



# A.N.T. International Academy

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## ONLINE EDUCATION

## BWR Fuel Engineering

### COURSE DESCRIPTION

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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 course involves reading technical reports, watching lectures and participating in online assessments (tests). The course material, including the online content, can be accessed at times convenient for practicing engineers and managers.



Assessments are done online, with an understanding of the current material (i.e., 70% required correct answers) needed to proceed to the next part of the course. After passing the final online test, a certificate will be issued to the student.

The course 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 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.

The content is described more in the [Appendix](#).

### AUTHORS/LECTURERS

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

*Structural Material Degradation:*

**Peter Ford, Peter Scott and Pierre Combrade.**

*Coolant Chemistry and Corrosion:*

**Samson Hettiarachchi, Robert Cowan and Wilfried Rühle.**

*Fuel Material:*

**Alfred Strasser, Richard Collingham, Charles Patterson, Friedrich Garzarolli,  
Ron Adamson and Peter Rudling.**

[Read more about the Experts](#)

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## COURSE MATERIAL

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The course material was developed by A.N.T. International and consists of earlier recorded A.N.T. International Seminars and associated Reports published by A.N.T. International.

Parts of the following Reports are being used in this course:

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|---|------------------------|
| • BWR Fuel Channel Distortion   | <a href="#">Sample</a> |
| • Effects of Coolant Chemistry on Fuel Performance (LCC9 STR)                       | <a href="#">Sample</a> |
| • Effect of Hydrogen on Zirconium Alloy Properties<br>— Volume I (ZIRAT5/IZNA1 STR) | <a href="#">Sample</a> |
| • Fuel Design Review Handbook (FDRH)  | <a href="#">Sample</a> |
| • Fuel Fabrication Process Handbook Rev 1 (FFPH)                                    | <a href="#">Sample</a> |
| • Fuel Material Technology Report (FMTR) – Volume I                                 | <a href="#">Sample</a> |
| • Fuel Material Technology Report (FMTR) – Volume II                                | <a href="#">Sample</a> |

## COURSE DURATION

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- Total time: around 130 hours (approx. 6,5 weeks for full time studies)
- Reading: 100 h
- Lectures: 25 h
- 4 Tests: 4h

The listed time for the lectures is the actual running time. More time may be needed to digest the information provided in this course.

## CERTIFICATE

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You will automatically receive an email with your 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](mailto:support@antinternational.com).

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



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# Appendix: Course outline and topics covered

## 1) INTRODUCTION

- 1.1 Fuel Design and Manufacturing
- 1.2 Structures and Components of the Fuel Assembly

## 2) MECHANICAL THERMAL-HYDRAULIC AND NUCLEAR DESIGN

- 2.1 Mechanical Design
- 2.2 Thermal-Hydraulic Design
- 2.3 Thermal-Hydraulic Fuel Design Audit
- 2.4 Nuclear Design Audit

## 3) FABRICATION AND MANUFACTURING

- 3.1 Pellet Production
- 3.2 Zirconium Alloy Manufacturing
- 3.3 Zirconium Alloy Component Fabrication

## 4) FUEL RODS AND SPACERS

- 3.1 Fuel Rod
- 3.2 Grid-Spacer Manufacturing
- 3.3 Spacers

## 5) END FITTINGS, ASSEMBLY AND MORE

- 5.1 End Fitting Manufacturing
- 5.2 Fuel Assembly Manufacturing
- 5.3 Bundle Assembly
- 5.4 Channel Manufacturing
- 5.5 BWR Fuel Outer Channels
- 5.6 Dimensional Stability

## 6) ZIRCONIUM AND BASIC METALLURGY

- 6.1 Zirconium Alloy Materials
- 6.2 Microstructure and Effect of Irradiation on Zirconium
- 6.3 Basic Metallurgy and Microstructure

## 7) FUEL RELIABILITY

## 8) CORROSION AND HPU

## 9) DIMENSIONAL STABILITY



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