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Fresh Fuel Handling and Storage Plan for Experimental Reactor Testing

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REVISION LOG

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ABSTRACT, SUMMARY, AND FOREWORD

The National Reactor Innovation Center (NRIC) has designed a testbed for advanced microreactor experiments that enables and encourages technology developers to bring advanced designs closer to commercial availability. The test bed, Demonstration of Microreactor Experiments (DOME), will be used to facilitate much of the operation and experimentation process of each advanced microreactor including fueling and operational power experiments. This report describes the plan for fresh fuel handling and storage for the advanced reactors in DOME. The fresh fuel transportation, receipt, and storage protocol are also discussed in this report. The locations that have been identified for the fresh fuel storage are the CPP-651 building, DOME, and the Transient Reactor Test (TREAT) reactor building. The latter two locations would only be used for storage prior to reactor fueling while the CPP-651 building is the primary location designated for fresh fuel storage.

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ACRONYMS

COC	Certificate of Compliance
CSI	Criticality Safety Index
DOE	U. S. Department of Energy
DOME	Demonstration of Microreactor Experiments
DOT	U. S. Department of Transportation
INL	Idaho National Laboratory
INTEC	Idaho Nuclear Technology and Engineering Center
MSCF	Material Security Consolidation Facility
NFM	Nuclear Facility Manager
NRC	Nuclear Regulatory Commission
NRIC	National Reactor Innovation Center
TID	Tamper Indication Device
TREAT	Transient Reactor Test
TRISO	tristructural isotropic

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Fresh Fuel Handling and Storage

1. PREPERATION AND HANDLING

Developers of new experimental microreactors slated to be tested in the INL DOME test bed will be required to provide the fuel for their experiments. Each developer must formulate plans to ship fuel to INL, fuel their reactor, transport their fuel and reactor inside INL, and disposition irradiated fuel after experimentation is complete.

1.1 Packaging of Fuel

Fresh fuel will be transported to INL for storage prior to reactor fueling activities. Each developer will determine the appropriate shipping and packaging configuration for the fresh fuel.

Developers may need to store HALEU feedstock at INL before sending it to a fuel fabricator. Shipping configurations of HALEU feedstock will need to meet the same storage and handling requirements for fresh fuel. Fabricated fuel can then be shipped to the INL fuel storage facility in preparation for reactor fueling. The stored fresh fuel will be transported to the fueling facility using the approved INL and U.S. Department of Transportation (DOT) protocols and regulations.

1.1.1 Readiness

A contractual agreement and fuel storage plan is required to set the groundwork for fuel transportation and storage. Before fuel handling and shipping startup activities at INL, a TEM-9902-A form must be completed to determine what level of readiness activity, if any, is necessary to receive and store fuel at CPP-651. While it is the responsibility of the Nuclear Facility Manager (NFM) to complete the TEM-9902-A Form, the developer shall provide all the pertinent information and data needed in the fuel storage plan to complete the form and subsequent approvals. Developer processes that require more stringent DOE readiness activities (i.e., Operational Readiness Reviews or Readiness Assessments) for fuel storage are more likely to experience schedule or cost overruns and should be addressed early in the planning and coordination with INL. An approved fuel storage plan must include the following information: material type, enrichment, material quantity, shipping container type, number of containers, criticality safety index (CSI) values, and storage schedule.

1.1.2 Packaging of Fuel

Packaging of fuel will take place at the fuel fabrication facility. The fuel must be packed into DOT-approved shipping/storage containers and packaging, selected by the developer, to ship from the fuel fabricator to INL. The DOT's Hazardous Material Regulations (HMR), 49 CFR 171-180 contain requirements and specifications for packaging. Additionally, the packaging should be compatible with a standard forklift for loading, unloading, and movement. In the event that a CSI approved shipping/storage package is overpacked into a larger container, it is acceptable to apply the appropriate inner package CSI to the larger overpack container.

Fuel shall be transported and stored only in containers that have current DOT and Nuclear Regulatory Commission (NRC) certificates of compliance (COC). A criticality assessment shall be performed for the fuel containers and a CSI value assigned to each container listed in the

storage plan. If the packing configuration deviates from those evaluated in the respective COC and Safety Evaluation Report, a new criticality evaluation shall be performed demonstrating why the new configuration is acceptable.

The packaging of the fabricated fuel, and the installation of a tamper indication device (TID) on each container shall be witnessed by trained and qualified personnel, such as an INL Safeguards TID Witness and Applicator/Remover, or equivalent at a qualified facility. Appropriate shipping packaging, i.e., overpack, shall be used.

It is expected that HALEU feedstock will be stored at CPP-651 prior to fabrication into usable reactor fuel. The HALEU feedstock will need to meet the same shipping, storage, and handling requirements as the fresh fuel. Once the fresh fuel has been fabricated, it may be returned to the fuel storage facility in preparation for reactor fueling. The INL document, "Shipments, Receipts, and Transfers of Nuclear Materials" (MCP-2752), contains the procedure for external shipments of nuclear material and will be used when shipping the feedstock to the fuel fabricator from the INL storage facility.

2. SHIPPING AND STORAGE

2.1 Transportation, Receipt and Storage of Fuel

Fresh fuel will be stored at an INL facility in advance of reactor fueling activities. Depending on where fueling occurs, the storage facility may also function as the fueling facility. The stored fresh fuel will be transported to the fueling facility using approved INL and DOT protocols and regulations.

2.1.1 Storage at CPP-651

In the interim period between arrival of fuel at MFC and fueling of the reactor, fresh fuel can be stored at the CPP-651 building at the Material Security Consolidation Facility (MSCF) at INTEC. Upon receipt at INL, all the containers will be inspected, inventoried, and the TIDs verified. All shipping configurations should be able to be unloaded using forklifts and similar equipment. Any shipping packaging that is not necessary for storage or fueling shall be dispositioned by the developer. Storage of fuel at INL shall not exceed the containers' certificate of compliance (COC) expiration date or be stored for a period that would require a container specific leak test to be performed. While the fuel is stored at INL, periodic visual inspections will be performed to verify the condition of the containers. If required, storage racks will be used to store the fuel containers, which will necessitate an engineering modification and a criticality evaluation. Fuel storage at CPP-651 is governed by the "Safety Analysis Report for the Material Security and Consolidation Facility (MSCF)" (SAR-416) document.

2.1.2 Alternative Storage Locations

Additional fuel storage locations will be needed to facilitate fueling operations. These include the buildings that will be used for fueling the reactors, namely the primary fueling location, DOME, and the backup fueling location, TREAT. Fresh fuel may be stored at these locations preceding and during the fueling activities.

2.1.3 Intra-INL Transportation

Following the storage period at CPP-651 the fuel will be transferred to the fueling facility. Transfer of fuel between CPP-651(at INTEC) and the fueling facility (at MFC) will be considered “intra-INL transportation”. If the fuel container does not exist in the intra-INL transportation approved container/payload list (LST-1128), an INL analysis must be completed for the container and payload to be added to the list as required by the “Safety Analysis Report for Intra-INL Transportation and MFC Inter-Facility Transfers” (SAR-413) document. All these types of analysis should be identified prior to receiving fuel. The fuel storage plan should account for any additional time that these analyses may take as well as the intra-INL transportation requirements and limitations that must be satisfied. The transportation process must comply with the DOT Hazardous Materials Regulations (HMR) (49 CFR Parts 171-180). The public will be precluded from close contact with the payload by closure of public roadways as necessary. Figure 1 below illustrates the intra-INL transportation routes.

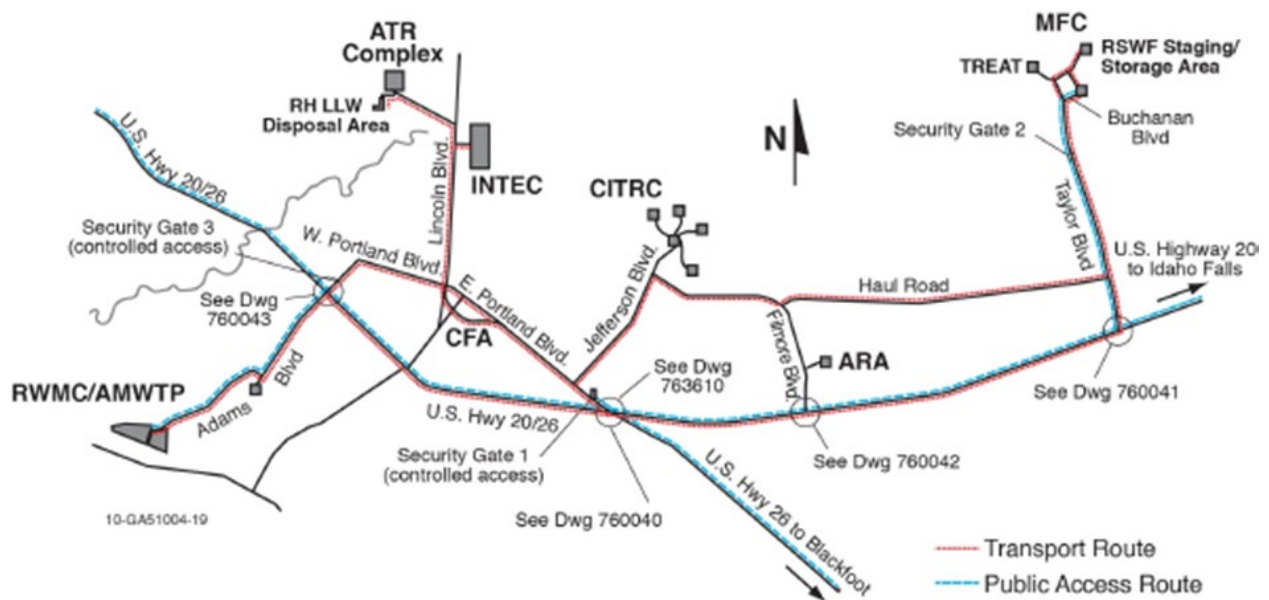


Figure 1 - INL Transportation Routes