# FUEL ROD PERFORMANCE MODELING, PROVIDED BY STRUCTURAL INTEGRITY ASSOCIATES

## CLASSROOM INSTRUCTORS

**Bill Lyon, P.E.**

Education:
- M.S. and B.S. Nuclear Engineering, Texas A&M University

Accreditations/Industry Leadership:
- P.E. Nuclear
- Has over 75 open literature publications and technical reports, and has published and/or presented papers at conferences in the United States, Europe, China and Japan

Background:
- Mr. Lyon has over 25 years of experience focusing on computational software development and coding, nuclear fuels and materials modeling, experimental design and analysis, and fuel performance design and analysis. He has worked with Los Alamos National Laboratory and the Advanced Thermal and Structural Technology Section of the Jet Propulsion Laboratory. Mr. Lyon previously was an Advanced Engineer in the Space and Defense Power Group at Westinghouse Hanford Company supporting the SP-100 space reactor development program as well as the FFTF and EBR-II nuclear fuel and materials experimental programs.

## CONTACT INFORMATION

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## INTENDED AUDIENCE

Licensed Senior Reactor Operators and nuclear engineering staff who seek a better understanding of fuel rod/cladding damage mechanisms and effective evaluation of spent fuel integrity related to transportation accident conditions as described in NRC regulations

## TYPE

Classroom Training

## DURATION

One day (7 PDH)

## LEARNING OBJECTIVES

Several key factors in nuclear fuel performance have come into prominence recently as a result of the trend toward increased fuel utilization. This demonstrates the need for a robust computational capability for both steady-state and transient fuel rod analysis.

This course will review a number of issues facing the industry. Topics addressed include how burnup-induced pellet changes and increased hydrogen uptake (as a byproduct of corrosion) occurring at higher burnups, impact both steady-state operation and licensing issues such as postulated Reactivity Initiated Accidents (RIA), Loss-Of-Coolant Accidents (LOCA), as well as spent fuel storage and transportation. This course will also identify why utilities have a need for an accurate and effective predictive fuel performance computational capability to provide guidance for both reactor operation, as well as feedback to the fuel design process.

Structural Integrity, with the addition of ANATECH has unique experience in developing material constitutive models and integral behavior codes for nuclear fuel and irradiated materials. Under EPRI sponsorship, we developed the Falcon code for the analysis of fuel rod behavior during normal operation, maneuvers, transients and postulated accidents. As a finite-element based code, Falcon has versatile 2-D geometric representation capabilities that can be used to model a full-length fuel rod or a local region of the fuel and cladding material. The Falcon code considers all aspects of nuclear fuel performance, including thermal, mechanical, chemical, and irradiation effects.

This class will provide real-world examples and approaches to improve fuel rod performance through the use of tools like Falcon. Discussions include fuel rod failure assessments during power maneuvers, postulated Reactivity Insertion Accidents and LOCAs, and fuel design verification.

**Topics Covered:**

- Relevant fuel performance phenomena
- Theoretical approach required to develop the computational tools and capabilities to analyze these phenomena under a variety of operational conditions
- Analysis examples of several fuel performance issues based on fuel rod experiments and commercial operational data

## KEY INDUSTRY DOCUMENTS

1. D. R. Olander, Fundamental Aspects of Nuclear Reactor Fuel Elements, Energy Research and Development Administration, TID-26711-P1, April 1976.
2. Fuel Analysis and Licensing Code: Falcon MOD01: Volume 1: Theoretical and Numerical Bases, EPRI, Palo Alto, CA, 2004, 1011307.
3. NUREG/CR-7022, "FRAPCON-3.5: A Computer Code for the Calculation of Steady-State, Thermal-Mechanical Behavior of Oxide Fuel Rods for High Burnup," Volume 1, Revision 1, October 2014
4. NUREG-800, Chapter 4, Section 4.2, Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants: LWR Edition — Reactor, Rev. 3, March 2007.
5. PCI Analyses and Startup Ramp Rate Recommendations for Westinghouse Fuel in Exelon PWRs, EPRI, Palo Alto, CA, 2006, 1012915.