TRANSPORT EXPERIENCE OF RECOVERED URANIUM BY TRUCK AND TRACTOR TRAILER

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SUMMARY

The Power Reactor and Nuclear Fuel Development Corporation (PNC) has been carrying out UF_6 conversion tests of the recovered uranium at Ningyo Toge Works, PNC in Okayama prefecture. The chemical formula of recovered uranium using these tests is uranium trioxide (UO_3). Uranium is recovered from spent fuel used in domestic light water reactors by PNC Tokai Reprocessing Plant in Ibaraki Prefecture. About 230 kg of the recovered uranium is placed in each storage vessel at the reprocessing plant.

Recovered uranium is transported by the trucks or trailers. It takes about 18 hours for transport and its distance from Tokai Reprocessing Plant to Ningyo Toge Works is approximately 900 km.

The transport control center is set up at Tokai Works. The transport starts from Tokai Works. During the transport, contacts from the control center to the convoy, Ningyo Toge Works and Tokyo head office are maintained. And the radioactive material handling expert accompanying the convoy from Tokai Works to Ningyo Toge Works. Further safety measures are undertaken with the cooperation of related authorities along the transportation route.

Approximately 220 metric tons of recovered uranium were transported in 30 separate trips from June 1994, when conversion test timescales was extended to October 1997. Safe transport was undertaken without any accident or disturbance. The transport package used for recovered uranium was type IP-2 F which was Japan's first licensed package. These packages underwent the falling test (9 m), and fire resist test (800 ℃×30 min) etc. before use for transport of radioactive materials. The package is cylindrical in shape with a diameter of 1.2 m, height 1.6 m and weights 1300 kg. It is designed to carry up to 260 kg of uranium with a maximum U235 concentration of 1.6%.

CLASSIFICATION OF TRANSPORT PACKAGE

Recovered uranium contains some uranium isotopes which do not exist in nature, such as U232, U236, etc, and a small quantity of transuranics (TRU) and fission products (F.P). By calculation, the maximum transport capacity of recovered uranium in a Type A transport package is as few as 10 kg, therefore a Type A transport package is not a practical transport method.

Type IP transport package was newly established which included not only the conventional concept of classification of a transport package, but also the concentration concept after domestic regulations introduced the IAEA Transport Regulation (1985 edition), published in January 1991. For the transport of recovered uranium, it was decided to use the IP-2 fissionable transport package, whereby solid recovered uranium oxides must satisfy the required condition for low specific activity (LSA－Ⅱ) ($<A_2/10000$).

CONSIDERATION FOR APPLICATION OF LOW SPECIFIC ACTIVITY

Recovered uranium, its chemical formula is uranium trioxide (UO_3), the material for transport, is recovered chemically from spent fuel of the domestic light water reactors at the reprocessing plant of PNC. The component of recovered uranium for the consideration for application of low specific activity has been established by calculation (ORIGEN-2 was used) with reference to the receiving condition of spent fuel at the Tokai Reprocessing Plant. Table 1 shows an example of the condition of the recovered uranium component for calculation.

From the calculation, the A_2 value and radioactivity are approximately 1.4×10^9 Bq, and 9.6×10^4 Bq/gUO_3 respectively, and those values satisfy the condition of LSA, i.e., radioactivity is less than 1/10000 of the A_2 value. U234 and U236 have a great influence on the A_2 value, and they occupy 90% of the total influence. On the other hand, the total influence of TRU, FP and Uranium daughter nuclides is approximately a few percent. Table 2 shows the recovered uranium component which was used for the consideration of LSA. Before actual transport was undertaken, those nuclide components were analysed.

Table 1 Calculating condition of recovered uranium component

U 235	4	%
Burn up	38000	MWD/T
Cooling	180	D

Table 2 Recovered uranium component which was used for considering of LSA

U 232	< 2 ppb/U
U 234	< 0.03 wt/%
U 235	< 1.6 wt/%
U 236	< 0.5 wt/%
U 238	Balance
TRU (α)	< 2.5×10^{2} Bq/gU
Ru 106	< 1.9×10^{4} Bq/gU

TRANSPORT CONTAINER

The transport container for recovered uranium, which had been approved as a Type A(F) container, was newly approved as UOX/C(F) after re-estimating by the technical standards for IP-2(F) type package. The package is a double structure cylindrical in shape, approximately 1.2 m in diameter, 1.6 m in length, and an approximate weights of 1300 kg. A cutaway view of the package is shown in Figure 1. This transport container which was the first approved IP-2(F) type container in Japan has satisfied the regulatory tests required for radio-nuclide transporting packages such as the 9 m drop test, thermal test (800℃, 30 min), etc.

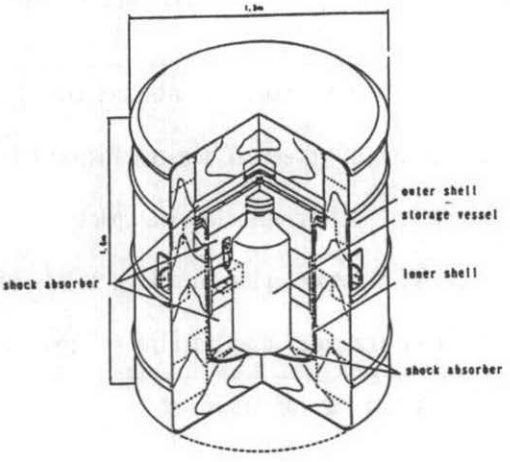

Figure 1 IP-2F type package

SECURITY MEASURES

The radioactive materials transport is carried out after preparing necessary safety, and physical protection measures, as required by domestic regulation. Recovered uranium is kept in hardened transport containers and tied securely on respective vehicles. The Public Safety Commissioner is informed about transport plans including the convoy arrangement, emergency equipment and procedures, the specific transportation route and date. Transport is only carried out after receiving the Certificate of Transport from the Public Safety Commissioner.

The distance from Tokai Works in Ibaraki prefecture to Ningyo Toge Works in Okayama prefecture is about 900 km.

When the transport plan was formed, such measures listed as below were undertaken because the main points of transport security were the prevention of traffic accidents and terrorist attack (including sabotage):

* prior investigation was undertaken to select the route such as the road integrity, the volume of traffic, length of time, number of bridges, tunnels, interruption locations of radio communication, etc. ;
* rest time was also included in the travelling plan ;
* additional support vehicles were arranged in the front and rear of the convoy ;
* supporting systems such as a transport control center which monitored and supervised the convoy's schedule were used.

TRANSPORT PROCEDURES

Negotiations with relevant local police stations along the transporting route were undertaken. The recovered uranium transport procedure was submitted one month before the transportation date under the domestic regulations municipal safe agreement. Figure 2 shows the different procedures and related dates.

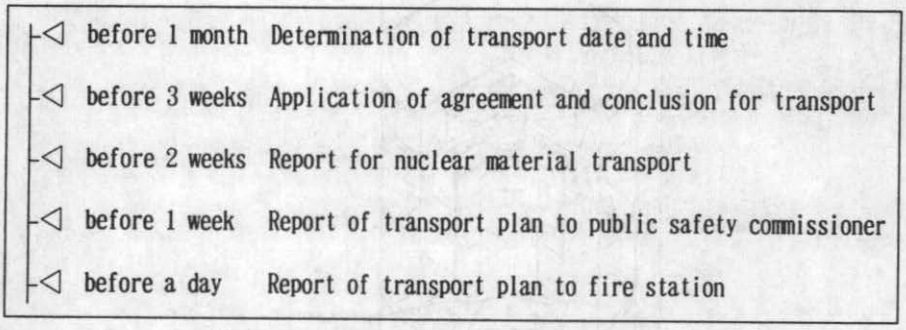

Figure 2 Procedures for transport

PREPARATION FOR TRANSPORT

To maintain transport security, the following measures had been taken by the transport control center:

* the loading decision had been made just before transport based on consideration of the forecast road condition, weather information, transport blockades, and so on ;
* the matching had been confirmed between IP-2 type package standard and the loading packages before transport ;
* the starting decision had been made on the transporting day after re-consideration of the road condition, weather information, transport blockades, and so on ;
* any unsafe elements due to lack of information had been cleared among transporter's (transport company, senders, receiver, and head office) by re-confirming safe measures such as action plan, car parking procedure, and emergency response measures during transport.

TRANSPORT

The convoy was arranged in a linear pattern. After surveying the road conditions, receiver's capacity, inhabitant's opinions and so on, a number of transports were initially made using 6-ton trucks. Subsequently, 8-ton tractor trailers were used.

Transport was carried out by arranging security guard vehicles at the front and rear of the convoy, and another vehicle with a convoy leader, a radioactive handling expert, and PNC's transport expert. The convoy also carried emergency monitoring equipment such as survey meters, decontamination kits, and car crush prevention units like signals, etc, which would have been necessary for the first response in case of some accidents. Table 3 shows the emergency supplies, Figure 3 shows a general convoy, and Figure 4 shows a photograph of the actual convoy.

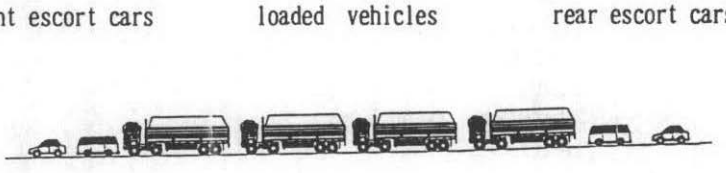

Figure 3 General convoy

Figure 4 The convoy

Table 3 Emergency supplies

survey meters(α, $\beta \cdot \gamma$)
signals
lights
ropes
radio communication set
fire extinguishes
decontamination kits
clothes of over all type
vinyl sheets and bags
etc.

COMMUNICATION SYSTEM

Communication between the transport control center in Tokai Works and the convoy was always possible during transport, and the convoy would regularly report its location and condition. Information from the convoy was also sent to Ningyo Toge Works and the head office. The communication system made it possible for information to be sent to Science Technology Agency, and Ministry of

Transportation from the transport control center in case of any accidents.

ARRIVAL

The reception team prepared sign posts for convoy's parking area before the convoy arrived at Ningyo Toge Works, navigated the convoy into Ningyo Toge Works, and measured the dose rate at the surface of vehicles immediately after arrival to confirm their safety. The reception team was able to prepare efficiently and effectively using accurate information on the convoy's location from the transport control center.

SURVEILLANCE BY ADVERSARIES

Some observations of the convoy were made by potential adversarial groups, such as taking pictures of the convoy, taking dose measurement during parking, etc., but there was no sabotage attempted.

TRANSPORT STATISTICS

The transport of recovered uranium began in August 1994. During this period, trucks were the only possible transport vehicles since large vehicles were restricted immediately after the unexpected Great Hanshin Earthquake. One-Half year after the earthquake, is restriction was removed and tractor trailers could be used. So far no accidents have occurred during transport. Transports have been conducted 30 times, safely moving at over 220 metric tons of recovered uranium. The maximum dose at the surface of any transport vehicle was 14 μSv/h, and at 1 m distance from the surface maximum measured dose was 3.3 μSv/h.

CONCLUSION

Recovered uranium has been successfully transported 30 times using Japan's first domestic IP-2 F type packages without any accidents or incidents. The keys of success included diligent preparation and maintaining continual contact between the transport control center in Tokai works, the receiver in Ningyo Toge Works, and the head office in Tokyo. These transports have demonstrated PNC's ability to manage radioactive materials safely.
The transport system, including the communication system functioned well as had been expected from the beginning. As a result, these systems will be used not only for recovered uranium transport but other radioactive materials transport in future as well.