UNARM System in Kazakhstan

Los Alamos National Laboratory (LANL), in cooperation with the Kazakhstan Atomic Energy Agency (KAEA) and the International Atomic Energy Agency (IAEA), has developed an unattended and remote monitoring (UNARM) system for the BN-350 Fast-Breeder Reactor in Aqtau, near the city of Shevchenko, on the Caspian Sea. The purpose of the UNARM system is to monitor the spent fuel discharged from the reactor to be packaged for long-term storage.

Spent-fuel monitoring is important because a fast-breeder reactor is where plutonium is generated and produced. Breeder reactors are of particular importance because the plutonium generated in these reactors has a relatively high-fissile content. This brochure describes several elements that make up the UNARM system.

Discharge

The first element in the UNARM system is the Unattended Fuel Flow Monitor (UFFM).

The spent-fuel transport is a lazy-susan mechanism; it can pick up an assembly from the spent-fuel drum located beneath it. The spent-fuel transport picks up the spent fuel from the drum, rotates it, and discharges it into a chute into the spent-fuel pool. The Unattended Fuel Flow Monitor (UFFM)—located at the top of the spent-fuel transport—measures the radiation when the spent fuel is in the upper chamber and tracks the movement of assemblies to the spent-fuel transport and the subsequent discharge of fuel into the pool.

Fissile Content of Spent Fuel

The Spent Fuel Coincidence Counter (SFCC) makes up the second element of the UNARM system. The SFCC was designed, built, calibrated, and installed by Los Alamos National Laboratory personnel to measure irradiated assemblies for plutonium content.

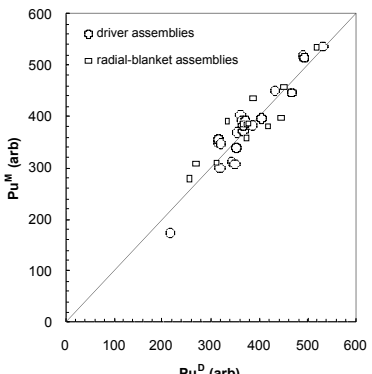

Figure 1. Measured plutonium masses versus facility-declared masses. The bias is 1.3% and the root means square difference between the measured and declared values is 8.2%

After the spent-fuel assemblies have been discharged into the spent-fuel pool, they are allowed to cool for a period of years. The IAEA requires measurements to be taken of each assembly before they are repackaged for difficult-to-access storage. The plutonium content of both driver and blanket assemblies are determined with the SFCC in the attended mode.

The SFCC is a neutron-based counter with 20 He^3 detectors embedded in polyethylene with 14 cm of lead shielding between the spent fuel and the detectors. The whole counter is submerged underwater in the deepest part of the spent-fuel pool so that the fuel can be loaded from the top. The singles and coincidence neutron rates will give the plutonium content of the spent-fuel assembly. The assay can be applied to both the blanket assemblies and the driver assemblies.[1] Using limited facility information, the combined measurement and facility declaration error is ~8%. Figure 1 shows the measured plutonium masses versus facility-declared plutonium masses for the first batch of first 34 BN-350 spent-fuel assemblies that were measured.

To date, the IAEA has been quite pleased with the SFCC's measurements. These are the first partial defect measurements the IAEA has ever achieved for spent fuel.

Spent-Fuel Packaging

The IAEA has been concerned with preserving the "Continuity of Knowledge" (CoK) for these assemblies. If CoK of the assemblies is lost, the assemblies must all be remeasured.

After the spent fuel has been sufficiently cooled and the fissile content determined, assemblies are loaded into a "six pack" container. These six packs are moved through a canal to the hot cell. In the hot cell, six-pack containers are lifted out of the water, dried, and welded for shipment. UNARM detectors monitor this entire operation. The underwater UNARM monitors consist of electronic modules for detectors, a video camera, and a radiation detector. These instruments are packaged into a stainless-steel tube that is lowered into the water to monitor the motion of the six-pack containers. When the container is moved out of the water and into one of the welding chambers, Characteristic Radiation Monitors (CHARM), which consist of He^3 and NaI detectors and video cameras, are used to monitor the movement of the six-pack containers.

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Reactor, Kazakhstan: BN-350 Fast-Breeder

Unattended and Remote Monitoring Systems

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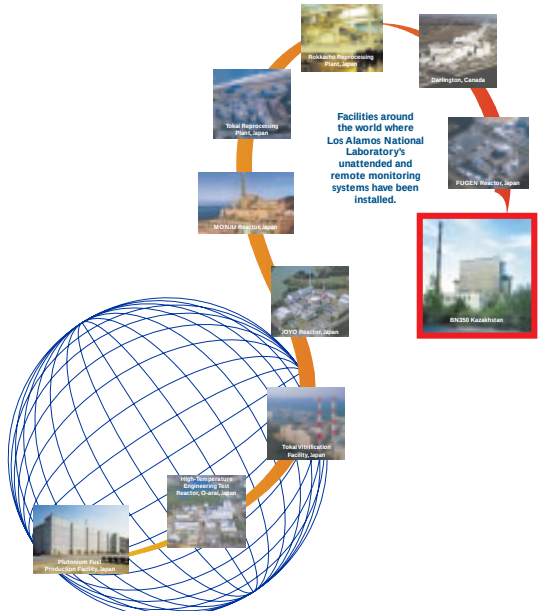


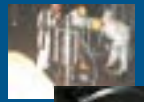
Unattended and Remote Monitoring (UNARM)

BN-350 Fast-Breeder Reactor in Kazakhstan

Spent-Fuel Monitoring—From Cradle to Grave

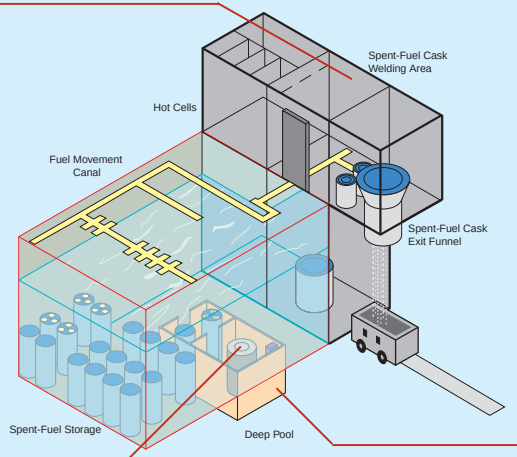
The UNARM Monitoring of Fuel Packaging

In a hot cell where spent-fuel six packs are lifted out of the water, dried, and welded for shipment, UNARM detectors monitor the fuel movement with underwater radiation detectors and cameras. The long, narrow picture to the left shows the electronic modules for the detectors, video cameras, and radiation detectors that were used to monitor fuel movement. The lower picture shows the installation of a radiation detector that monitors the movement of fuel after it comes out of the spent-fuel pool and into one of the two welding chambers.



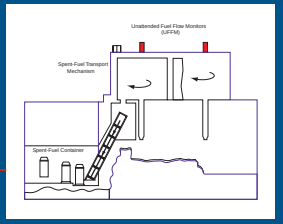
Spent Fuel Coincidence Counter (SFCC)

After the spent-fuel assemblies have been discharged into the spent-fuel pool, they are allowed to cool. The plutonium content of both driver and blanket assemblies are determined with the SFCC in the attended mode. The SFCC is located in the deepest part of the pool.



IAEA inspector using the software to review inspection data and images.

Shirley Klosterbuer (LANL) training IAEA inspectors and facility personnel to use UNARM software.



Unattended Fuel Flow Monitor (UFFM)

The spent-fuel transport is a lazy-susan mechanism; it can pick up an assembly from the spent-fuel drum, rotate it, and discharge it into a chute into the spent-fuel pool. UFFMs track the movement of assemblies to the spent-fuel transport and the subsequent discharge of fuel into the pool.