MOX Fuel Fabrication Facility:
Leading the Nuclear Renaissance

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At the end of the Cold War, U.S. and Russia began to cooperate to prevent the proliferation of weapons of mass destruction.

In 1995 National Academy of Sciences studied and recommended disposal options for Weapons Grade fissile materials:
- Plutonium: mix with depleted U to produce mixed oxide fuel (MOX Program).

In 2000, both countries signed an agreement:
- Each to dispose of 34 metric tons of surplus weapons-grade plutonium:
  - Enough for thousands of nuclear weapons
  - Convert to MOX Fuel for power reactors
Pu Disposition Program

Weapons Dismantlement at Pantex

Pit Disassembly & Conversion at Savannah River

MOX Fuel Fabrication (MP)

Aqueous Purification (AP) Capability

Clean Metal

Impure Plutonium Oxide

Interim Storage at SRS

Spent fuel is unsuitable and unattractive for use in nuclear weapons

Obj. 1
MFFF Prime Contract

- MFFF prime contract awarded in 1999 to Duke Cogema Stone & Webster, now Shaw AREVA MOX Services

- Base Contract - Design, Licensing, Reactor Upgrades, Lead Test Assemblies

- Option 1 - Construction and Cold Start-up

- Option 2 - Hot Start-up, Fuel Production Operations, and Irradiation Services

- Option 3 - Deactivation
MFFF Main Functions

- Aqueous Polishing (AP) - Purify PuO$_2$ to produce a feed stock to suitable for MOX fuel.

- Manufacturing Process (MP) - Blend PuO$_2$ with DUO$_2$, produce fuel pellets, and load into MOX fuel assemblies.
U.S. Congress mandated (Public Law 105-261, 17 October 1998, Section 3134) the MFFF will be:

- Licensed and regulated by the NRC (10 CFR 70)
- Comply with Occupational Safety and Health Administration Act of 1970

DOE and NRC requirements met for Physical Security

NRC requirements (10 CFR 74) for Material Control and Accountability

Supplemented by a selected set of DOE Directives imposed by contract for project management, financial management, record keeping, etc.
MOX Fuel Fabrication Facility

1. Purify plutonium oxide
2. Mix with uranium oxide
3. Fabricate Pellets
4. Fabricate fuel assemblies
5. Irradiate MOX fuel assemblies

MOX Fuel Fabrication Facility

Commercial Nuclear Reactors
MFFF Design Reference Plants

La Hague – model for the MFFF AP Process
- 20,000 tons of spent fuel reprocessed at La Hague

MELOX - model for the MFFF MP Process
- > 1400 tons MOX fuel produced at MELOX
Aqueous Polishing (AP)
• used to remove contaminants (primarily Ga, Am, and Cl)

MOX Process (MP)
• process blends UO2 and PuO2 powder into pellets
• loads pellets into rods
• manufacture of fuel assemblies
Aqueous Polishing Process

Electrolytic Dissolution of PuO₂ Powder into a Nitric Acid Solution

Chemical Purification Steps to Separate Pu from Contaminates

Conversion of Pu in solution to PuO₂ Powder
Oxide Powder Blending

1 - Primary blending of Powder to 20% PuO₂ mixture

2 - Secondary blending of Powder to 5% PuO₂ mixture
Pellet Prod. & Rod Assembly

1 - Blended PuO2 Powder
2 - Pellet Pressing
3 - Pellet Sintering
4 - Pellet Grinding
5 - Rod Loading
6 - Assembly Fabrication
MFFF Production Rates

- 3.5 metric tons of Pu per year
- 70 tons of MOX fuel per year production capacity
- 1 Assembly built per day
MOX Fuel Fabrication Facility

- MFFF Process Building is a 500,000 ft highly secure, seismically-resistant steel reinforced concrete structure
- Construction approved in April 2007
- Began Construction in August 2007
- Baseline
  - Total Project Cost $4.86 Billion
  - Project Completion, October 2016
MFFF Design Facts

• Three discrete facilities combined in a single building:
  – Aqueous Polishing building: 7 levels including underground
  – Fuel Fabrication building: 3 levels all above ground
  – Shipping and Receiving building: 3 levels including underground

• Complex architecture and layout
  – 598 rooms/cells
  – 300 glove boxes

• Highly automated systems
  – 40,000 Control Inputs/Outputs
  – 80 non-safety Programmable Logic Controllers (PLC)
  – 13 safety PLCs
  – Manufacturing Management Information System (MMIS): 2 million lines of code drives the production process
Safety & Security Design

- Nuclear Material Confinement
- Criticality Prevention
- External Events
- Radiation Protection
- Fire Protection
- Security Functions
MFFF Construction Site
August 2007

Start of Construction
MFFF Construction Site
May 2010
MFFF Construction
Interior wall rebar installation
MFFF Construction
Floor section ready for concrete placement
MFFF Construction
Wall Rebar Installation
MFFF Construction Site
Rod Storage Room, Aug. 2010
Typical AREVA Gloveboxes
MFFF Construction Site
Sintering Furnace Cooling Water Tank, Aug. 2010
Annular Tanks in Process Cell
(AREVA Facility)
Piping Gallery
(AREVA Facility)
MFFF, Aug. 2010
Setup of KCB unit gloveboxes for assembly and test
DOE Experience

• Microcosm of larger nuclear industry
  - No large new nuclear facilities built for nearly 20 years
  - Emergence of several major projects in recent years
    - Hanford Waste Treatment Plant
    - Mixed Oxide Fuel Fabrication Facility
    - Uranium Processing Facility
    - Chemical and Metallurgical Replacement
    - Pit Disassembly and Conversion
    - Salt Waste Processing Facility
DOE Experience

- Supplier network not in place to support multiple large projects

- Existing qualified suppliers could only support ongoing operations, maintenance and smaller projects

- New projects have had to address supplier challenges
Meeting the Challenge

• Sponsor and support vendor workshops to highlight opportunities and requirements for nuclear work

• Develop flexible acquisition strategies that address alternatives when suppliers can’t perform

• Plan for and allocate budget to offset cost and schedule risks of supplier issues
Meeting the Challenge

- Enhance the technical capabilities and training of federal oversight staff to assess supplier work
- Perform risk-based supplier reviews and assessments against requirements
- Exchange lessons learned and supplier information with other DOE projects
Obtaining Desired Results
Lessons Learned

• Construction Approach – Develop Construction Management Plan very early in the project in enough detail so the reader knows the intent and goals of each section, get peer and client buy in, modify as project progresses and assure revisions are disseminated to Eng. QA, Procurement etc. (try and keep everyone on the same page)

• Host Site Integration – Make sure the roles, responsibilities and protocols are formalized in a document and agreed upon

• Readiness for Construction – Perform a detailed assessment on all articles and activities necessary to start and maintain construction activities (the results will surprise you)
Lessons Learned

- Readiness for Construction II – Perform a second detailed assessment to guarantee all findings from the 1st assessment are implemented

- Imbed Construction with Design – During the design phase perform constant constructability reviews (add disciplines as design matures, and also perform formals constructability reviews at 30, 60, 95% design complete (otherwise design will never complete)

- Procurements – Vendors with a NQA-1 qualified program are very scarce, fabricators are better but the population is limited, Installation subcontractors with a NQA-1 qualified program are almost extinct because they have not used their programs in many years. Put all installation under one program or the record keeping will become chaotic
  - Prequalify as many vendors, fabricators and subcontractors as you can if you intend on bidding the entire project scope
  - Increase your lead time on procurements and carefully examine your schedule for long lead procurements
  - Develop and qualify your Commercial Grade Dedication program early.
  - Use the best value approach when subcontracting, it is more work than low bid technically qualified but allows you to select the best subcontractor
Lessons Learned

• Concrete Batch Plant – If you are going to establish an onsite batch plant (recommended for large NQA-1 concrete projects) you should
  - Allow one year to set it up and get it qualified
  - Qualify all your mix designs during batch plant qualification
  - Operate the plant yourself and use your QA/QC program for material qualification and inspection
  - Evaluate your concrete placement schedule and size the plant material storage for at least 1 ½ more than the largest pour

• Material Receipt - Operate the warehouse and lay down in accordance with your QA/QC requirements
  - Establish the program responsibilities i.e. what group is responsible for inspection, inventory etc
  - Determine storage parameters and size warehouse appropriately
  - Determine quality inspection attributes
  - Quality level 1 material must be controlled in a ‘chain of custody’

• Plan and Execute the construction by procedure and written work plans that are constantly reviewed for accuracy
Project Performance Summary

• Project is 46% complete overall
  – Facility construction is 32% complete

• Process Building construction continues on schedule and cost

• Project safety continues to be excellent
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END........Questions?