Japanese Nuclear Fuel Accident

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Current Analysis

Initial reports from wire services and Japanese sources indicate that the accident causing extensive evacuation in and around the town of Tokai in Japan was at a facility inside the Tokai Mura nuclear fuel fabrication facility. At this complex, plutonium is extracted and mixed with uranium oxide to make mixed oxide fuel.

Nautilus Institute is pleased to provide a detailed description of this plant and its set of radiochemical processes from a study prepared for a US Government agency and released to Nautilus Institute under the Freedom of Information Act.

- Overview (pdf 1,337kb)

- Details on fuel fabrication section of the plant (pdf 1,424 kb)

In brief, it appears that the accident involved the facility in which low enriched uranium is converted to mixed uranium oxide powder. Various news sources are contradictory about where and what happened. Some say it happened in storage; others say it happened in a conversion facility. None are specific about where in the overall flow of the various processes at Tokai Mura and comment at this time must be speculative rather than definitive.

An important fact that remains unknown is whether the accident took place before or after plutonium is mixed with the uranium fuel. As reports state that a criticality accident occurred, it is plausible that the accident involved plutonium. In general, this plant would not have processed uranium at a high enough concentration of uranium 235 to cause a criticality accident. At this site, it would appear that plutonium is the only material present that could have caused a criticality accident.

(A criticality accident is one in which a sufficiently dense mass of fissile material is brought together such that the neutron density increases to levels sufficient to cause a chain reaction, but not sufficient to cause a self-sustaining chain reaction known as a nuclear explosion. Rather, a criticality accident results in a brief release of nuclear radiation which blows apart the critical mass such that the neutron density drops and the fissile material falls below the mass necessary for criticality).

Also, a criticality accident involving highly enriched uranium is unlikely to create large quantities of radioactive products whereas one involving plutonium could-if the various barriers to releasing fission products or remaining plutonium to the environment are breached-result in dispersal of dangerous quantities of plutonium. If a plutonium criticality accident started a fire, then the dispersal can be greatly worsened.

Thus, this accident may have resulted from the use of direct denitrification which is unique to this plant whereby plutonium nitrate and uranyl nitrate are mixed in a dissolver at a conversion plant after receipt from the reprocessing plant at Tokai Mura. This mixing should be done at a low rate of plutonium to uranium to ensure that a critical mass is never assembled by mistake. Ironically, this method of creating mixed-oxide fuel was adopted at this plant under pressure from the United States to ensure that Japan did not have direct access to plutonium in a metallic form.

Whatever its cause, this accident will likely increase greatly the pressure on and within Japan to abandon its plutonium energy strategy. It will also undermine efforts to create a regional nuclear fuel cycle that facilitates plutonium flows around East Asia.
[http://www.nautilus.org/papers/energy/dvh_hayesNukeScenarios.html]

Also of interest is that the US military refused to respond to the Japanese government's request for assistance in responding to this accident, citing lack of capability. This response is consistent with the interpretation that US military nuclear weapons accident teams formerly posted at US military facilities in Japan to respond to nuclear weapons accidents involving nuclear weapons in-transit have been removed.

References:

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