CURRENT STATUS OF SAFETY REGULATIONS AND EMERGENCY RESPONSES FOR NUCLEAR FUEL TRANSPORTATION IN JAPAN

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Abstract

CURRENT STATUS OF SAFETY REGULATIONS AND EMERGENCY RESPONSES FOR NUCLEAR FUEL TRANSPORTATION IN JAPAN.

Japan has 48 nuclear power plants with total electric capacity of 40 694 MW, including those in operation, under construction and in preparation. The amount of nuclear fuel materials transported in connection with the operation of these power plants in 1984 was 730 ton U metal of UF_6, 889 ton U metal of UO_2 powder, 1094 ton U metal of fuel assembly and 396 ton U metal of spent fuel. The nuclear fuel transports are regulated at the package design, packaging approval (registration) and shipment confirmation phases by national competent authorities such as the Science and Technology Agency and/or Ministry of Transport using Japanese regulations based on the 1973 IAEA Transport Regulations. By the end of 1989, the 1985 IAEA Transport Regulations will be introduced into the regulations. Concerning emergency responses for nuclear fuel transport, the consignor concerned is obliged to make the necessary arrangements, with the competent authorities concerned also making arrangements. The authorities are currently developing guidelines for a manual on safe transport.

1. INTRODUCTION

Approximately thirty years have passed since the development (and subsequent use) of nuclear energy in Japan first began. In the past ten years, the electric capacity of these nuclear power plants has grown to six times that of the previous ten-year period.

TABLE I. NUCLEAR FUEL MATERIAL TRANSPORTS FOR NUCLEAR POWER PLANTS[1]

year		1980		1981		1982		1983		1984	
item		Number of Transports	Total Quantity (ton U)	Number of Transports	Total Quantity (ton U)	Number of Transports	Total Quantity (ton U)	Number of Transports	Total Quantity (ton U)	Number of Transports	Total Quantity (ton U)
Fresh Fuel	UF_6	23	434	23	342	29	525	29	526	39	730
	UO_2	96	474	94	510	84	533	95	683	111	689
	fuel assembly [2]	30	396	44	623	42	619	50	792	67	1094
spent fuel		24	217	26	315	27	363	31	385	27	396

1 Data which STA confirmed for the application based upon the Regulations

2 Excluding GCR fuel

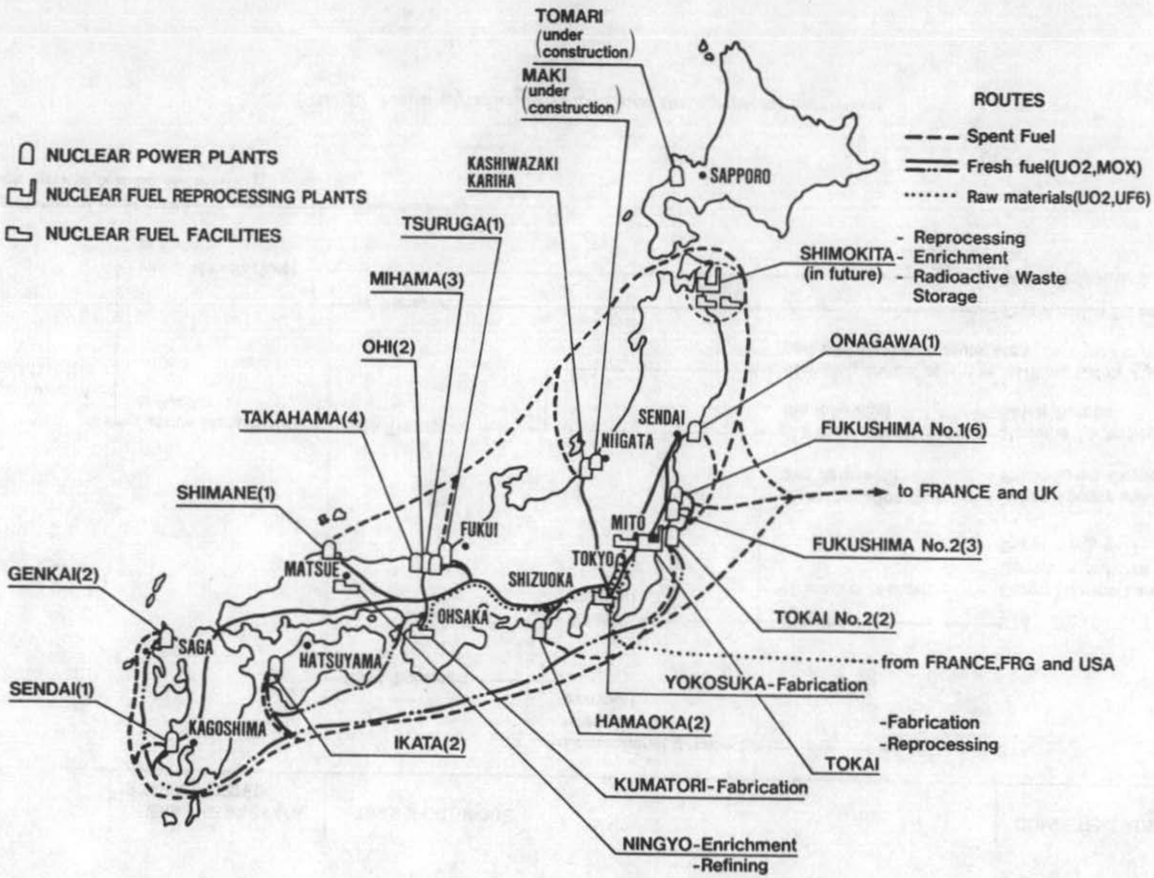


FIG. 1. Transportation routes for nuclear fuel materials and locations of nuclear facilities in Japan.

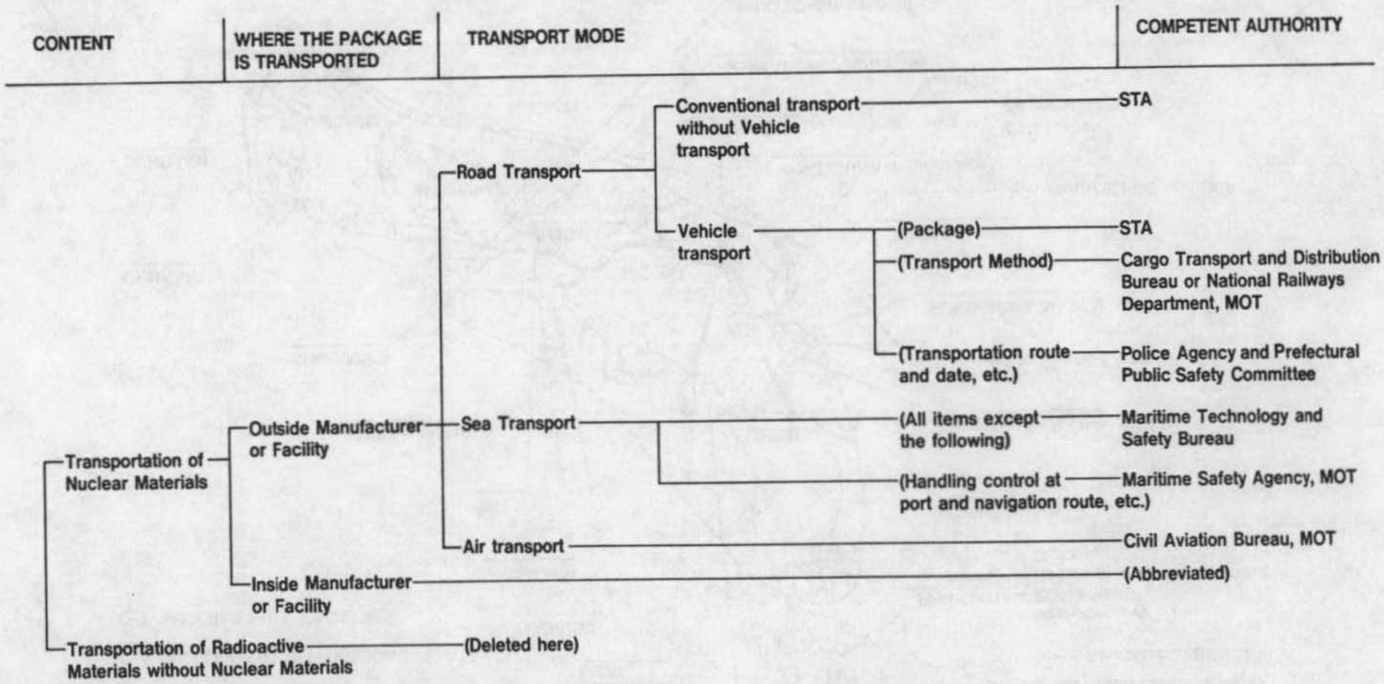


FIG. 2. Latest jurisdiction scheme and the competent authorities.

Such an increase in nuclear power has increased dramatically the frequency and quantity of nuclear fuel transports. A plan for the construction of nuclear fuel cycle facilities, consisting of enrichment, reprocessing and radioactive waste storage facilites, is being developed. As a result, it is expected that a variety of transport modes will also develop.

One of the basic principles is to protect workers and the public from the exposure "as low as reasonably achievable" (ALARA) in order to assure safe transport of nuclear fuel.

Japan has regulated package design and shipment based on this principle of safety and, as a result, there has not been any accident reported during nuclear fuel transport. However, regulations have been formulated for the contents a consignor can transport in an emergency and meetings have been arranged for other types of emergency responses, such as sending experts and equipment for rendering assistance. Currently, the Government of Japan is establishing guidelines for a manual on safe transport which will be available to consignors so that they can also develop a system of emergency response.

2. CURRENT STATUS OF SAFETY REGULATIONS FOR NUCLEAR FUEL TRANSPORT

2.1. Nuclear power generation and nuclear fuel transport in Japan

As of October 1985, there were 31 nuclear power plants in operation (14 PWR, 16 BWR, 1 GCR, with a total of 23 631 MW), while 11 plants were under construction (10 780 MW). In addition, there are six nuclear power plants (6275 MW) which are under consideration for construction, making a total of 48 power plants with a capacity of 40 694 MW.

The number of nuclear material transports in relation to the power plants during 1980–1984 are shown in Table I. The transport of nuclear fuel and materials among the various facilities is shown in Fig. 1. For example, if each nuclear fuel cycle facility at Shimokita in northern Japan, as indicated in the figure, is constructed and begins operation, the number of transports which start or finish there will greatly increase in quantity and frequency.

2.2. Current status of safety regulations

Regulations relating to nuclear fuel transport in Japan are governed by the Law for Regulation of Reactors, by Maritime Safety Law and by Aviation Law. The technical standards for their transport are stipulated in ministerial ordinances and notifications based on these laws. The contents of these technical standards are mainly based on the 1973 IAEA Transport Regulations. The jurisdiction scheme and authorizations related to nuclear fuel transport are shown in Fig. 2.

As far as practical operation of these regulations is concerned, safety confirmation based on the law is required when transporting either fissile or Type B(M) and B(U) packages. The safety confirmation procedure consists of three steps: approval of the design of the nuclear fuel package, approval (registration) of the packaging and confirmation of the safety of the shipment (confirmation of the package and confirmation of transport method; the latter is required only for class 3 fissile packages).

2.2.1. *Approval of the package design*

The competent authorities, the Science and Technology Agency (STA) and the Ministry of Transport (MOT), carry out the safety examinations, with the help of advisory committees (consisting of experts in such fields as structure, heat conduction, containment, shielding and criticality), related to safety analysis of the package. The term of validity of a certification for the package design is three years. The certification can be extended by following the appropriate procedures.

2.2.2. *Packaging approval (registration)*

The applicant must obtain the approval of the competent authorities, who examine the results of inspections carried out according to the inspection manual, defined in advance, which consists of an inspection method and the relevant criteria. The competent authorities carry out inspections as necessary during manufacture and at the time of the completion of the packaging. The term of validity of a certification for packaging approval (registration) is three years. This certification can also be extended.

2.2.3. *Confirmation of shipment*

(a) Confirmation of the safety of a package.

The competent authorities examine, prior to each shipment, whether the contents meet the approved design specification and are in the approved packaging. Before the shipment, inspections (as necessary) such as measurements of surface dose rate and sealing performance are carried out by inspectors from the competent authorities. Only then is the confirmation certificate issued for the package.

(b) Confirmation of the safety of a transportation method.

In addition to the procedure detailed in (a), the MOT carries out a safety inspection of the method of fastening the package on the conveyance being used (vehicle, vessel, aircraft, etc.), of the structure and equipment of the conveyance and the method of radiation exposure control. The confirmation certificate is then issued for the relevant transport method.

2.3. Incorporation of the 1985 IAEA Transport Regulations into Japanese regulations

The technical aspects of Japanese regulations related to the transport of radioactive materials are based on the 1973 IAEA Transport Regulations. Measures are now being taken to incorporate the 1985 IAEA Transport Regulations. This action will be realized first in terms of the standards for the transport of radioactive materials, to be laid down by the Nuclear Safety Commission of Japan based on the 1985 IAEA Regulations. Second, competent authorities will legislate these safety standards into law. The new regulations are to be enacted by the end of 1989.

3. EMERGENCY RESPONSES FOR NUCLEAR FUEL TRANSPORT

Safety confirmation of Type B and fissile packages, as well as of the method of transport, for all transport modes, is required by the competent authorities (STA and/or MOT), as is notification of the Prefectural Public Safety Commission in the case of land transport. In the case of sea transport, notification to the Maritime Safety Agency (MSA) is required (Fig. 3). In the interests of greater safety, escort cars are frequently assigned in front of and behind truck convoys when transporting nuclear fuel packages by road (Fig. 4).

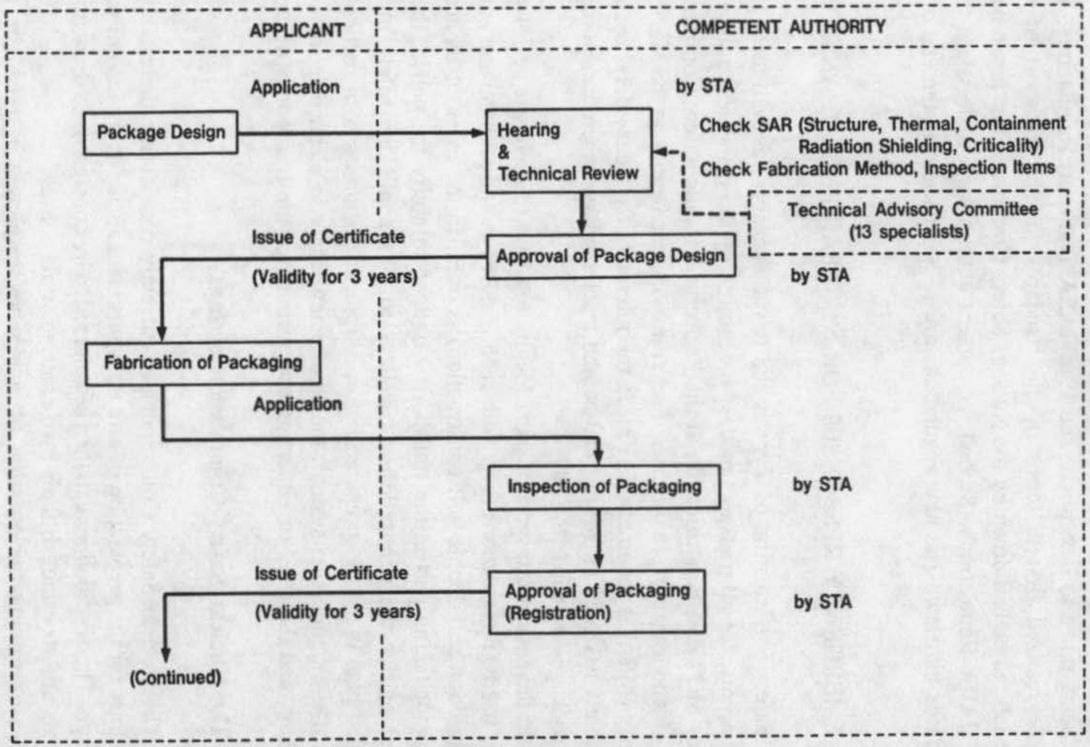
In the case of transport of spent fuel by sea, an exclusive-use vessel which conforms to MOT regulations (e.g. with such features as anticollision and antistranding construction and double-hull construction) is used. In the event of an accident, the consignor taking part in the transport is obliged to notify the police, the maritime officer and/or the fire-station, as well as to take applicable safety measures. A detailed plan is usually prepared before shipment, including such particulars as the type of communication system, the emergency response planned in the event of an accident, and the level of education and training of the transport workers.

3.1. The Nuclear Safety Commission of Japan

The Nuclear Safety Commission is currently considering the establishment of guidelines for the preparation of safe transport manuals for every kind of nuclear fuel package. These guidelines can then be referred to by consignors to draw up their own manuals and to establish their own emergency responses.

In examining the question of emergency response, it should be noted that Type B and/or fissile packages which withstand accident conditions (i.e. suffer severe damage) during transport are required not to release their contents.

In an emergency, however, other measures to prevent the release of contents are required. As for packages which may release their contents in an accident, i.e. Type A and/or non-fissile packages, it is necessary to take the quantity of release into account, with appropriate measures for an emergency being required. Consequently,


APPLICANT
COMPETENT AUTHORITY
Application
by STA
Package Design
Hearing
&
Technical Review
Check SAR (Structure, Thermal, Containment
Radiation Shielding, Criticality)
Check Fabrication Method, Inspection Items
Technical Advisory Committee
(13 specialists)
Issue of Certificate
(Validity for 3 years)
Approval of Package Design
by STA
Fabrication of Packaging
Application
Inspection of Packaging
by STA
Issue of Certificate
(Validity for 3 years)
Approval of Packaging
(Registration)
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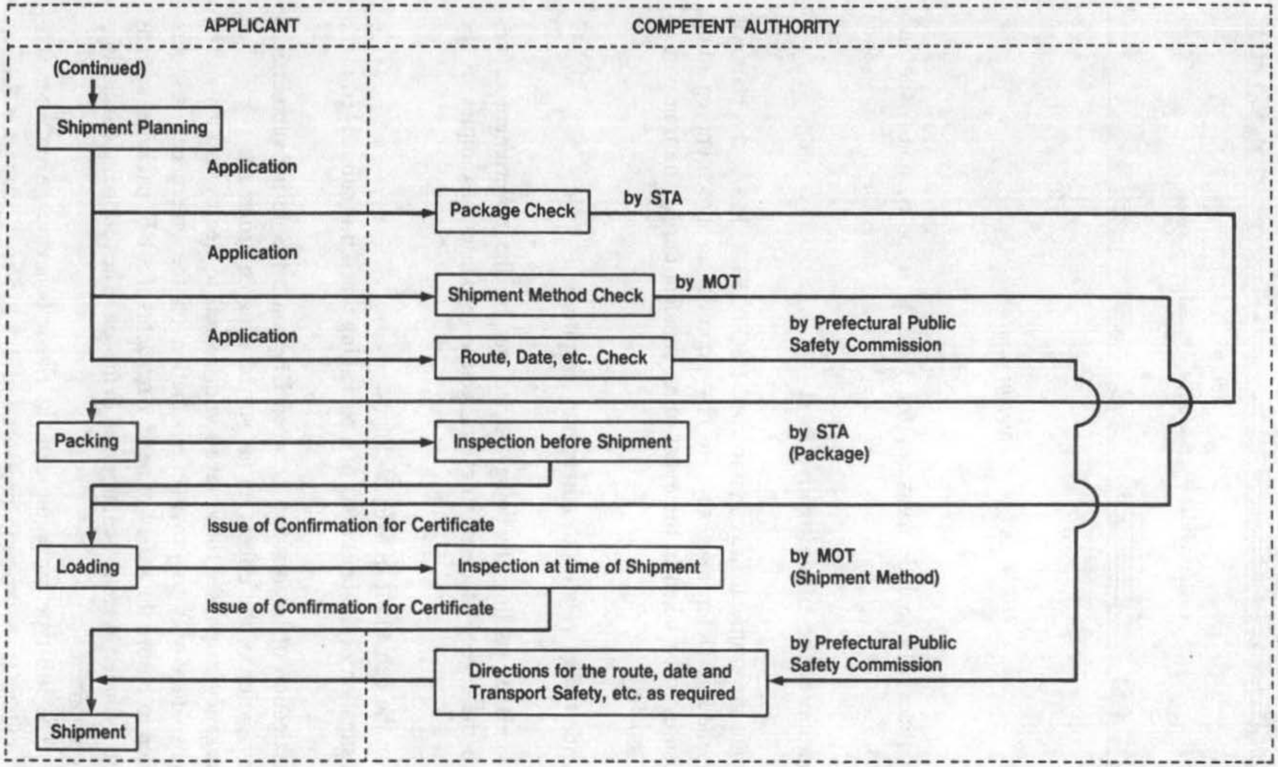

FIG. 3. Safety review procedure for transport of nuclear materials (excluding transport by vehicle of a Type B package with high radioactivity).

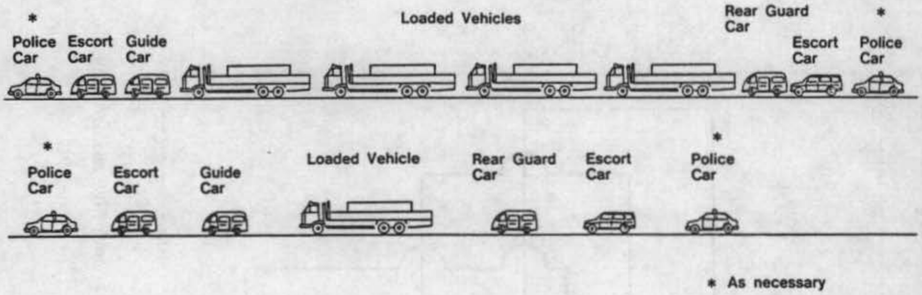

FIG. 4. A typical transport caravan.

the above guidelines will include measures for Type A, Type B, non-fissile and fissile packages.

3.2. Consideration at the administrative level

The relevant government offices concerned (MOT, STA, MSA, the National Policy Agency, the Fire Defense Agency, etc.) have come to an agreement regarding the safety measures to be taken in the event of an accident during the transport of radioactive materials.

3.3. Survey and studies related to emergency response

Various kinds of studies are being carried out by the government offices concerned with the object of examining emergency responses. Examples of the studies are:

(1) A study on the behaviour of UF_6 packages.
   - (a) Investigation of the behaviour of a packaging when it is submerged in the sea.
   - (b) Investigation of the reaction between UF_6 and brine during submersion.
   - (c) Investigation of the effects on the surrounding environment.
   - (d) Emergency responses to be taken with regard to nearby residents. The purpose here was to provide information on the emergency response needed to ensure the safety of nearby residents if a UF_6 package, such as a 30B cylinder, were to be immersed in the sea. The following conclusions were obtained:
     - (i) The 30B-type packaging exhibits elastic behaviour, even when submitted to hydrostatic pressures of 1.5 kgf/cm² gauge for 8 h, as prescribed by regulations, and 20 kgf/cm² gauge for 1 h.[1]

[1] $kgf/cm^2 = 9.807 \times 10^4$ Pa.

Moreover, the soundness of the seals for all other parts, including valves and blank plugs, remains unchanged. At approximately 60 kgf/cm^2 gauge of hydrostatic pressure, buckling of the cylinder occurred, as predicted by calculation.

(ii) As a result of the reaction experiment, it was observed that white smoke (caused by reaction products) was created when brine got into the simulated cylinder. However, when the interior of the cylinder became flooded, the reaction speed became very slow. As a result, an explosive reaction did not occur.

(iii) As for the effects of uranium and hydrofluoric acid on the human body in the event of submersion of a UF_6 package, they are presumed to be negligible even in the worst-case scenario.

(iv) The following would be reflected in an emergency response:
- — Countermeasures taken immediately after the acccident.
- — Countermeasures taken until the container is retrieved.
- — Retrieval of the container.
- — Countermeasures taken if the container cannot be retrieved.

(2) Study on the behaviour of nuclear fuel packages when the truck is crashed into on the side.

In crash studies, it was estimated that the accident would result in a fall and fire. It is thus important that the behaviour of the package be accurately predicted.

The simulation considered three crash possibilities, front, rear and side. It was concluded that the effects of front and rear impacts were already well understood. However, there were few data for the side crash. Since it is important to understand the effects on packages when a truck loaded with nuclear fuel is hit on the side by another large vehicle, such as a truck, further studies are now being carried out:

- — 1984 (Japanese fiscal year: JFY). Fundamental study of phenomena in a side crash.
- — 1985 JFY. Experiment to estimate behaviour of the 'crashing' truck, the crashed truck and the loaded goods.
- — 1986 JFY. Experiment to confirm that the package will keep its integrity.

4. CONCLUSION

In spite of an increase in the transport of nuclear fuels in Japan, no accidents have been reported. The relevant competent authority regulates nuclear fuel materials transport according to their type. Currently, the technical standards for regulating transport are based on the 1973 IAEA Transport Regulations. The incorporation of the 1985 Transport Regulations is planned. On the question of emergency response, though the arrangement to be used is already established, guidelines for the preparation of safe transport manuals are being developed and other studies on emergency response, such as studies on the behaviour of UF_6 and nuclear fuel packages in a side crash of a truck, are being carried out.