RIA
17. Interim Dry Storage

Full appendix and more information on this and other courses can be found at: www.antinternational.com

Authors/Lecturers

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

TRY THIS COURSE FOR FREE!

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

sales@antinternational.com

Additional Information

- Course length: Around 3 weeks for full time studies
- Reading: 90 hours
- Lectures: 25 hours
- Tests: 4 tests (4 hours)
- Difficulty level: Intermediate
- Language: English
BWR Fuel Engineering

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.

Course Material

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

Course Appendix

1. Mechanical Thermal-Hydraulic and Nuclear Design
2. Fabrication and Manufacturing
3. Fuel rods and Spacers
4. End fittings, assembly and more!
5. Zirconium and basic Metallurgy
6. Fuel Reliability
7. Corrosion and HPU
8. Dimensional Stability
9. Irradiation Creep & Irradiation Growth
10. Fuel Channel Bowing
11. Deformation and Mechanical properties
12. Hydrogen
13. PCI
14. UO2 and MOX
15. Performance
16. LOCA & RIA
17. Interim Dry Storage

Full appendix and more information on this and other courses can be found at: www.antinternational.com

Authors/Lecturers

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.

TRY THIS COURSE FOR FREE!

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

sales@antinternational.com

Additional Information

- Course length: 130 hours (3-5 weeks for full time studies)
- Reading: 100 hours
- Lectures: 25 hours
- Tests: 4 tests (4 hours)
- Difficulty level: Intermediate
- Language: English
PWR Fuel Advanced

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.

Course Material

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

Course Appendix

1. Introduction & Background to Material Degradation
2. Physical Metallurgy of Structural Alloys
3. Corrosion Basics
4. Environmentally-Assisted Cracking of Austenitic and, Ni-base Alloys
5. Radiochemistry
6. Primary Coolant Chemistry and CRUD Formation
7. Mechanical Thermal-Hydraulic and Nuclear Design
8. Fabrication and Manufacturing
9. Fuel rods and Spacers
10. End fittings, assembly and more!
11. Zirconium and basic Metallurgy
12. Fuel Reliability
13. Corrosion and HPU and AOA
14. Dimensional Stability
15. Irradiation Creep & Irradiation Growth
16. Fuel Assembly Bowing
17. Deformation and Mechanical properties
18. Hydrogen
19. PCI
20. UO2 and MOX
21. Performance of Ni-base alloys
22. PWR Control rod
23. LOCA & RIA
24. Interim Dry Storage

Additional Information

- Course length: 180 hours
- Reading: 145 hours
- Lectures: 36 hours
- Tests: 6 tests (6 hours)
- Difficulty level: In-depth
- Language: English

TRY THIS COURSE FOR FREE!

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

Authors/Lecturers

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

Full appendix and more information on this and other courses can be found at: www.antinternational.com
BWR Fuel Advanced

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.

Course Material

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

Course Appendix

| 1. Introduction & Background to Material Degradation | 11. Zirconium and basic Metallurgy |
| 3. Corrosion Basics | 13. Corrosion and HPU and AOA |
| 5. Radiochemistry | 15. Irradiation Creep & Irradiation Growth |
| 6. Primary Coolant Chemistry and CRUD Formation | 16. Fuel Assembly Bowing |
| 7. Mechanical Thermal-Hydraulic and Nuclear Design | 17. Deformation and Mechanical properties |
| 9. Fuel rods and Spacers | 19. PCI |
| 10. End fittings, assembly and more! | 20. UO2 and MOX |
| 21. Performance of Ni-base alloys | 22. PWR Control rod |
| 23. LOCA & RIA | 24. Interim Dry Storage |

Full appendix and more information on this and other courses can be found at: www.antinternational.com

Additional Information

- Course length: 200 hours
- Reading: 130 hours
- Lectures: 60 hours
- Tests: 6 tests (6 hours)
- Difficulty level: In-depth
- Language: English

TRY THIS COURSE FOR FREE!

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

Authors/Lecturers

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

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

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 field. A guide for design tool verification is included as well as a guide to auditing the vendor design QA system.

Course Material

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

Course Appendix

1. Introduction
2. Audit Procedures
3. Mechanical Design Audit/Review
4. Thermal Hydraulic and Nuclear Design Audit/Review
5. LOCA/RIA Audit/Review

Authors/Lecturers

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

Additional Information

- Course length: 70 hours (2 weeks for full time studies)
- Reading: 60 hours
- Lectures: 7 hours
- Tests: 2 tests (2 hours)
- Difficulty level: Expert
- Language: English

Try This Course for Free!

All of our currently available courses have selected content you can access completely free of charge such as lectures, reading materials and much more. For more information, feel free to email us at: sales@antinternational.com
Fuel Fabrication Audit/Review

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.

Course Material

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

Course Appendix

1. Audit Procedures
2. Quality Assurance Systems
3. Qualification Programs
4. Fuel Pellet Manufacturing
5. Zr Alloy Component Manufacturing
6. Fuel Rod Assembly
7. Spacer Grid Assembly
8. End Fitting Fabrication and Assembly
9. Fuel Bundle Assembly
10. BWR Channel Assembly
11. Dimensional Stability and BWR Channel Bowing
12. Statistical Quality Control
13. Software Quality Assurance

Full appendix and more information on this and other courses can be found at: www.antinternational.com

Authors/Lecturers

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
- Mr. Kenneth Epperson
- Dr. Graham Walker

TRY THIS COURSE FOR FREE!

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

Additional Information

- Course length: Around 2 weeks for full time studies
- Reading: 23 hours
- Lectures: 9 hours
- Tests: 2 tests (2 hours)
- Difficulty level: Expert
- Language: English
Interim Dry Storage

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.

Course Material

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

Course Appendix

1. Managed Storage: A Global Perspective
2. Interim Storage Options – Consequences for Transportation
3. Radiological Risks
4. Zirconium-based Alloy Technology
5. Oxidation and Hydriding
6. Potential Cladding Degradation Mechanisms During Dry Storage
7. Laboratory vs. Deployment Conditions
8. Transportation
9. Selected R&D Topics

Additional Information

Course length: 12 hours (Under 1 week for full time studies)
Lectures: 10 hours
Difficulty level: Expert
Language: English

Authors/Lecturers

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

- Mr. Alfred Strasser
- Dr. Richard Collingham
- Mr. Peter Rudling
The following courses are available.

<table>
<thead>
<tr>
<th>Course</th>
</tr>
</thead>
<tbody>
<tr>
<td>Material Introduction</td>
</tr>
<tr>
<td>PWR Material Introduction</td>
</tr>
<tr>
<td>BWR Material Introduction</td>
</tr>
<tr>
<td>Material Engineering</td>
</tr>
</tbody>
</table>
Material Introduction

The objective of the Material Introduction is to provide engineers/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.

Course Material

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

Course Appendix

1. Introduction and Background to Material Degradation
2. Physical Metallurgy of Structural Alloys
3. Corrosion Basics
4. Environmentally-assisted Cracking of Austenitic and Ni-base alloys
5. Low Temperature EAC in LWRs
6. Oxidation and Cation Release of Stainless Alloys in Light Water Reactors and FAC

Additional Information

- Course length: 11 hours
- Lectures: 10 hours
- Tests: 1 test (1 hour)
- Difficulty level: Basic
- Language: English

Authors/Lecturers

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

• Dr. Peter Ford
• Dr. Peter Scott
• Dr. Pierre Combrade

TRY THIS COURSE FOR FREE!

All of our currently available courses have selected content you can access completely free of charge such as lectures, reading materials and much more. For more information, feel free to email us at: sales@antinternational.com
PWR Material Introduction

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.

Course Material

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

Course Appendix

1. PWR System specific topics
2. Corrosion Fatigue, Corrosion Testing and Degradation Management

Full appendix and more information on this and other courses can be found at: www.antinternational.com

Authors/Lecturers

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

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

Additional Information

- Course length: 20 hours
- Lectures: 18 hours
- Tests: 1 test (1 hour)
- Difficulty level: Basic
- Language: English
BWR Material Introduction

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.

Course Material

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

Course Appendix

1. BWR System specific topics
2. Corrosion Fatigue, Corrosion Testing and Degradation Management

Full appendix and more information on this and other courses can be found at: www.antinternational.com

Authors/Lecturers

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

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

Additional Information

- Course length: 20 hours (1 week for full time studies)
- Lectures: 18 hours
- Tests: 1 test (1 hour)
- Difficulty level: Intermediate
- Language: English
Material Engineering

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.

Course Material

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

Course Appendix

1. Introduction and Background to Material Degradation
2. Physical Metallurgy of Structural Alloys
3. Corrosion Basics
4. Environmentally-assisted Cracking of Austenitic and Ni-base alloys
5. Low Temperature EAC in LWRs
6. Oxidation and Cation Release of Stainless Alloys in Light Water Reactors and FAC
7. BWR System specific topics
8. PWR System specific topics
9. Corrosion Fatigue, Corrosion Testing and Degradation Management

Full appendix and more information on this and other courses can be found at: www.antinternational.com

Authors/Lecturers

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

TRY THIS COURSE FOR FREE!

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

Additional Information

- Course length: 20 hours  
  (Around 1 week for full time studies)
- Lectures: 18 hours
- Tests: 1 test (1 hours)
- Difficulty level: Intermediate
- Language: English
COOLANT CHEMISTRY AND CORROSION

The following courses are available.

<table>
<thead>
<tr>
<th>Course</th>
</tr>
</thead>
<tbody>
<tr>
<td>PWR Chemistry Intro</td>
</tr>
<tr>
<td>BWR Chemistry Intro</td>
</tr>
<tr>
<td>PWR Chemistry Engineering</td>
</tr>
<tr>
<td>PWR Chemistry Advanced</td>
</tr>
</tbody>
</table>
PWR Chemistry Introduction

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.

Course Material

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

Course Appendix

1. Radiochemistry
2. Primary Coolant System
3. Auxiliary Systems
4. Secondary System
5. Chemical Control

Authors/Lecturers

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

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

Additional Information

- Course length: 24 hours (1 week for full time studies)
- Tests: 1 tests (1 hour)
- Difficulty level: Basic
- Language: English
BWR Chemistry Introduction

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.

Course Material

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

Course Appendix

1. BWR Designs and Materials Selection
2. BWR Water Chemistry, Electrochemistry and Corrosion Fundamentals
3. Auxiliary System
4. Dose Rate Mitigation
5. IGSCC Mitigation Technologies
7. Plant Operational Chemistry and Controls
8. Water Chemistry Impacts on Fuel
9. Activation Products and Fission Products

Authors/Lecturers

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

- Dr. Sam Hettiarachchi
- Dr. Wilfried Rühle

Additional Information

- Course length: 25 hours (1 week for full time studies)
- Tests: 1 tests (1 hour)
- Difficulty level: Basic
- Language: English
PWR Chemistry Engineering

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.

Course Material

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

Course Appendix

1. Radiochemistry
2. Primary Coolant System
3. Secondary System
4. Auxiliary systems, Maintenance

Authors/Lecturers

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

TRY THIS COURSE FOR FREE!

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

sales@antinternational.com

Additional Information

- Course length: Around 3 weeks for full time studies
- Reading: 90 hours
- Lectures: 15 hours
- Tests: 2 tests (2 hours)
- Difficulty level: Intermediate
- Language: English
PWR Chemistry Advanced

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.

Course Material

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

Course Appendix

1. Structural Material Degradation
2. Fuel Cycle, Reactor/Fuel Design
3. Reactor Safety
4. Fuel Design and Design Criteria
5. Fuel Performance during Normal Operation, Accident Conditions and Interim Dry Storage
6. Current Fuel Performance
7. Radiochemistry
8. Primary Coolant System
9. Secondary System
10. Auxiliary systems and Maintenance

Additional Information

- Course length: Around 6 weeks for full time studies)
- Lectures: 85 hours
- Reading: 125 hours
- Tests: 4 test (4 hours)
- Difficulty level: In-depth
- Language: English

Authors/Lecturers

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. Ron Adamson
- Mr. Peter Rudling
- Dr. Francis Nordmann
- Dr. Suat Odar
- Mr. Dewey Rochester

Full appendix and more information on this and other courses can be found at: www.antinternational.com

TRY THIS COURSE FOR FREE!

All of our currently available courses have selected content you can access completely free of charge such as lectures, reading materials and much more. For more information, feel free to email us at: sales@antinternational.com
CONTACT

For more information and/or an offer welcome to contact us at sales@antinternational.com

Please also visit our website for the latest updated information www.antinternational.com