Oil Spill by Mizushima's Tank Damage

Dec. 18th, 1974, Kurashiki City, Okayama Prefecture

AKATSUKA, Hirotaka (Inst. for Safety of High-Pressure Gas Eng.)
KOBAYASHI, Hideo (Tokyo Institute of Technology)

(Summary)

The crack occurred in the weld in the dome roof tank at the oil refinery that faced the Inland Sea, and the fuel oil leaked on December 18, 1974. It failed in the transportation of the fuel oil, the dike destroyed by the fall of the vertical stairs in the tank, and the fuel oil that flows out had diffused to the Inland Sea through the drain ditch. Because the installation work of the oil fence in the sea had a rough going, the amount of the outflow of the fuel oil became an important reason that it reached about as much as 80,000 kiloliters, and 1/3 of the Inland Sea was polluted. It is a cause of the crack that the installation construction of the vertical stairs is done during the hydraulic test of the tank, and the basic ground has subsided locally because the consolidation of the foundation was insufficient, and an excessive stress acted on the main body of the tank. The petroleum kombinat etc. disaster prevention law was enacted with this accident and Fire Defense Law was amended.

1. Event

C fuel oil was accepted to the dome roof tank of 50,000 kiloliters in the tank yard of the Mitsubishi Oil Co Ltd Mizushima refinery. When the liquid level in the tank reached 17m height, patrolling operator discovered the oil leakage from the tank bottom and informed the control room (Refer to Figure 1, Figure 2, and Figure 3). The chief operator was directed to move oil in a tank concerned to the adjacent tank. A large amount of oil began to gush with the vibration sound when the operator opened the transportation valve. The chief operator directed the emergency halt of all devices seeing the gush situation of oil and informed a related organization such as fire stations and Japan Coast Guard. The foundation in the vicinity of the going up and down stairs (19.65m in height and vertical stairs) of the tank sank after a while. The vertical stairs fell because basic sand and macadam were swept away and the dike was destroyed (Refer to Figure 4). Therefore, the oil retaining wall is not done for, and the oil that flows out has diffused to the Inland Sea through the drain ditch. The installation work of the oil fence had a rough going for strong trouble and nighttime. The burst size of oil reached about as much as 80,000 kiloliters (What flowed backward from the adjacent tank was included), and 1/3 of the Inland Sea was polluted (Refer to Figure 5). When amends to the inshore fisherman, collection cost of spilled oil, and a long-term shutdown, etc. were included, about as much as 50 billion yen became huge amount of damage that reached though the loss of spilled oil was about 1.5 billion yen. The trial for a long term was fought over between four companies of the petroleum company, the engineering company, the tank construction company, and the basic construction company for this compensation. The petroleum kombinat etc. disaster prevention law was enacted with this accident and the restriction was strengthened in 1975. Moreover, Fire Defense Law was greatly amended in 1979, a technological standard concerning a base of the tank, a main body of the tank, a dike, and other outflow prevention measures was provided for in detail, and a regular overhaul inspection was obligated.

Only nine months have passed in the accident tank (52.3m in diameter, 23.67m in height, and 27mm thickness of 60 kg/cm^3 class high tensile strength steels in the lower) since use began. The occurrence part of destruction is a bottom of the tank where the vertical stairs were set up. The crack occurred at the fillet welded joint of the shell plate in the lower and the annular plate (12mm in thickness of 60 kg/cm^3 class high tensile strength steels). This crack has reached about 13m in the direction of the circumference at the fillet welded joint even by the annular plate (9mm in thickness of SS400 steel) and about 3m from the fillet welded joint toward the tank center. Moreover, the dome roof tank becomes the state of vacuum by a rapid outflow of oil and has been broken two exact halves through the sinking center.

Rain during the previous night remained until the morning, and water in the dike according to an inequitable subsidence of the ground on that day of the accident. The ground under the tank spreads macadam on the sand mat, and, in addition, fills on that with the mountain sand. The ground was adopted for the method of weighting water on the tank in pressure close. However, after the main body of the tank had been completed by making a mistake in the construction plan, the vertical stairs were set up alone. At this time, the nearest foundation of a tank was dug up for about 5m according to the tank outer and in the direction of the center by about 0.4m from the shell plate, and the base of the vertical stairs was placed, as the water level of hydraulic test is 12m height. The foundation was buried after construction ended and it was returned. However, it is presumed not to have been tightening enough and hardened due to the difficulty of work. Therefore, the amount of an inequitable subsidence in the vicinity of the vertical stairs was the largest with about 160mm. It is thought that the mountain sand of the foundation was carried away by the process that the concentrating rain water flows in the macadam layer, decreases with the include water strength, occurs in partial destruction of the support ground and the annular plate the crack, and arrived at the accident.

2. Course

A completed inspection was done on December 15, 1973, and it began to use the accident tank in March, 1974. The operator was patrolled west side and north side of accident tank for the check the mixers of Accident tank etc., December 18, 1974. In that time, abnormality was not admitted. At this time, the tank east side where oil leaked was not patrolled. At about 20:40, the patrol security member discovered to fall as oil spouted from the upper part of the accident tank of the vertical stairs near tank (It is the upper part from the bottom by about 5-6m) by about 30cm in width while passing on the tank east side. Oil had not collected in the dike at the time of this. As for oil, it blew about 1m in width higher than before, and more intensely, it went out, and considerable oil had collected in the dike when he reported on the leakage of oil and returned again.

At about 20:50, to change carrying oil from the desulfurization process unit to the accident tank to carrying adjacent tank the valve was operated. Next, at about 21:05, the valve was operated to carry adjacent tank from the accident tank by using the difference of the height of the oil side. Afterwards, a large amount of oil flowed out with a large sound. Therefore, the valve was not able to be closed, and about 6500 kiloliters flowed out through the accident tank among the oil having been accommodated by the adjacent tank, by about 23:15 when the valve was closed. The gross weight of the oil that flows out is about 43000 kiloliters.

After a while, the foundation in the vicinity of the vertical stairs sank, the vertical stairs fell, and the dike was destroyed. Therefore, oil besides the dike flowed out, and 7500-9500 liters in that flowed out to the sea.

The oil fence was set up around the Mizushima port entrance to prevent spreading of oil upon the sea. However, it flows out outside the Mizushima port on the evening of the 19th, and it has extended widely with the time passage.

3. Cause

・ Imperfect foundation work

It is presumed to be a cause of the crack that the installation construction of the vertical stairs is done during the hydraulic test of the tank, and the basic ground has subsided locally because the consolidation of the foundation was insufficient, and an excessive stress acted on the main body of the tank.

・ Installation of the vertical stairs after the tank completed

An enough examination was not done about the stress generated in the main body of the tank when the vertical stairs were set up after the tank was completed.

4. Immediate Action

To prevent the fuel oil from extending, the installation work of the oil fence was done. However, it has a rough going the installation work for the burst size of the fuel oil numerous and strong wind and the fuel oil has diffused widely.

5. Countermeasure

The petroleum kombinat etc. disaster prevention law was enacted with this accident in 1975, and the restriction was strengthened. Moreover, Fire Defense Law was greatly revised in 1979, and a technological standard concerning a base of the tank, a main body, an oil retaining wall, and other outflow prevention measures was provided for in detail. In addition, the inspection of regular open of the measurement of an inequitable subsidence etc. was obligated.

It was restricted to secure the distance between the Tank and the fire and the distance between Tanks because of security so far. The feature in the petroleum kombinat etc. disaster prevention law was to have specified the kombinat that accumulated a large amount of petroleum and the high-pressure gases for “The petroleum kombinat etc. special disaster prevention district” (It is 75 places in the whole country). In the refinery, it was divided into the manufacturing facility district, the storing facilities district, and the clerical work management facilities district, etc. The area and arrangement were restricted. The restriction by the area was provided as the width of the disaster prevention passage (specific passage) corresponding to the area of each facilities district was provided.

6. Knowledge

・ Generalization of the entire foundation work

In this accident, strength of the ground was not obtained and the tank was destroyed because the vertical stairs were set up after the base of the tank was maintained. In important construction of the foundation work etc., the judgment of the engineer in the standpoint where the whole is generalized is necessary. Those' who construct it each intimately contacting under the generalization each other, and scheduling it neatly are important.

・ Welding installation of the addition thing

The secondary stress by the restraint is generated in the weld if the addition thing is installed by the welding after the equipment is completed, a additional stress for the main part of equipment is generated, and it causes the failure accident. The welding installation of the addition thing should be recognized the re-doing of the design of the equipment. Moreover, it is necessary to strengthen the inspection thereafter for a certain period.

7. Information Source

(1) Mitsubishi Oil Co Ltd Mizushima refinery tank accident cause investigation report (December 8, 1975) and Mitsubishi Oil Co Ltd Mizushima refinery tank accident cause investigation committee

(2) Outline of Mitsubishi Oil Co Ltd Outflow Accident (March, 1975), Okayama Prefecture

8. Primary Scenario

01. Organizational Problems
02. Inflexible Management Structure
03. Lack of Communication
04. Lack of Management
05. Poor Value Perception
06. Poor Safety Awareness
07. Lack of Risk Awareness
08. Insufficient Analysis or Research
09. Insufficient Practice
10. Lack of Imagination
11. Planning and Design
12. Poor Planning
13. Welding
14. Failure
15. Fracture/Damage
16. Crack

17. Failure
18. Large-Scale Damage
19. Leakage

20. Secondary Damage
21. Damage to Environment
22. Sea Pollution

23. Loss to Organization
24. Economic Loss

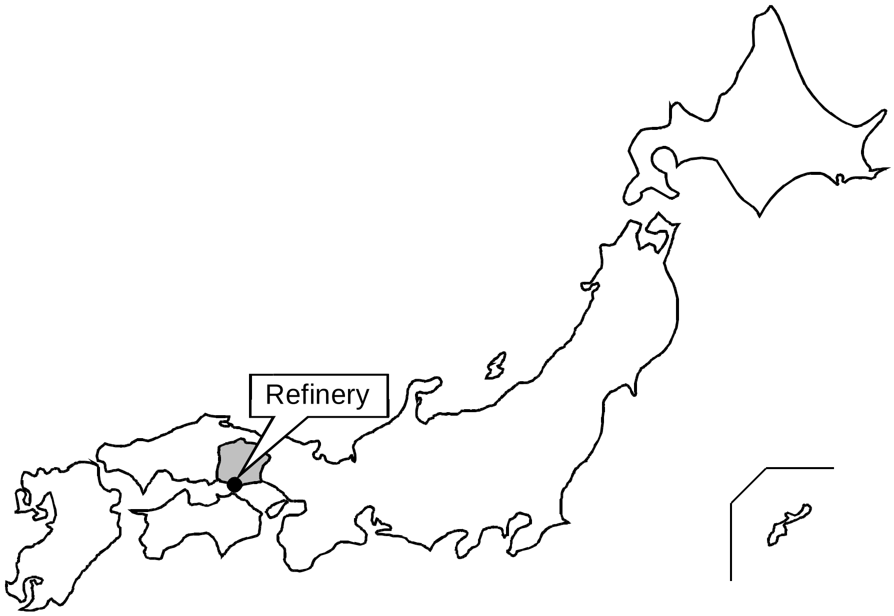


Fig. 1   Location of the Refinery.

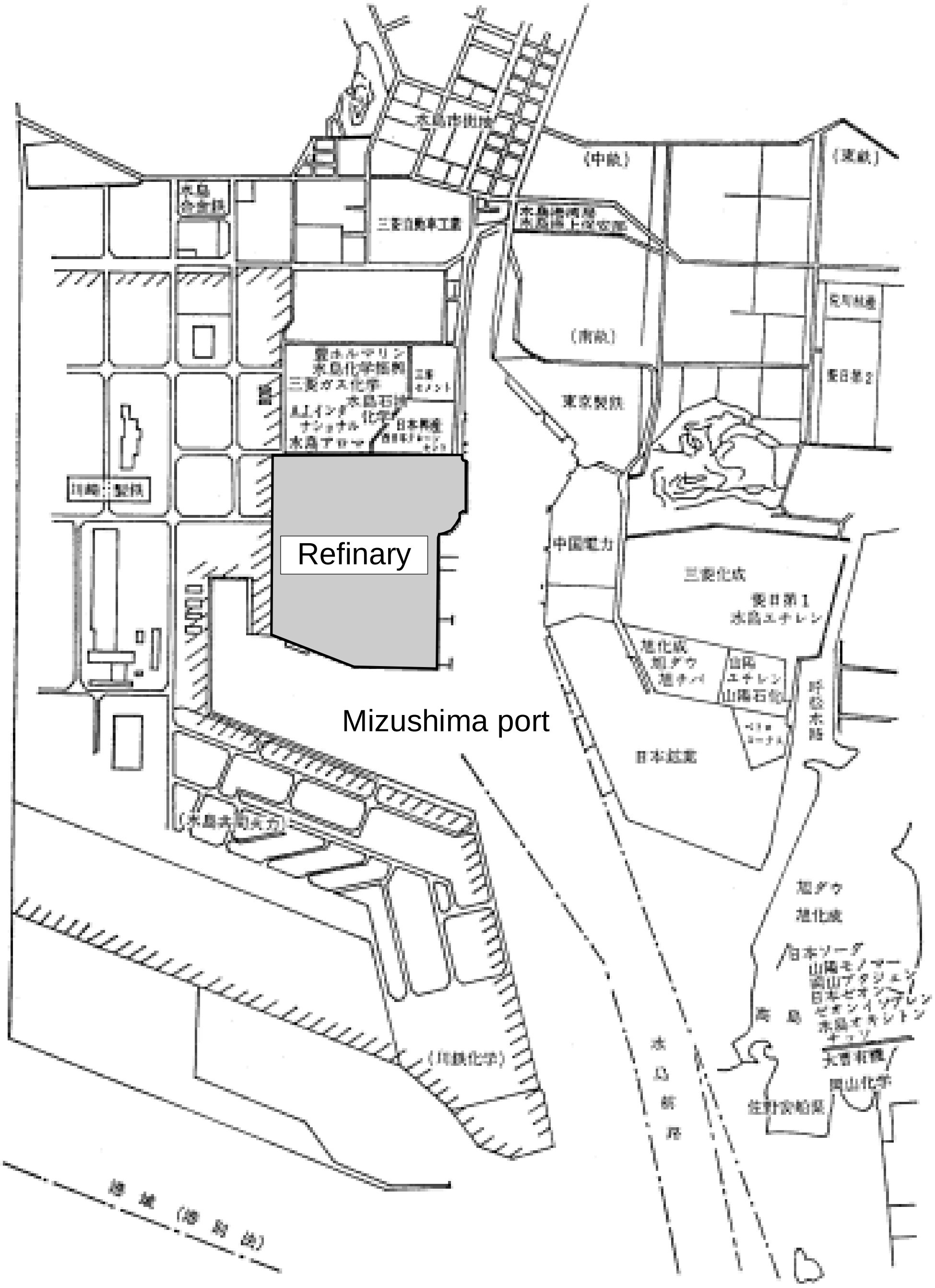


Fig. 2 Outline of the refinery.

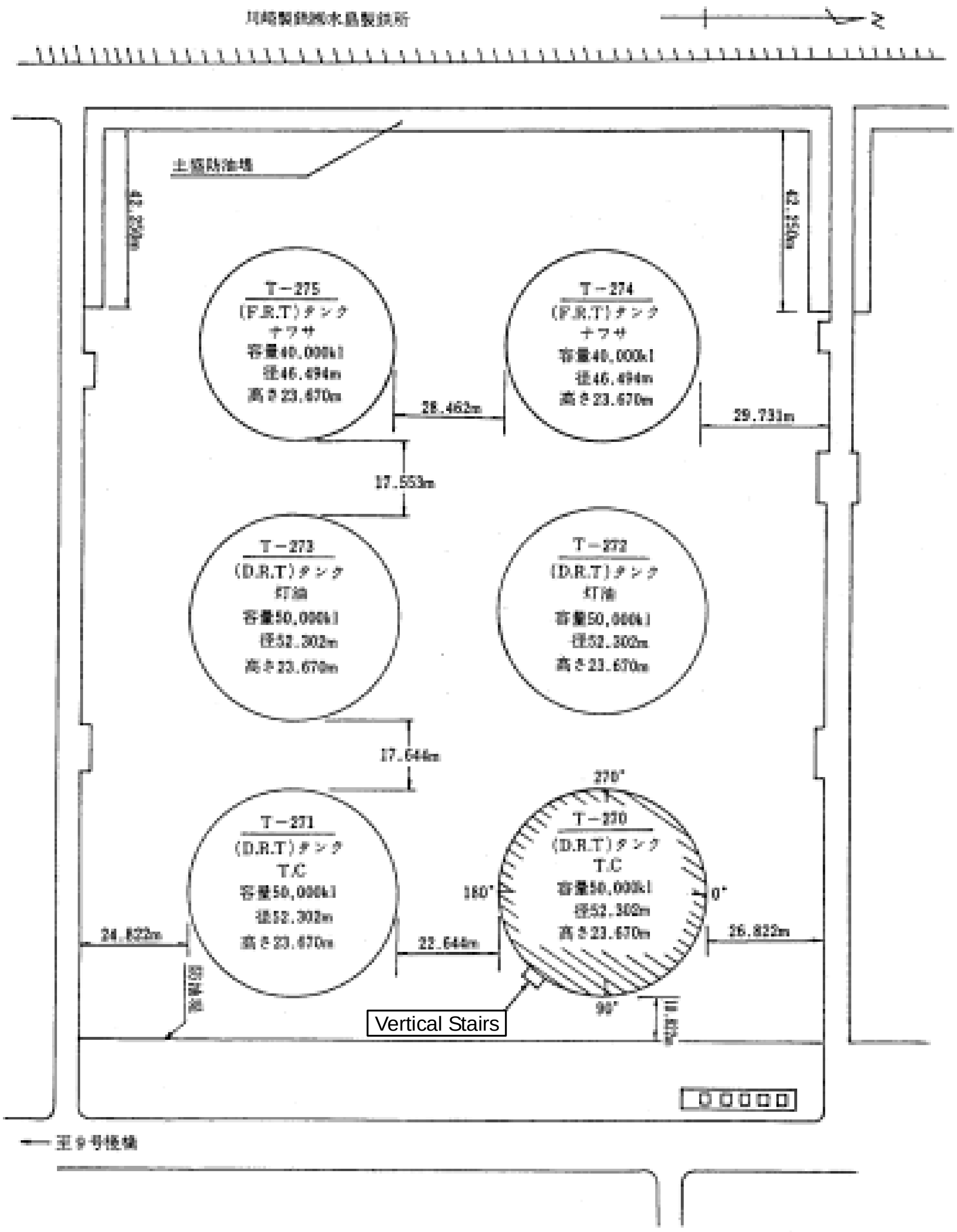
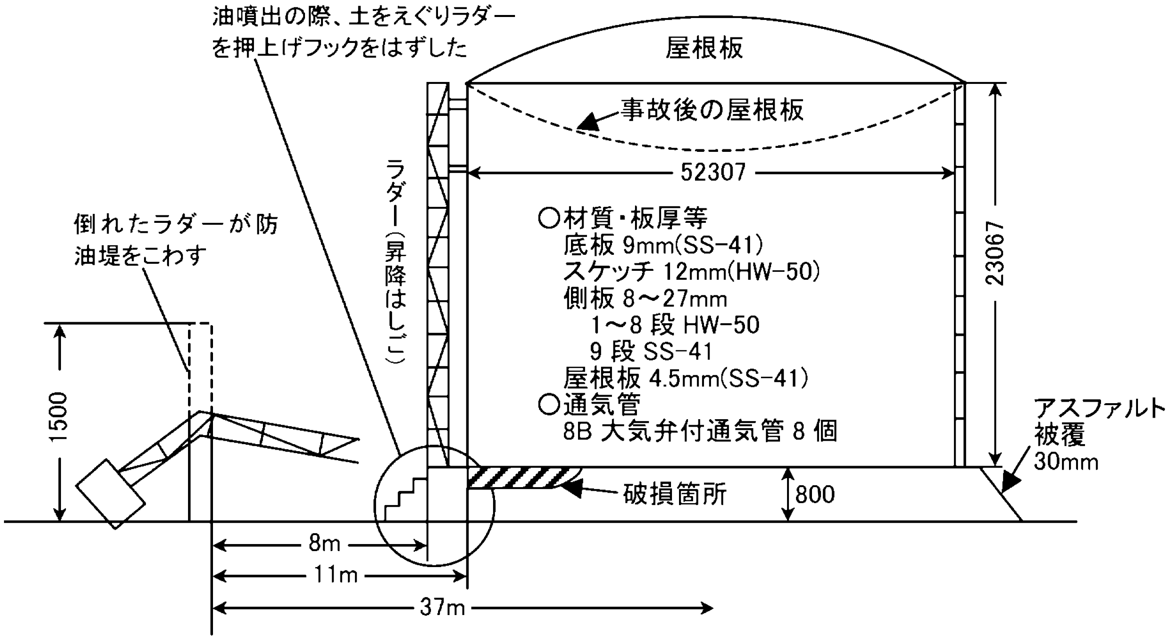
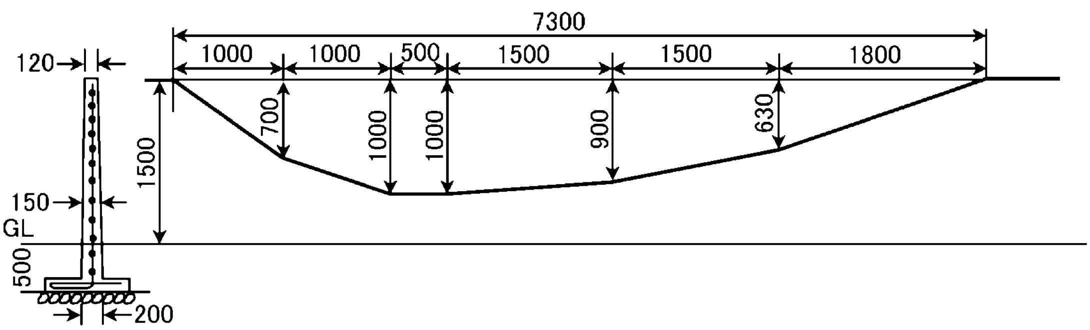


Fig. 3 Location of T-270.



(a) Outline of Damaged Tank



(b) Dike damage situation

Fig.4 Outline of damage of accident facilities.

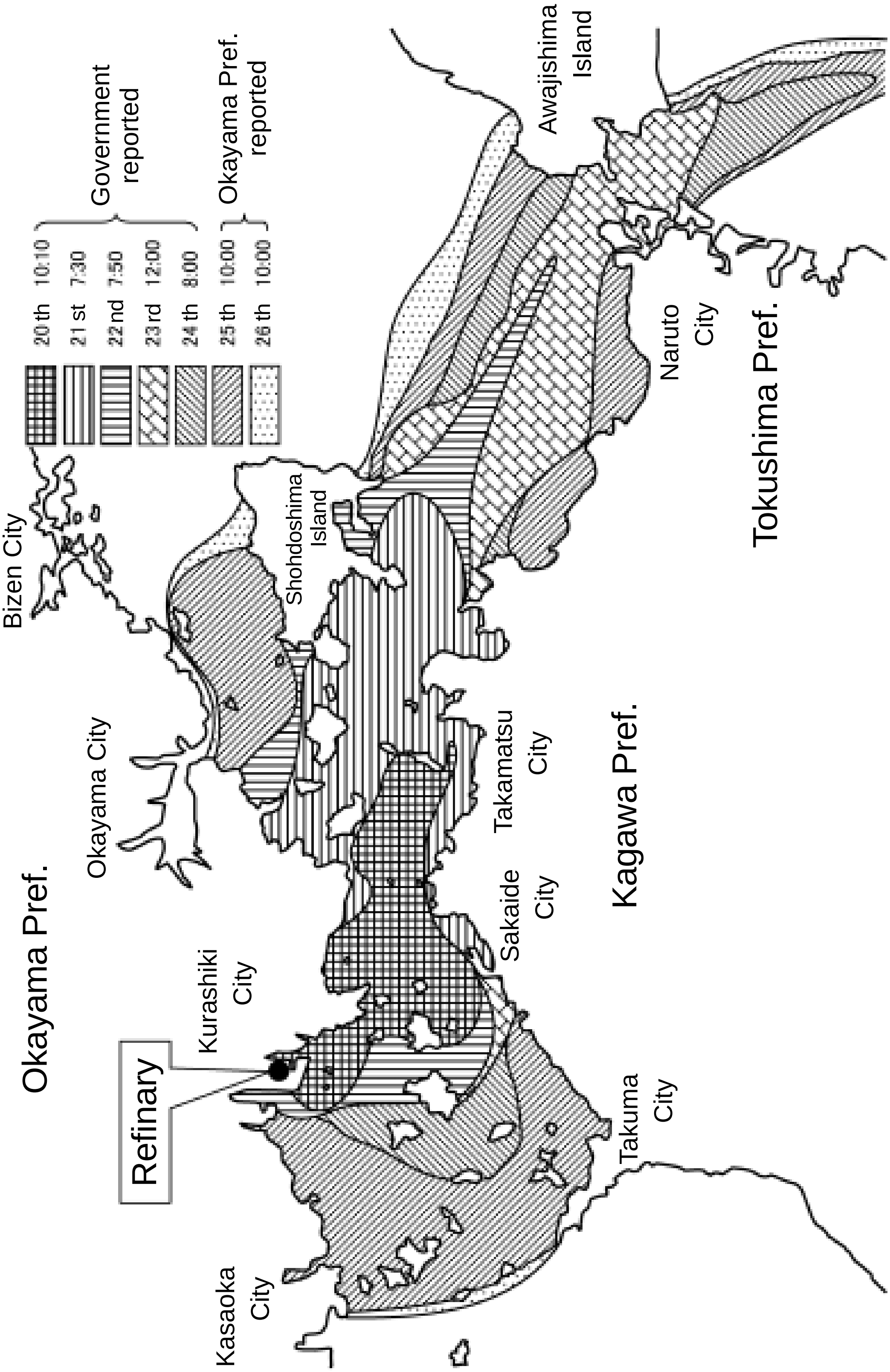


Fig. 5 Diffusion situation of spilled oil (20th - 26th in December).