Automatic monitoring System on LLW Transportation

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INTRODUCTION

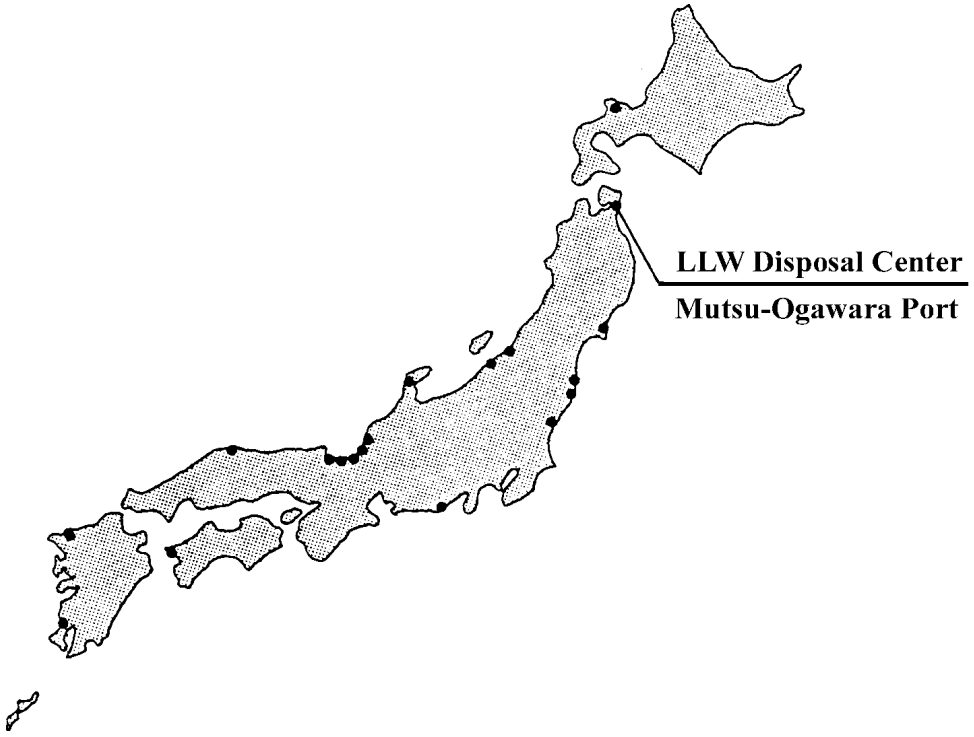
Japan has 52 nuclear power plants generating 45GW of electricity at 17 sites.

Nuclear energy supplies about 36% of Japan's electric power. LLW produced at these nuclear power plants is packed in 200 liter drums and temporarily stored on-site. At present about 400,000 drums of LLW are stored at domestic nuclear power plants. In December 1992, Japan Nuclear Fuel Limited (JNFL) started an LLW Burial Center as part of its nuclear fuel cycle facilities in Rokkasho-mura, Aomori Prefecture.

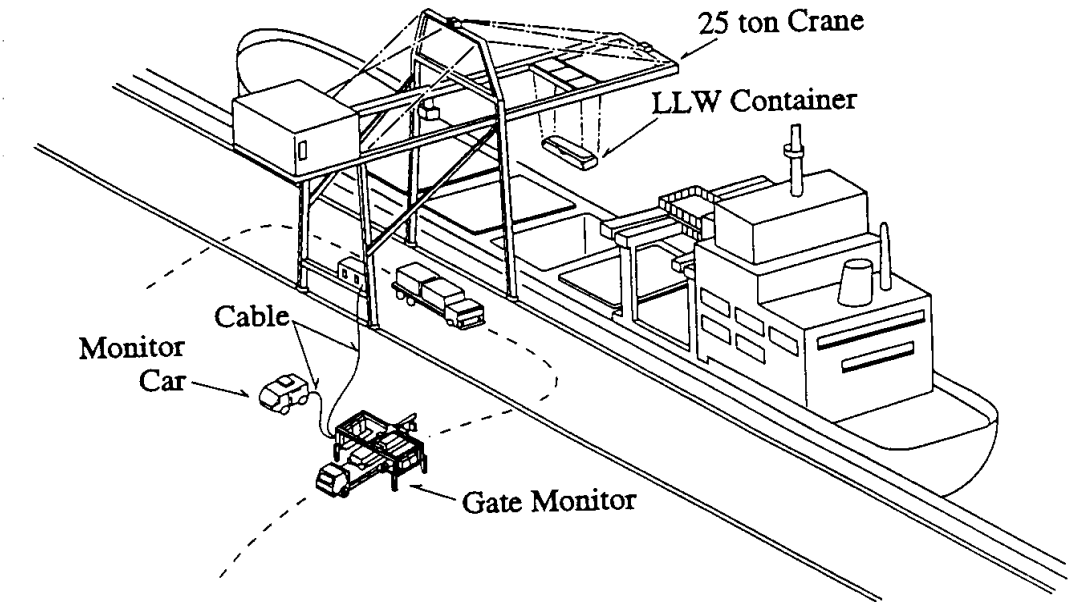
Approximately 28,000 LLW drums are annually generated from these plants and placed in containers of 8 drums each, and then loaded into a specially built ship for shipment to Mutsu-Ogawara Port. They are subsequently transferred overland to the an LLW Disposal Center, located 9km from the port. The annual shipment is approximately 2,500 containers corresponding to 20,000 drums. This takes 12 voyages, as the ship carries approximately 210 containers no average. As the ship usually stays 2 days at the port, unloading operations of LLW drums must be accomplished during this short period. In order to transport all the containers to the Disposal Center, 60 round trips of 2-container trucks are required per day. Radiation levels around the container are measured and confirmed before shipment at the nuclear power plants. Although the radiation level is not thought to increase during the voyage, measurements of the dose-equivalent rate are carried out on all of the containers in order to ensure the safety of land transport.

Nuclear Fuel Transport Co., Ltd. (NFT) is committed to reducing the radiation exposure of transport workers in accordance with the ALARA principle.

The Automatic Radiation Measurement System which we call "Gate Monitor" has been developed to meet the requirements at the port.



Sites of Nuclear Power Plants and LLW Disposal Center



Unloading of LLW Containers

PURPOSE OF SYSTEM DEVELOPMENT

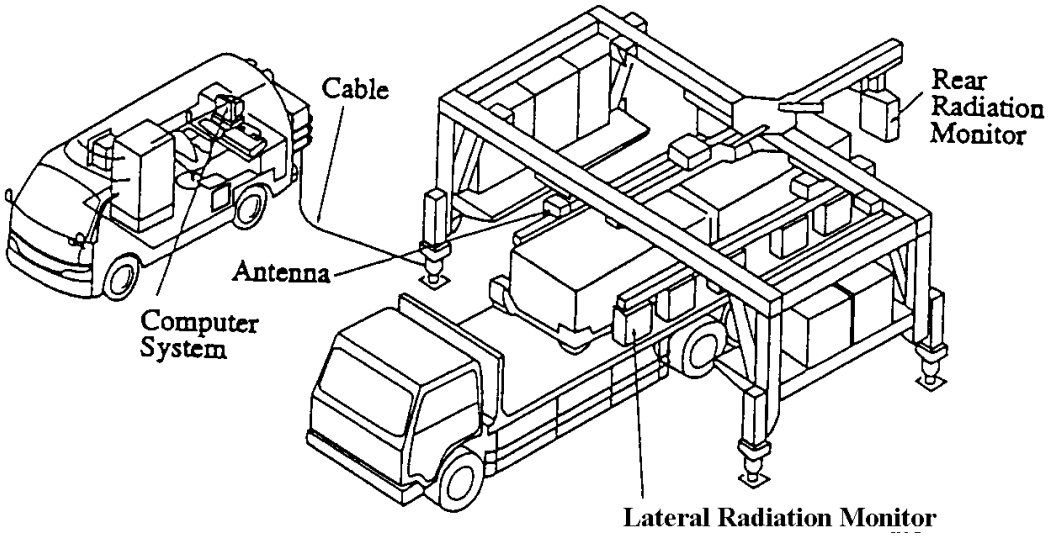
a) Reduction of personnel radiation exposure
About 60 vehicles need to be measured daily which makes the reduction of inspectors' exposure imperative. Using the Gate Monitor greatly reduces exposure compared to manual measuring methods.

b) The period of time allowed for radiation measurement is about 4 minutes per truck, and as many as 5 to 6 persons have to be engaged in such an operation.
With the use of the Gate Monitor this is reduced to 1-2 persons.

c) Enhancement of safety in cold weather
Radiation measurement is carried out at the quay, outdoors, and in cold and snowy conditions. Automated operation enhances the safety of the personnel.

d) Enhancing reliability of measurement
Data compiled mechanically and automatically maintains a consistent level of accuracy. This enhances the reliability of measurements for transport operations.

e) Ease of recording measurement data
The Gate Monitor and Monitor Vehicle are connected on-line, and by using a personal computer data can be stored and analyzed.



Gate Monitor

DESIGN REQUIREMENTS

(1) Operational conditions

a) Entry of LLW-loaded ship at the port	times per year
b) Period of port call	2 days per entry
c) Number of vehicles inspected	100 vehicles per day
d) Time spent for inspection	4 minutes per vehicle

(2) Environmental conditions

a) Temperature	
Outdoor maximum temperature	40℃
Outdoor minimum temperature	-20℃
b) Rainfall	
Maximum rainfall	50 mm/h
c) Snowfall	
Maximum snowfall	190cm
d) Wind velocity	
Maximum wind velocity during operation	16m/s
Maximum wind velocity during installation	30m/s

DESIGN AND CONSTRUCTION OF “GATE MONITOR”

Based on the above objectives and design requirements, an automatic radiation measurement system or “Gate Monitor” was designed and constructed with the following components:

(1) Radiation monitoring devices
Consisting of radiation monitors, and vehicle number and container number recording devices, the radiation devices are driven by a drive mechanism.

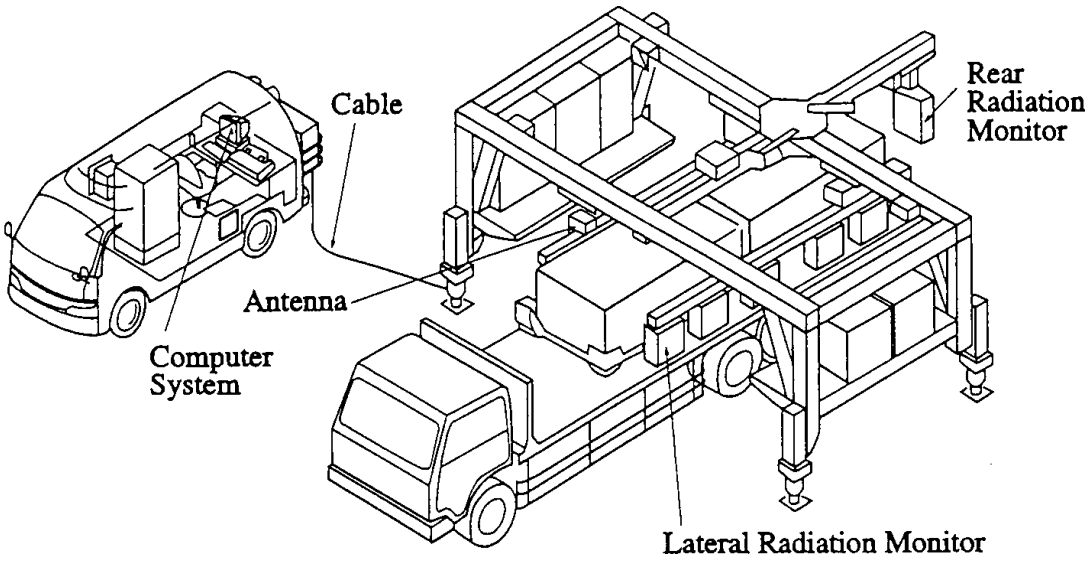
(2) Drive mechanism
The Drive mechanism moves the radiation monitoring devices to the surface of the vehicle and to a point 1m therefrom.

(3) Control device
The control device operates the drive mechanism and is controlled by a computer system via an interface. Start up of the control device is initiated by the control panel in the monitor car.

(4) Computer system
The computer system processes and records the vehicle number and dose-equivalent rates data given by the radiation monitoring device.

(5) Monitor car
An air conditioned monitor car carries the control device, computer system and emergency power source, and also accommodates the operator.

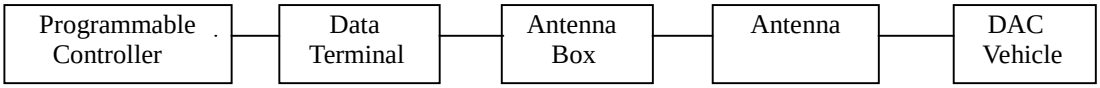
(6) Power supply
Power for the radiation monitoring devices, drive mechanism and monitor car is supplied via the 25-ton wharf crane.



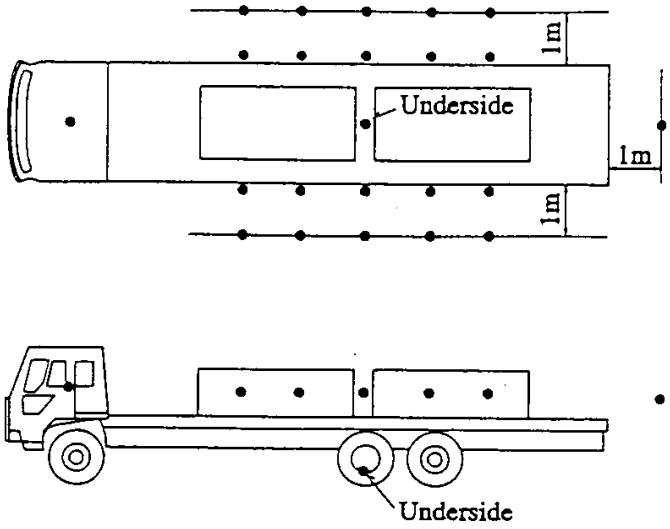
Gate Monitor

MEASUREMENTS

a) One data carrier (DAC) is attached to the vehicle which emits weak signal waves to the antenna of the Gate Monitor 25cm apart. It automatically records the vehicle number which is fundamental to vehicle management.
b) Recording of container number
By the same process as (1) the number of containers and the container number which is central to contents distribution are automatically recorded.
c) Measurement of dose-equivalent rate at the vehicle surface
The dose equivalent rate is automatically measured at 5 points on each side of the vehicle by a semiconductor type area monitor. Acceptance level is set at 20% below the regulatory value. The vehicle number and container number are also recorded.
d) The dose equivalent rate is measured at 1m from the vehicle surface at 5 points on each side and 1 point at the rear of the vehicle.
e) The dose equivalent rate is measured at 1 point on the underside of the vehicle.
f) The dose equivalent rate is measured at the driver's seat by a GM survey meter and data is recorded together with the vehicle and the container numbers.



Recording of Vehicle Number

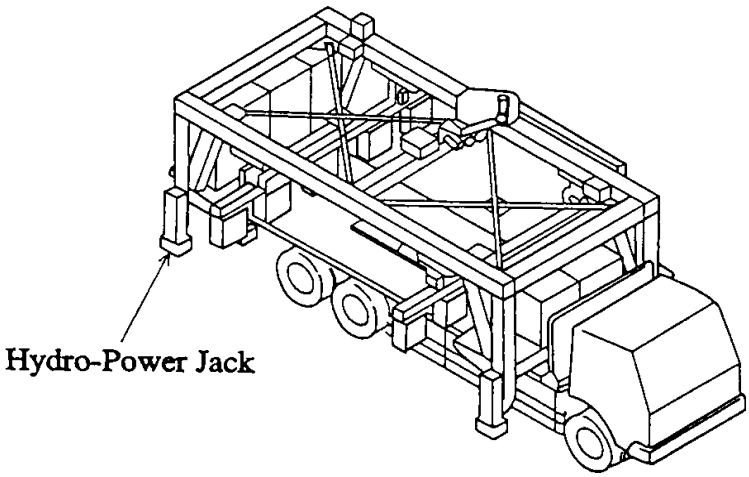


Radiation Measurement Points

FEATURES

a) Mobility

A hydraulic jack attached to the Gate Monitor raises the main unit and allows it to be installed on a transport vehicle. The Gate Monitor can therefore be moved to and installed in any place.



Moving of the Gate Monitor

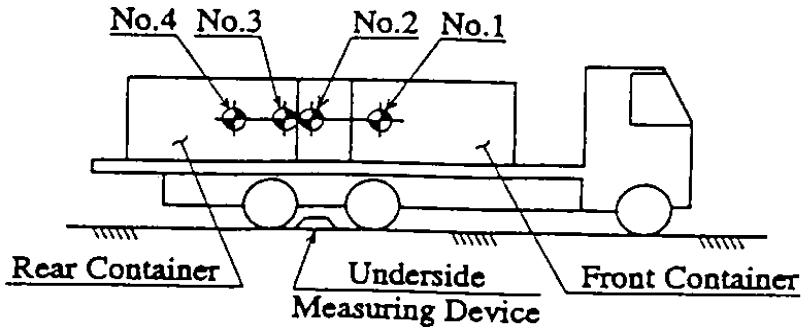
b) Vehicle positioning

Positioning of the vehicle is determined by the position of the two loaded transport packages. When there is only one transport package, it is placed on the rear of the vehicle, its position is detected and the driver is signaled to

stop by the following method:

Light Sensors No.1-4 on the Gate Monitor determine the correct vehicle position. Sensors 1-2 detect the presence of the transport packages. The vehicle's position conditions can be determined by Sensor No.2's ON or OFF status.

The accuracy of the vehicle positioning is determined by the distance of the light sensors 2 and 3, and is set at +/－10cm.



Method of Vehicle Positioning

c) Remote measurement of transport packages and radiation

A supersonic wave machine detects the package surface and conditions at a distance of 1 meter therefrom.

d) Control of transport package and transport vehicle ID numbers

Lithium-battery operated DACs attached to both the container and vehicle memorize the ASCII code number. When the command from the programmable controller to read out the number is received, the DAC transmits the number through the antenna.

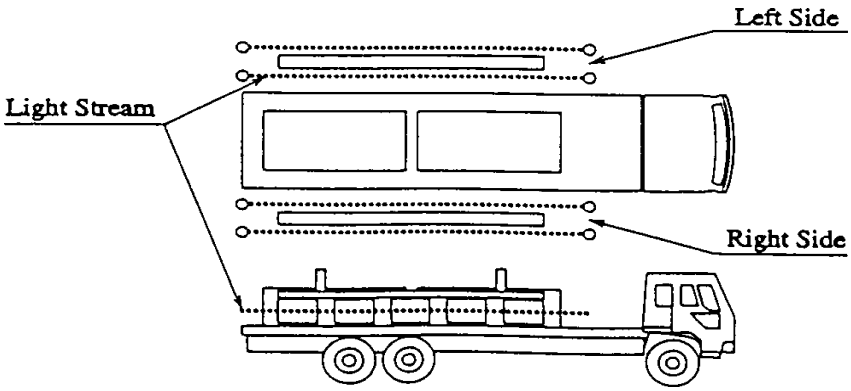
e) Safety measures for the side driving mechanism

With regard to the driving mechanism, measures are taken to prevent:

(i) personnel getting jammed between the vehicle and the radiation detector

(ii) the vehicle entering at an angle and hitting the measuring instruments

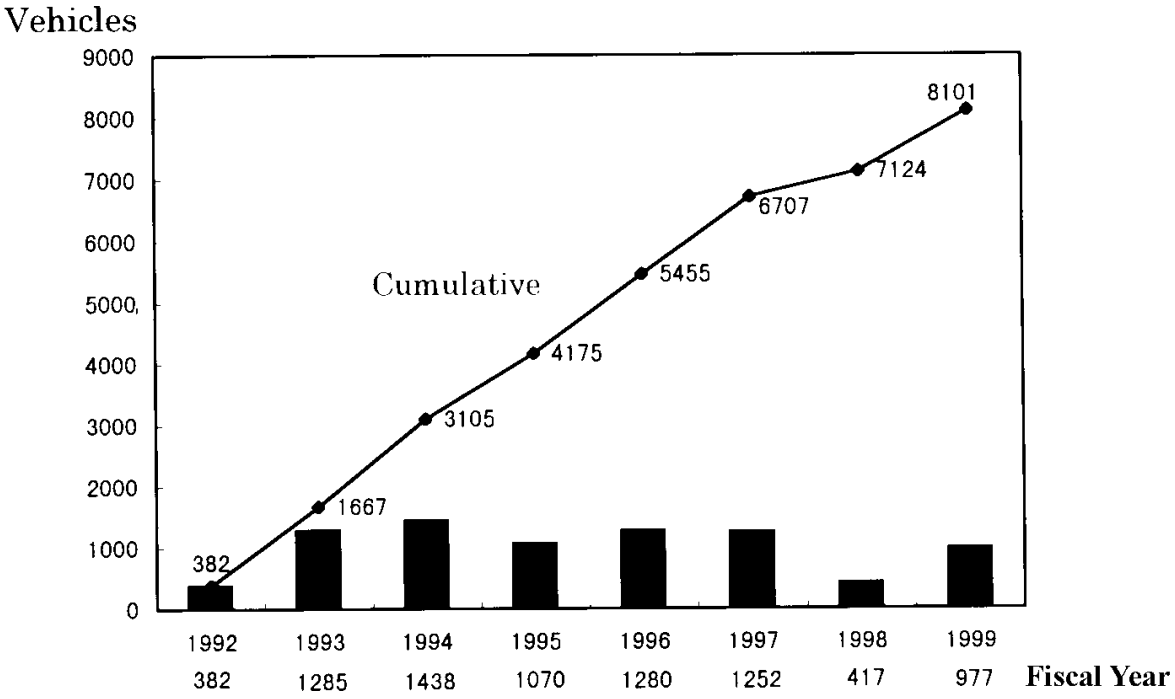
In the dotted area around the Gate Monitor infrared rays are emitted. If the rays are interrupted by a person or materials, operation of the Gate Monitor automatically stops. Even if the safety devices become inoperative, the operation automatically stops by means of a back-up overload detector (70kg).



Safety Devices

OPERATIONAL EXPERIENCE

Since December 1992 the Gate Monitor has been in use and 8,101 vehicles have been measured as of December 1999. There has been no significant failure in the operation of the Gate Monitor. There have been some cases of dead batteries in the DAC and incorrect alignment of the vehicle in the Gate Monitor.



Transport of LLW Vehicles

PROPOSED IMPROVEMENTS

(1) The Gate Monitor is made of steel and weighs approximately 8 tons. In the future it is proposed to make it lighter by replacing steel with aluminum and providing casters for ease of transfer. It may be possible to move it by a tractor in approximately 10 minutes.

(2) It is also proposed to implement automatic radiation measurement at the driver's seat. At present the measurement is carried out manually by the driver and then input to the computer operator by wireless equipment.

(3) Instead of cable transmission to relay data, all devices in the monitor car are proposed to be installed indoors to protect the instrument under severe weather conditions. All data will be transmitted by wireless equipment.

(4) The data carrier (DAC) is at present out of production although the manufacturer has guaranteed to supply it as needed for a few years.
Therefore, alternate articles are now being considered to replace it in the future.

ACHIEVEMENTS

The automatic radiation measurement system was first used in December 1992. By December 1999 it had measured asmany as many as 8,101 loaded vehicles on 162 days.
The maximum radiation exposure of workers recorded was only 10 μ Sv which was approximately 1/150 of what was expected for workers without the automatic radiation measurement system.

There has been no significant failure on the system, even though there was a 1.7% error-rate in

identifying the packaging numbers. Approximately 80% of the errors was caused by misalignment of vehicles under the Gate Monitor with the remainder due to dead batteries of number emitters.

CONCLUSION

An automatic radiation measurement system, or Gate Monitor, has been developed for application to LLW loaded vehicles in order to reduce radiation exposure and manpower of those involved in the measurement, to cut manpower, to enhance operational safety, and to improve measurement reliability and data recording.

The system consists of radiation survey meters, the driving equipment, a monitor car and so on. It has been used since December 1992 and has conducted radiation measurement of 8,101 vehicles as of December 1999. It has performed effectively even under severe climate conditions in winter without significant failure.

As a result, the main objectives of reducing radiation exposure and manpower have been achieved.

The experience gained so far many to be fully applied to the development of an automatic radiation measurement system for both spent fuel and high level waste loaded vehicles.