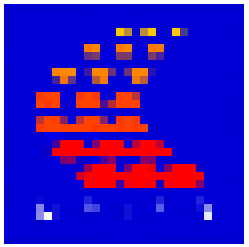
Large oil tank fires in Japan and our mutual fire fighting system in oil tank complexes

National Research Institute of Fire
and Disaster, Japan

Hiroshi Koseki



Contents

- Introduction
- Large oil tank fire, in Tomakomai, Hokkaido, Japan
- Post-Earthquake oil tank fires
- Change of Japanese Regulation
- Construction of Mutual Fire fighting systems
- Foam for oil tank fires
- Important of trainings
- Conclusion

Intruduction

- Oil tank fires is very difficult to extinguish. Sometime it continues for more than two weeks. In Japan we have experienced many earthquakes, and it damages oil tank and sometimesmakes fires.
- When we have earthquake, our fire-fighting ability reduces. So it is important to have mutual help system.
- It is also important to do training and research to keep our ability. And in trainings, to ignite large oil tank costs very much, so to do collaborate trainings is important.

Large oil tank fire, in Tomakomai, Japan

- In Japan, we have many earthquakes. And after the large earthquake in Tomakomai, Hokkaido, Japan, in September 2003 (2003 Tokachi-oki earthquake, Magnitude; 8.0, Seismic intensity in Tomakomai; 5), we experienced two large oil tank fires in a refinery, Tomakomai, Hokkaido.
- First one was a fire in crude oil tank, which was ignited due to the fuel sloshing just after the earthquake and continued for seven hours. It was a ground and roof rim fire.

First fire in Crude oil tank

Large oil tank fire, in Tomakomai, Japan

- The second one started two days after the earthquake. The cause was that sinking of the floating roof and operation error of covering oil surface by foam induced ignition.
- Second fire continued for 44 hours. Light naphtha was stored in this tank, which size was; Diameter was 42.7m, Height was 24.4m, and floating roof type (Tank size and type of first one was the same).
- According to our research after these fires, light naphtha has the low boiling point, low flash point, high burning rate and strong radiation, so we understand it is difficult to extinguish.

Large oil tank fire, in Tomakomai, Japan

The Naphtha tank burns for 44hours. Many fire fighting units gathered to Tomakomai area, and joined fire fightings. Large problem was lack of foam, so asked the USA military to give foam, and also imported from out-side country.

Oil tank fires and accidents after earthquakes

Year	Place	Earthquake (Magnitude)	Summary of oil tank fire
1923.9	Navy base, Yokosuka, Japan	Kanto Large Earthquake(7.9)	Fuel oil leaked from tanks, and spreaded on sea, burns continued for about two weeks.
1964.3	Valdez oil terminal, Alaska, USA	Great Alaska Earthquake(8.3)	Tanks damaged by earthquake, and fires continued for two weeks.
1964.6	Nigata, Japan	Nigata earthquake (7.5)	Dozens of tanks were ignited, continued for two weeks. Boilover occurred.
1978.6	Sendai, Japan	Miyagi-oki earthquake(7.4)	Fuel oil tank damaged and leaked.
1983.5	Akita, Japan	Middle-Japan sea (Hanja, East sea) Earthquake(7.7)	Crude oil tank ignited. A rim fire occurred.
1999.8	Izmit refinary, Turkey	Izmit earthquake (7.8)	Naphtha tank ignited and burned for 3days.
2003.9	Tomakomai, Japan	Tokachi-oki earthquake(8.0)	Crude oil tank ignited, fire continued 7hours. And naphtha tank burns for 44hours.

Naphtha is rank 1 materials of class 4 (Flammable liquid) in Japanese regulations for hazardous materials, same as gasoline and crude oil. But its burning characteristics are different with gasoline.

	naphtha	gasoline	Arabian crude oil
flash point, C	-40	<-40	<0
burning rate, mm/min	10.3, 14.5	5.5	4.8
radiation*, kW/m^2	5～8	-	3～5

4.5 m pan fire test (Feb. 2004)

Revise of the Law for Prevention of Disasters at Petrochemical Complexes

- Japan is divided to twelve areas, and each area has to have unit for fire-fighting system which includes large fire fighting gun by the end of 2008. Most areas have two units, so totally 24 units exists in Japan.
- Specifications of large gun;

  10000～50000 kL/min, depends on oil tank size

- Members of the unit have to do proper trainings.

Oil tank in Japan

- Number of oil tank

  Volume >100,000 kL; 437

  50,000 to 100,000 kL; 451

  Diameter >60m; 891

Oil complex area of Japan is divided into 12 areas.

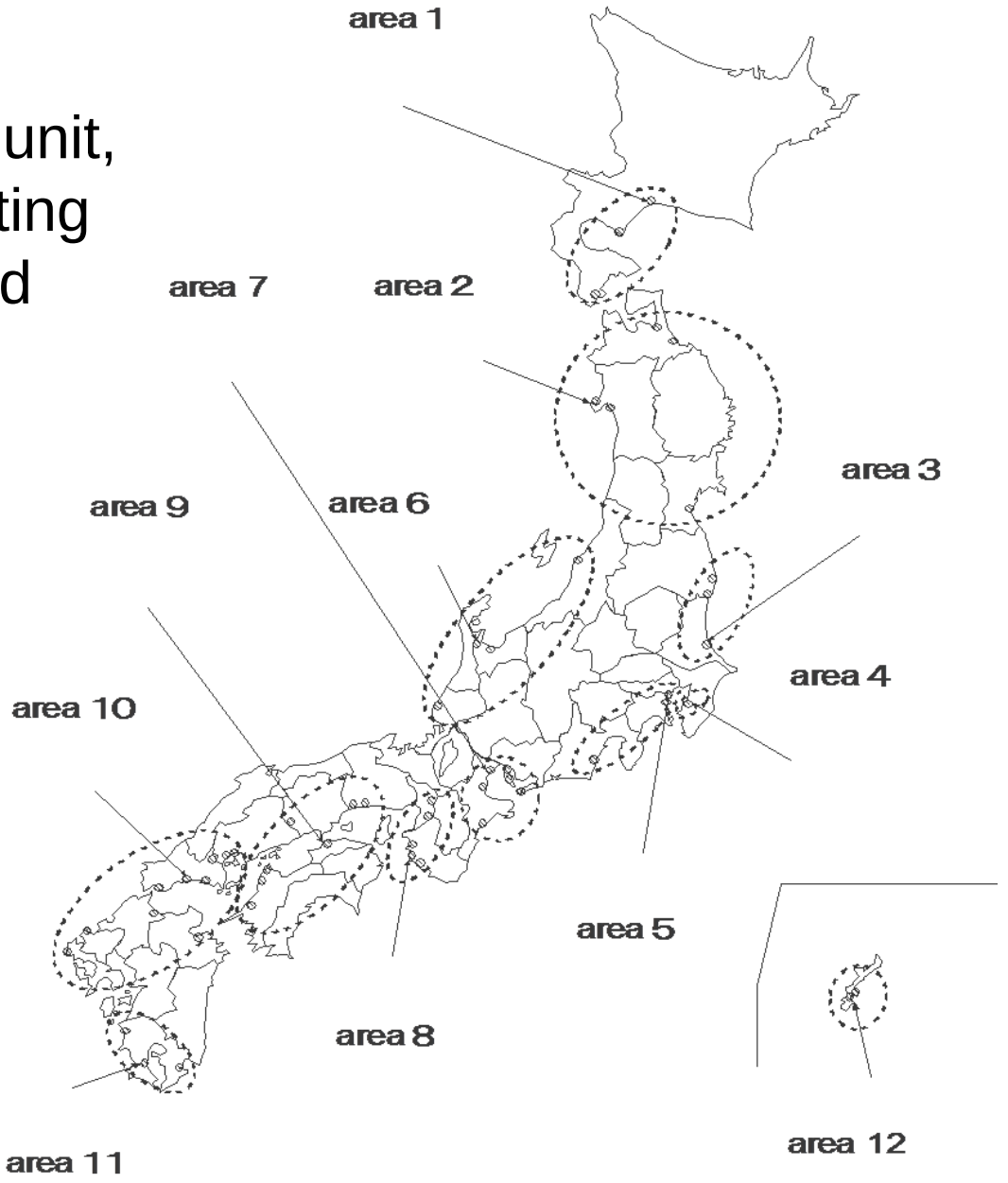
And, 22 fire-fighting guns in Japan set in 12 areas,

892 kL AFFF foam existed.

Oil complexes of Japan are divided into 12 areas.

Each area has a fire-fighting unit, which includes large fire-fighting gun system, proper foam, and operating people.

Large fire-fighting gun system (MOL Hungary)



Area 1 includes Tomakomai area

Refinery

National oil storage base, totally about 9,800,000 kL crude oil stored in about 90 oil tanks. Each tank has about 120000 kL oil, and its diameter is about 82 m.

Trainings of large fire-fighting gun (cannon), Hokkaido, Japan

Trainings is so important in prevention of oil tank fires.

Training using a large fire fighting gun, in Japan (Nov. 2003).

Foam for large gun

Which foam is best for large gun ?

- FP (Fluoro Protein Foam) and AR-AFFF (Alcohol Resistant Foam) are better for large fire-fighting gun because it is strong against contamination with oil, and good spread on the oil surface.

(our tentative results)

Foam tests conducted at NRIFD

Tomakomai large tank fire tests

We had two large fire tests in Tomakomai, Japan.

Boilover test D=5m, Arabian Crude oil (Feb. 1999)

20m tank fire （Jan. 1998）

According to our experiences and study, we understand that;

- In most tank fires, causes of the fires relates with human error. And many fires have very similar causes. In regard to second Tomakomai fire, we found fires with similar cause and process which were occurred in USA and other places. So we can reduce fires through study of the past causes of fires.
- It is very important to arrange man power and equipments efficiently for conducting fire fighting. To extinguish large oil tank fires, we need huge amount of proper foam. Therefore it is necessary to build nation-wide or world-wide control/ rescue system.

- Trainings of fire fighting people are also very important.

- Especially to experience real scale oil burning is so useful for firemen to understand oil tank fires, because occurrence of such large oil tank fires are very rare and most firemen have not experienced.

Conclusions

- To conduct such training and experiment costs very much, so it is necessary to conduct national or international collaboration.

- Thank you for listening. If you have any question, please contact me;

koseki@fri.go.jp