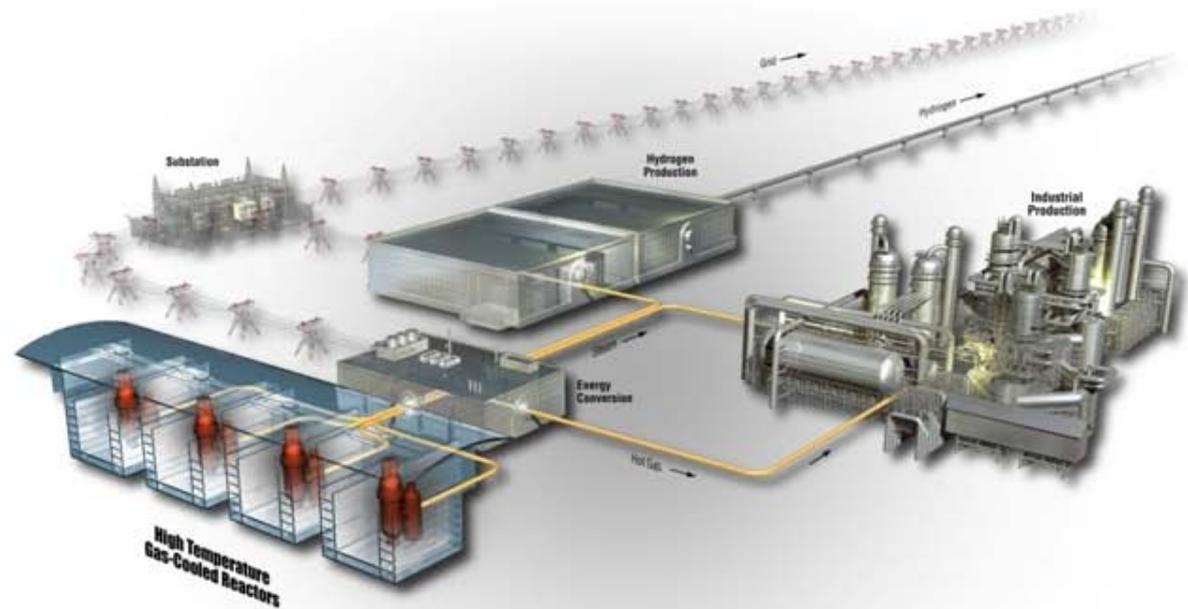


Discussion of Selected RAI Responses for NGNP Fuel Qualification and Mechanistic Source Terms White Papers

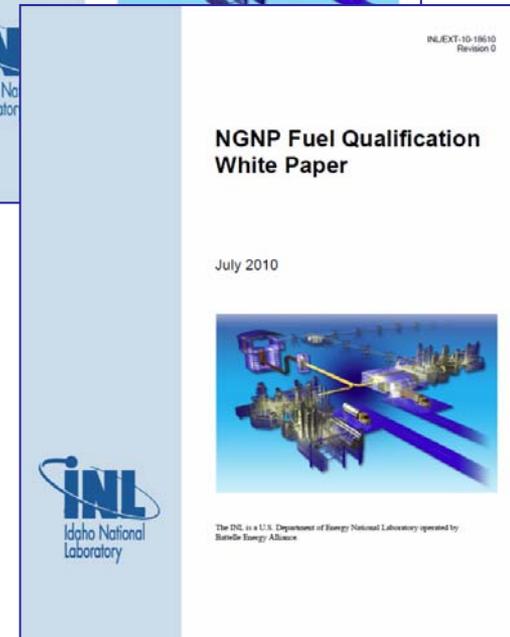
October 19, 2011

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Overview

- Purpose
- Background
- Summary
 - Fuel Qualification White Paper
 - Mechanistic Source Terms (MST) White Paper
- Topics of Discussion – Selected RAI Responses
- Questions and Answers
- Public Comments



Purpose

- Discuss selected RAI responses to assure that the NRC Staff has the necessary information to address the associated NGNP white paper outcome objectives
- NGNP white papers being covered today:
 - Fuel Qualification
 - Mechanistic Source Terms

Background

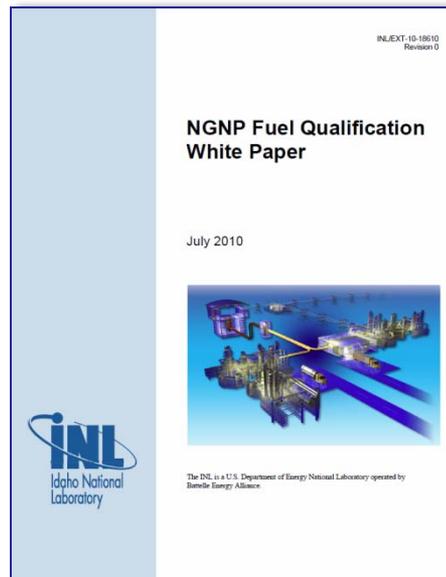
- July 21, 2010, submitted to NRC
 - NGNP Fuel Qualification White Paper (CCN 221270)
 - NGNP Mechanistic Source Terms White Paper (CCN 221271)
- September 2, 2010 – public meeting held to discuss white paper submittals
- May 3, 2011, submitted to NRC
 - Supplemental Information to NGNP Fuel Qualification and MST White Papers (CCN 223977)
 - Letter requested that material in the NGNP Fuel Qualification White Paper related to qualification of pebble bed fuel based on the PBMR, (Pty) Ltd. approach be withheld from review (affecting Sections 1.3, 4.2, 5.2 and 6)
 - While the Fuel Qualification White Paper was being finalized, the Demonstration Power Plant (DPP) expected to be built in South Africa was cancelled. The approach to pebble bed fuel qualification described in the white paper was based upon leveraging the fuel qualification activities by PBMR (Pty) in support of the DPP. Updated information regarding the revised plan for pebble bed fuel qualification will be provided once that plan is established

Background – Cont

- June and July 2011, received NRC RAIs for Fuel Qualification and MST White Papers
 - First set of RAIs dated June 7, 2011 (NRC RAI Letter No. 002)
 - Second set of RAIs dated July 25, 2011 (NRC RAI Letter No. 003)
- August and September 2011, submitted NGNP responses to NRC RAIs (NRC letter numbers 002 and 003)
 - First set of RAI responses on August 10, 2011 (CCN 224915)
 - Second set of RAI responses on September 21, 2011 (CCN 225363)

Summary

Fuel Qualification White Paper



Purpose of the Fuel Qualification WP

- Identify existing regulations, regulatory guidance, and licensing precedents relevant to the qualification of fuel for the NGNP project
- Summarize existing understanding, data, and analysis methods regarding coated-particle fuel performance
- Review reactor and fuel designs and resulting fuel service conditions and performance requirements
- Describe planned fuel fabrication, irradiation, testing activities, and planned approach to fuel qualification
- Obtain feedback from the Nuclear Regulatory Commission (NRC) on the planned approach to fuel qualification and information required for the combined license (COL) application

Outcome Objectives For Fuel Qualification WP

- The primary issues for which feedback is requested include
 - Confirmation that plans established for qualification of the UCO fuel type are generally acceptable based on the NGNP/AGR Fuel Development and Qualification Program
 - Identification of any additional information or testing needed to meet NGNP fuel performance requirements
- Per May 3, 2011 letter, requested that material in the NGNP Fuel Qualification White Paper related to qualification of pebble bed fuel based on the PBMR, (Pty) Ltd. approach be withheld from review (affecting Sections 1.3, 4.2, 5.2 and 6)

Summary Mechanistic Source Terms White Paper



Purpose of Mechanistic Source Terms (MST) White Paper

- Define/describe proposed approach for developing event-specific MSTs for HTGR licensing
- Describe currently planned technology development programs needed to validate methods used to develop MSTs
- Obtain agreement from NRC that, subject to appropriate validation through the needed technology development program, the event-specific MST approach is acceptable

Outcome Objectives of MST White Paper

- The definition of the mechanistic source term is acceptable
- The approach to calculation of MST, which includes a radionuclide retention concept (“functional containment”) that includes the multiple barriers discussed in the white paper is acceptable, subject to validation of design methods and supporting data
- The approach of the planned fission product transport tests of the NGNP/AGR Fuel Development and Qualification Program, supplemented by existing irradiation and accident testing data, is acceptable for validation of the fission product transport models that support determination of mechanistic source terms

HTGR Source Term Definition

- Quantities of radionuclides released from the reactor building to the environment during Licensing Basis Events. This includes timing, physical and chemical forms, and thermal energy of the release
- HTGR Source Terms are:
 - Event-specific
 - Determined mechanistically using models of fission product generation and transport that account for reactor inherent and passive design features and the fission product release barriers
 - Different from the LWR source term that is based on a severe core damage event

Topics of Discussion – Selected RAI Responses

Topics of Discussion – RAI Responses

- FQ-3/MST-3
 - Discuss non-LWR licensing process: 10 CFR 50.43(e)
 - Demonstrate safety features through analysis, test, and/or experience, or
 - Test a prototype plant over a sufficient range conditions
- FQ-23/MST-28, FQ-26/MST-31, FQ-52/MST-56 and FQ/MST B-55
 - Examples
 - Technical Specifications
 - Fuel Surveillance
 - In-core Instrumentation

Topics of Discussion – RAI Responses – Cont

- FQ-4/MST-5 (FQ-13/MST-18, MST-72, and B-57)
 - Discuss fission product species that can pass through intact SiC under normal operation and under accident conditions
- MST-9 (MST-40, MST-96)
 - Discuss use of Fick’s Law radionuclide bulk diffusion approximation versus “more rigorous” transport model(s) and comparative study
- MST-17 (MST-12, FQ-29/MST-34, FQ-30/MST-35, FQ-32/MST-37 and MST-68)
 - Discuss use of conservative assumptions or simplifications in Best Estimate analyses

Topics of Discussion – RAI Responses – Cont

- FQ-19/MST-25
 - Discuss significance of inventories of short half life fission products under heatup tests and accidents
- FQ-43/MST-47
 - Discuss process control and characterization procedures for fuel fabrication

Topics of Discussion – RAI Responses – Cont

RAIs related to Risk Informed Performance Based White Papers

- MST-65 (MST-74, MST-83, MST-89 and MST-107)
 - Discuss MST relationship to LBE and DiD white papers
- MST-71
 - Consideration of BDBEs in siting assessment
- MST-89
 - Discuss treatment of Prompt Fatality (300-500 rem dose) in MST development and top-level Frequency-Consequence requirements

Topics of Discussion – RAI Responses – Cont

- FQ/MST B-4
 - Discuss Mode I, II and III type cracking
 - The type of cracking that was observed is Mode I (tensile stress normal to the plane of the crack).
 - No in-plane or out of plane shear (Mode II or III) have ever been observed in TRISO particles
- FQ/MST B-5
 - Discuss path dependency of fuel behavior
- FQ/MST B-11 (FQ-MST B-13)
 - Discuss definitions of intact, functionally failed, and failed particles

Topics of Discussion – RAI Responses – Cont

- FQ/MST B-18
 - Discuss constant isothermal versus transient (time-temperature) testing
- FQ/MST B-24
 - Discuss blind code predication vs. code analysis
 - Pretest prediction of experiments
- FQ/MST B-48
 - Discuss impact of accelerated irradiation on time at temperature effects
 - The journal article describes such effects
 - J. T. Maki, D. A. Petti, D. L. Knudson and G. K. Miller, “The challenges associated high burnup, high temperature, and accelerated irradiation for TRISO-coated particle fuel,” Journal of Nuclear Materials, 371 (2007) 270-280

Topics of Discussion – RAI Responses – Cont

- FQ/MST B-78
 - Discuss need for Th contamination specification
- FQ/MST B-81
 - Discuss multiple enrichments, fissile/fertile particles and impact on testing
- FQ/MST B-82
 - Discuss temperature control during irradiation

