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Material Transfer System in Support of the Plutonium Immobilization Program

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Material Transfer System in Support of the Plutonium Immobilization Program

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Introduction

The Plutonium Immobilization Project is currently undertaking formulation and process development to demonstrate the immobilization of surplus plutonium in a titanate-based ceramic. These ceramic forms will be encapsulated within canisters containing high level waste glass for geologic disposal. Process development work is being conducted with sub-scale, process prototypic equipment. Final validation of the process will be done using actual plutonium material and functionally prototypic equipment within a glovebox. Due to the radioactive nature of the material, remote material handling is necessary to reduce the radiation exposure to the operators. A remote operated Material Transfer System to interface with process equipment has been developed.

Process Equipment Layout in Glovebox

The ceramification fabrication process consists of five steps: milling the actinide oxides; blending milled actinide oxides with ceramic precursors; granulating blended powders; pressing granulated powders; and sintering pressed ceramic forms or pucks. The final product of the ceramification process is a sintered puck which weighs 500g, is 6.7 cm in diameter, and 2.5 cm thick. The equipment being used to demonstrate this process is functionally prototypic of the proposed plant equipment. This equipment includes: two attritor mills (one for milling and one for blending); one granulator, one press, and one furnace. This equipment is installed in a glovebox line which is 9.2 meters long and 0.9 meters wide. The maximum glovebox ceiling height is 2.8 meters. The layout of this Plutonium Ceramification System is shown in Figure 1.

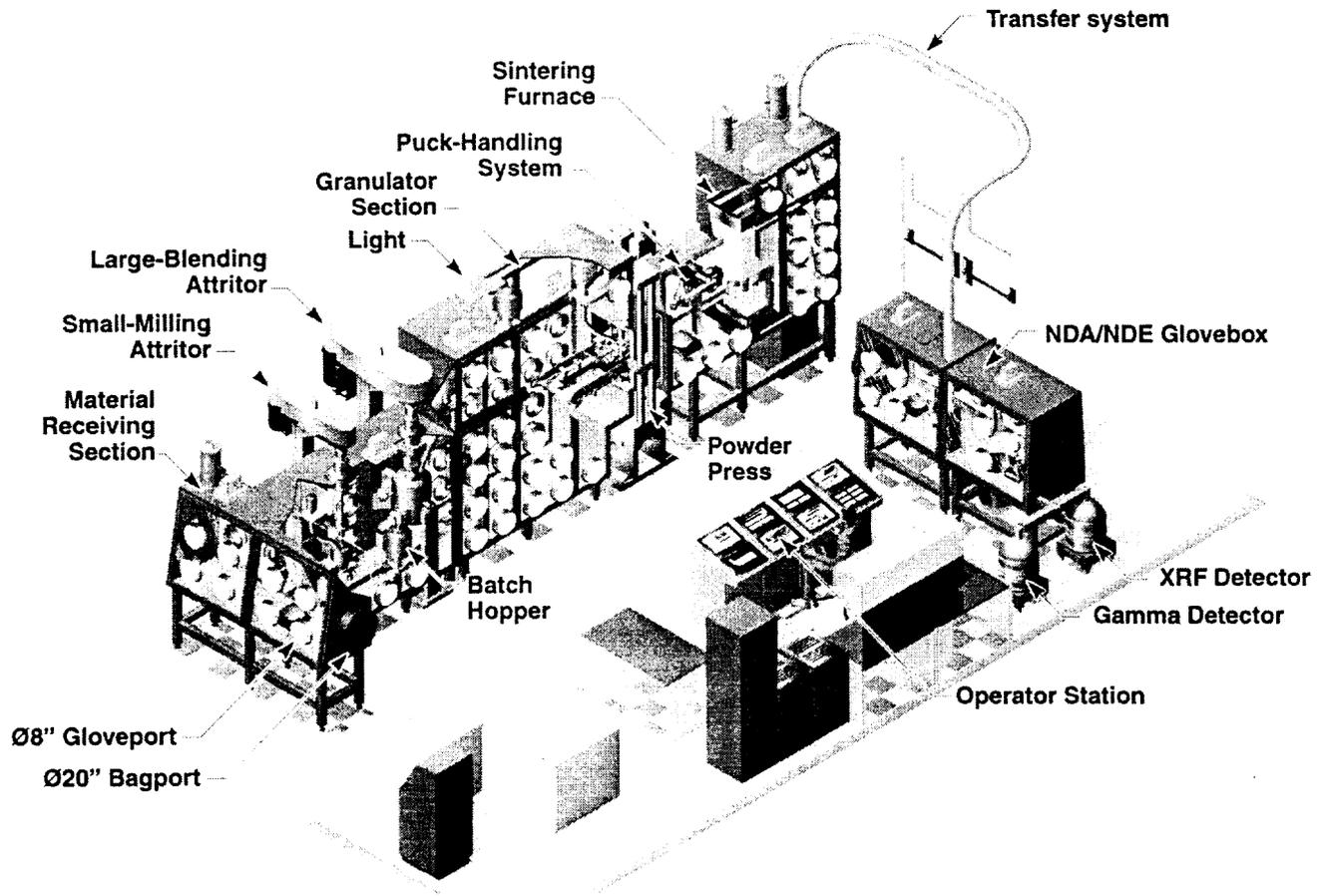


Figure 1: Plutonium ceramification process development system

Material Transfer System for the Process Line

The Material Transfer System (MTS) remotely transports powders between the attritors, granulator, and press. It also provides a weighing function for material accountability. This system operates within the glovebox. The system is also required to be simple and modular for ease of maintenance in the glovebox environment. The MTS transfers material within the ceramification line in hoppers. Two different size hoppers are used: 1) a small hopper for the actinides; and 2) a large hopper for the blended and granulated material. The small hopper has a single valve and a one-liter volume. The

large hopper, with an inlet dust cover on the top and an outlet valve, has a 12-liter volume (see Figure 2). Both hoppers have grips for handling by MTS.

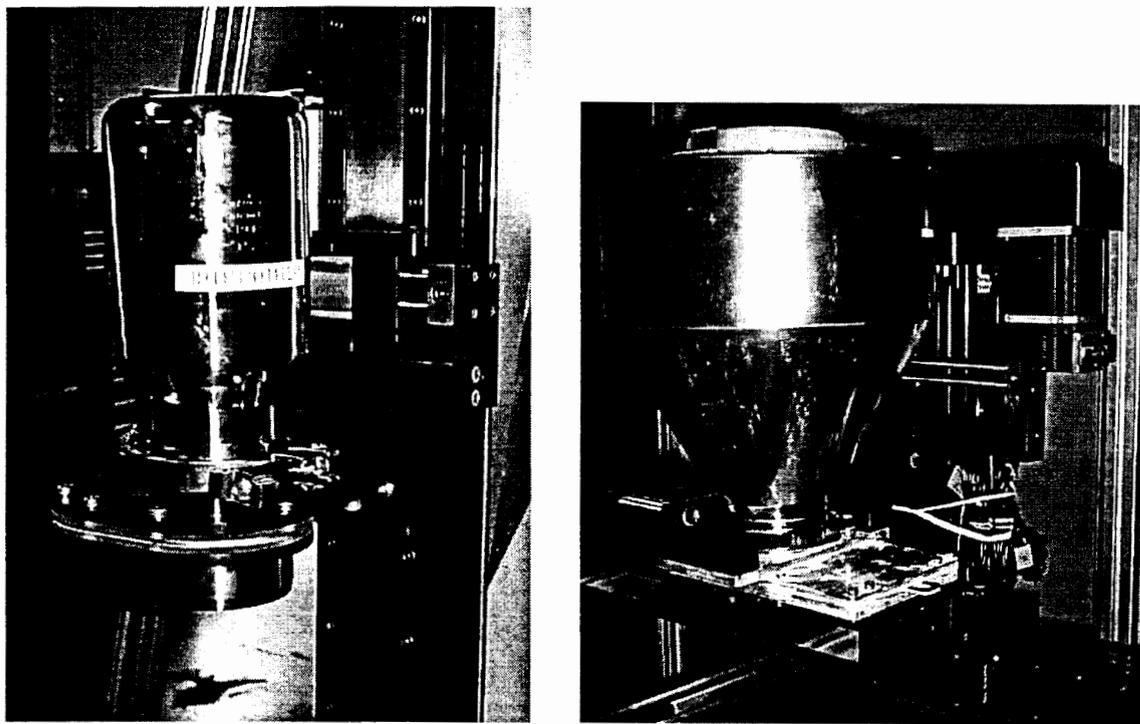


Figure 2: Small and large hoppers engaged with the hopper transporter of the MTS

The large hopper has two grips located opposite to each other to allow gripping from both sides during hopper transfer between axes. The empty small hopper weighs 2.3 Kg and holds 3-Kg of actinide material. The large hopper weighs 8 Kg and holds 20 Kg of mixed material. Both hoppers may be equipped with either slide gate or rotary type valves. The custom designed slide gate valves have wiper seals to provide dust proof operation. Rotary type valves will be used if the process requires regulating material during the discharging operation. This need will be determined during testing. To transport the hoppers in the glovebox, three sets of two actuators with X-Z axes motion and two single actuators with Z axis are used (see Figure 3). The actuators are commercially available

except for X-2 axis (mounted on the floor with 4.4-meter travel). The X-2 axis actuator was custom designed and fabricated to facilitate installation through a glovebox window.

Each axis actuator is driven with a single brushless servomotor and closed loop control. Four docking stations are provided. These engage hoppers for discharging and feeding material to process equipment. Each docking station is equipped with hopper valve actuator and pneumatic vibrator for material discharging.

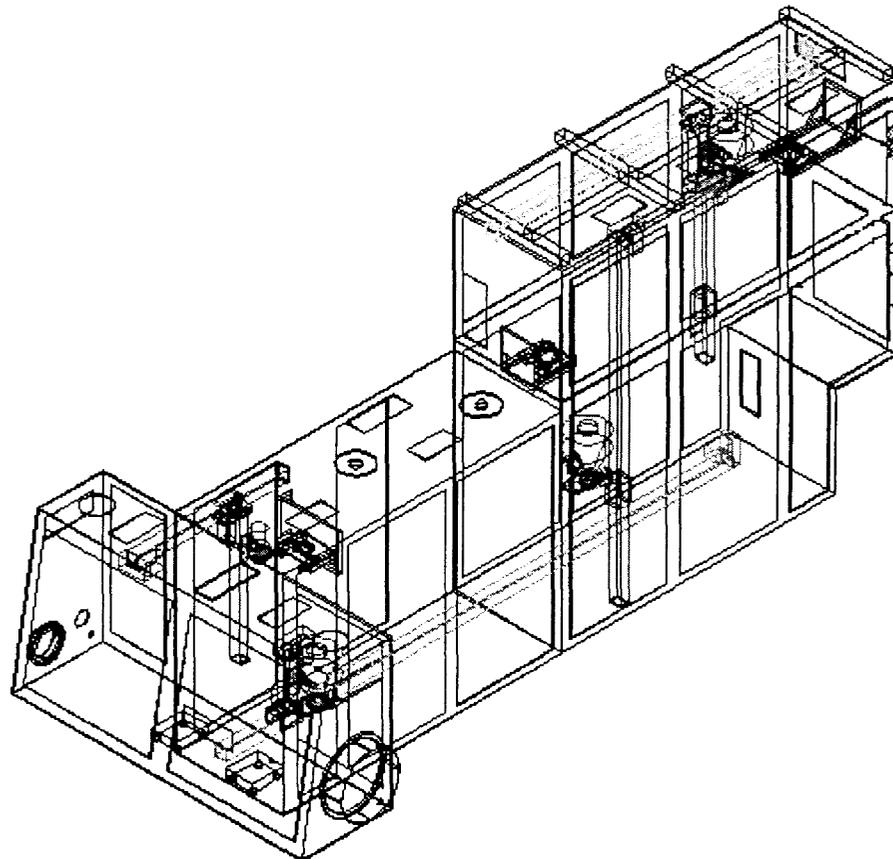


Figure 3: Hopper transport system arrangement. Base frame of the glovebox, attritor mills, granulator, and press are not shown for clarity

The MTS is capable of two operational modes: manual and programmed. In the manual mode, the operator can move any axis to a desired point. The manual mode is used for finding position information or recovering from an emergency stop. In the

programmed mode, hoppers can be sent to pre-defined positions according to the process sequences.

Conclusion

The Material Transporting System for the Plutonium ceramification line has been designed and fabricated. The system is currently being installed in the glovebox for testing. After the testing, the entire ceramification system will be installed in the Plutonium Facility in mid-2000.