Advanced Cladding
World Class Material Designed for Unmatched Corrosion Resistance and Hydrogen Uptake

AREVA NP
AREVA NP offers an advanced zirconium alloy for PWR fuel rod cladding and fuel assembly structural components to provide our customers with increased efficiency in their nuclear operations.

This fully re-crystallized Zirconium-Niobium alloy containing no tin but controlled oxygen, iron, and sulfur content produces much improved corrosion, hydrogen, growth, and creep behavior. The stable microstructure responsible for these performance improvements is the result of the alloy’s composition and innovative manufacturing parameters.

Introducing commercially in the 1990s after an extensive development program, M5® is more than an improvement on existing material — it is a breakthrough in the development and fabrication of zirconium alloys. The alloy is in use in 14x14 to 18x18 fuel assembly designs in PWRs with a full range of operating parameters (moderate to high-duty) such as two-year cycles, high lithium, high power densities, high temperatures, and sub-cooled boiling. Over five million fuel rods have been irradiated in commercial PWRs to burnups exceeding 80,000 MWd/tU — numbers that continually increase.

**M5® Cladding Process**

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<th>Zircon Powder</th>
<th>Zirconium Sponge</th>
<th>Addition of M5® alloying elements</th>
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<td></td>
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<td>(\text{S}^{16})</td>
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<td>(\text{Nb}^{41})</td>
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**Extensive Global Operating Experience**

5 Million+ fuel rods
94 PWRs worldwide
Minimizes Licensing Costs and Risks

- New NRC regulations reflect the degradation in accident resistance due to operational hydrogen uptake
- M5® leads the industry in corrosion resistance and demonstrates the lowest hydrogen uptake
- M5® provides cycle design flexibility without sacrificing margin for accidents such as LOCA and RIA

Impact of Alloy EOL Hydrogen Content on LOCA Performance

Transient oxidation limit: 6% ECR at 400 EOL ppmH

- PCT ≤2200° F
- PCT ≤2050° F

M5® EOL <150 ppmH

Added margin with M5®

Competitor’s EOL ppmH

Current AREVA NP fuel customers — no changes are needed to fuel, cladding, cycle design, or analyses to retain margin in accident performance.

New AREVA NP fuel customers — will gain significant design and performance margin versus available alternatives.

Extruded Billets → Pilgering → M5® Advanced Cladding → Final Inspection
Features and Benefits

- Proven performance in a wide range of PWR operating conditions and fuel assembly designs
- Maintains significant margins to current and changing safety regulatory requirements
- Low corrosion & extremely low hydrogen pickup
- Increased performance margins at high burnup for additional operational flexibility for plants

M5® exhibits less than 150 ppmH at EOL

M5® has industry leading corrosion performance

AREVA NP is a major international player in the nuclear energy market focused on designing, building, maintaining and advancing the global nuclear fleet. In North America, AREVA NP (AREVA Inc.) combines U.S. and Canadian leadership to deliver innovative solutions and value-added technologies to support the operation of the commercial nuclear fleet and prepare for the next generation of nuclear power plants. Leveraging the expertise of its 2,300 North American employees, AREVA NP is helping its customers improve the safety and performance of their nuclear plants and achieve their economic and societal goals. Join the energy conversation with AREVA Inc. on Twitter: @AREVA_NP_US, Facebook: AREVAInc, and our other social media channels.

AREVA Inc.

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