Columbia Fuel Fabrication Facility

Governors Nuclear Advisor Committee, April 29, 2024

Chris Hudson

CFFF Senior Director Technical Services

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AGENDA

- Introductions
- Plant Expansion
- New Nuclear Plant Fuel
- Status of License Modification
- Economic Impact
- Closing Remarks

Significant Upgrades to Existing Facility

Our infrastructure work also positively impacts our ESG efforts through improved energy efficiency and reduced emissions

- **Major Infrastructure Risk Reduction Improvements - Replaced/Upgraded**
  - Replaced and installed two 600 HP Cleaver-Brooks Steam Boilers (100% redundant units)
  - Replaced and installed four CAT Emergency / Backup power diesel generators and 4 automatic transfer switches
  - Replaced Nine 300–500-ton Carrier chillers – process and area cooling
  - Replaced and installed three 250-300 HP Air Compressors
    - Two Ingersoll-Rands units are continuously on-line, plus one Atlas-Copco spare.
  - Replaced and installed two Laser chillers (100% redundant units)
  - Replaced and installed Stills Cooling towers (two cells)
  - Replaced and installed multiple area HVAC units
  - Replaced approximately 125,000 sq. ft. of the facility's roof
  - MCC upgrades/Bus Duct elimination
  - Upgraded Lighting in several areas to LED
  - Replaced Conversion Piping
  - Implemented several Fire System Upgrades/Post indicating Valves
  - Replaced Hydrogen and Natural Gas piping and headers and installed double isolation valves
  - Administrative Building electrical/HVAC/fire protections upgraded to current day code
  - IT infrastructure Improvements implemented

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2023 Capital Improvements

Infrastructure/Stability	Automation/Digitalization/Growth	Risk Reduction Environmental/Safety
• Pellet Furnace Rebuilds (1 Furnace) • Pellet Press Line 5 Rebuild • Truck Portal Replacement • Lime Slaker Replacement • URRS MCC Replacement • IFBA Oven Turbo Pump Replacement • WS-210 Welder Replacement • Numalogic Replacement • LECO Analyzer Replacement	• ADOPT Pellet Manufacturing – in progress • Pellet Grinder Cell Replacement • Laser A Implementation – in progress • Poly Pak Sample AI • IFBA Coater Runtime AI • Grid Inspection System (Blue Light) • Pellet Press Column PLC Replacement • Final Assembly Loader Controls (1 Loader to be completed) • VVER440 Grid Production • Bar Code Reader Upgrade UT2 • Grid Laser Auto Alignment	• Pellet Furnace Safety Upgrade • Oracle Upgrade • UF6 System Safety Upgrades • Perchloroethylene (PCE) Drum Processing Project • Fixed Ladder Replacement Project • Remove Legacy Ventilation System Off Roof • Sanitary Lagoon Package Plant design • AC-13/14 Replacement • Grey - Is Complete

2024 Capital Improvements

Infrastructure/Stability	Automation/Digitalization/Growth	Risk Reduction Environmental/Safety
• Pellet Furnace Rebuild • Pellet Press Line Rebuilds • WS-210 Welder Replacement • Numalogic Replacement • Honeywell Upgrades BPCS • UT2 Rod Inspection Upgrade • NMS Active Rod Scanner • Chem Side Lighting Upgrades • Ammonia Chiller Replacement • IFBA Dehumidification Skid Enclosure • Capital Tooling Replacement • Asset Maintenance Minor Programs (EFIN)	• ADOPT Pellet Manufacturing • GM3 Furnace • Pellet Grinder Cell Replacement • Laser A Implementation • Poly Pak Sample AI • IFBA Coater Runtime AI • Grid Inspection System (Phase 2) • Pellet Press Column PLC Replacement • Final Assembly Loader Controls • Grid Laser Auto Alignment • Oracle Upgrade • WATTS to CMS Upgrade Highlighted - In Process	• Pellet Furnace Safety Upgrade • Oracle Upgrade • UF6 System Safety Upgrades • Fixed Ladder Replacement Project • Sanitary Lagoon Package Plant design • Exhaust Stack Ports • Pellet Press Safety Shutoff • Rod Weigh Entry Conveyor

2025-2028 Capital Improvements

Infrastructure/Stability	Automation/Digitalization/Growth	Risk Reduction Environmental/Safety
• Bulk Container Replacement • Pellet Furnace Upgrade/Rebuild • Pellet Press Refurbishment • Conversion Ammonia Chillers • Pellet Molybdenum Boats • SOLX Glass Column Replacement • Grid Furnace Hot Zone • Additional Numalogic PLC Replacement • V-x19 Upgrade	• BWR Fuel Manufacturing • Skeleton Build Automation • Grid Assembly Automation • Grid Cell Optimization • WS-210 Welder Replacement Full Implementation • Thermal Stability Furnace Capacity • Rotary Oxidation Furnace	• Sanitary System Replacement/ Lagoon Decommissioning • HF Tanks Replacement • Calciner Combustion System Replacement • MCC Upgrade/Replacement • Conversion Filter Press Ventilation • Fire Protection Excellence Plan • AC-01 and AC-02 Power Panels • URRS T-19 Controls Upgrade

New Projects in Addition to Ongoing 2024 Projects

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Plant Expansion

Blending for ADOPT fuel Manufacturing, LASER A for VVER440, and Truck Portal Monitor for enhanced security

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New Advanced Fuel Products

Advanced DOped Pellet Technology (ADOPT ™)

- Developed to improve fuel cycle economics and accident tolerance
- Increases burn efficiency and corrosion resistance
- Supports achieving higher fuel burnups through increased enrichments
- Doping pellets with small amounts of chromia and alumina – fuel achieves greater uranium efficiency - 50 percent lower oxidation rate compared to conventional uranium oxide pellets

Benefits
- ~2% higher Uranium density for improved fuel cycle economics
- High thermal stability (negligible densification)
- Oxidation resistance (Oxidation rate for ADOPT fuel is 50% that of standard (UO2)

Extensive operating experience
- Standard product in European BWR market
- PWR experience through EDF's liner ADOPT AXIOM (LAX) program and US LTR/LTAs

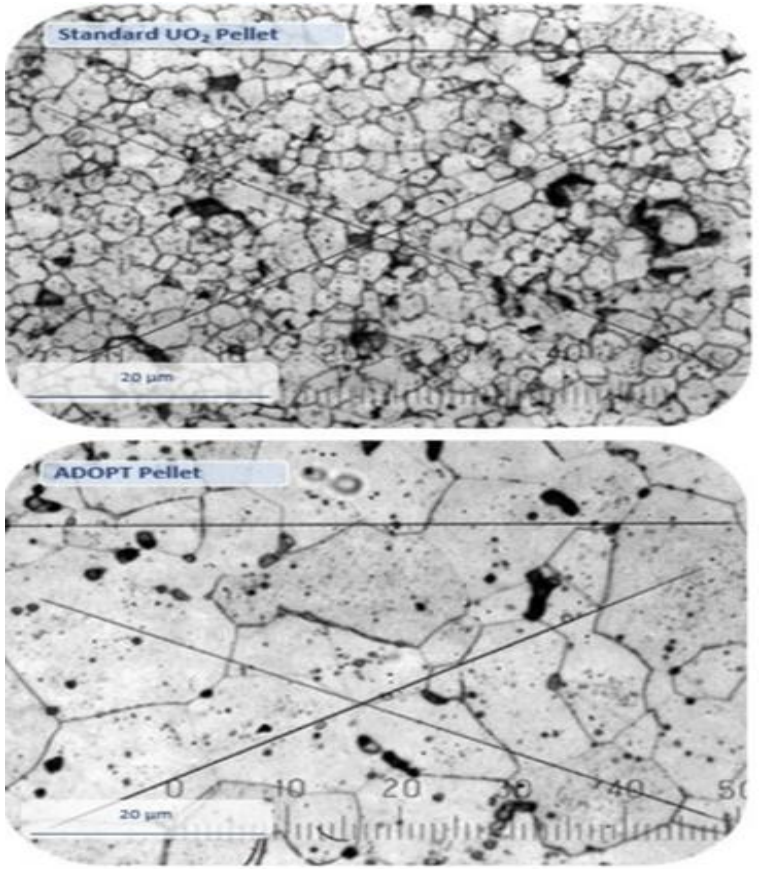
Received NRC Approval of Final SER for AXIOM Pellet Topical on June 17, 2022

Manufacturing Capability
- Full capability from fuel fabrication plant in Sweden
- Initial fabrication trials completed for solid and annular pellets at CFFF
- Good results from blending to achieve grain size and pellet density

Westinghouse US delivery beginning Spring 2025

ADOPT: Standard UO2 fuel doped with small amounts of Cr2O3&Al2O3

Additives facilitate densification & diffusion during sintering resulting in a higher density & enlarged grain size compared to undoped UO2



ADOPT Fuel Pellets available in 2024

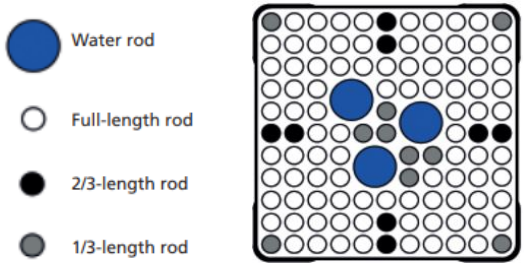
New Advanced Fuel Products

TRITON11™ Westinghouse 11x11 BWR Fuel Design

New Generation BWR Fuel with

- Superior Fuel Economy
- Robust Mechanical Design
- Uncompromised Reliability
- High Performing Materials

- Offers utilities power to improve fuel cycle cost savings and optimize operations
- TRITON11™ fuel assembly consists of:
  - 91 – fuel rods of full length
  - 10 – 1/3-length rods
  - 8 – 2/3-length rods
  - 3 – cylindrical rods
- Each key design aspect - carefully considered, analyzed and tested to meet customer's current and anticipated operational requirements



Advanced debris mitigation with the AM Stronghold filter, better thermal margins, and a more robust fuel assembly

- **11x11** fuel rod lattice with 18 part-length rods
- Handling loads taken by 3 centrally located water channels
  - **Low** Tin ZIRLO™ material
- 109 fuel rods resting freely on bottom tie plate
  - **HiFi**™ cladding with liner
  - **ADOPT**™ pellets
- Same sleeve type spacer concept as SVEA-96 **Optima3**™
  - X-750+ material
- Advanced thick-thin outer channel with expansion of flow area and elimination of thick corners at 2/3 axial level
  - Low Tin ZIRLO™ material
- **StrongHold** AM debris filter

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LEU+ Project Overview

- Manufacture fuel assemblies with a maximum of 8% enrichment by constructing a new building for LEU+ manufacturing at the Columbia Fuel Fabrication Facility in Hopkins, SC.
- Improve Process flow
- Longer reactor refuel cycles – potentially less spent nuclear fuel
- Reduce potential impacts to our people the public and the environment for example
  - Reduce site use of ammonia
  - Reduce site liquid and gaseous effluents
  - Reduce collective CFFF site dose
- Generating ~400 jobs over the next 5 years to design, constructed and commission the facility
- Implementing lessons learned in engaging community and stakeholders

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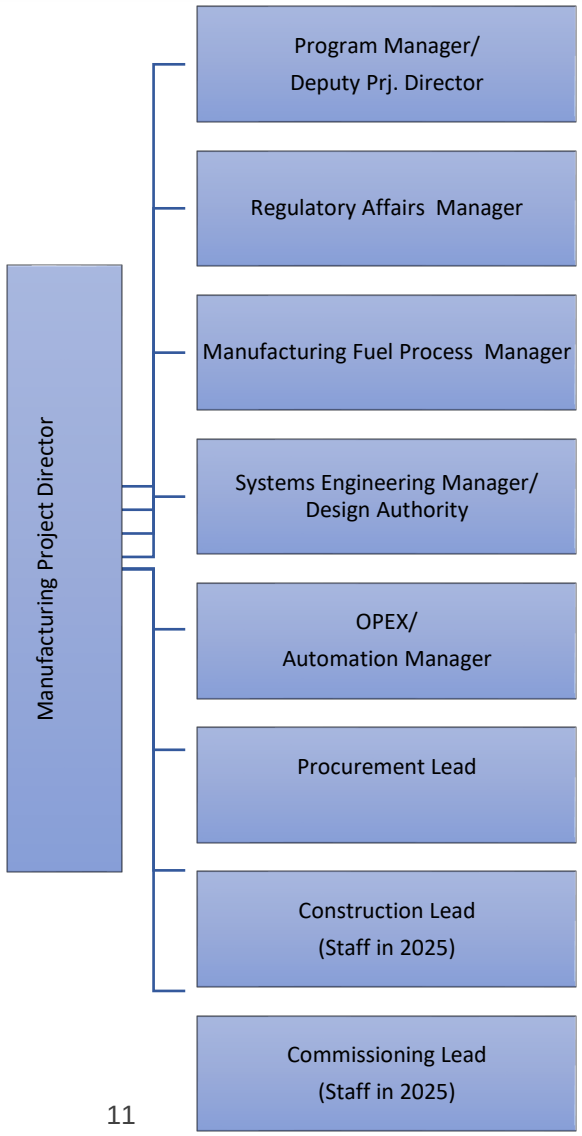
New building is an opportunity to continue to improve site margin

LEU+ Overview

- LEU+ Staff Project Team in Place
- Resources in criticality and environmental secured external to CFFF
- Building and Process Design
  - Process layout revision is being incorporated into building model
  - Finalizing building footprint for revised process flow
  - Initiated designs on conversion process
- Environmental Report
  - Currently incorporating NRC RAI responses into Environmental Report from 2020
  - Gathering updates for ER sections not impacted by the building and process design
- Licensing Amendment Request
  - Established licensing strategy
  - Preparing Regulatory Engagement Plan
- Fundamental Nuclear Material Control Plan (FNMCP)
  - Developing strategy to incorporate LEU+ with updated FNMCP



Conversion
- Two Step Dry (TSD) conversion max 8% enriched UF6
- Ammonia free process (no ammonia scrubbers needed)
- Generated HF can be scrubbed and sold for industrial use

Pelleting
- ADOPT blending established at CFFF
- Automatic Pelleting lines and enclosed processes

Burnable Absorbers/ Rods
- IFBA Dry Room
- Gadolinium Line
- Automatic Rod loading and resistance welded rods minimizing dose

URRS
- Use of Microwave technology to eliminate need for wet processes in URRS from Scrap.
- No Nitrate discharge to environment
- Cylinder and recertification of 30B cylinders

Mechanical
- Skeletons received from CFFF
- Eliminate fuel assembly washing
- Single control access point
- Ship in Traveller shipping container (Submittal in Q1 2026)

Summary

- Foundation going forward has been clearly established
- Continuous Focus on reducing Risk, improving Safety, Quality and Process Controls
- Focusing on growth and meeting customer/industry demand
- We owe it to our customers, the communities they operate in and the public to provide leak free fuel
  - About 10% of US electricity comes from nuclear fuel manufactured by Columbia
- Our goal is to operate in a safe, environmental conscious manner, produce leak free fuel and provide high quality components to our customers to ensure health and safety of the public and surrounding communities

CFFF will continue to do the right thing in an open transparent manner with all stakeholders