Future Perspective
Based on the JAEA's Experience
in MOX Fuel Transport

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Overview

1. Framework for Nuclear Energy Policy of Japan
2. Overview of transport by JAEA
3. History of MOX Transport by JAEA
4. Transition of the returned MOX transport mode
5. Ensuring transport ship
6. Development of MOX packages
7. Measures for MOX transport
8. Future trend and challenges of MOX transport

Framework for Nuclear Energy Policy

JAEA/NPSTC

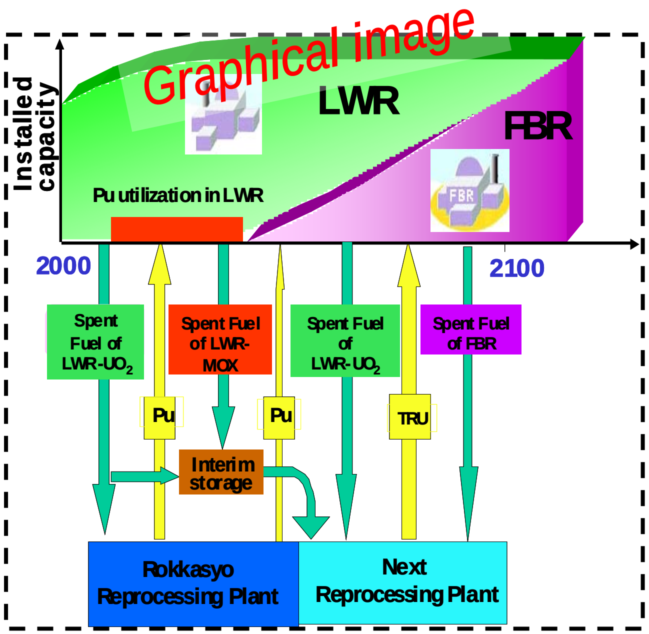
The Atomic Energy Commission of Japan (AEC) concluded a new "Framework for Nuclear Energy Policy", endorsed by the Cabinet in October 2005. (http://www.aec.go.jp/jicst/NC/tyoki/taikou/kettei/eng_ver.pdf)

Basic Concepts for Nuclear Power Generation

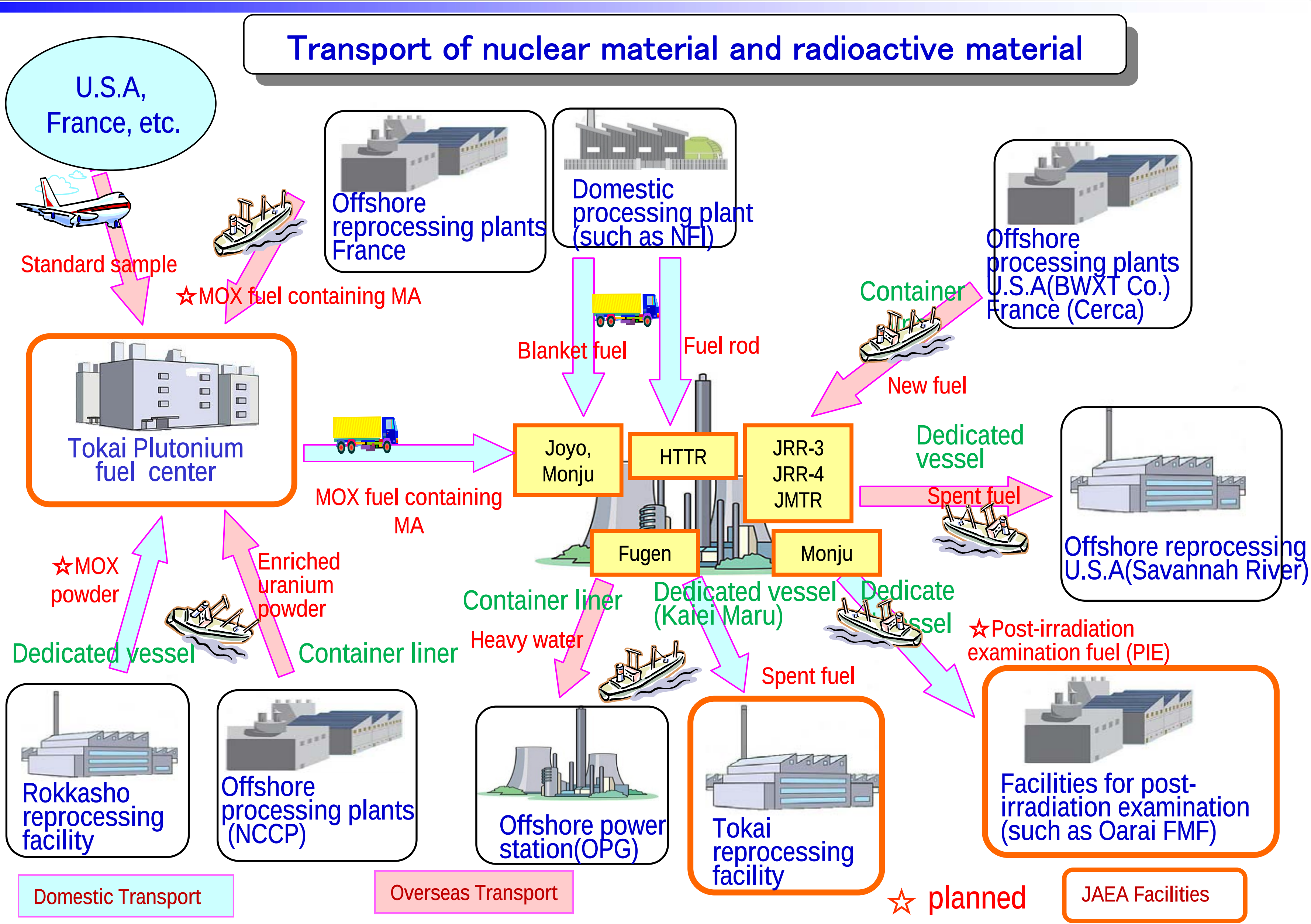
Expectation in pursuit of optimum energy supply mix for Japan that nuclear energy generation continuously contributes to the stable energy supply in Japan.

=>To aim at maintaining or increasing the current level of nuclear power generation (30 to 40 % of total electricity generation) even after 2030 for stable energy supply.

1. Optimal utilization of existing NPP
2. Advanced models of LLWs
3. Commercial use of FBRs from around 2050



Structural Outline of JAEA's Transport for NM and RAM

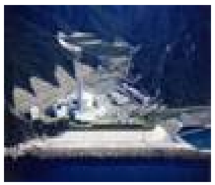


Inland MOX Transport of JAEA

JAEA/NPSTC

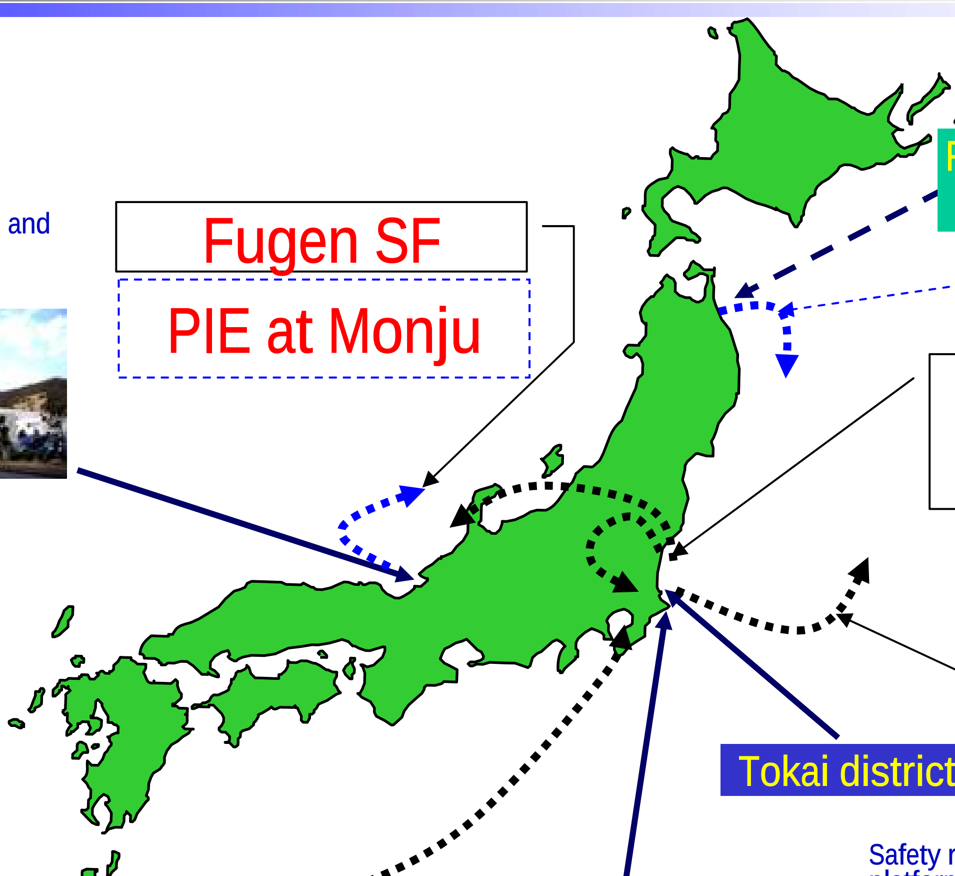
Tsuruga district

Fast Reactor Cycle Technology Development Project at Monju, decommissioning study at Fugen, and disaster prevention training



Fugen SF

PIE at Monju



Rokkasho Reprocessing Plant (JNFL)

MOX powder

MOX new fuel (Joyo, Monju)

New fuel from overseas enriched uranium research and test reactor

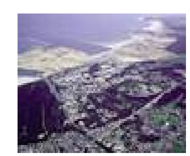
Research and Test reactor SF

Tokai district

Oh-arai district

Fast reactor cycle technology development at post-irradiation examination facility of Joyo, as well as research and development concerning the innovative reactor and various application of the atomic energy, are conducted

Safety research, promotion of basic and platform research of atomic energy, promotion of neutron utilization study, research for disposal of high activity waste, development of FBR fuel processing, development of light-water reactor reprocessing technology, and training program are conducted



History of MOX Transport and R&D

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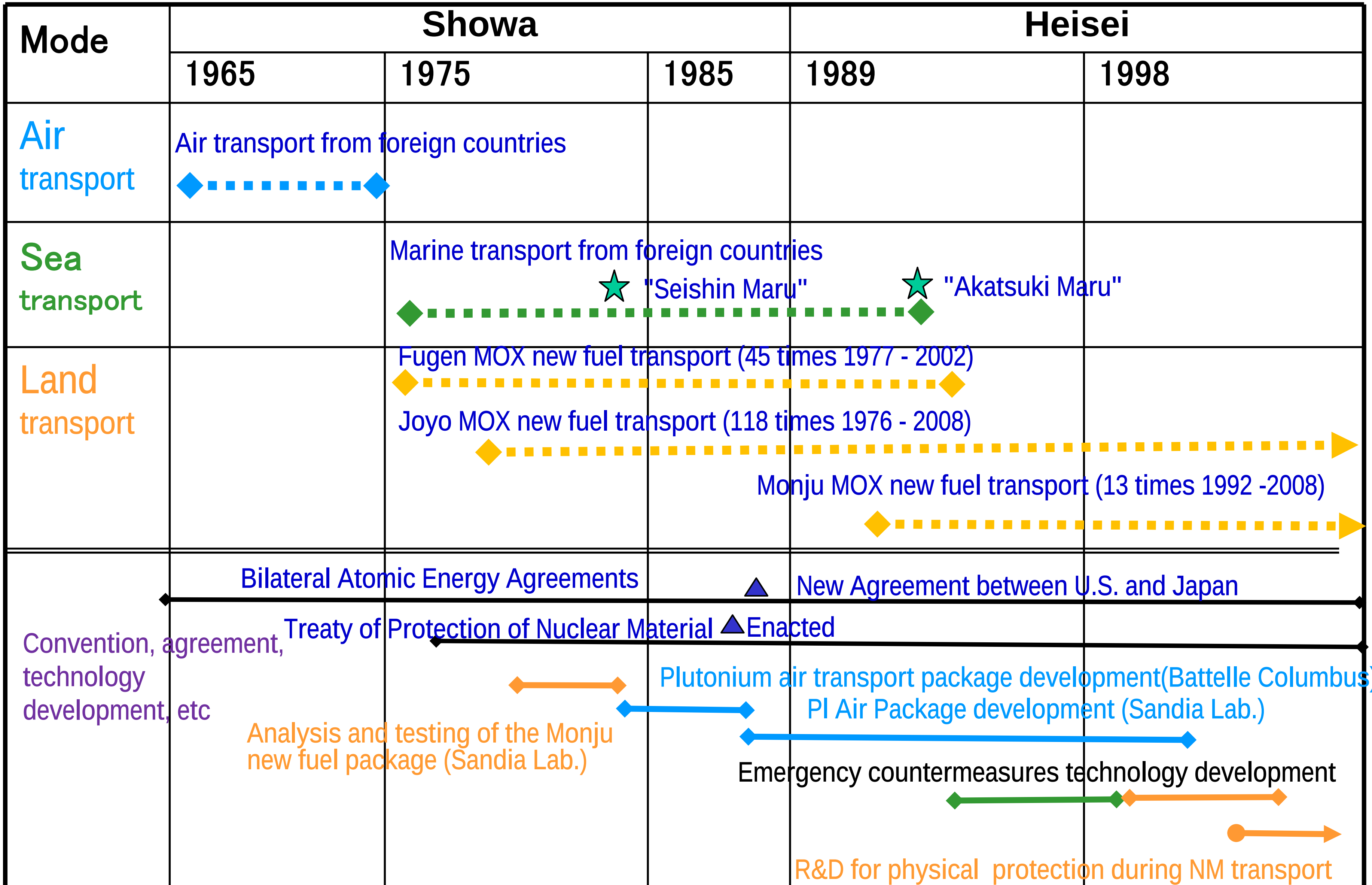

Major MOX Transports

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Land transport of MOX new fuel to Fugen

- About 134 tons of MOX fuel transported from 1977 through 2002, or 45 times of transportation in total

Land transport of MOX new fuel to Joyo

- About 7.9 tons of MOX fuel transported from 1977 through present time in 2008, or 118 times of transports in total

Land transport of MOX new fuel to Monju

- About 9.6 tons of MOX fuel transported from 1922 through July, 2008, or 13 times of transportation in total

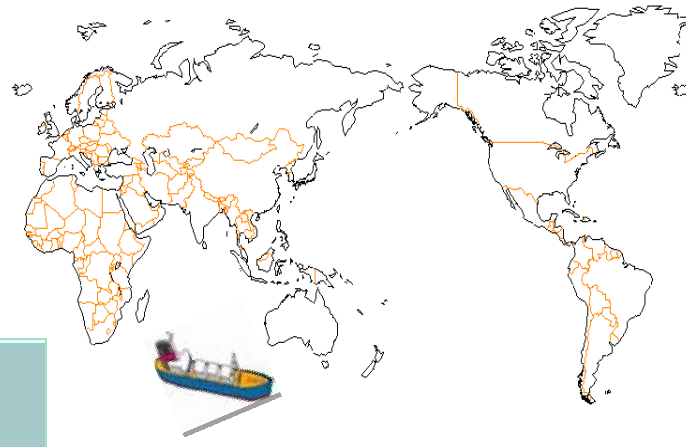
Others, including sea transport of offshore irradiation testing sample

Safe transport has been achieved without any accidents/incidents in around one hundred eighty transport activities.

Transition of transport mode for the returned plutonium

JAEA/NPSTC

【 Transition of transport mode】



Sea transport of the returned Plutonium by "Seishin-Maru" from France (based on the bilateral Agreement between Japan and the U.S.)

Technology development for air transport package started for returning Plutonium

NUREG-0360 criteria of the U.S.

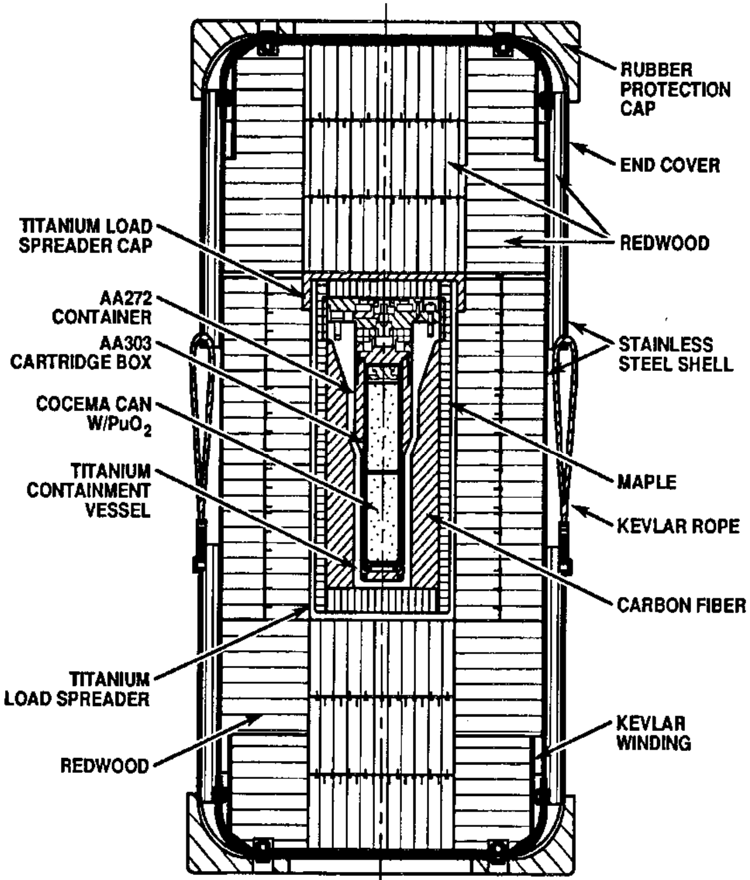
Further severe requirement by Murkowski Amendment

Sea transport mode selected

Sea transport of the return Plutonium by "Akatsuki-Maru" from France (in accordance with a comprehensive consent based on the new Agreement)

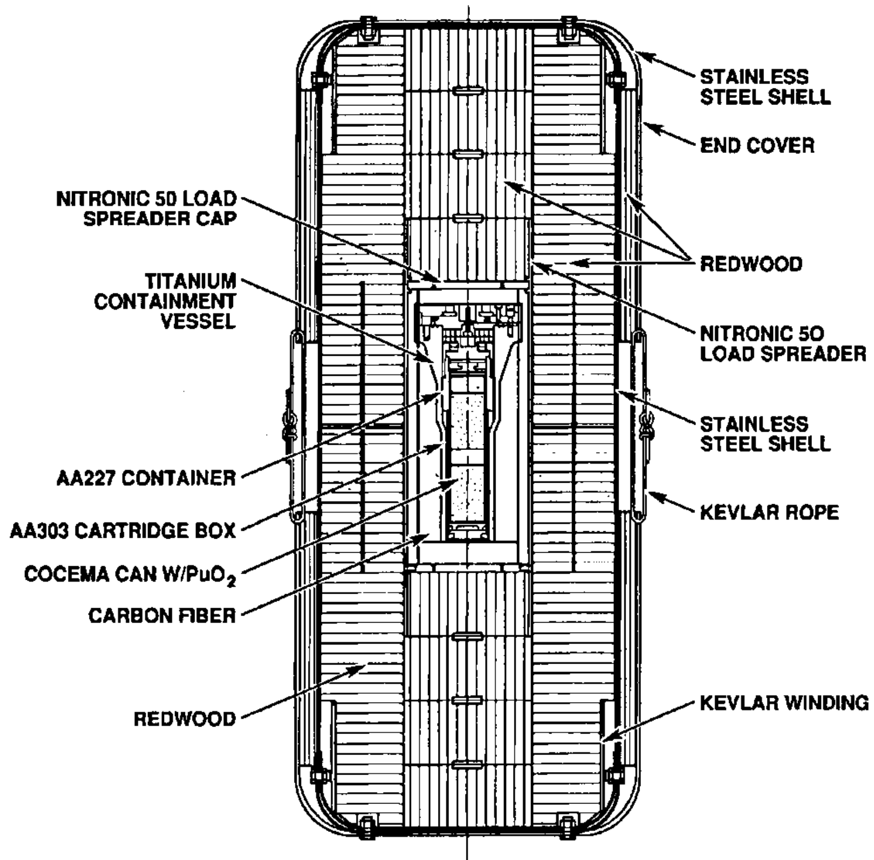
Note) Japan-U.S. bilateral agreement on the cooperation concerning peaceful use of nuclear

Pu Air Transport Packagings for NUREG-0360 Tests



Diameter	1.2m
Length	2.3m
Weight	2,551 kg

JNC common packaging type 1(Kobe)

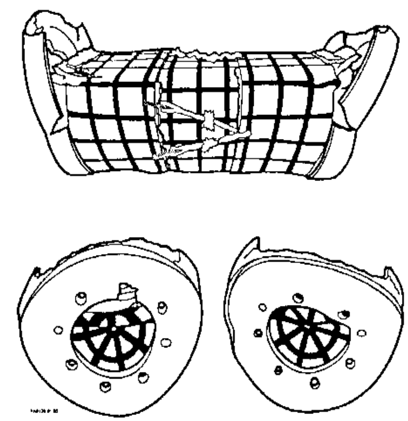
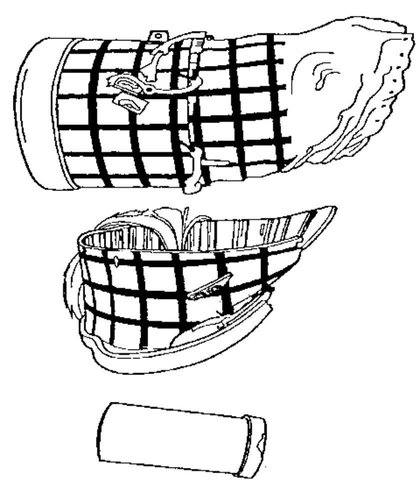


Diameter	1.16 m
Length	2.6m
Weight	2,830 kg

JNC common packaging type 2 (JSW)

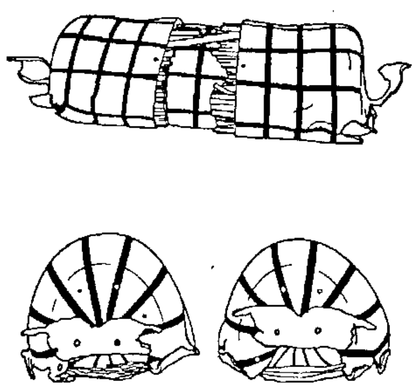
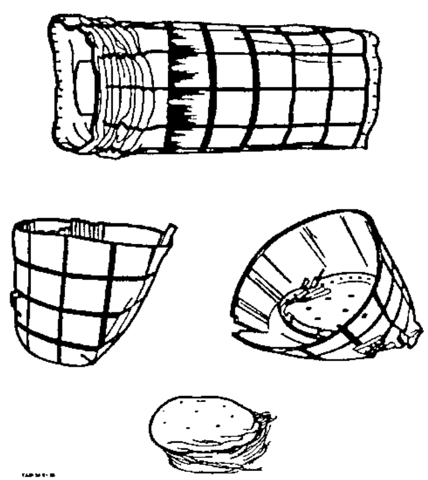
Development of Pu Air Transport Package

Test result to NUREG-0360 criteria (1)

	Impact test	Transportation	Leakage test result	Judgment
Common packaging type 1 (Kobe 1) (Horizontal impact)	Date of testing: November 2, 1989 Velosity:131m/s Direction of impact : Horizontal		# Leak rate of primary containment vessel : 9.3 atm cm3 / sec # Leak rate of the inner container (AA303) : 5.6 x10-7 atm cm3 / sec # Powder can deformed but no breakage	Good
Common packaging type 1 (Kobe 2) (center of gravity - corner impact)	Date of testing: November 16, 1989 Velosity:129.5 m/s Direction of impact : Corner		# Leak rate of primary containment vessel : 0.1 atm cm3 / sec # Leak rate of the inner container (AA303) : 3.8 x10-8 atm cm3 / sec # Powder can deformed but no breakage	Good

Development of Pu Air Transport Package

Test result to NUREG-0360 criteria(2)

	Impact test	Transportation	Leakage test result	Judgment
Common packaging type 2 (JSW1) (Horizontal impact)	Date of testing: November 9, 1989 Velosity:127.9 m/s Direction of impact : Horizontal		# Leak rate of primary containment vessel : 3.4 atm cm3 / sec # Leak rate of the inner container (AA303) : 5 x10-8 atm cm3 / sec # Little or no deformation seen on the powder can	Good
Common packaging type 2 (JSW2) (center of gravity - corner impact)	Date of testing: November 30, 1989 Velosity:97.7 m/s Direction of impact : Corner		# Leak rate of primary containment vessel : 2.0 x10-9 atm cm3 / sec # Leak rate of the inner container (AA303) : 1 x10-6 atm cm3 / sec # Powder can deformed but no breakage	Good

Technological achievement Level of Pu Air Transport Package to NUREG-0360 criteria

JAEA/NPSTC

1. Four prototype packagings designed and improved and fabricated by JAEA reflecting an advice by SNL were tested successfully at the SNL facilities in terms of impact, penetration, tearing and fire, which are required by NUREG-0360 criteria.
2. Other fringe phenomena such as crush by two or more packages, mitigation effect by aircraft fuselage, and penetration by jet engine debris were also evaluated.
3. As the result, technical prospect was obtained that the packages will meet the criteria.

Development of Pu Air Transport Package

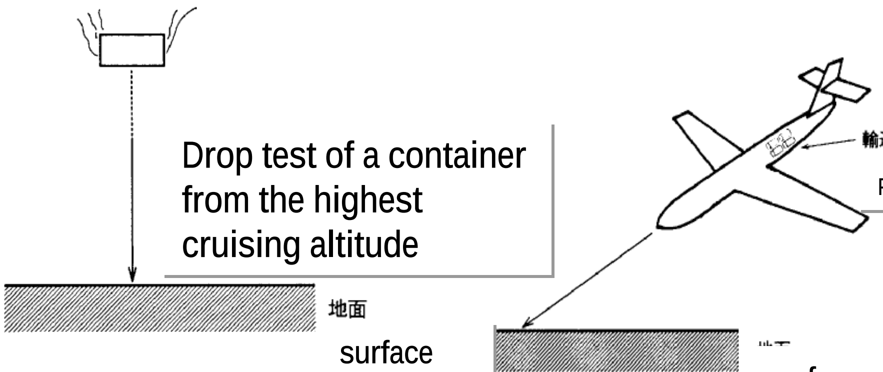
JAEA/NPSTC

Murkowski Amendment

The Amendment to the Appropriations for Energy and Water bill under discussion at the time was proposed by the Senator Murkowski (Alaska), which requires safety of air transport of plutonium carried over the U.S. territory. The Amendment gained approved.

1. Package drop test

Actual test for a real scale package containing a testing material is dropped from the cruising attitude.



2. Crash test of an aircraft

Actual crash test for a aircraft fully loaded with real scale testing packages containing testing material is implemented.

The worst case of the aircraft accident was assumed:

･Accidents of PSA Flight number 1771 occurred in California on December 7, 1987.

･Clashed to the sandstone surface at a speed of 282m/s at an angle of 60 degrees.

= > ※ *The kinetic energy was about five times as large as the NUREG-0360 criteria.*

Simulation of Murkowski Amendment Test


1/5 scale model of lashing apparatus and Air Transport Packaging of a cargo air plane floor


Target used in the impact testing




Ensuring Transport Ship for NM

JAEA/NPSTC

Japan has established and applied for a long time the strict structural criteria to the transport ships such as spent fuel carriers

Proposed to International Maritime Organization= >The proposition became to be an international standard as international rules for safe marine transport (INF code) for Irradiated Nuclear Fuels.

IAEA Regulations for Safe Transport of Radioactive Material (TS-R-1)

(United Nations recommendation)

Recommendation concerning hazardous materials transportation (Orange Book)

The Law for Nuclear Reactor and Nuclear Material Regulation
The Law for Radiation Hazard Prevention

International Maritime Organization (IMO)
International Convention for the Safety of Life at Sea: SOLAS convention

International Maritime Dangerous Code (IMDG code)

INF code: mandated in January, 2001

The Law for Safety of Ships

International Civil Aviation Organization (ICAO) (ICAO convention)

The Aviation law

INF-1 :Less than 4000TBq

INF-2 :Less than 2×106TBq (less than Pu-2×105TBq)

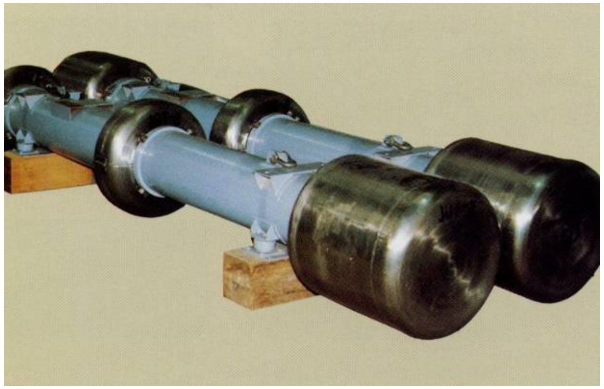
INF-3:Unlimited.

(Rokuei-Maru)

Applicable objects: Irradiated fuel, plutonium, and high-level waste

Requirements: Stability (double hull , fire resistant structure, hold thermal management, power supply, radiation protection, etc

Typical MOX Fuel Packages



TN-9121 / B model (for Joyo MOX new fuel)
Type BM Fissile packaging
Outside dimension and weight
- Outside diameter: About 0.6 meters
- Length: About 4 meters
- Weight: About 0.6 ton

Gross weight of fuel package: 710 kg or less
Number of fuel unit loaded: 1

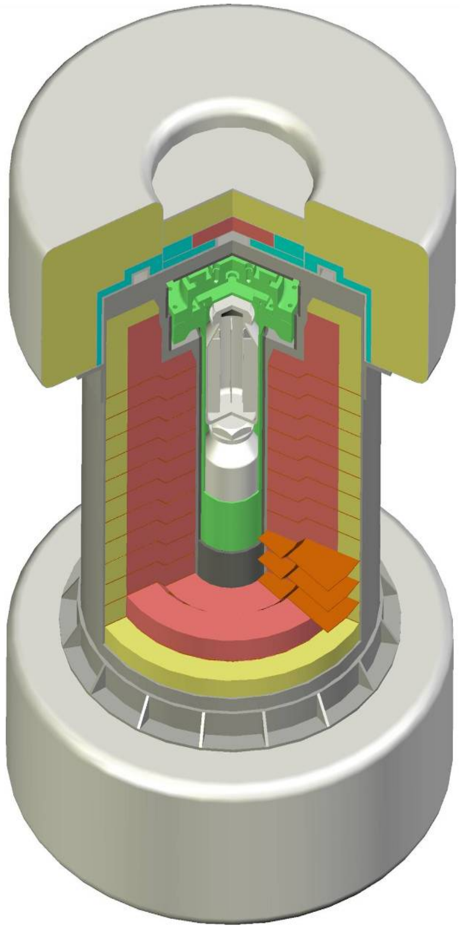
TN-9180 / A model (for Fugen MOX new fuel)
Type BM Fissile packaging
Outside dimension and weight
- Outside diameter: About 0.7 meter
- Length: About 5 meters
- Weight: About 1.2 tons

Gross weight of fuel package: 1,670 kg or less
Number of fuel unit loaded: 2

MONJU-F model (for Monju MOX new fuel)
Type BU Fissile packaging
Outside dimension and weight
- Outside diameter: About 0.6 meters
- Length: About 5 meters
- Weight: About 2.3 tons

Gross weight of fuel package: 2,630 kg or less
Number of fuel unit loaded: 2

Package for MOX powder from RRP



Packaging for MOX powder from Rokkasho Reprocessing Plant (RRP)

Maximum weight of package

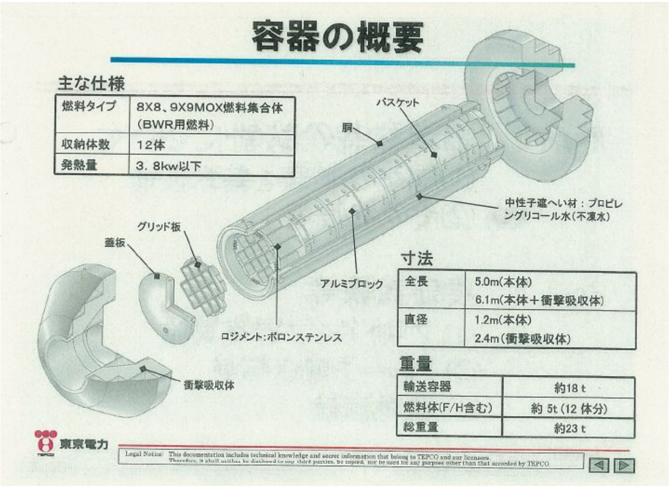
: 4,010kg

(packaging : 3,750kg)

Dimension of the package

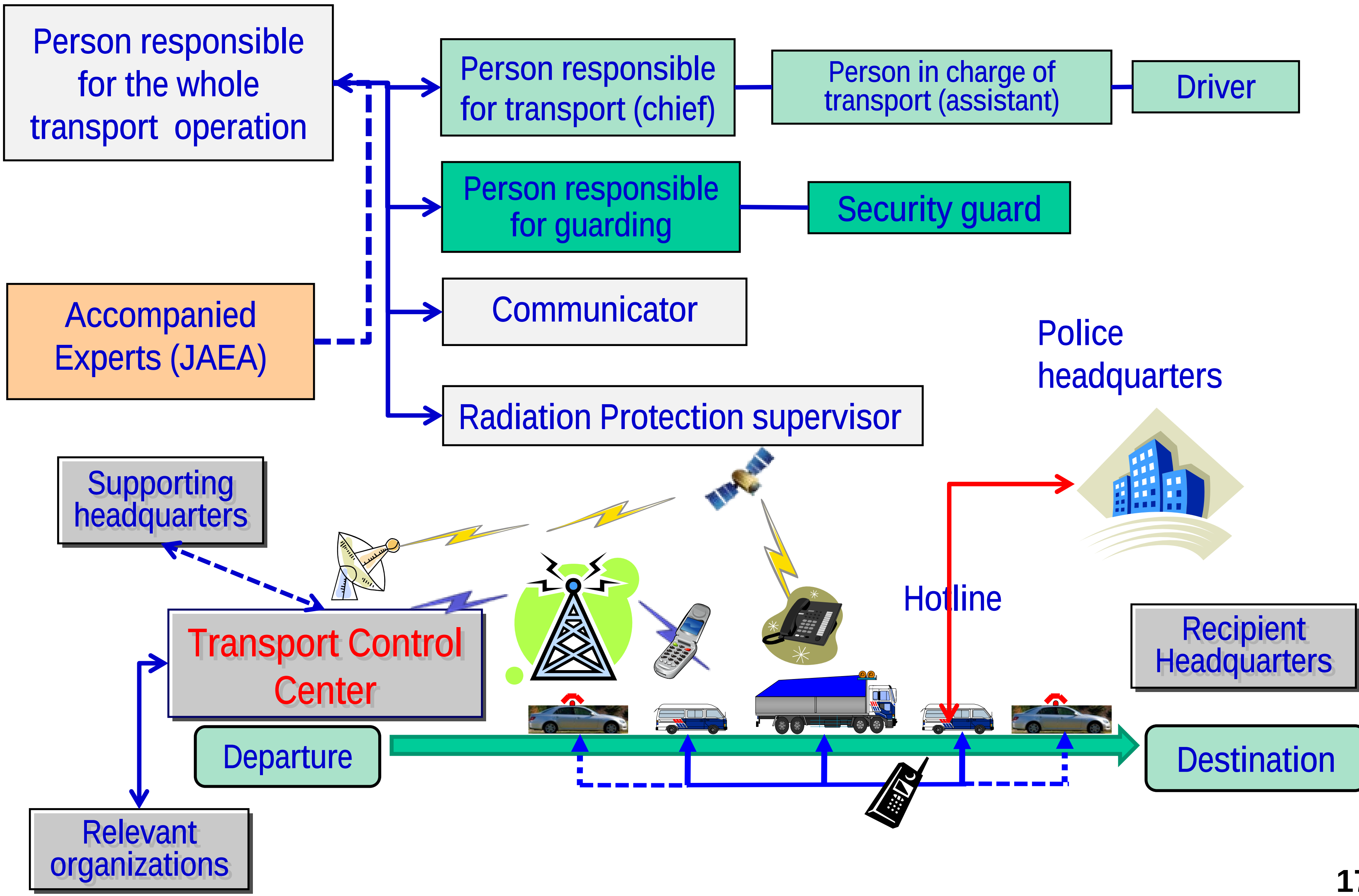
: about 1,440mm in diameter,

: about 2,160mm in height



(reference) JMOX packaging

Safety Measures for Land MOX Transport



Air Transport of Small Nuclear Material Sample

JAEA/NPSTC

Safeguards activity of nuclear fuel facility

⇒A small amount of nuclear material is needed as a standard sample

⇒Transport is done by air from abroad (Sea transport of plutonium is difficult to implement even a small amount.)

Special Law on Nuclear Disaster Countermeasures

⇒Countermeasures are required for damage of the package during transport of nuclear material even in the amount of type A package.

⇒“ The procedures to prepare manuals for the countermeasures against nuclear disaster during air transport " is provided for nuclear industries and air transporters to take appropriate measures (October, 2003 by Civil Aviation Bureau of the Ministry of Land, Infrastructure and Transport)

Enhancement of Physical Protection of Nuclear Material and Quality Assurance

Enhancing Physical Protection of Nuclear Material – The Revised Regulations

1. Physical Protection Inspection system to check performance of protective measures installed by nuclear facilities and transport was introduced.
2. Physical Protection Secrets have to be kept not to be public. Penalties are imposed on a breach by personnel including government officials and operators of nuclear industry who could have known the PPS as need-to-know basis.
3. Potential terrorism-related threats are assumed (Design Basis Threats, or DBT) by the Japanese Government (relevant competent authorities, Police and Coast Guard), to which operators (nuclear industries) were required to take an appropriate measures.

Enhancing Quality Assurance System

1. Based on the lessons of an inappropriate handling of shielding material data for fabricating a spent fuel package in 1998 in Japan, MEXT (the then-Science and Technology Agency) decided to improve Quality Assurance system for fabricating the package. A guideline was publicized in February 1999. A Quality Management Guideline for fabrication of the package in July 2002.
2. Based on those steps JAEA has enhanced the quality assurance of nuclear facilities and nuclear transport.

Future Perspective of MOX Transport

JAEA/NPSTC

【Global trends 】Countermeasures toward the low Carbon Society for controlling global warming

Development of Nuclear Power Generation

Development of Renewal Energy

Japan's targets : Gradual increase of LWRs and MOX Utilization by LWRs and future FBRs

- High demands for the safe and smooth transport / supply of NNP fuel
- Still high attention to *MOX* transport
- Steady requirement to maintain the Rules stricter which in turn leads to an increasing complexity
- Need for accountability for safety of NM transports, at the same time, establishment of their Physical Protection and Nuclear Security

Challenges to the future

JAEA/NPSTC

【Challenge-1】Achieving a good balance between the combination of accountability of the MOX transport and appropriate information control

【Challenge-2】Maintenance and enhancement of the measures for safety, physical protection of nuclear material, and nuclear security

【Challenge-3】Establishing an effective system to correspond to incidents for atomic energy disaster prevention, training and educating private and national organizations, and reflecting the improvements

Challenges to the future

JAEA/NPSTC

【Challenge-4】Developing the transport system on the premise of safety, and securing appropriate economic efficiency

【Challenge-5】Improvement and maintenance of transport technology. Fostering human resource and recruiting those who have the technology and knowledge, and educating and training the relevant persons

【Challenge-6】Continuous review of adoption of air transport safety standards for MOX fuel, and its level

Thank you for your attention.