

Brazilian Nuclear Fuel Cycle (front end): INB's Integrated Approach for U_3O_8 and UF_6

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Abstract

The safe and secure transportation of nuclear materials is a strategic and highly regulated activity for Indústrias Nucleares do Brasil (INB). This paper describes INB's integrated approach to the road transport of uranium concentrate (U_3O_8) from the mining site to the port in Bahia and the transport of uranium hexafluoride (UF_6) from the port to the nuclear site in Rio de Janeiro. These operations, crucial for Brazil's nuclear fuel cycle, involves distinct technical, regulatory, and security challenges, requiring also robust coordination among national authorities such as CNEN/ANSN, IBAMA, the Federal Police, and the Brazilian Navy. By integrating safety, security, and environmental considerations, INB strengthens regulatory compliance, operational reliability, and public confidence.

Keywords

Uranium, nuclear transport, safety, security and best practices.

Introduction

The nuclear fuel cycle in Brazil, a monopolistic market, begins with uranium mining and processing in Caetité, Bahia, where uranium concentrate (U_3O_8), also known as yellowcake, is produced. This material is subsequently exported for conversion services, where it undergoes transformation into uranium hexafluoride (UF_6) — a process not presently carried out in Brazil. While Brazil possesses the technological capability to perform this stage and all the others, it is not currently utilized for commercial purposes. Subsequently, the UF_6 is enriched with the U-235 isotope at INB's Nuclear Fuel Factory in Rio de Janeiro or abroad. At the INB Nuclear Fuel site the enriched gas is reconverted into uranium dioxide (UO_2) powder, processed into pellets, and assembled into zircaloy rods to form nuclear fuel, which is ultimately used at the Angra nuclear power plants.

The Challenges of Nuclear Material Transportation

The transport of uranium concentrate (U_3O_8) from the mining site to the nearest port, a distance exceeding 700 km, is the first significant logistical step. For this U_3O_8 export operation to conversion services abroad, INB contracts road transport and charter vessels for direct shipment, which requires the application of multiple licenses. Furthermore, INB manages in-transit storage of cargo before loading onto the vessel, adhering to a wide range of regulations. The return of the converted material (UF_6) to Brazil also requires a series of steps for the safe and secure due to the characteristic of the fissile cargo



which involves more approvals and has other difficulties to contract the necessary logistics services, such as cargo transportation insurance. Besides, export and import licenses and approvals from port authorities at origin, transit, and destination are needed in every transport operation.

Safety and Security: The Operational Pillar

INB implements a rigorous safety and security policy to mitigate the risks associated with nuclear material transportation. From a safety perspective, INB operates intrinsically linked to packaging design and administrative requirements, all in accordance with national transport safety regulations, which are aligned with the latest edition of IAEA SSR-6 (Regulations for the Safe Transport of Radioactive Materials). All INB nuclear cargo transports are carried out in convoys escorted by national forces, including the Brazilian Intelligence Agency (ABIN), Police, and INB's own Physical and Radiological Protection teams. The physical protection of nuclear material during transport involves also minimizing the total operation time, protection according to material category and confidentiality of information. Permanent communication and real-time satellite tracking, by both national forces and INB, are also essential for continuous control and security.

Best Practices

Despite the robust system, nuclear material transport faces common challenges across all modes involving the nuclear fuel cycle. INB adopts various best practices to mitigate these challenges. One example is the supplier accreditation for the handling and transport of INB's nuclear materials which is based on proving technical capability, financial standing, and legal compliance. This includes well-established internal procedures to prevent sabotage and unauthorized removal, strictly following international and national standards. Shipment denials/delays are also difficulties we have to deal with, highlighting the critical role of the National Focal Point in Brazil.

Conclusion

Indústrias Nucleares do Brasil's integrated approach to the transport of uranium concentrate and hexafluoride is a model of complexity and rigor. The inherent challenges of this activity are met with a continuous commitment to operational excellence and process improvement, solidifying Brazil's role in the global landscape of safe nuclear material transport.

