

PWR Chemistry/Radiochemistry Data Evaluation and Interpretation Course Outline

- 1.0 Introduction 1**
 - 1.1 Introduction

- 2.0 Quality Data Generation**
 - 2.1 Quality Data Generation
 - 2.1.1 Representative Sampling
 - 2.1.1.1 On-Line Chemistry Monitors
 - 2.1.1.2 Quality Control Program
 - 2.1.1.3 On-Line Instrument QA/QC Considerations
 - 2.1.1.4 Data Evaluation Tools
 - 2.1.1.5 Source Term Evaluation
 - 2.1.1.6 Source Term Contribution from Total Organic Carbon
 - 2.1.2 ALARA Chemistry Principles
 - 2.1.3 Integrated Exposure
 - 2.1.4 Mass Balance Calculations

- 3.0 Primary Chemistry**
 - 3.1 Introduction
 - 3.2 Coordinated Boron Lithium Control
 - 3.2.1 Discussion of Chemistry Regimes
 - 3.2.2 Calculation of pH_T
 - 3.2.3 Determining consistency between pH, conductivity, boron, and lithium
 - 3.2.3.1 Low Temperature pH, Boron, Lithium Calculations/Data
 - 3.2.3.2 Data Consistency (pH at 25°C/Conductivity at 25°C/Boron/Lithium)
 - 3.3 Materials Integrity in the Reactor Coolant System
 - 3.3.1 Corrosion Modes of Structural Materials
 - 3.3.2 Effects of Chemistry Parameters
 - 3.3.2.1 PWSCC Mechanisms
 - 3.3.2.2 Dissolved Oxygen
 - 3.3.2.3 Dissolved Hydrogen
 - 3.3.2.4 pH
 - 3.3.2.5 Lithium
 - 3.3.2.6 Chloride
 - 3.3.2.7 Fluoride
 - 3.3.2.8 Sulfate
 - 3.3.2.9 Organics
 - 3.3.2.10 Zinc
 - 3.4 RCS Activity
 - 3.4.1 Formation of Radionuclides in the RCS
 - 3.4.2 Radionuclides Formed by Fission
 - 3.4.3 Radionuclides Formed by Activation

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- 3.4.4 Measurement of Radionuclides in the Reactor Coolant System
- 3.4.5 Expected Concentrations and Trends of RCS Radionuclides
- 3.5 Review Actual Plant Data (supplied prior to the course)
 - 3.5.1 Identify any adverse trends
 - 3.5.2 Discuss corrective actions if needed
- 3.6 Review applicable Industry Operating Experience

4.0 Secondary Chemistry

- 4.1 Introduction
- 4.2 ALARA Chemistry
- 4.3 Molar Ratio Control
- 4.4 Boric Acid Treatment and Additives (TIO₂)
- 4.5 Elevated Hydrazine or (alternate)
- 4.6 Cycle pH Control
- 4.7 Steam Generator Deposit Management
- 4.8 Review Actual Plant Data (supplied prior to the course)
 - 4.4.1 Identify any adverse trends
 - 4.4.2 Discuss corrective actions if needed
 - 4.4.3 Review applicable industry operating experience

5.0 Shutdown and Startup Chemistry

- 5.1 Shutdown Chemistry Controls General Principles
 - 5.1.2 Recent Experience Requiring Plant-Specific Technical Justification
- 5.2 Chemistry Control During Shutdown
 - 5.2.1 Evaluation of Shutdown Chemistry Data
 - 5.2.2 Hydrogen Removal Practices
 - 5.2.2.1 Mechanical Degassing
 - 5.2.2.2 Chemical Degassing
 - 5.2.3. Activity Releases
 - 5.2.4. RCS Oxygenation Practices
 - 5.2.4.1 Hydrogen Peroxide Treatment
 - 5.2.4.2 Hydrogen Peroxide Qualification
 - 5.2.4.3 Coolant Oxygenation Results
 - 5.2.4.4 Control of Refueling Water Clarity by Hydrogen Peroxide Treatment
 - 5.2.5. Fission Product Control during Shutdowns
- 5.3. Principles of Chemistry Control During Startup
 - 5.3.1. Post Refueling Startup and Mid-Cycle Chemistry Management Issues
 - 5.3.2. Corrosion Product Behavior during Heat-up
 - 5.3.3. Reactor Coolant Oxygen Control Practices
 - 5.3.3.1 Overview of RCS Oxygen Control Practices
 - 5.3.3.2 Coolant System Oxygen Removal Practices

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- 5.3.3.2.1 Traditional RCS Fill and Vent Process
- 5.3.3.2.2 Vacuum Refill— Standard Approach
- 5.3.3.2.3 Vacuum Refill—Improved Method
- 5.3.3.3 Residual Dissolved Oxygen Removal by Chemical Methods
 - 5.3.3.3.1 Dissolved Oxygen Removal by Hydrogen Addition
 - 5.3.3.3.2 Pressurizer Oxygen Control
- 5.3.4. VCT Operation and Hydrogen Control
- 5.3.5. Lithium Additions and pH Control
- 5.3.6. RCS Fill and Oxygen Control Sequence
- 5.3.7. Dilutions for Silica Control
- 5.3.8. Mid-Cycle Startups and Shutdowns
 - 5.3.8.1 Mid-Cycle Shutdown Chemistry Considerations
 - 5.3.8.2 Mid-Cycle Startup Chemistry Considerations
- 5.3.9. Control and Diagnostic Parameters, Frequencies, and Limits for Startup
- 5.3.10 Example Utility Experience with Startup Chemistry
- 5.4. Review Actual Plant Data (supplied prior to the course)
 - 5.4.1. Review actual plant templates for shutdown and most recent shutdown
 - 5.4.2. Each student to walk through time line of shutdown template
 - 5.4.3. Review applicable Industry Operating Experience