U.S. DEPARTMENT OF ENERGY | OFFICE OF ENVIRONMENTAL MANAGEMENT

A Brief Presentation
on

Potential Acceptance of German Pebble Bed Research Reactor Highly Enriched Uranium (HEU) Fuel

Edgard Espinosa
Office of Environmental Management

Briefing to the Institute for Nuclear Materials Management
January 13, 2015

OFFICE OF ENVIRONMENTAL MANAGEMENT

Outline of Presentation

- **Genesis for Activity**
- **Source of Material**
- **Development in Technology**
- **Current Work**
- **Underlying Benefits from Technology**

OFFICE OF ENVIRONMENTAL MANAGEMENT

Background

- **US Policy is to reduce the amount of HEU available in the world thus, eliminating the potential for the material to be used for an improvised nuclear device, a radiological dispersal device, or other radiological exposure device.**
- **German Pebble Bed Research Reactor Fuel under consideration is approximately one million graphite spheres stored in Jülich and Ahaus, Germany containing ~900 kg of highly enriched uranium (HEU) from US.**
- **At the request of German government, EM is conducting a feasibility evaluation for possible acceptance, return to Savannah River Site (SRS), and alternatives for disposition.**
  - Research and Development (R&D) at Savannah River National Laboratory (SRNL), in collaboration with Forschungszentrum Jülich (FZJ), provides a means for graphite removal from the fuel kernels without the development of graphite fines as seen in mechanical graphite removal methods.
- **Environmental Assessment (EA) is being conducted to evaluate impacts of return of this US-origin material at the SRS and alternatives for disposition.**
  - No decision has been made on the acceptance of this fuel

OFFICE OF ENVIRONMENTAL MANAGEMENT

Source of Material

- **US-origin HEU material was provided for purposes of peaceful uses and development of nuclear energy**
  - Explored the use of coated fuel particles embedded in graphite spheres, used in pebble-bed reactors, cooled by helium (high temperature gas-cooled reactor, HTGRs)
- **Used in two reactors in Germany**
  - AVR Reactor (*1967-1988*) was the first high temperature reactor in Germany to test the technology of graphite spheres
  - THTR-300 (*1983-1989*) was a demonstration research reactor to prove the AVR concept design to produce electricity

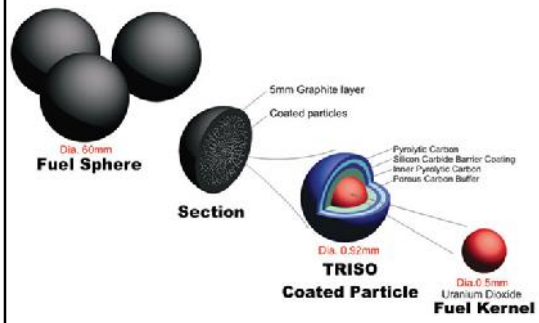
graphite UNF spheres

AVR Research Reactor, 15MW(e), Jülich

THTR-300, Prototype Research Reactor, 300 MW(e), Hamm-Uentrop

OFFICE OF ENVIRONMENTAL MANAGEMENT

Composition of German HEU Fuel



- **Approx. 1 million, 60mm graphite spheres**
- **Characteristics of a Sphere:**
  - ~ 200 g of A3-3 graphite
  - 1g of Uranium, ~93% enriched
  - 10g of Thorium
- **Currently Stored in 455 CASTOR casks:**
  - AVR, (Jülich): 152 CASTOR casks
  - THTR-300 (Ahaus): 303 CASTOR casks

OFFICE OF ENVIRONMENTAL MANAGEMENT

Current Storage of Fuel: CASTOR® Cask

- **All fuel is stored in CASTOR casks**
- **Casks are certified in Germany by the German equivalent to the US Nuclear Regulatory Commission (NRC)**
- **Casks are being reviewed for acceptance as DOE/US Department of Transportation (DOT) - certified Type B Casks.**

CASTOR Cask cut away

OFFICE OF ENVIRONMENTAL MANAGEMENT

Efforts to Date

- **Funding for Research and Development (R&D) has been provided by Forschungszentrum Jülich (FZJ).**
- **SRNL R&D focused on chemical digestion of the graphite, results to date are very successful.**
  - Technology aims to majority graphite matrix and breach silicon carbide coating
- **Next research steps are to maturate and validate the technology, and work the scale-up of technology and optimize conceptual process.**
  - Large-scale production rate of execution is projected to digest 1000 units/day
- **EA will be conducted on the options for the German Pebble Bed Research Reactor fuel if it is returned to the US.**

OFFICE OF ENVIRONMENTAL MANAGEMENT

Preliminary Results

graphite SNF spheres

0.5mm dia metal ball from ballpoint pen

TRISO coated particle, ~10,000/sphere

Residual product after digestion of carbon matrix on unirradiated spheres

OFFICE OF ENVIRONMENTAL MANAGEMENT

NEPA Process

- **Environmental Assessment (EA) being developed**
  - Notice of Intent issued in Federal Registrar
    - DOE Public Meeting Held in North Augusta
  - Analyzing potential environmental impacts
    - receipt, storage, processing, and disposition
- **Over 200 comments received (Duration of comment period: 6/2/2014 – 7/21/2014)**
- **Drafted Chapters 1, 2 and 3**

OFFICE OF ENVIRONMENTAL MANAGEMENT

Alternatives being evaluated

- **No action**
- **Options for Disposition of the Uranium *after* receipt, storage and chemical digestion of the graphite matrix:**
  - H-Canyon – No HEU down blend, everything sent to HLW
  - H-Canyon – Separate U and down blend, then dispose as LLW (either on or offsite)
  - H-Canyon – Separate U and Thorium, then dispose as LLW (either on or offsite)
  - L-Area - Melt and Dilute, then dispose of ingots as HLW

OFFICE OF ENVIRONMENTAL MANAGEMENT

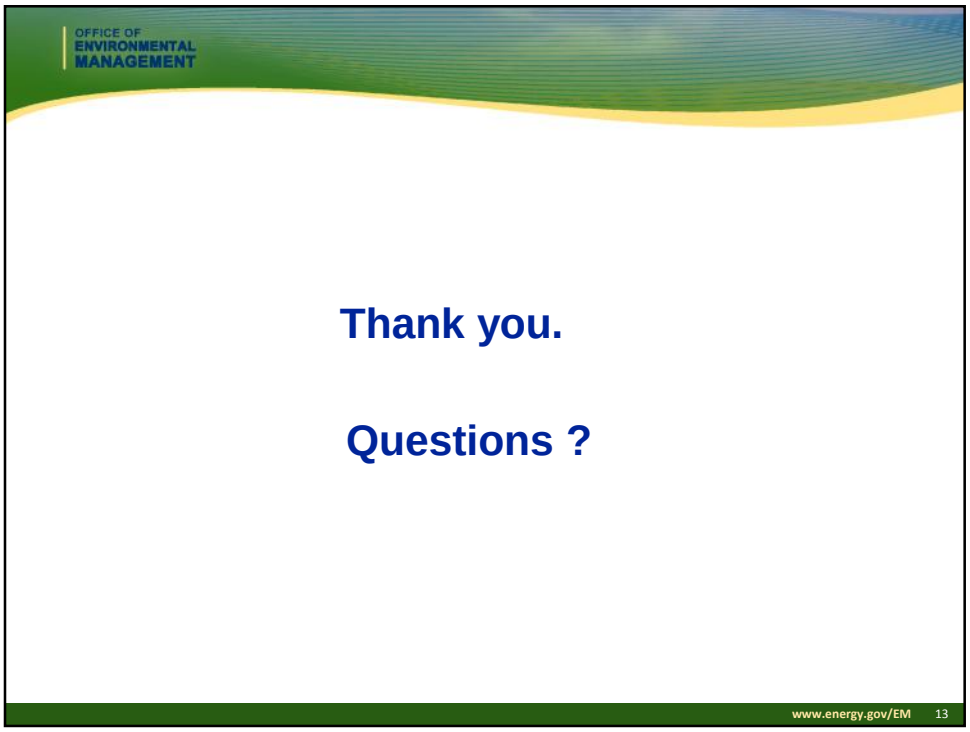
Benefits from Work

- **Supports HEU minimization objective: Repatriate and disposition ~ 900 kg of US-Origin HEU.**
- **Should R&D be successful, the graphite fuel cycle would be closed; disposition path identified and developed.**

OFFICE OF ENVIRONMENTAL MANAGEMENT

Summary

- **The return of this material supports the US HEU minimization objective by removing the US origin HEU from Germany and returning it to the US for safe storage and disposition in a form no longer usable for an improvised nuclear device, a radiological dispersal device, or other radiological exposure device.**
- **If proven successful, the technology closes the back-end of the fuel cycle for graphite-based fuels.**


OFFICE OF
ENVIRONMENTAL
MANAGEMENT
Thank you.
Questions ?
www.energy.gov/EM
13