Inspection of Packages and Loadings before Transport of Nuclear Fuel Materials

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1. Introduction

In Japan the domestic transportation of nuclear fuels, such as uranium fluoride, uranium oxide, fuel assembly and spent fuel, shows steady increase in frequency and quantity with increase of electricity generated by nuclear power.

For safe transport of these nuclear fuels, a domestic law; the Law for the Regulations of Nuclear Source Material, Nuclear Fuel Material and Reactors(the Regulation Law), stipulates that before land transport of nuclear fuel material with the radioactivity in more than a definite quantity, users et al. shall be subject to the confirmation of safety on package and loading method by Prime Minister and Minister of Transport(MOT) respectively.

So far, all the inspections had been performed by the government, but the provision added on May 27, 1986 to the above-mentioned law, also prescribed that an organization designated by Prime Minister may carry out a part of the inspections for packages using packagings which comply with the definite standards(certified packagings) and an organization designated by MOT may perform a part of the inspections for loading of packages using certified packagings.

Nuclear Safety Technology Center(NUSTEC) was designated as agencies of designated package confirmation and designated loading method confirmation by Science and Technology Agency (STA) and MOT respectively in 1987. Since the year 1988, NUSTEC has been carrying out inspections for confirmation of safety on packages and loading methods of nuclear fuels etc. on behalf of the government, except the inspections for packages containing special nuclear materials like plutonium performed by the government.

2. Designation of Confirmation Organization by the Government

In case radioisotopes etc. with more than definite quantities of radioactivity are transported in Japan, it has been necessary to confirm that the packages containing radioisotopes and their transport methods conform to the technical standards provided by a law. Based on the law; the Law Concerning Prevention from Radiation Hazards due to Radioisotopes, etc, NUSTEC was already designated as an agency of the inspections for transport of radioactive materials, excluding nuclear fuel materials containing uranium, plutonium, or thorium, and since then it has been performing inspections for them.
Dated on January 27, 1987, NUSTEC was newly designated as an agency of both the inspections for nuclear fuel package and transport method by Minister of Science and Technology and Minister of Transport respectively.

2.1 Agency of Designated Package Confirmation

The items, methods and criteria of package inspection before transport are described in the safety analysis report (SAR) of a package, which shall be subject to approval by STA. Users et al. shall be subject to the inspection by STA to confirm that the package complies with the safety standards before transport by inspections described in SAR.
For a regular type of package as used for transport of commercial nuclear fuels, users et al. may receive the certificate of approved packaging from STA. The certificate includes information necessary for controlling the safety of packages such as the kind, form, quantity, enrichment, radioactivity and burnup of nuclear fuel, the type, name, weight and transport index of package, and the number and registered number of packaging.
While the government continues to perform inspections for packages and loading methods using packagings without certificates as before, NUSTEC has begun to carry out inspections for the following packages with certificates:

1) Uranium and its compounds containing no more than 20% of uranium-235 and uranium-233
2) Fuel assemblies composed of uranium dioxide with the content of no more than 20% of fissile uranium mentioned above
3) Spent fuels confirmed not to have leakage of radioactive materials
4) Irradiated materials for examinations

However, among inspections of packages using certified packagings, the government continues to perform the inspections of Type B(M) and B(U) packages imported from abroad.

2.2 Agency of Designated Transport Method Confirmation

Users et al. who intend to carry a Type B package shall be subject to the inspection before shipment by MOT to confirm that the transport method complies with conditions to ensure the safe transport.

For a fixed type of transport on Type B package with a certificate of approved packaging, users et al. may also receive a certificate of approved loading method from MOT. The certificate includes information necessary for controlling the safety of transport such as the designation of package and vehicle, the stowage, the operation system and measures in an accident.

While the government continues to perform inspections of transport method using packagings without certificates as before, since 1987 NUSTEC has been carrying out inspections of transport method for land transport of the following nuclear materials etc.:

a) Spent fuels confirmed not to have leakage of radioactive materials

b) Irradiated materials for examinations

Furthermore, in case of transport by sea or air of the package of nuclear fuel materials etc. confirmed by NUSTEC, this package may be considered as having been already confirmed by MOT, based on the provisions of the Ship Safety Law or the Civil Aeronautics Law.

3. Procedures of Transport Confirmation by NUSTEC

3.1 Confirmation on Safety of Package

Users et al. who intend to undertake the package confirmation by NUSTEC must submit an application filling up necessary information such as the specification of nuclear fuels etc., the purpose and expected period of transport and the specification of packaging with a copy of approval certificate, and a document explaining the result of self-imposed check on the packaging.

For Type A package, NUSTEC examines whether the items filled in the application comply with the technical standards of package by the documents. When confirmed that there is no problem, NUSTEC will issue an approval certificate of confirmation for nuclear fuel material package to the applicant.

For Type B package, after confirming that the items filled in the application comply with the technical standards of package by the documents, NUSTEC performs inspections of the package. As an example, Table I indicates the inspections of packages carried out on the

Table I. Inspections of Packages Before Shipping of Spent Fuels

Items	Methods	Criteria
1. Visual examination	Observation of the appearance of package charged with fuels	No presence of abnormality such as defect and crack on the surface
2. Lifting test	Observation of the appearance of trunnions after raising and lowering the package	No presence of abnormality at trunnions
3. Weight examination	Estimation of the total weight including packaging, cooling water and contents	A definite weight with tolerance
4. Surface contamination measurement	Measurement of contamination density by the smear method	α-emitter ≤ 0.4 Bq/cm^2 β,γ-emitter ≤ 4 Bq/cm^2
5. Dose equivalent rate measurement	Measurement of dose equivalent rates of gamma-ray and neutron at the package surface and spot distant 1-meter from there	At the surface: ≤ 2 mSv/h 1 m from the surface : ≤ 100 μSv/h
6. Subcriticality examination	Visual examination of the appearance of fuel basket within the packaging before charging fuels	No presence of abnormality such as deformation and damage having influence on charging fuels
7. Content examination	a. Visual examination of fuel appearance, fuel number etc. b. Check of documents including radioactivity, uranium weight, burnup, heat rate, cooling time etc. c. Check of water level in the packaging	No presence of abnormality on fuel appearance and number Conformity to the conditions of design approval Drainage to a definite water level
8. Temperature measurement	Measurement of the surface temperature of package charged with fuels	Temperature of the accessible surface in the ambient of 38°C does not exceed 85°C
9. Airtightness test	Measurement of leak rate through seals under a pressure no less than a definite value	Total leak rate through parts of seals does not exceed a definite value
10. Pressure measurement	Estimation of pressure within the packaging from the surface temperature of package	No more than a design base pressure

spot before shipment of spent fuels. When confirmed that there is no problem, NUSTEC will issue an approval certificate of confirmation for packages of nuclear fuel materials to the applicant.

3.2 Confirmation on Safety of Transport Method

Users et al. who intend to undertake the transport method confirmation by NUSTEC must submit an application with an operation plan including necessary information such as the specification of nuclear fuels, the purpose and expected period of transport, the specification of package, the capacity of used vehicle, the stowing method, the operation system with radiation control, and measures taken in an accident to NUSTEC.
For Type B package, after confirming that the items filled in the application comply with the technical standards of package by the documents, NUSTEC performs inspections of the transport methods such as the stowage of package, the adjustment of vehicle, the operation system, and the radiation control system with measurement of radiation.
When confirmed that there is no problem, NUSTEC will issue an approval certificate of confirmation for transport of nuclear fuel material to the applicant.

4. Results

Since 1988, NUSTEC has been conducting inspections on various A and B types of packages for domestic transport and shipment to abroad partially including domestic land transport.
As for Type A package, the objects of package confirmation are composed of nuclear fuel materials such as uranium hexafluoride, uranium oxide and fuel assembly before use for commercial use. In addition, they include specimens for research and development containing a small quantity of nuclear fuel.
As for Type B package, the objects of package and transport method confirmations are composed of nuclear fuel materials such as spent fuel assembly from nuclear power stations to reprocessing plants inside and outside Japan. In addition, they include nuclear fuel specimens for research and development and surveillance test rigs irradiated in a nuclear reactor, which are carried to post-irradiation examination facilities.
Figs. 1, 2 and 3 show the results of package and transport method confirmations carried out by NUSTEC along with total domestic confirmations including those performed by other organizations.
In these figures, Domestic Total means the results of total domestic confirmations includ-

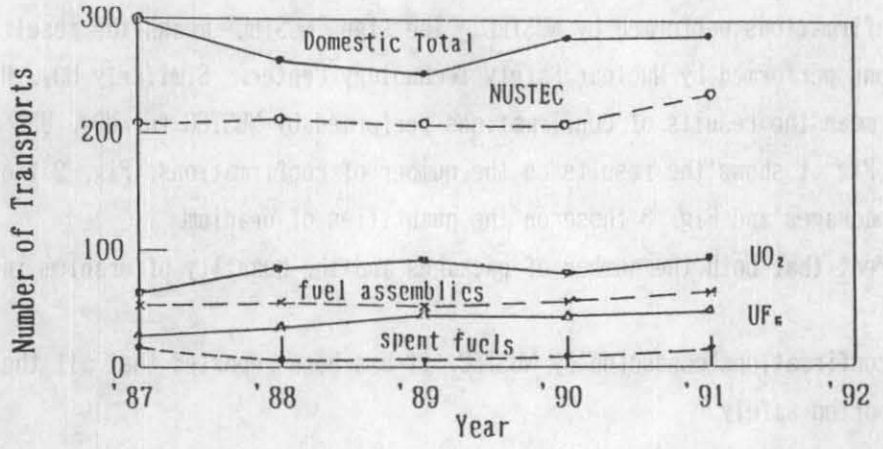

Fig. 1. Number of Transports Confirmed by NUSTEC Each Year

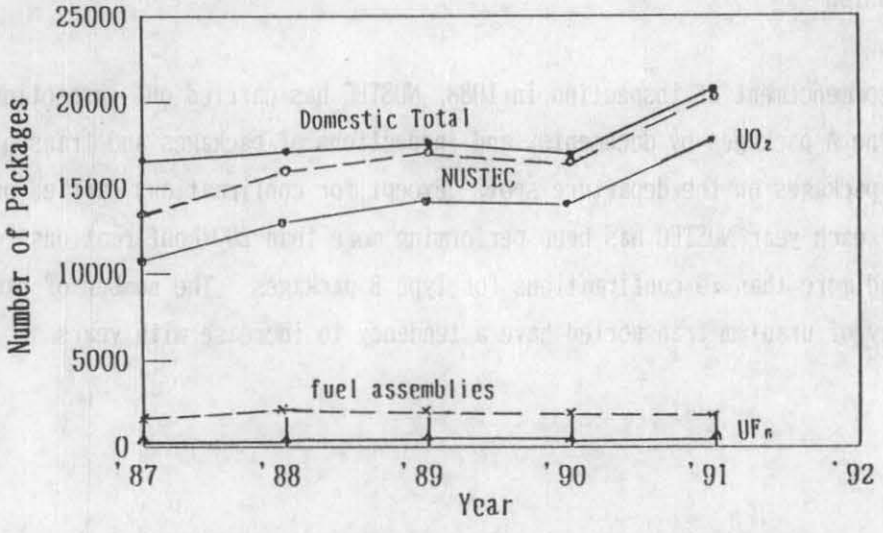

Fig. 2. Number of Packages Confirmed by NUSTEC Each Year

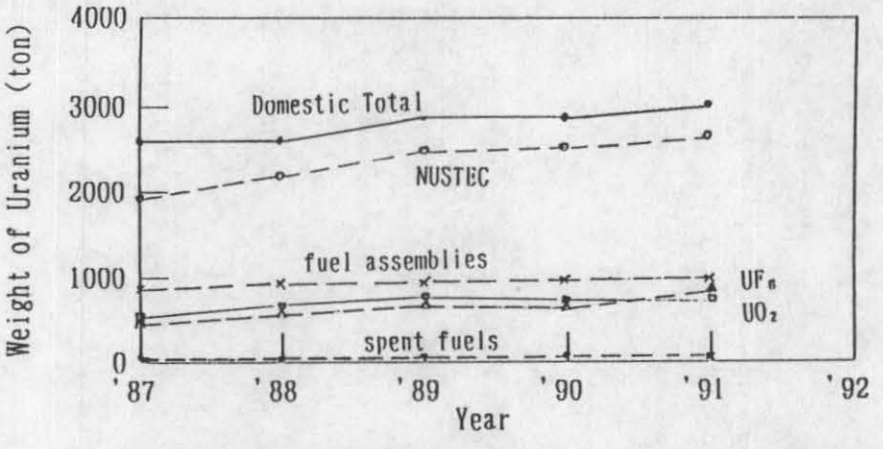

Fig. 3. Weight of Uranium Contained in Packages Confirmed by NUSTEC Each Year

ing the confirmations performed by NUSTEC. The sign "NUSTEC" means the results of total confirmations performed by Nuclear Safety Technology Center. Similarly UO_2, UF_6 and fuel assemblies mean the results of confirmations performed by NUSTEC for UO_2, UF_6 and fuel assemblies. Fig. 1 shows the results on the number of confirmations, Fig. 2 those on the number of packages and Fig. 3 those on the quantities of uranium.

It is apparent that both the number of packages and the quantity of uranium increase with years.

After the confirmations conducted by NUSTEC, it has been reported that all the packages were transported safely.

5. Conclusion

Since the commencement of inspection in 1988, NUSTEC has carried out inspections of packages for Type A packages by documents, and inspections of packages and transport methods for Type B packages on the departure spot. Except for confirmations carried out by the government, each year NUSTEC has been performing more than 200 confirmations for Type A packages and more than 10 confirmations for Type B packages. The number of packages and the quantity of uranium transported have a tendency to increase with years.