NRC PART 170 FEES

- MOX FABRICATION FACILITY
- USE OF MOX FUEL

STAFF HOURS AND CONTRACT COSTS WILL BE ASSESSED FOR:

-PRE-APPLICATION REVIEWS

-APPLICATION/LICENSING REVIEWS

-TOPICAL REPORT REVIEWS

-INSPECTIONS

-RESEARCH

-PROJECT MGRS.

COSTS CAPTURED FOR:

FABRICATION FACILITY

- By Docket # 070-03098
- Costs Began May 1999

USE OF MOX FUEL

- By Docket # 50-369/370 and 50-413/414
- Review of Topical
- By TAC MB0024
- Research
- Costs Began April 1999

RESEARCH COSTS FOR USAGE NOT YET BILLED

- COSTS BEGAN OCTOBER 2000

- COSTS THROUGH 9/22/2001 ARE APPROX. $305K

- COSTS WILL BE BILLED 10/22/2001

QUARTERLY SCHEDULE FOR BILLING

QUARTER ENDS	*BILLS DATED*
9/22/2001	10/22/2001
12/29/2001	1/27/2002
3/23/2002	4/22/2002
6/29/2002	7/29/2002
9/21/2002	10/21/2002

NRC CONFIRMATORY RESEARCH ON MIXED-OXIDE FUEL

Presented by

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October 4, 2001

NRC CONFIRMATORY RESEARCH ON MIXED-OXIDE FUEL

ISSUE

Licensing the use of weapons-grade mixed oxide (MOX) fuel in specific U.S. Pressurized Water Reactors (PWRs)

BACKGROUND

- U.S. Department of Energy issued Record of Decisions (1/14/97 and 1/4/00) to pursue an approach to safely and securely dispose of surplus plutonium from the U.S.

- Savannah River Site has been selected for weapons-grade MOX fuel fabrication.

- Weapons-grade MOX is to be used in selected U.S. PWR commercial reactors (McGuire and Catawba).

Background (continued)

- USNRC Commission Paper on "Mixed Oxide Fuel Use in Commercial Light Water Reactors," April 14, 1999.

- ACRS letter from Dana A. Powers to Chairman Shirley A. Jackson, "Use of Mixed Oxide Fuel in Commercial Nuclear Power Plants," May 17, 1999.

- Letter from William D. Travers to Dana A. Powers of ACRS, "Use of Mixed Oxide Fuel in Commercial Nuclear Power Plants," July 13, 1999.

- USNRC Internal Memorandum from S. Collins to A. Thadani, "Research User Need for Development of Multiple Issues to Prepare for Reviewing Amendments Associated with Mixed-Oxide Fuel," November 5, 1999.

- USNRC Commission Paper on "Agency Plan for Confirmatory Research Associated with the Use of Mixed Oxide Fuel Use in Commercial Light Water Reactors," February 11, 2000

- USNRC Internal Memorandum from A. Thadani to S. Collins, "RES Response to NRR Request on Research User Need for Development of Multiple Issues to Prepare for Reviewing Amendments Associated with Mixed-Oxide Fuel," February 23, 2000

NRC Confirmatory Research

Technical support: Improvement to Analysis Codes and Assessment of Environmental Impact of MOX fuel use

- Neutronics: develop models for MOX, benchmark against critical experiments, computational benchmarks, and plant data
- Fuel: revised model for MOX, assessment of fuel behavior under normal and abnormal conditions
- Source Terms: validate model(s) against relevant experimental data, and perform consequence analysis

RESOURCES

FY 2001: $450K
FY 2002: $1.1M
FY 2003: $1.1M
FY 2004: $1.1M

NRC Confirmatory Research (continued)

- Conduct Phenomena Identification and Ranking Tables (PIRTs) for MOX

  - PIRT for LOCA and reactivity accident completed. See http://www.nrc.gov/RES/PIRT/
  - PIRT for source term started (September 24-25, 2001)

- Neutronics:

  PARCS code development at the Purdue University
  - initiated in November 2000
  - implement and assessment of multi-group, P1 and P3 for X-sections representations
  - collaboration with France - Saclay, comparison of CRONOS vs. PARCS
  - development of a "theoretical" benchmark for reactivity transient for MOX under discussion with OECD/NEA
  - PARCS has been updated (Version 2.2 - September 2001)

  BNL

  - independent assessment of PARCS and NEWT
  - provide feedback to code developer
  - assist in assembling benchmark/assessment problems for PARCS analysis of MOX cores
  - assist NRR in review of technical issues related to MOX licensing as needed (e.g. MOX fuel qualification program)

NRC Confirmatory Research (continued)

- Neutronics:

  ORNL

  - initiated the development of the NEWT lattice physics code in March 2001

- Fuel:

  PNNL

  - initiated modifications of fuel codes for MOX analysis
  - assess code against MOX fuel behavior (e.g., Halden)

- Source Terms:

  - Initiated effort to obtain relevant experimental data (e.g., VERCORS, France; VEGA, Japan) for the assessment of fission products release models for MOX fuel

  - Additional experimental data may be available in the future from the IPSN MAGRAGUE and PHEBUS-2K programs at Cadarache, France

- Assist in licensing review of technical issues as they arise.

- Briefed ACRS Reactor Fuel Subcommittee on April 4, 2001.

NRC Confirmatory Research (continued)

MOX RESEARCH SCHEDULE

PROGRAM	TIMELINE			
	FY2001	FY2002	FY2003	FY2004
NEUTRONICS	PARCS code modification, NEWT code development	PARCS and NEWT codes assessment and application for MOX core		
FUEL	MATPRO MOX data	FRAP- codes assessment and application for MOX core		
SOURCE TERMS		Assessment of fission products release models against experimental data (VERCORS, VEGA , MAGRAGUE)	Perform consequence analysis for MOX core	
PIRT	PIRT for MOX source term			

PARCS - Purdue Advanced Reactor Core Simulator (3D kinetics code); NEWT - Lattice Physics code
MATPRO - Material properties package
FRAPCON - Steady-state fuel behavior code; FRAPTRAN - Transient fuel behavior code;
VERCORS, MAGRAGUE (France); VEGA (Japan) - Fission products release tests

Potential data base considered for code validation

Neutronics

Assembly/Small critical experiments Saxton EPICURE ERASME/L VENUS-2 MOX benchmark	 pin power distribution, criticality, various absorbers, void effects
Power Reactor Benchmarks St. Laurent B1 Cycles 5-10 (France) Goesgen (Switzerland) McGuire 1 or 2: Cycles 12/13/14 Catawba 1: Cycles 11/12/13 Catawba 2: Cycles 9/10/11	At start up/HZP: critical born concentrations, control rod bank worth, isothermal temperature coefficient At power: critical born concentrations, assembly power distributions
Transient Benchmark Dynamic rod worth calculations (LEU fuel) (Westinghouse analytical results) Theoretical" benchmark for reactivity transient for MOX (under discussion w/-OECD/NEA) KAIST/Purdue Benchmark	 Compare dynamic rod worths, individual/and total banks code-to-code comparisons 8, 4 and 2 energy group 2D and 3D steady and transient 5x5 assemblies, 17x17 pins, UO_2/MOX/Reflector control rods, burnable absorbers (Gd)

KAIST: Korean Advanced Institute of Science & Technology

Fuel

BAW-10231 Chapter 13 (Copernic code) ORNL/Russian report Halden experimental data	Pellet thermal conductivity of MOX and Gd_2O_3 Radial power profile, burnup profile
Halden experimental data ANS 5.4 (update for MOX)	fission gas production and release
BAW-10227PA (M5)	M5 cladding corrosion, irradiation growth, creep, high temperature oxidation
McGuire or Catawba core loading UO_2 vs. UO_2/MOX	rod power histories vs. burnup (kW/ft) axial power profile vs. burnup (Assembly)
Fuel design information	Pu fraction and Gd_2O_3 fraction, and axial variation if any
CABRI Na-loop: Na-6, Na-7 and Na-9 Water-loop: S4 series	Reactivity initiated accident
ATR MOX irradiation program	WG-MOX fuel performance Affects of gallium impurities on fuel performance

Source Terms

UO_2 fuel VERCORS RT-1 (50 GWd/tU) VERCORS HT-2 (46 Gwd/tU) VEGA -1 (47 GWd/tU) Ref. VEGA - 4 (47 GWd/tU) MOX fuel VERCORS RT-2 (41 GWd/tU) RT-7 (41 GWd/tU) VERCORS HT-4 (41 GWd/tU) VEGA - 7 (40 GWd/tU) Ref. VEGA - 9 (40 GWd/tU)	radionuclides release from irradiated MOX fuel under severe accident conditions

MOX Fuel Qualification and Irradiation Plans

- November 2001: Submit Advanced Mark-BW Fuel Assembly Design Topical Report (Framatome)
- November 2001: Submit MOX Fuel Design Topical Report (Framatome)
- January 2002: Submit MOX Fuel LOCA Topical Report (Framatome)
- 2002?: Submit MOX Fuel Lead Assembly License Amendment Request (Duke Power)
- 2002?: Submit Fuel Qualification Plan (DCS)

Duke Power.
A Duke Energy Company

MOX Fuel Qualification and Irradiation Plans (cont)

- August 2002: Submit Fuel Reconstitution Topical Report addendum for MOX fuel (Duke Power)
- April 2003: Submit MOX Fuel Safety Analysis Topical Report (Duke Power)
- December 2003: Submit License Amendment Requests for Batch Utilization of MOX Fuel at McGuire and Catawba (Duke Power)
- 2004?: Begin MOX fuel lead assembly irradiation

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Ongoing U.S. MOX Fuel Research

- Advanced Test Reactor (ATR) MOX Fuel Test Program
  - Sponsored by DOE and directed by Oak Ridge National Lab
  - MOX fuel pellets and rods fabricated at LANL with various gallium concentrations
  - Purposes: (1) demonstrate acceptable performance of weapons grade MOX fuel irradiated in a reactor and (2) show that gallium levels significantly above trace levels will not adversely affect fuel/cladding
- Current maximum burnup ~32 GWD/t
- Excellent performance to date
- November 2003: Completion of irradiation of pellets to 50 GWD/t

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NRC Research Plan - Related Activities

- Duke Power, Framatome, and ORNL submittals and activities relate to the three areas cited in the 2/11/00 Travers memo
- Reactor physics
  - Fuel Qualification Plan Section 7
  - Nuclear Analysis Topical Report
  - MOX Fuel Safety Analysis Topical Report
  - MOX fuel lead assembly performance confirmation

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MOX Fuel Qualification and Irradiation

- Maximize use of European experience base
  - Research programs
  - Proven manufacturing process
  - Reactor irradiation experience
- Proven fuel assembly design
- Confirmatory lead assembly program
- NRC reactor operating license amendments in accordance with 10 CFR 50.90

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MOX Fuel Qualification and Irradiation

- June 1999: Overview Meeting with NRC
- July 2000: DCS Fuel Qualification Plan provided to NRC for information
- August 2000: Framatome COPERNIC Topical Report submitted to NRC (MOX applications)
- October 2000: Meeting with NRC on Fuel Qualification Plan
- December 2000: Meeting with NRC on Oak Ridge National Laboratory (ORNL) MOX fuel activities

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MOX Fuel Qualification and Irradiation (cont)

- April 2001: DCS MOX Fuel Qualification Plan revised and provided to NRC for information
- August 2001: Duke Power Nuclear Analysis Topical Report submitted to NRC (MOX and LEU applications)
- September 2001: Duke Power Thermal-Hydraulic Statistical Core Design Topical Report (Appendix E) submitted to NRC (advanced Mk-BW fuel assembly design, to be used for MOX fuel)

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MOX Fuel Lead Assembly Program

- Original approach - fabricate two MOX fuel lead assemblies at Los Alamos National Laboratory (LANL) and begin use in McGuire Nuclear Station in fall 2003
- LANL fabrication activities terminated May 2000
- Alternatives under consideration
  - Fabrication at existing European MOX fuel fabrication facilities
  - Fabrication at Savannah River MOX Fuel Fabrication Facility, when constructed and licensed

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Mixed Oxide (MOX) Fuel Project Status

Meeting with Nuclear Regulatory Commission Offices of Research and Nuclear Reactor Regulation

S. P. Nesbit
Duke Power
October 4, 2001

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Plutonium Disposition Program

- **Goal: To dispose of surplus weapons plutonium**
  - **January 2000 Department of Energy (DOE) Record of Decision**
  - **September 2000 U.S.-Russian Federation Plutonium Disposition Agreement**
- **Approaches**
  - **Fabrication into mixed oxide (MOX) fuel and use in existing light water reactors**
  - **Immobilization in vitrified high-level radioactive waste**

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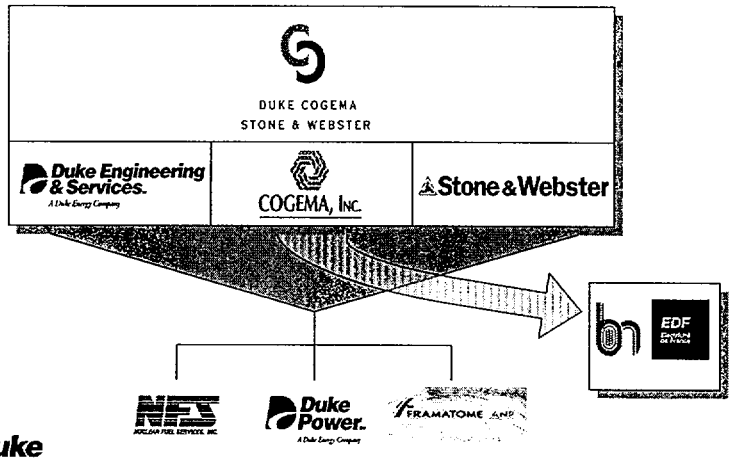
Duke Cogema Stone & Webster (DCS) Team



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MOX Fuel Project

- **MOX Fuel Fabrication**
  - **12/00: DCS submitted Environmental Report to NRC**
  - **2/01: DCS submitted Construction Authorization Request to NRC**
- **MOX Fuel Qualification**
- **MOX Fuel Irradiation**
- **Fresh MOX Fuel Transportation and Packaging**
- **Project Management**

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NRC Research Plan - Related Activities

- **Fuel behavior**
  - Fuel Qualification Plan Sections 5, 6, 7, and 8
  - COPERNIC Topical Report
  - MOX Fuel Design Topical Report
  - MOX Fuel LOCA Topical Report
  - MOX Fuel Safety Analysis Topical Report
  - ATR test program
  - MOX fuel lead assembly performance confirmation
- **Source terms**
  - Fuel Qualification Plan Sections 5 & 7
  - COPERNIC Topical Report
  - License Amendment Request Dose Analyses
  - License Amendment Request Level III PRA Analyses

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Perspective on NRC Research Program

- **DCS team recognizes the role of NRC Research in the regulatory review process**
- **Our goal: work with NRC to ensure thorough and cost-effective review of submittals**
  - Support confirmatory work by NRC
  - Make maximum practical use of the existing data and experience base with MOX fuel
  - Focus on risk-significant issues
  - Defined scope, cost and schedule

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