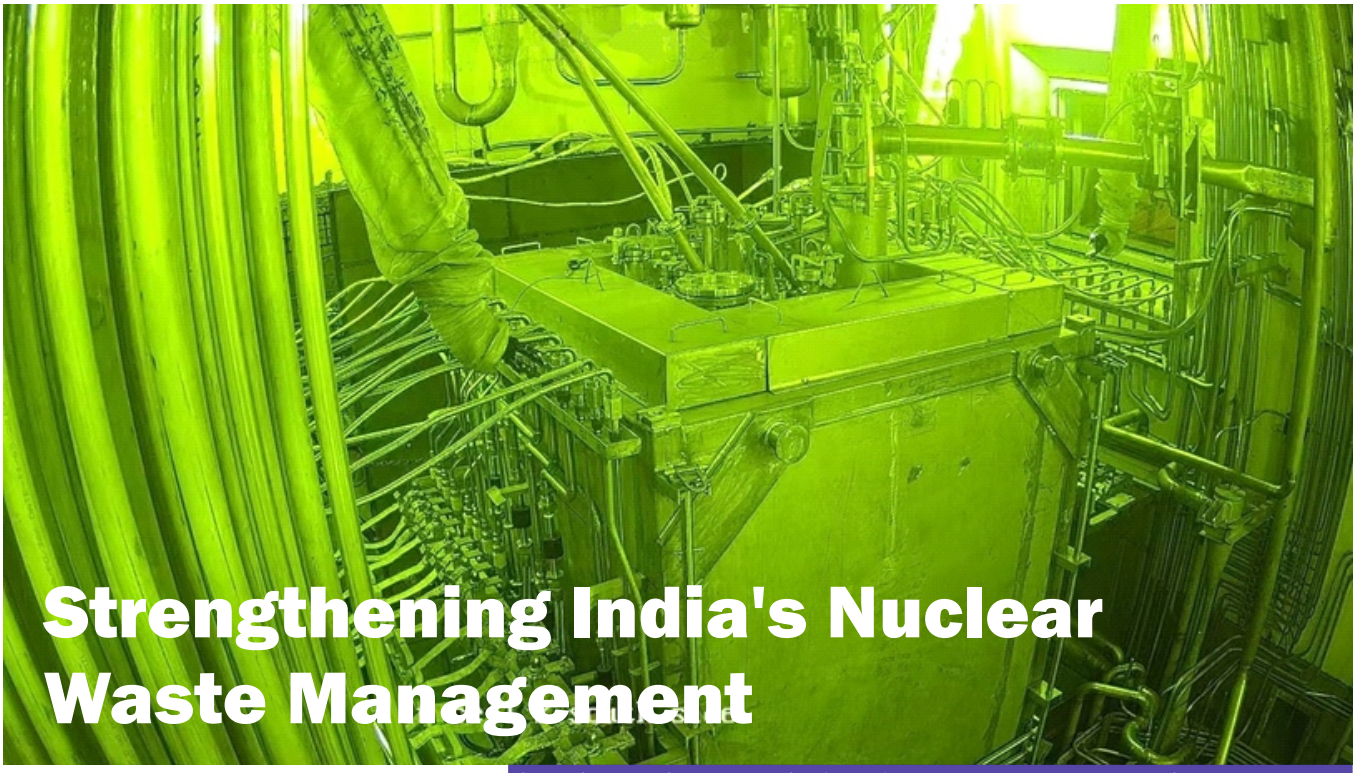

Strengthening India's Nuclear Waste Management

The Joule Heated Ceramic Melter (JHCM) in operation at AVS Annex Facility in NRB Tarapur.

Nuclear Recycle Board, BARC hot commissioned the AVS Annex Vitrification Facility at Tarapur, advancing sustainability, strategic capabilities and self-reliance in nuclear waste management plant operations

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India's nuclear power programme emphasizes fuel reprocessing or the Back-End Fuel Cycle to ensure both energy sustainability and safe management of nuclear waste. A cornerstone of this effort is vitrification of high-level waste (HLW), carried out in specialized facilities equipped with Joule Heated Ceramic Melter (JHCM) systems. Operating in extreme high-temperature and corrosive conditions, these plants reflect advanced engineering capabilities while opening avenues for innovation in materials development-cum-engineering and safe operational practices.

Vitrification Process and Waste Conditioning

The vitrification process immobilizes HLW in glass matrices, offering safe and long-term containment. The newly commissioned AVS Annex Facility at Nuclear Recycle Board Tarapur enhances this effort with two key units: 1. The Melter Cell which is built on a pioneering roll-in roll-out design (first-of-its-kind in nuclear waste management operations) and a 2. Decommissioning Cell which enables safe melter replacement and dismantling operations.

In a recent development, the AVS Annex Facility began hot commissioning in June 2025 and has the capacity to treat HLW from PREFRE-2 at Tarapur. It is specifically designed to handle HLW resulting from the reprocessing of spent PHWR reactor fuel averaging 6,700 MWD/ton burn-up of Uranium from fuel cooled for more than three years.

Engineering Challenges and Material Innovation

The operational life of JHCM is primarily limited by degradation of heating elements and internal components, exposed to harsh conditions of high radiation, continuous corrosive attack, and sustained temperatures upwards of 950^{0}C. To address this, a new material, UNS N06690, was developed locally through collaboration between MIDHANI, Nuclear Fuel Complex, and NRB. The key components of JHCMs are now mostly fabricated from UNS N06690 billets, thereby nullifying the reliance on imports.

Key components such as electrodes, thermowells, freeze valves, and feed pipes are manufactured from UNS N06690 and thoroughly qualified for service. This material development represents a strategic technological

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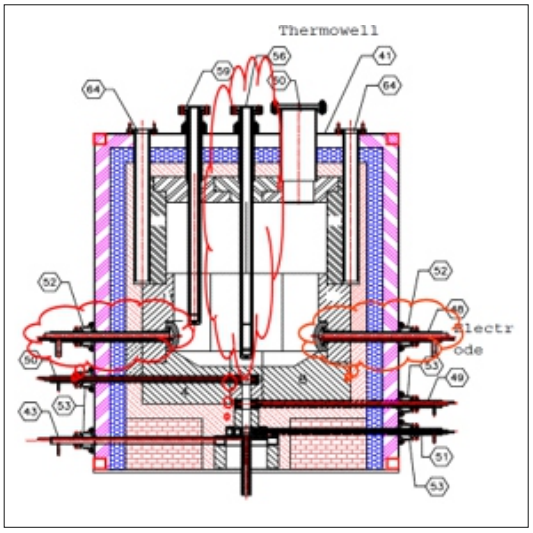
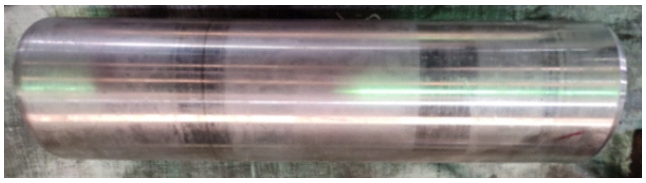


The schematic of Joule Heated Ceramic Melter (JHCM). The operational life of JHCM is primarily limited by degradation of heating elements and internal components, exposed to harsh conditions of high radiation, continuous corrosive attack, and sustained temperatures upwards of 950^{0}C.

achievement, ensuring self-reliance and long-term operability of melters in India's backend fuel cycle programme.

Advanced Control and Power Systems

The AVS Annex incorporates modern SCADA and PLC-based systems for remote monitoring and control, minimizing worker exposure to radiation while enhancing operational efficiency. To support uninterrupted operations and ensure safe shutdown, a centralized electrical substation (TWMP Substation) has also been commissioned. These advanced systems guarantee that operational parameters remain within safe limits under all conditions.



The key components of JHCMs are now mostly fabricated from UNS N06690 billets (in picture), thereby nullifying the reliance on imports.

Strategic Significance of AVS Annex

The indigenous development of UNS N06690, integration of cutting-edge systems, and seamless inter-agency coordination highlight the strategic importance of the AVS Annex facility. Its commissioning not only strengthens India's nuclear waste management infrastructure but also establishes a benchmark for back-end fuel cycle facilities in the future.

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