



# Drying Studies

## **Mission**

Ensure repository performance requirements can be met

## **Benefits**

- Minimize fuel handling with one-time packaging of spent nuclear fuel
- Maintain canister integrity during long-term storage

## **Current Issues**

No process currently available to accurately measure moisture in spent nuclear fuel

## **Project Status**

Both hot and cold test equipment is already available for use

## **Purpose**

Before the geologic repository will accept spent nuclear fuel for emplacement, the U.S. Department of Energy (DOE) must dry the fuel it manages to eliminate excess moisture and to meet the repository Waste Acceptance System Requirements Document (WASRD). The National Spent Nuclear Fuel Program is supporting development of packaging standards to meet the evolving WASRD specifications. The program will perform drying studies and use the results from those studies to generate consensus standards for dryness of spent nuclear fuel destined for packaging in the standardized DOE canister.

## **Project Description**

Research at the Idaho National Engineering and Environmental Laboratory (INEEL) indicates that it may be possible to adequately dry fuel with warm vacuum drying and remove the mechanisms by which moisture could degrade the standardized DOE spent nuclear fuel canister during interim storage. By using a very high vacuum (approximately 5 torr) for an adequate time, the drying process can run at temperatures low enough (approximately 250 °C) to not melt the fuel. This boiling process can remove all free water, water contained in corrosion products and sludge, and some chemically bound water.

INEEL researchers will conduct warm vacuum tests on both simulated and actual spent nuclear fuel and monitor pressure buildup, corrosion, and hydrogen generation. Scientists will conduct the simulated fuel tests, or cold tests, in a half-height, nonradiological replica of the INEEL Irradiated Fuel Storage Facility canning station. During the cold tests, they will correlate pressure and temperature readings with the precise measurement of water content.



*Half-height mockup of the Irradiated Fuel Storage Facility Fuel Canning Station showing instrument port for monitoring temperature and pressure during drying.*



*Warm vacuum drying test being prepared for mock fuels.*



Researchers will conduct the tests on actual spent nuclear fuel, or hot tests, in the INEEL Irradiated Fuel Storage Facility canning station. They will measure the temperature in the drying canister and compare it to the time it takes for the pressure to rise as a result of water evaporation. Researches will then infer water contents from these data.

### **Benefits**

Establishing drying standards for spent nuclear fuel and packaging the fuel only once for both interim storage and emplacement in a permanent repository may minimize packaging operations and reduce the risk of human exposure. Reducing handling operations and minimizing special packaging or exotic materials also reduces packaging costs. Assuring canister integrity during long-term storage in the repository is an integral step for spent nuclear fuel acceptance.

### **Unique Capabilities**

Both "hot" and "cold" drying facilities are available through collaboration with the INEEL spent nuclear fuel operations group and the University of Idaho. Project personnel have extensive experience with warm vacuum drying, spent nuclear fuel, and both wet and dry spent nuclear fuel storage. The actual fuel planned for these tests is in poor condition and will provide the opportunity to study "worst-case" fuel drying conditions.

### **Current Issues**

Presently it is impossible to accurately measure the water in spent nuclear fuel canisters to meet repository acceptance criteria. These drying studies will establish a correlation between package performance and dryness levels in terms of corrosion, pressurization, and hydrogen generation. They will also form the basis to establish guidance for achieving acceptable drying performance levels.

### **Project Status**

Schedules for both the hot and cold tests are complete. Researchers are developing test plans based on the needs and related research activities of DOE sites managing spent nuclear fuel. Hot tests will begin in Fiscal Year 2001 and continue into Fiscal Year 2002.



*Visual indication of dry and damp areas shows progression of drying across a distinct boundary on this mock fuel. Dry material near boundary is essentially as dry as when entire bundle is dry.*

### **Fiscal Year 2000**

Use National Spent Nuclear Fuel Program to communicate with DOE sites to identify user needs and to coordinate related research efforts

### **Fiscal Year 2001**

Generate test plans for both the hot and cold vacuum facilities

Begin cold and hot facility tests

### **Fiscal Year 2002**

Complete cold facility tests

Conduct hot facility storage performance measurements

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