Study on Tracking System for Radioactive Material Transport

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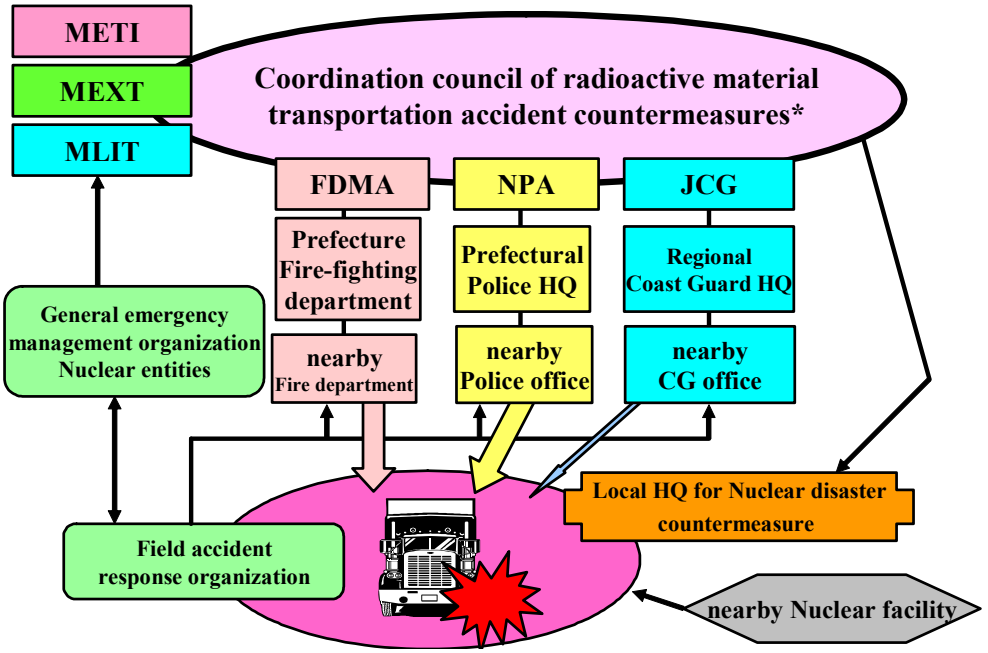
1. Introduction

When a transportation accident occurs, all entities including the shipper, the transportation organization, local governments, and emergency response organizations must have organized and planned for civil safety, property, and environmental protection. When a transportation accident occurs, many related organizations will be involved, and their cooperation determines the success or failure of the response. The point where the accident happens cannot be pinpointed in advance. Nuclear fuel transportation also requires a quick response from a viewpoint of security.
A tracking system for radioactive material transport is being developed for use in Japan. The objective of this system is, in the rare event of an accident, for communication capabilities to share specific information among relevant organizations, the transporter, and so on.



***This council becomes "Inter ministerial committee of radioactive material transport accident countermeasure" after receive a specific incident report based on a special law for nuclear disaster.**

METI	Ministry of Economy, Trade and Industry
MEXT	Ministry of Education, Culture, Sports, Science and Technology
MLIT	Ministry of Land, Infrastructure and Transport
FDMA	Fire and Disaster Management Agency
NPA	National Police Agency
JCG	Japan Coast Guard

Fig-1 Radioactive transportation accident response structure in Japan

2. Radioactive transportation accident response structure in Japan

Safe standards for the transport of radioactive materials in Japan are defined based on the Law on the Regulation of Nuclear Fuel Materials and Reactors and the Law Concerning Prevention from Radiation Hazards. Moreover, radical strengthening of nuclear emergency response systems has occurred due to lessons learned from a JCO criticality accident, resulting in the establishment of the Law on Special Measures for Nuclear Disaster.

Accident occurrence and first response

If there is a radioactive release from the shipment, or the shielding of the package deteriorates, the transport organization should immediately notify the nearby emergency response officials, including the police, fire department and so on, while cordoning off the area and preventing the spilled material from spreading.
The government will quickly convene a body to coordinate radioactive material transportation accident countermeasures, providing close contact and adjustment among related ministries and government offices, and requesting the prompt dispatch of nuclear emergency support specialists.

Reporting the specifics of the incident

When 100μSv/h at 1m of radioactive dose rate is detected, or radioactive material is released from the transport package, it is reported as a specific incident based on a Special Law for Nuclear Disasters.
When a formal accident report is received, the government will establish the council of an Inter ministerial committee on radioactive material transport accident countermeasures.

Declaration of a state of nuclear emergency

When radioactive material is released exceeding a specified quantity or radiation is exposured over 10mSv/h at 1m, the government will declare a state of nuclear emergency, and in accordance with the law, establish a nuclear disaster countermeasures HQ.

3. Overview of the tracking system for radioactive material transport in Japan

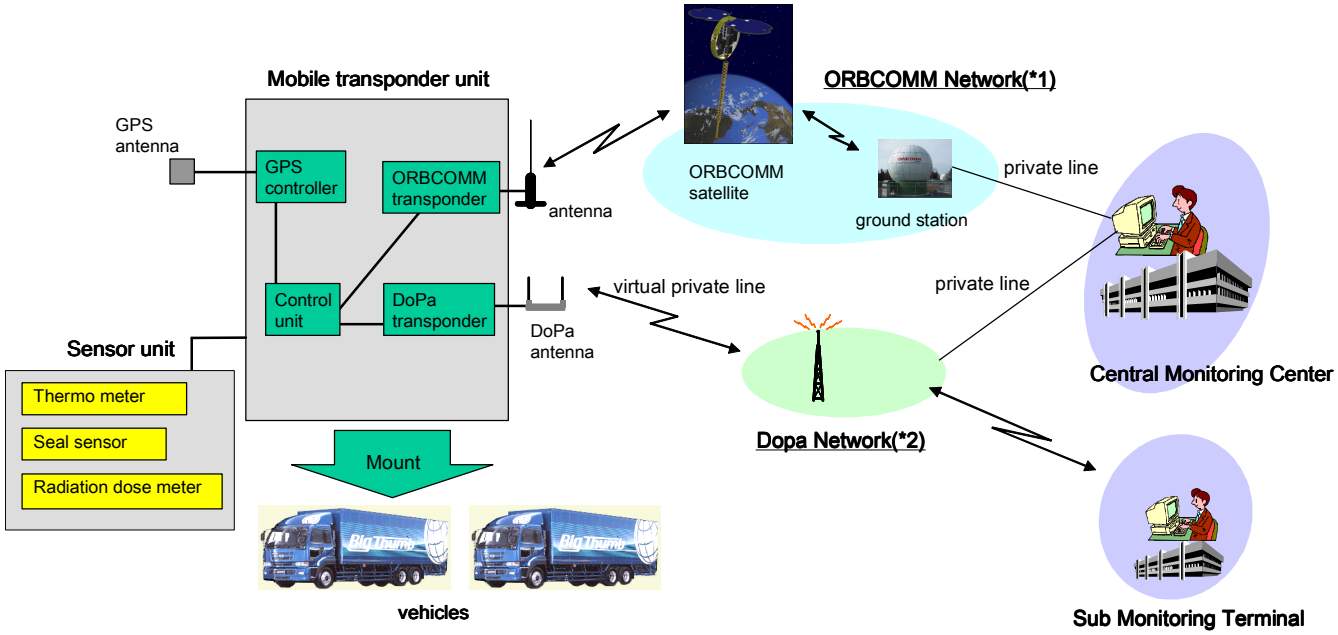
The system consists of a transponder for each transport vehicle, a central monitoring center, and a sub monitoring-terminal. This transponder transmits various monitoring data in near-real time, such as location, seal conditions, etc., by use of a global positioning system (GPS). The information is displayed on a geologic information system (GIS) at the monitoring center.

Tracking and telemetry

As the shipment's location is fundamental to emergency response procedures, this is the first and most vital information ascertained at the time of an accident.

Mobile transponder unit and sensor unit

In this trial production, the mobile transponder unit was intended to be used in the driver's cabin of several different vehicles, and so for ease of portability, it was installed in a suitcase.



(*1)ORBCOMM : A company of satellite communication
(*2) DoPa : NTT DoCoMo's(*3) Digital packet communication service
(*3) NTT DoCoMo : A Japanese cellular phone company

Fig-2 System overview

Sensor unit

The suitcase incorporates three kinds of sensors; temperature, radiation dose, and seal surveillance, and the unit is set up on the loading platform of the vehicle. The sensors' signals are sent to the transponder through a cable.

Fig-3 Mobile transponder unit

Communication network

Lines of communication are provided by a cellular-phone packet network and a low-orbit satellite network, forming a redundant communication system. Usually, the packet communication is routed via a ground-based system.
At the central monitoring center, the information about position, temperature, radiation dose and seal surveillance can be obtained at 2-minute intervals. When contact is momentarily interrupted, positioning data is transmitted after contact is restored. When a longer interruption occurs on the ground-based packet communication network, the system switches to a satellite system communications network.

Limited user and encipher

The control of the information on run route or present position needs to be managed appropriately, not only during transportation, but at all times.
Packet communication is limited to the terminals which the organizations concerned use.
All information on the networks is encripted using the MULTI-2 (ISO 9979-009) system.

Central monitoring center and sub-terminals

A central monitoring center has a GIS that accurately displays a shipment's location and monitoring information. A sub-terminal will be provided to appropriate organizations before a shipment so that they may monitor the same information as the center. The location data that the center acquires can be shared by the shipper and the governmental agency responsible for emergencies. The information acquired is shared in near-real time between the organizations concerned.

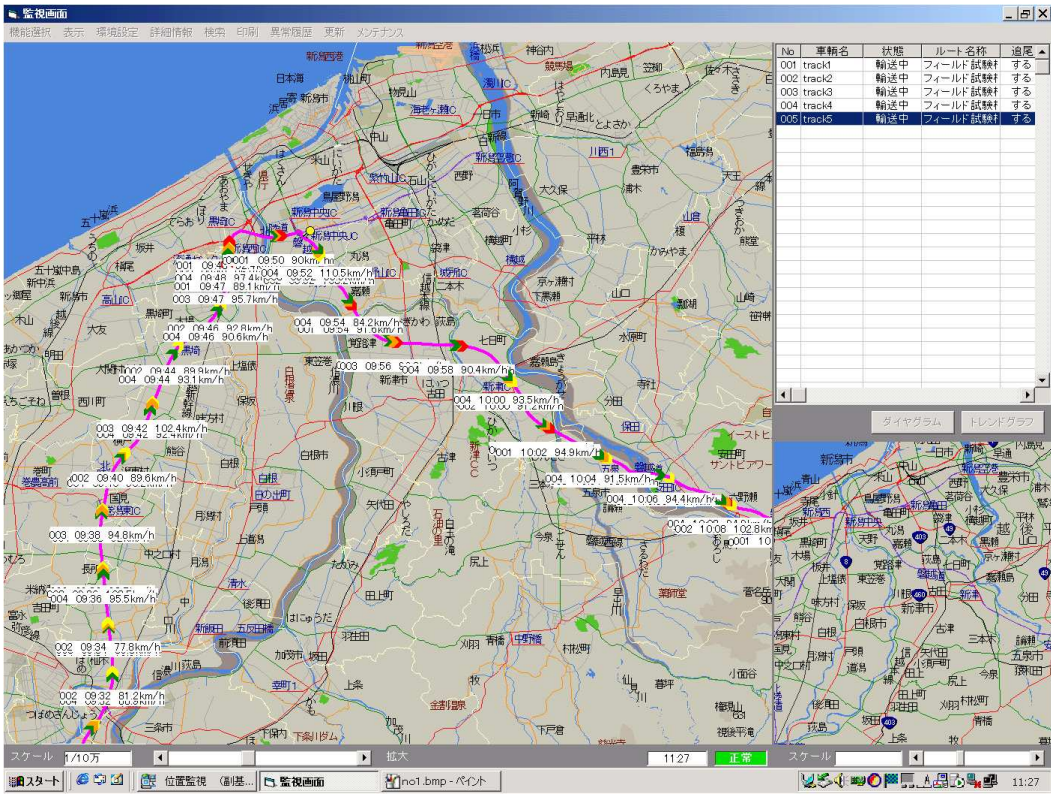


Fig-4 tracking view

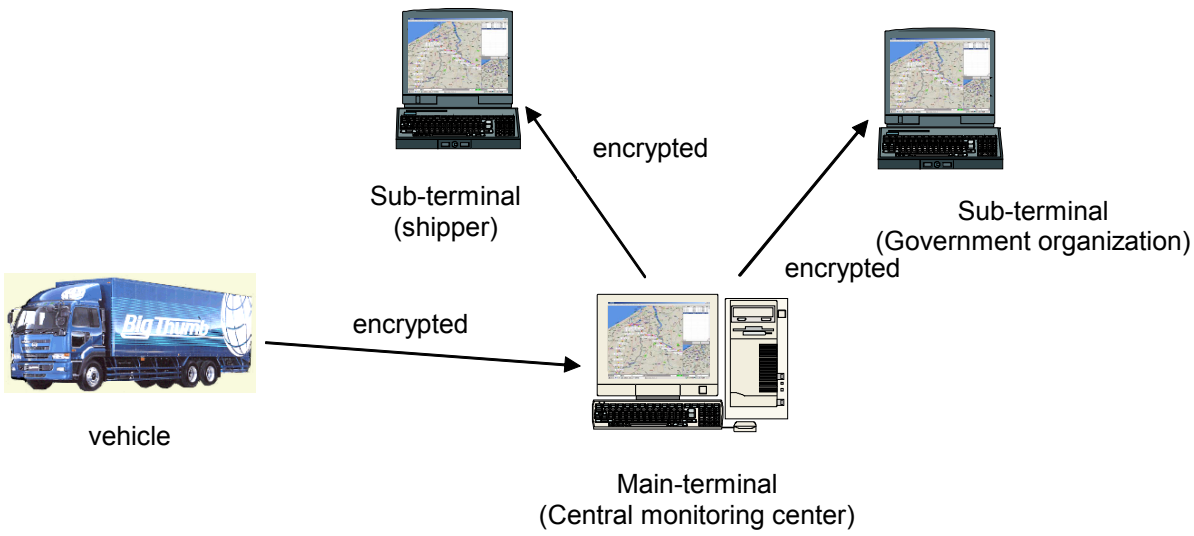


Fig-5 information sharing between HQ and other locations

Trend viewer

The sensor-derived information and vehicle progress can also be displayed as trend graphs or diagrams.

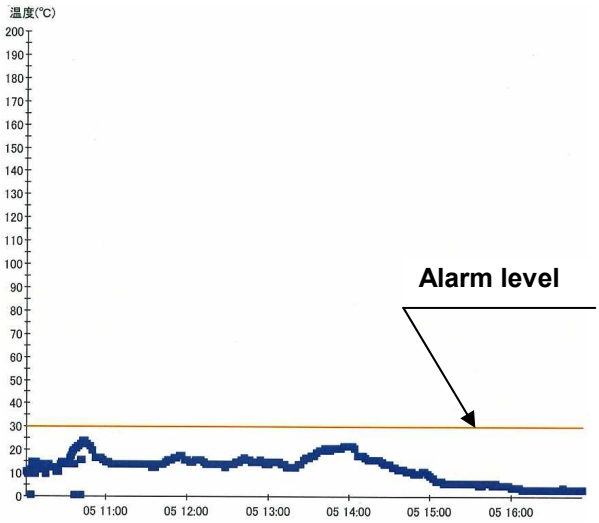


Fig-6 temperature trends

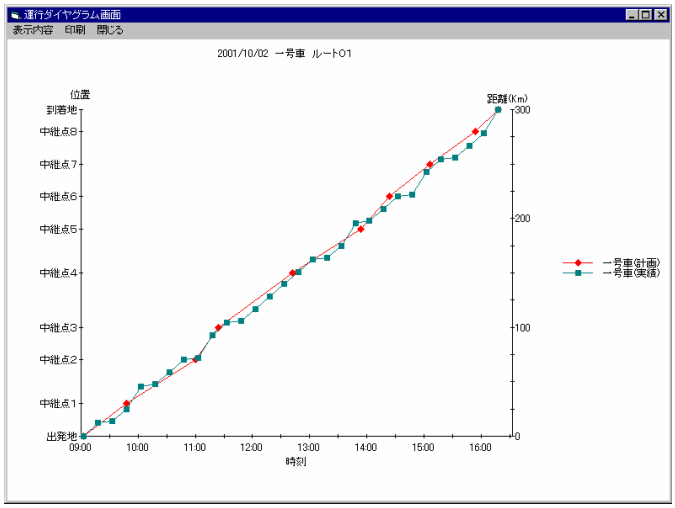


Fig-7 planned vs actual vehicle progress

Abnormal situation detection

The following abnormal situations are decided on based upon the information acquired.
Deviation from the planned route
Gap from scheduled time
Temperature alarm
etc.

Current situation and next step

This system has been developed, and performance testing carried out successfully. Future evaluations will consider database management of all emergency correspondence and related information shared during a shipment or accident.

4. Acknowledgments

This study is being carried out thanks to a grant from the Ministry of Economy, Trade and Industry.