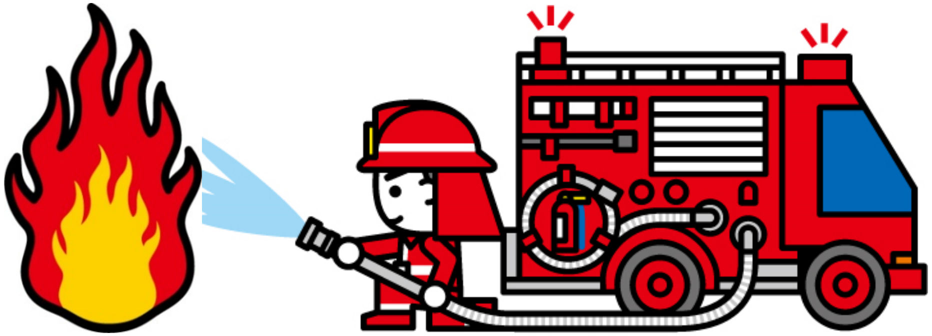
Disaster Prevention Measures at Petrochemical Complexes in Japan

December 7, 2017



Extraordinary Disaster
Management Office

What Are Petrochemical Complexes?

"Petrochemical complexes" → group of facilities handling large quantities of petroleum and high pressure gas

(Ex.) ○ Facilities of petroleum refining business and petrochemical industry, etc.

○ Storage terminal of petroleum and high pressure gas

*The Act on Disaster Prevention in Petroleum Industrial Complexes and Other Petroleum Facilities covers overall facilities handling petroleum and high pressure gas, and steel plants, etc. are also subject to the Act if requirements are met.

(Petroleum storage terminal)

(High pressure gas storage terminal)

(Steel plant)

*High pressure gas is generally handled in large quantities.

Special disaster protection areas such as petrochemical complexes and other petrochemical facilities and Specific Place of Business

Define special disaster protection areas and specific place of business under the Act to establish necessary disaster risk reduction systems

○ Special disaster protection areas such as petrochemical complexes and other petrochemical facilities (Art. 2 of the Act)

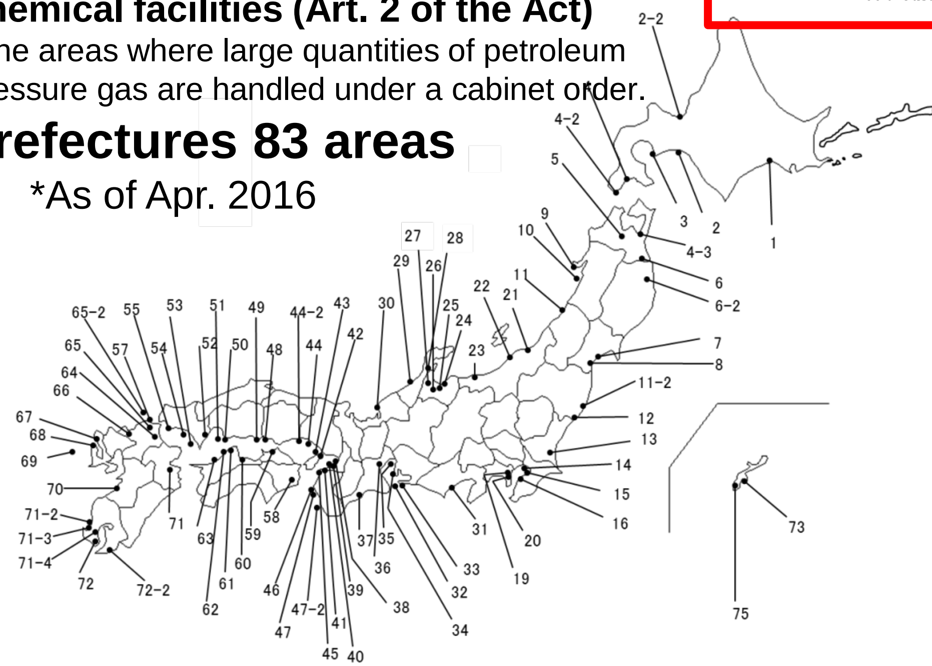
Designate the areas where large quantities of petroleum and high pressure gas are handled under a cabinet order.

32 prefectures 83 areas

*As of Apr. 2016

(Major idea of area) *100 thousand kL of petroleum or 20 million m^3 of high pressure gas

$$\frac{\text{Total petroleum storage and handling quantities}}{\text{100 thousand kL}} + \frac{\text{Total processing quantities of high pressure gas}}{\text{20 million Nm}^3} \geq 1$$



No.	Special disaster protection areas	No.	Special disaster protection areas	No.	Special disaster protection areas	No.	Special disaster protection areas	No.	Special disaster protection areas
1	Kushiro	14	North Keiyo coast	34	Kinuura	50	Etajima	68	Ainoura
2	Tomakomai	15	Central Keiyo coast	35	Port of Nagoya coast	51	Nomi	69	Kamigoto
2-2	Ishikari	16	South Keiyo coast	36	Yokkaichi coast	52	Iwakuni/ Otake	70	Yatsushiro
3	Muroran	19	Keihin coast	37	Owase	53	Kudamatsu	71	Oita
4	Hokuto	20	Negishi coast (Negishi Waterfront)	38	Osaka North Port	54	Shunan	71-2	Sendai
4-2	Shiriuchi	21	Port Niigata (East)	39	Sakai Senboku coast	55	Ube/Onoda	71-3	Kushikino
4-3	Mutsu-Ogawara	22	Port Niigata (West)	40	Kansai International Airport	57	Mutsurejima	71-4	Kagoshima
5	Aomori	23	Naoetsu	41	Misaki	58	Anan	72	Kiire
6	Hachinohe	24	Toyama	42	Kobe	59	Bannosu	72-2	Shibushi
6-2	Kuji	25	Fuchu	43	Higashiharima	60	Niihama	73	Henza
7	Shiogama	26	Shinminato	44	Himeji coast	61	Namikata	75	Onaha
8	Sendai	27	Fushiki	44-2	Ako	62	Kikuma		
9	Oga	28	Port of Nanao, Mimuro	45	Northern coast in north Wakayama	63	Matsuyama		
10	Akita	29	Kanazawa Port north	46	Central coast in north Wakayama	64	Buzen		
11	Sakata	30	Fukui coast	47	Southern coast in north Wakayama	65	Kitakyushu		
11-2	Hirono	31	Shimizu	47-2	Gobo	65-2	Shirashima		
12	Iwaki	32	Atsumi	48	Mizushima coast	66	Fukuoka		
13	Kashima coast	33	Tahara	49	Fukuyama/ Kasaoka	67	Fukushima		

○ Specific place of business (Art. 2 of the Act)

$$\frac{\text{Ptroleum storage and handling quantities}}{\text{10 thousand kL}} + \frac{\text{Processing quantities of high pressure gas}}{\text{2 million Nm}^3} \geq 1$$

Class 1 place of business (363 places)
A place of business handling large quantities of petroleum or high pressure gas

Layout place of business (174 places)
Of Class 1 place of business, a place of business handling petroleum and high pressure gas

Class 2 place of business (323 places)
A place of business handling petroleum or high pressure over a certain quantity

$$\frac{\text{Petroleum storage and handling quantities}}{\text{1,000 kL}} + \frac{\text{Processing quantities of high pressure gas}}{\text{200 thousand Nm}^3} + \cdots \geq 1$$

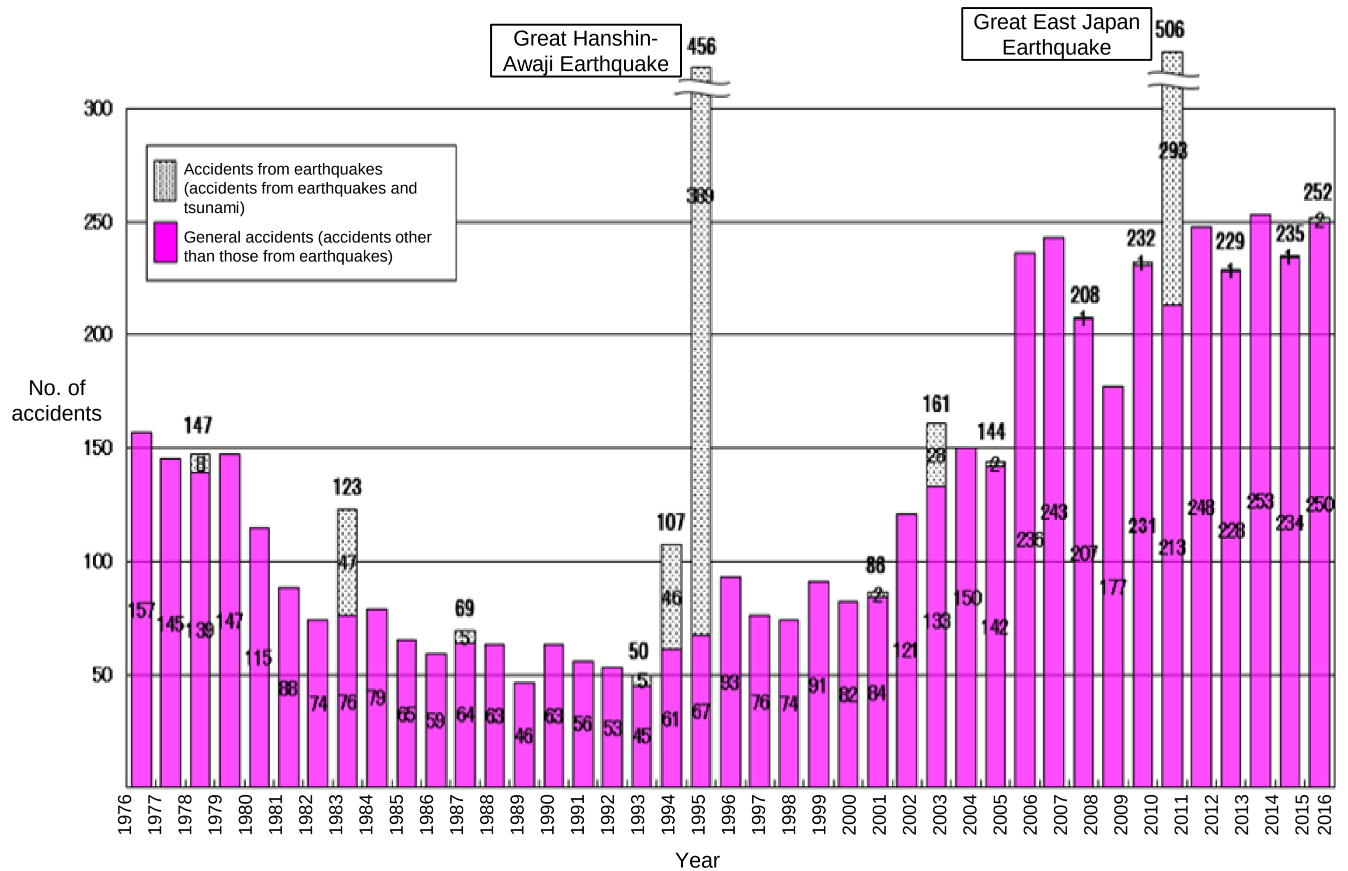
*The number of places of business is the number as of Apr. 1, 2016.

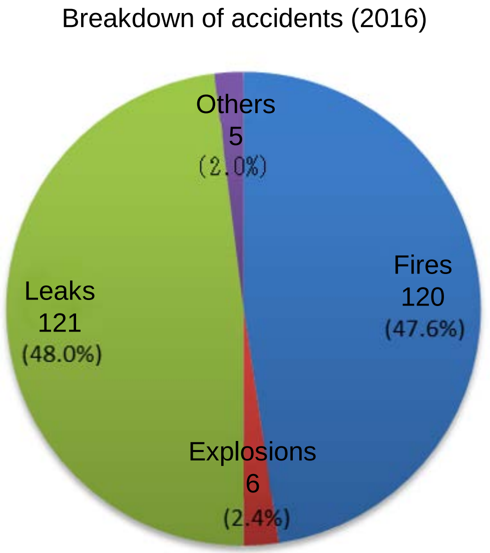
Status of Accidents at Petrochemical Complexes (No. of Accidents and Breakdown)

- The number of accidents has been increasing from 1994 and recently has remained at a high level of 200 accidents or more per year.

⇒ (1) Human factors such as inadequate maintenance and management (2) Causes accompanying physical factors, such as corrosion and other types of deterioration

- Half of all accidents are leaks and the other half are fires and explosions, etc.





Great Hanshin Earthquake (Earthquake in Southern Hyogo)

Happened: 5:46 A.M., January 17, 1995
Main affected Areas: Kobe City and Awaji Island in Hyogo
Scale of the Earthquake: Magnitude 7.3, Biggest intensity of the Earthquake: 7 on the Japanese scale
Damage: Number dead and missing people: 6,435
Number of completely destroyed buildings: 104,906
Number of burned buildings: 7,483

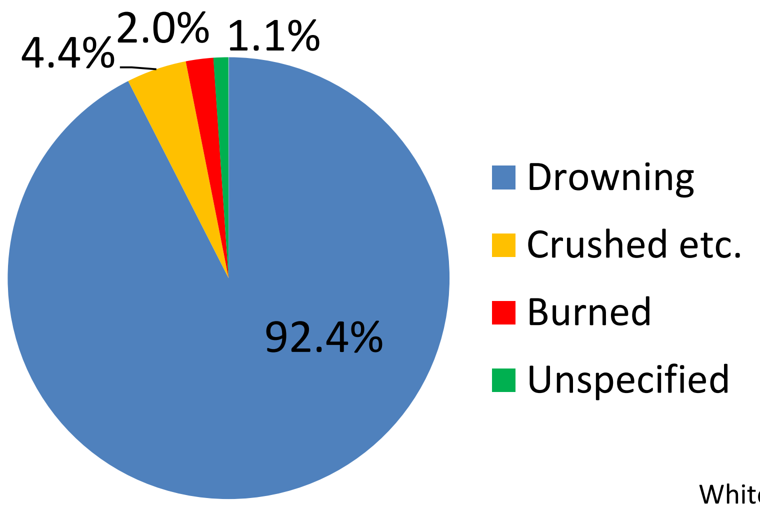
Bus that stopped on the verge of cropper on the destroyed expressway

Kobe on fire

Collapsed building because of the earthquake

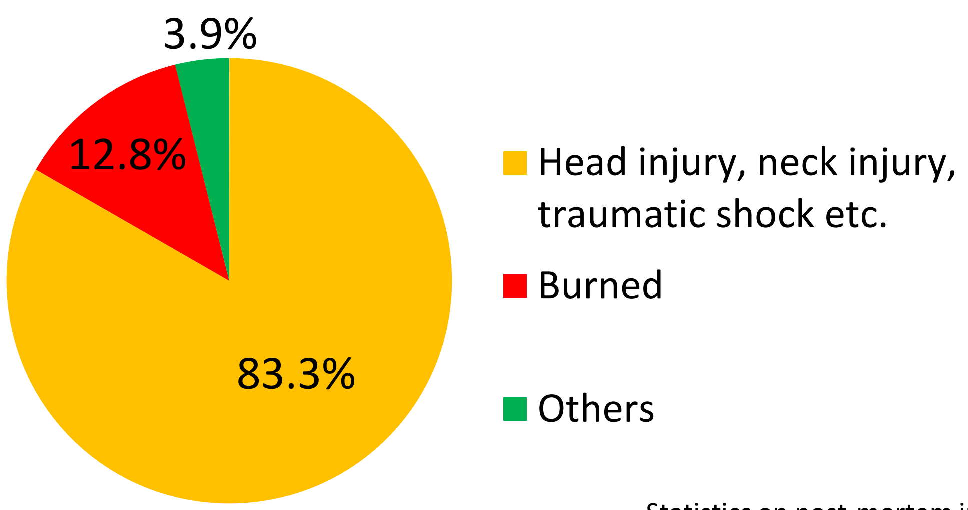
Comparison of death cause between 2011 East Japan Great Earthquake and 1995 Great Hanshin-Awaji Earthquake

2011 Great East Japan Earthquake



White Paper on Disaster Management 2011

1995 Great Hanshin-Awaji Earthquake (Kobe)



Statistics on post-mortem inspection in Kobe 1995

Damage on Tanks due to Great Hanshin-Awaji Earthquake in 1995

The earthquake created liquefaction, making the tanks lean, breaking the pipes, getting the oil leaked

Tokachi off shore Earthquake, September 2003

A petroleum tank fire started at the Hokkaido refinery of Idemitsu Kosan after the occurrence of the Tokachi offshore earthquake on September 26 2003. The fire triggered a big social anxiety in addition to extremely difficult fire-fighting activities

Fire of oil tank in Hokkaido in 2003

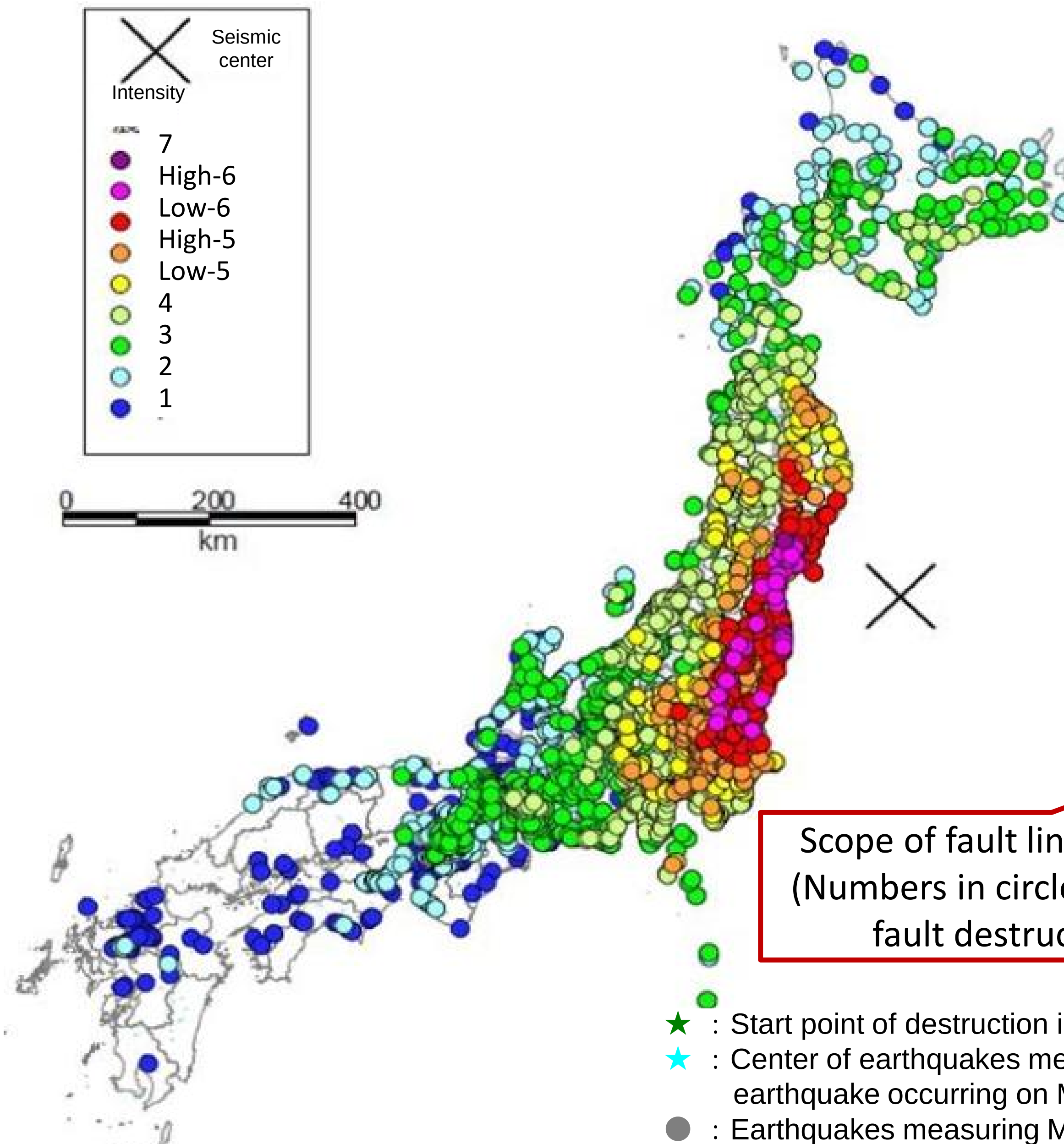
Great East Japan Earthquake, March 2011

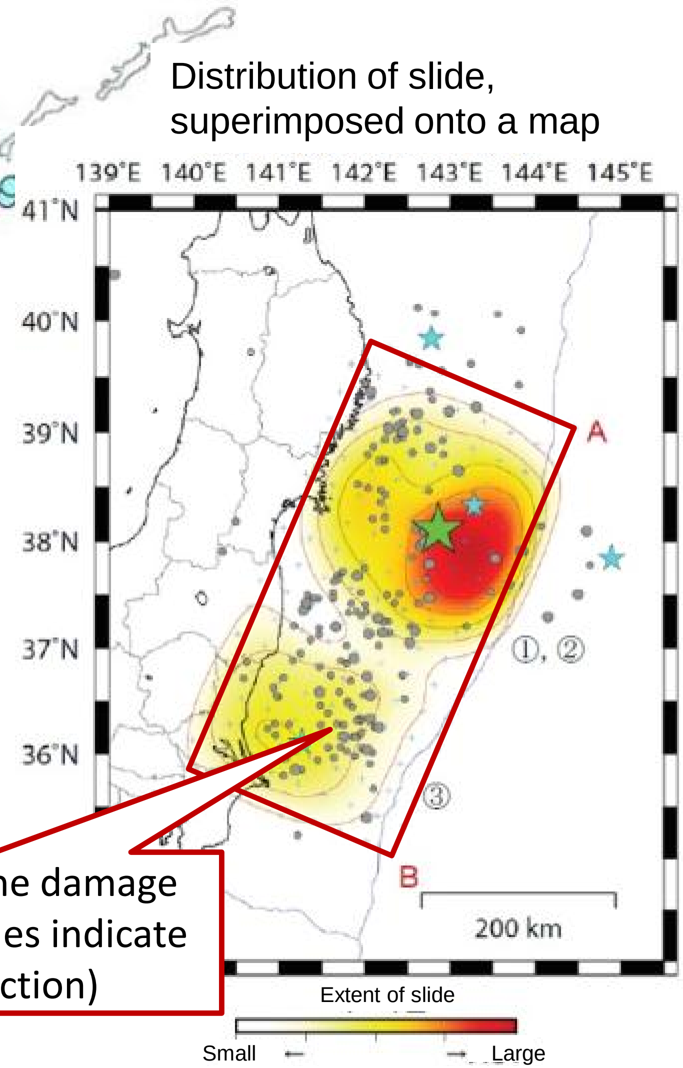
A massive earthquake of magnitude of 9.0 occurred on Friday 11th March, off the Pacific coast of the northeastern part of the Japanese mainland (Tohoku Region).

Date and Time	11 March, 2011, 14:46
Magnitude	9.0
Epicenter	N38.1, E142.9, Depth 24km

- The largest earthquake recorded in Japan
- 6 minute long tremor observed
- Destruction by Tsunami. The maximum height of the water level was recorded as 9.3m and the run-up height was 39.7m, the highest ever recorded in Japan. Total inundation area: 535km^2
- Tsunami caused fires
- Damage by liquefaction
- Maximum number of evacuees: 450,000 (14th March, 2011)
- Subsequent Fukushima Daiichi nuclear power plant accident

Intensity Distribution during the Great East Japan Earthquake





★ : Start point of destruction in the Great East Japan Earthquake

★ : Center of earthquakes measuring M7.0 or higher, subsequent to the M7.3 earthquake occurring on March 9th off the Sanriku coast

● : Earthquakes measuring M5.0 or higher, occurring within 1 day of the Great East Japan Earthquake

Based on Meteorological Agency

Overview of damage by the Great East Japan Earthquake

Personnel damage		Iwate pref.	Miyagi pref.	Fukushima pref.
Dead	18,703	5,086	10,449	3,057
Missing	2,674	1,145	1,299	226
Injured	6,220	212	4,145	182

Damage of houses		Iwate pref.	Miyagi pref.	Fukushima pref.
Fully-destroyed	126,574	18,460	82,889	21,190
Half-destroyed	272,302	6,563	155,099	73,021
Partial-damage	759,831	14,191	222,781	166,758

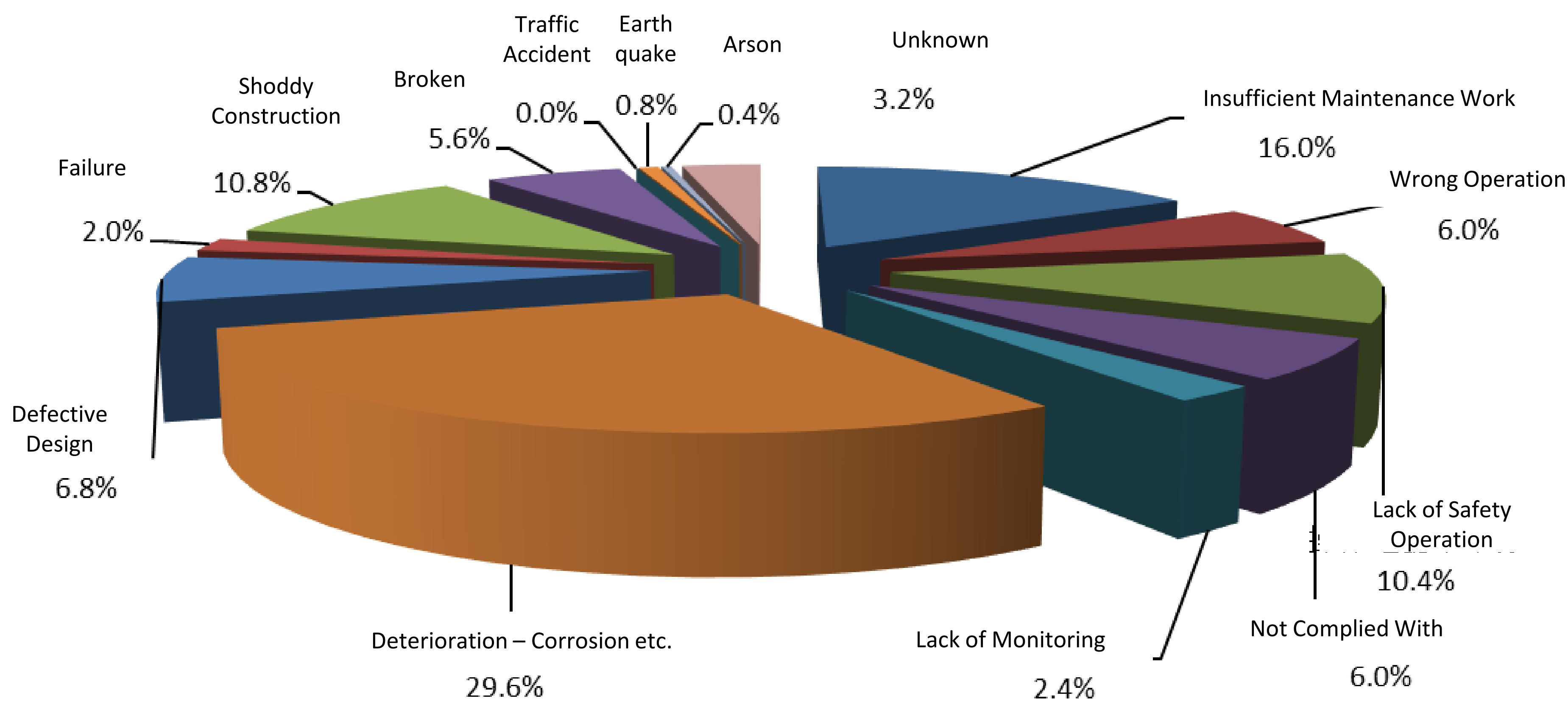
Number of fires	Iwate pref.	Miyagi pref.	Fukushima pref.
286	34	135	11

White book 2013, Fire and Disaster Management Agency

Oil refinery fire in Chiba Prefecture

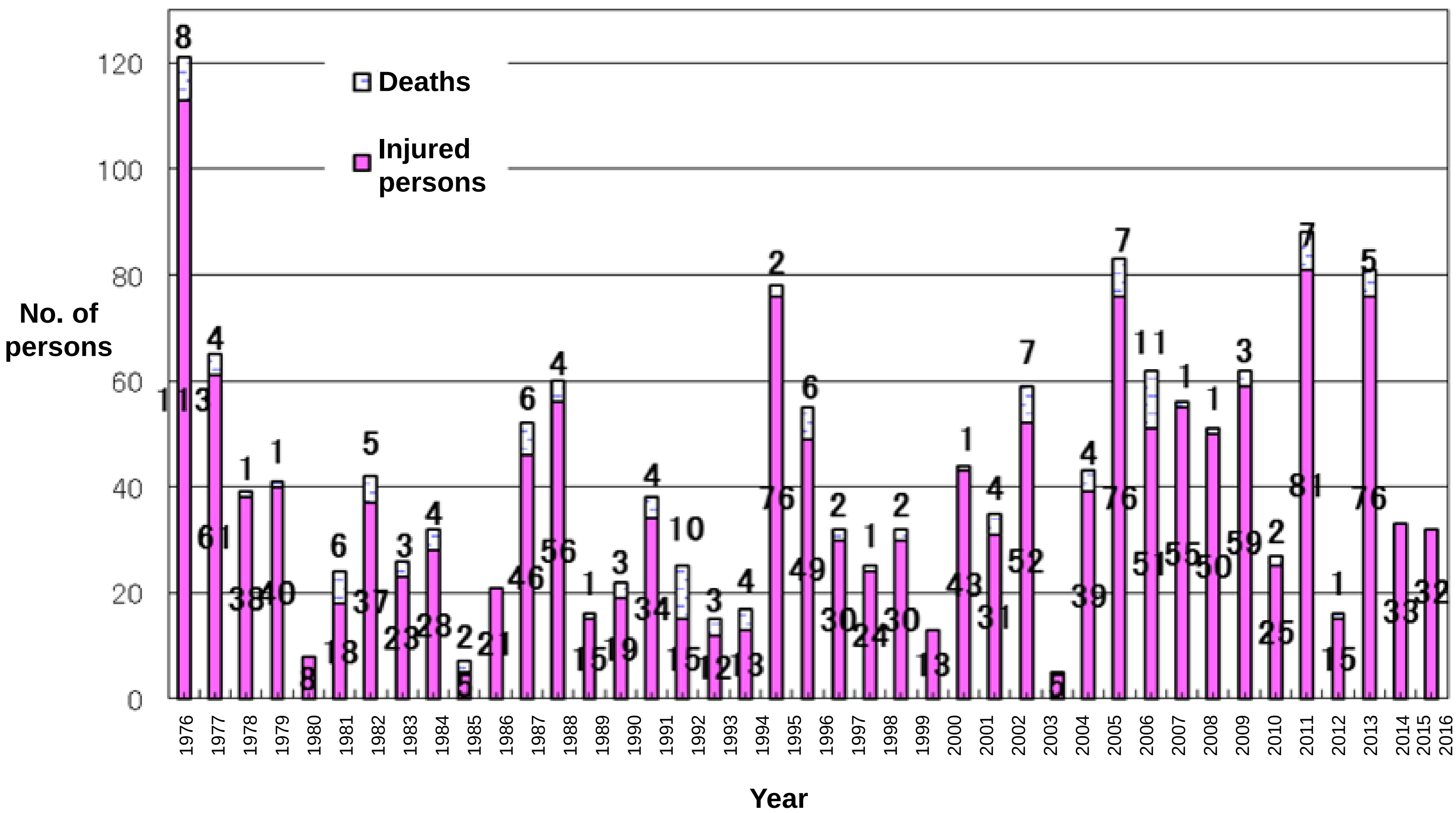
A huge fire ball generated due to an exploding LPG tank

Breakdown of Accident Causes – 250 Accidents, in 2016



Transition of the Number of Deaths and Injuries Accompanying Accidents at Petrochemical Complexes

The number of deaths and injuries differs from year to year, but is not yet on a downward trend.



Establishment of the Act on Disaster Prevention in Petroleum Industrial Complexes and Other Petroleum Facilities in 1975

○ In 1974, an accident of heavy oil leak occurred at Mizushima Refinery of Mitsubishi Oil Company.

*Vertical stairs of a tank fell, the dike was destroyed, and heavy oil leaked in the ocean. As the days and time passed, the leaked area expanded and stretched not only to the coast of Okayama Prefecture but also to the whole part of the east of the Seto Inland Sea, including Kagawa Prefecture and Tokushima Prefecture. It became an unprecedented disaster among oil leak accidents of petrochemical complexes.

○ In the midst of growing public concern regarding risk reduction countermeasures against disaster of petrochemical complexes, the then Prime Minister Miki responded to Diet question to the effect that "examination will be made to revise related laws and regulations to prevent accidents" (a meeting of the Lower House Budget Committee on Jan. 30, 1975).

⇒ Promulgation in Dec. 1975 (enforced in June of the following year) <2016 is the 40th year from the enforcement>

<Points of drawing up a bill>

Individual laws (The Fire Service Act for petroleum and the High Pressure Gas Safety Act for high pressure gas, etc.) were inadequate.

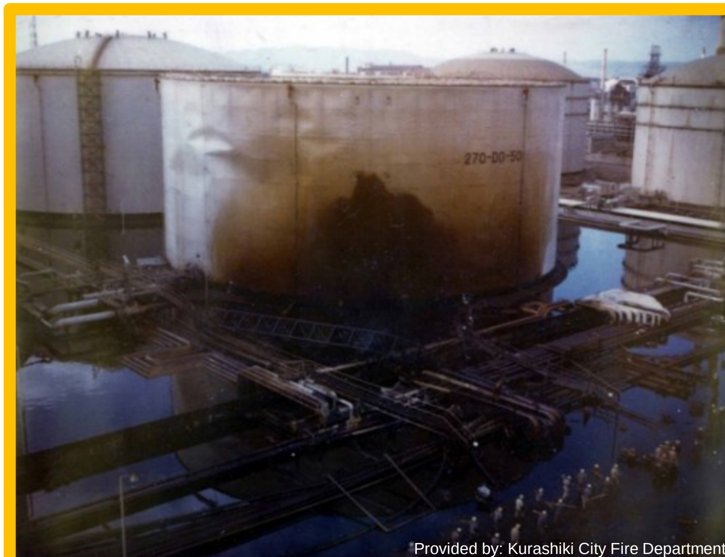
Establishment of an **extended, comprehensive, and integrated disaster risk reduction system** was promoted.

Also, based on the reflection of the Mizushima accident,

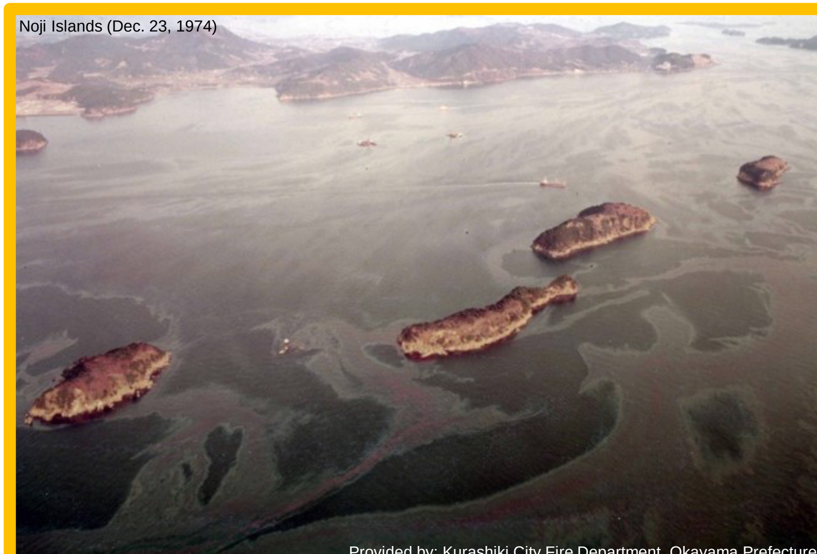
- Clarify "matters concerning the assumption of disaster" in a "disaster risk reduction plan for petroleum industrial complexes and other petroleum facilities"
- Oblige to set up a private disaster protection organization in a place of business
- Promote the setup of a "council" and a "combined disaster protection organization" to establish combined disaster protection system among local places of business
- Set up a disaster risk reduction headquarters including prefecture, municipalities, branches of national government, and business operators
- Obligate a specific place of business to set up materials and equipment for disaster risk reduction and facilities, etc. in addition to provisions of individual laws

1974 Accident of Mizushima Heavy Oil Leak

○ **An accident of heavy oil leak occurred at Mizushima Refinery in 1974 and became a major social problem.**
***Vertical stairs in a tank fell, the dike was destroyed, and 42,888 kL of heavy oil (for about 200,000 of drum cans) were leaked in the ocean. One-third of the Seto Inland Sea was contaminated, resulting in an unparalleled large-scale accident with about 50 billion yen of damages.**



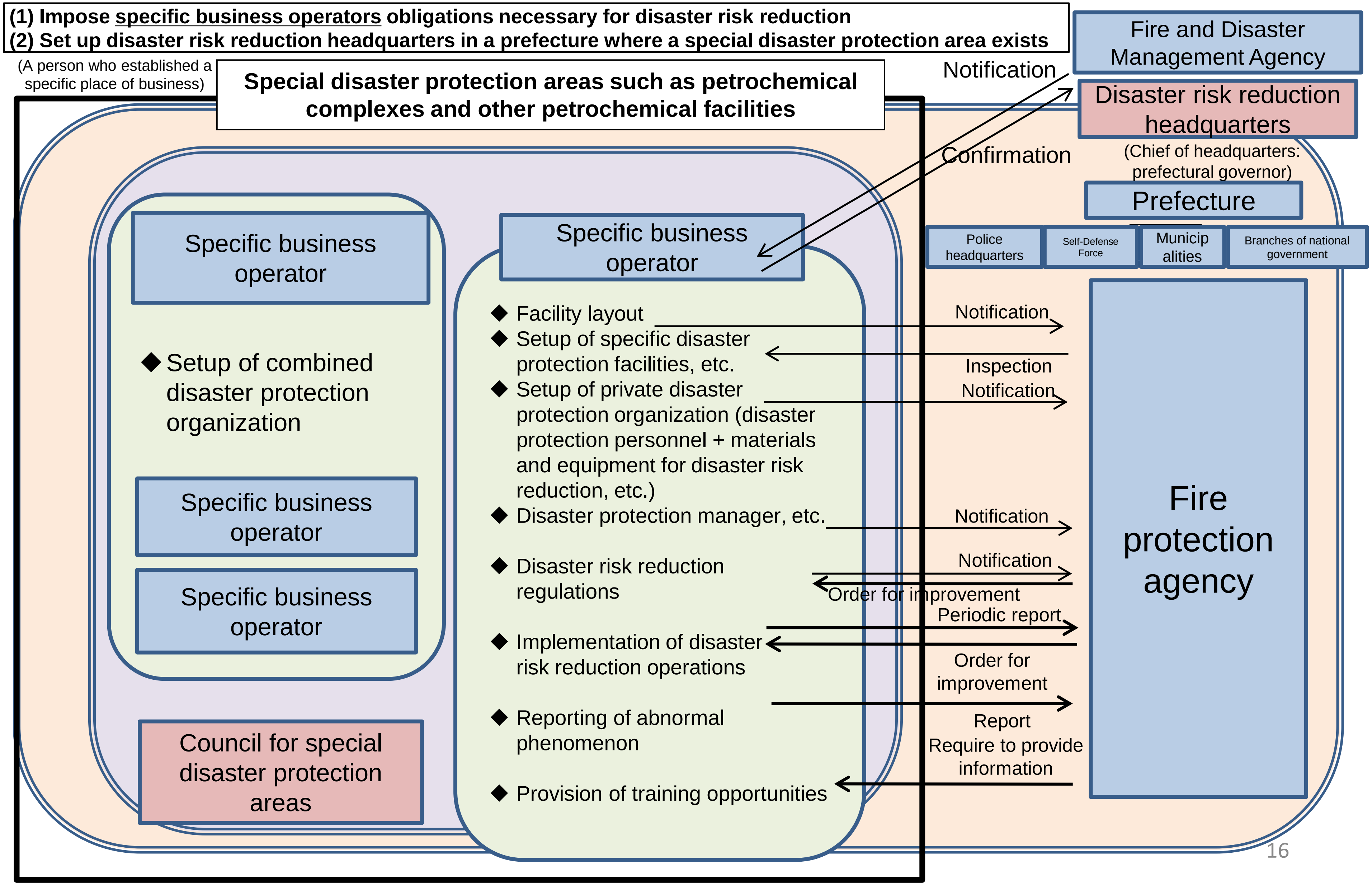
Provided by: Kurashiki City Fire Department


Noji Islands (Dec. 23, 1974)
Provided by: Kurashiki City Fire Department, Okayama Prefecture


Omuro Coast, Kiyo, Kurashiki City (December 26, 1974)

Outline of the Act on Disaster Prevention in Petroleum Industrial Complexes and Other Petroleum Facilities

(1) Impose <u>specific business operators</u> obligations necessary for disaster risk reduction
(2) Set up disaster risk reduction headquarters in a prefecture where a special disaster protection area exists



Layout Regulations

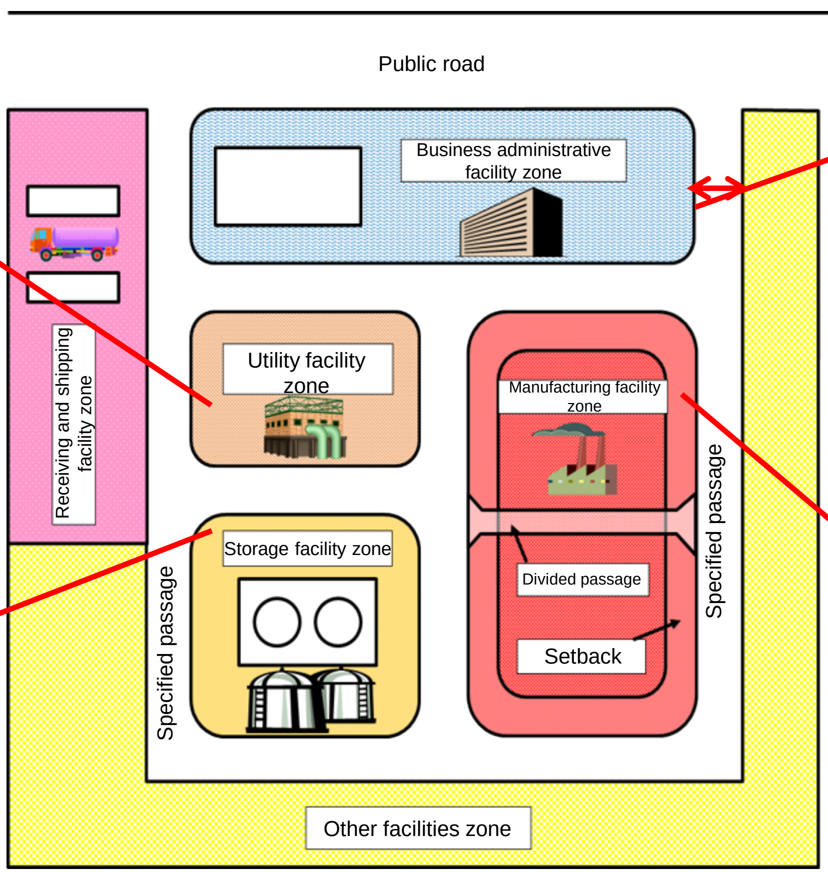
Since various equipment and devices are laid out complicatedly in a specific place of business (layout place of business) which handles both petroleum and high pressure gas and a risk of occurrence and expansion of a disaster is particularly large, the layout of facilities is regulated.

<Major contents>

- Layout of facilities according to their use and restriction of area
- Securing the width of passages according to the standards
- Restriction of height of piping crossing passages
- Securing vacant lot, etc. for a fire brigade to engage in activities

○ Utility facility zone
Mainly electricity self-generation facilities, steam generation facilities, and purification facilities, etc.
A half or more of the outer periphery is required to contact with specified passages.

○ Storage facility zone
Mainly petroleum tanks and high pressure gas tank facilities.
The entire outer periphery is required to contact with specified passages.
The upper limit area is 90,000 m^3.



○ Specified passage
Must connect to a public road.
The width is at least 6 m.
The minimum width differs (6 m, 8 m, 10 m and 12 m) by the type of adjacent zone and the area.

○ Manufacturing facility zone
Mainly plant facilities.
The entire outer periphery is required to contact with specified passages.
The upper limit area is 80,000 m^3.
Setback and divided passage are required to be established depending on the area.

Disaster Prevention and Emergency Measures pertaining to Specific Business Operator

For a specific business operator, obligations necessary for disaster risk reduction are imposed, such as the installation of specific disaster protection facilities and establishment of a private disaster protection organization.

○ **Installation of specific disaster protection facilities (Art. 15 of the Act)**

*Install to prevent expansion of disaster

- **Effluent oil block embankment**
- **Outdoor feed water facilities for fire extinction**
- **Emergency reporting equipment**

○ **Establishment of private disaster protection organization (Art. 16 of the Act)**

- Appoint **disaster risk reduction manager**
  → **Control private disaster protection organization**
- Formulate **disaster risk reduction regulations**
  → Matters concerning disaster risk reduction operations
- Assignment of **disaster protection personnel**
  → Assign personnel necessary for materials and equipment for disaster risk reduction to be deployed
- Deploy **materials and equipment for disaster risk reduction**
  → Deployment of chemical trucks, etc. in accordance with types and quantities of petroleum to be handled

○ **Reporting of abnormal phenomena (Art. 23 of the Act)**

Report to a fire station, etc. concerning occurrence of abnormal phenomena such as fires, explosions, leaks of petroleum, etc.

○ **Disaster emergency measures (Art. 24 of the Act)**

When abnormal phenomena occur, a private disaster protection organization, etc. shall implement measures to prevent occurrence or expansion of disaster.

*At a disaster site, the fire protection agency may request provision of information concerning matters regarding structure, etc. of a specific place of business. (Art. 24-2 of the Act)

<Combined disaster protection organization> (Art. 19 of the Act)

A specific place of business located in one special disaster protection area may establish a combined disaster protection organization to make it carry out a part of operations of a private disaster protection organization.

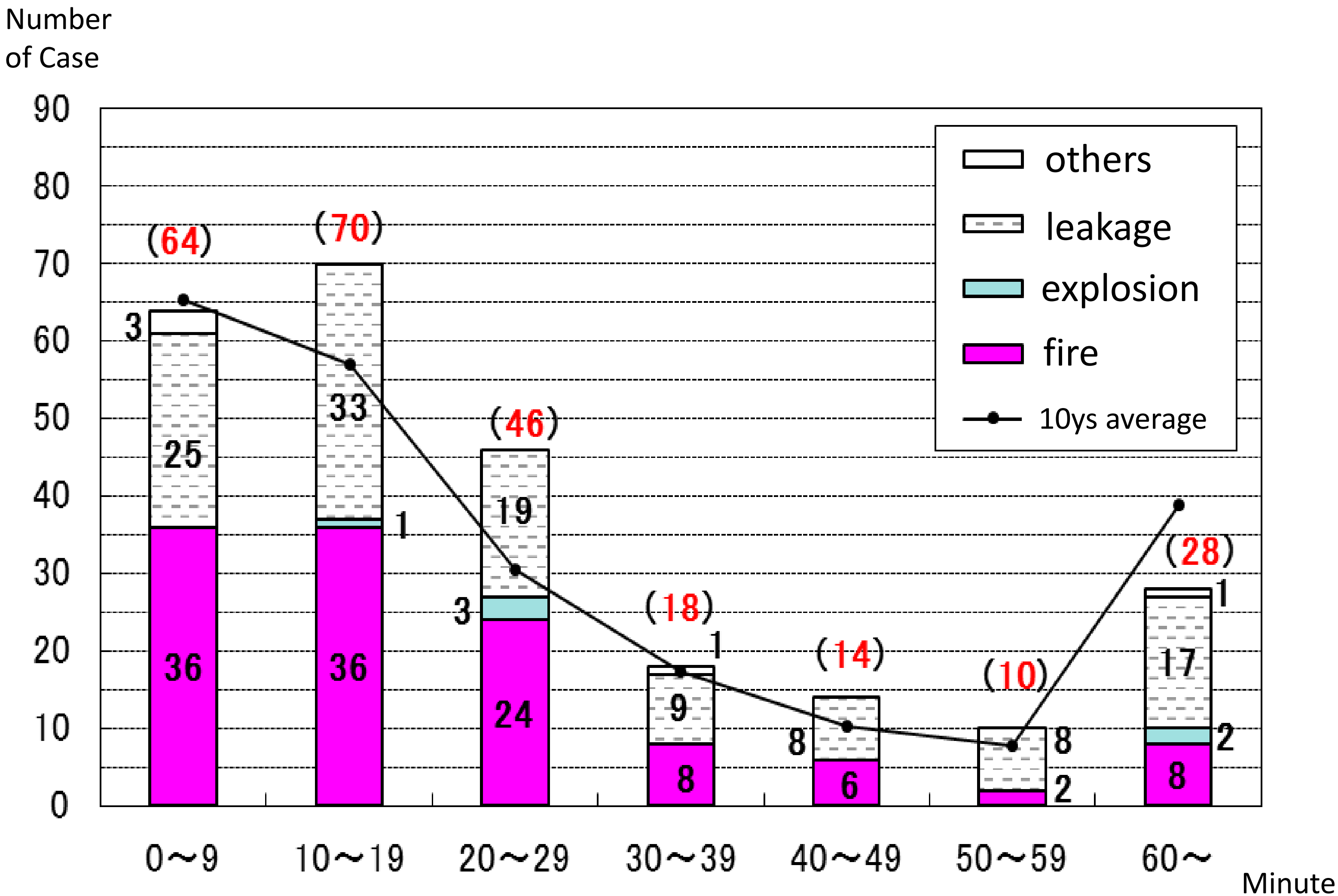
<Wide-area combined disaster protection organization> (Art. 19-2 of the Act)

In the area extending over two or more special disaster protection areas and specified by the Cabinet Order,(*1) a wide-area combined disaster protection organization may be established to make it carry out operations specified by the Cabinet Order(*2) among operations of a private disaster protection organization of a specific place of business.

(*1) Currently 12 areas are designated and 11 wide-area combined disaster protection organizations exist (one is a combined disaster protection organization).

(*2) Operations concerning high capacity foam system

How Late Business Operators Made Accident Reports to Fire Services – 250 Cases, 2016



time difference between recognition and report by business operators

Thorough Reporting of Abnormal Phenomena

Obligation to notify abnormal phenomena
(Art. 23 of the Act on Disaster Prevention in Petroleum Industrial Complexes and Other Petroleum Facilities, extract)

(1) The supervising manager of a specific place of business shall immediately notify a fire station, etc. when he/she receives a report on fire, petroleum leak, or the breakout of other abnormal phenomena or when he/she finds the same by himself/herself.
(2) The fire station chief, etc. shall report to a police station or maritime security and rescue organization to that effect.

Scope of abnormal phenomena (Notice issued by Director of Local Disaster Risk Reduction Department, Notice Shobo-chi No. 158 on July 13, 1984, extract)

(1) Fire
Burning phenomena requiring extinguishment and requiring use of fire extinguish facilities for extinguishing fire
(2) Explosion
Chemical or physical explosive phenomena that accompany damages of facilities and equipment
(3) Leak
Leak of hazardous materials, combustible solids, combustible liquid, high pressure gas, combustible gas, poisonous substances, deleterious substances, and other harmful substances, except for the case of leak caused by normal functioning or operations of facilities to be conducted to return to normal conditions and the leak of small amount in the case where the leak is stopped immediately by minor emergency measures
(4) Damage
Those which hinder maintenance and continuation of functions of manufacturing and other facilities and equipment and which immediately require emergency measures, such as suspension of use
(5) Runaway reaction, etc.
Control is impossible with normal functioning and operation of control devices

Thorough reporting of abnormal phenomena (Notice issued by Director of Extraordinary Disaster Management Office, Notice Shobo-toku No. 144 on July 13, 2012, extract)

Since reporting of abnormal phenomena is an extremely important emergency measure in preventing the spread of disaster, reporting is obligatory for a specific place of business from the initial enactment of the Act. Moreover, periodical reporting on the implementation status of disaster risk reduction operations to municipal mayors is obligatory for a specific business operator under the provision of Art. 20-2 of the Act. The annual reporting on the implementation status of reporting abnormal phenomena is also specified under said provision.
In your prefecture, reconfirmation should be made concerning the reporting system specified in Paragraph 2, Article 23 of the Act, and necessary guidance should be provided to related municipalities of your prefecture concerning general inspection of the reporting system at a specific business operator and notification should be given to them to pay special attention in the case of on-the-spot inspection such as strictly checking the on-site system, etc.

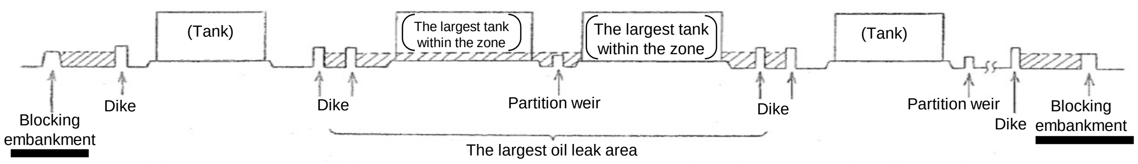
Specific Disaster Protection Facilities, etc.

A specific business operator must install and maintain specific disaster protection facilities as follows.

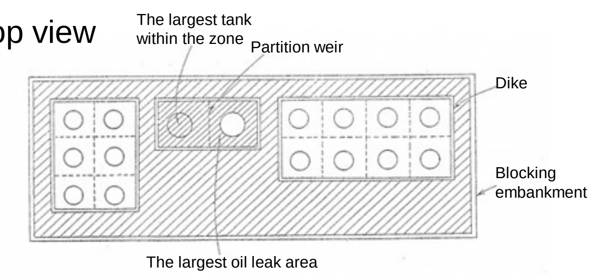
(1) Effluent oil block embankment, etc.

・Install if a petroleum tank of 10,000 kL or more is present.

Section view



Top view



*Install a “partition weir” around a tank with capacity of 10,000 kL or more and install a “dike” in each tank zone. Install a “block embankment” to surround the entire dike.

(2) Outdoor feed water facilities for fire extinction

*The capability of supplying water with quantities possible to discharge (A + B) x 120 minutes continuously

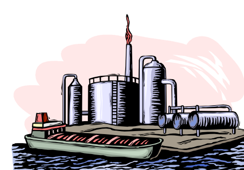
A: Total of water discharging capability of large-scale chemical trucks, etc. of private disaster protection organization

B: Of relevant large-scale chemical trucks, etc., water discharging capability of the largest one

(3) Emergency reporting equipment

*The installation is obligated at all specific places of business.

- Dedicated telephone (hotline)
- General subscriber phone
- Radio equipment



Fire department headquarters (command and control console)

Materials and Equipment for Disaster Risk Reduction, etc.

A specific business operator must furnish materials and equipment for disaster risk reduction, etc. as follows.

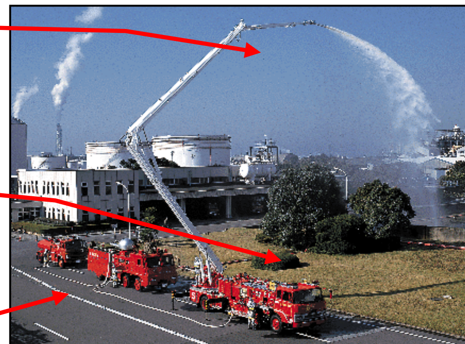
(1) Chemical trucks, etc.

<3 vehicles for petroleum complex fire>

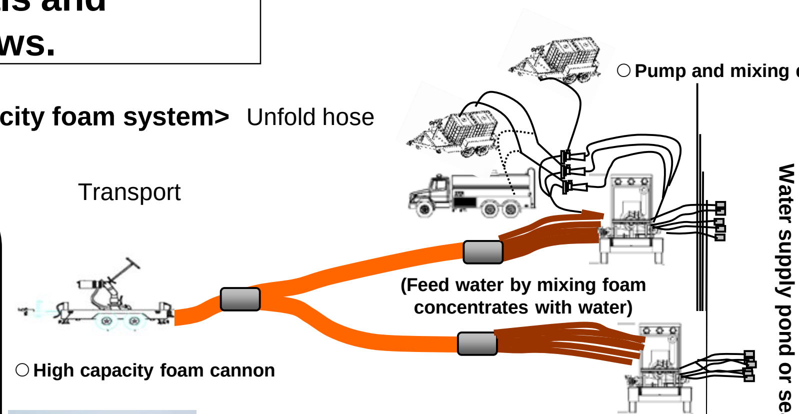
Large-scale water tower
Raise a water tower and spray foam from a high place

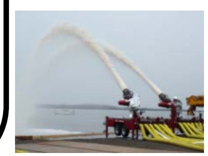
large-scale chemical truck
Take water from a fire hydrant, mix with foam fire extinguishing agent, and supply to a large-scale water tower

Foam concentrate truck
Supply foam fire extinguishing agent to a large-scale chemical truck



<High capacity foam system>





<Long-distance water feed system>

*The system is specified to be installed at a specific place of business having a floating roof outdoor storage tank with a diameter of 34 m or more, but 11 wide-area combined disaster protection organizations and one combined disaster protection organization install the system on behalf of a specific place of business.

*A high-capacity foam system is materials and equipment for disaster risk reduction consisting of a high capacity foam cannon with capability of discharging 10,000 liters or more of water per min, a water feed pump, a foam mixing device, hose, etc. One unit of high capacity foam cannon can spray three-fold to ten-fold foam compared to 3 conventional vehicles for petroleum complex fire (3,100 liters per min.).

(2) Oil fence, etc.

*Oil fence
(Petroleum storage and handling quantities)
1 million kL or more Length 2,160 m
100,000 kL or more and less than 1 million kL
Length 1,620 m
10,000 kL or more and less than 100,000 kL
Length 1,080 m
*Oil recovery vessel
Deployment is necessary in the case of 1 million kL or more.

Comprehensive Disaster risk reduction System

A disaster risk reduction headquarters is established in a prefecture to promote a comprehensive and integrated disaster risk reduction system.

Disaster risk reduction headquarters for petrochemical complexes, etc. (Art. 27 of the Act)

The headquarters is specified to be established in the prefecture where a special disaster protection area exists.

○ Organization of headquarters

- Headquarters chief: Prefectural governor
- Headquarters personnel: Head of a specific local government organization, mayor of municipality/head of fire protection agency, representative of a specific place of business, etc.

(Branch of each ministry/agency, Self-Defense Force, head of police headquarters)

○ Administration of headquarters

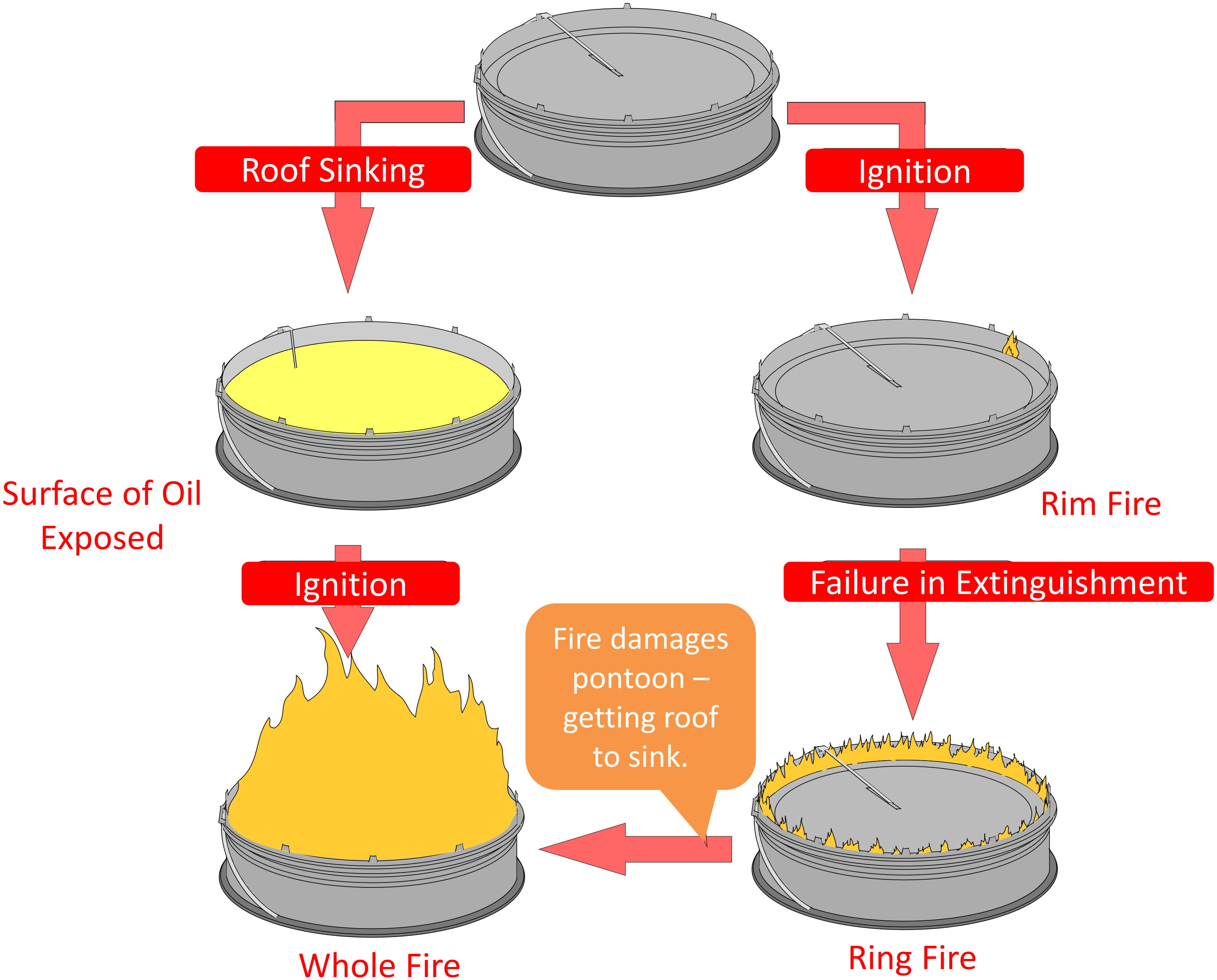
- Preparation and implementation of a disaster risk reduction plan for petrochemical complexes, etc.
- Communication and coordination on disaster emergency measures and disaster recovery, etc.
- Communication and coordination with national government or governments of other prefectures during a disaster, etc.

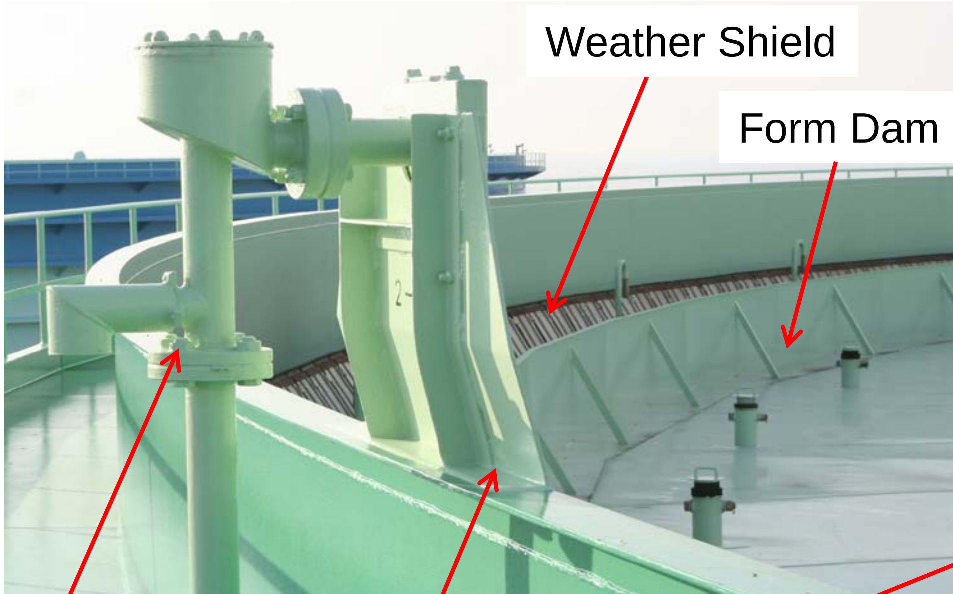
○ Establishment of disaster risk reduction headquarters for petrochemical complexes, etc. when emergent and integrated disaster risk reduction activities are necessary to be implemented during a disaster (Art. 29 of the Act)

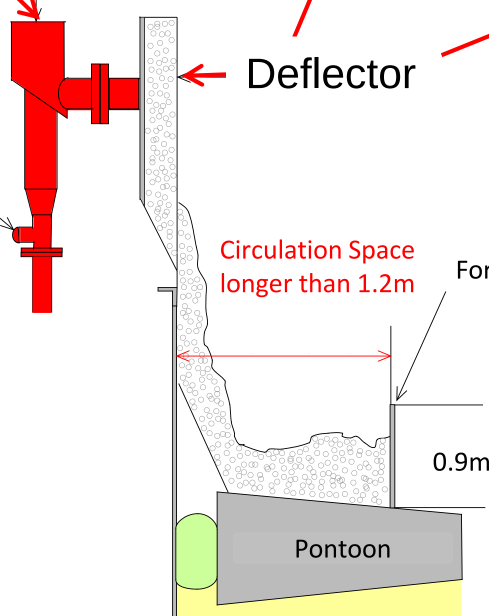
<Contents of disaster risk reduction plan for petrochemical complexes, etc.> (Art. 31 of the Act)

- Development of organization related to disaster risk reduction of related organizations, etc. and administration concerning disaster risk reduction
- Matters concerning disaster risk reduction education and training for staff of specific place of business and other related organizations, etc.
- Matters concerning installation of facilities, machinery, and equipment and materials for disaster risk reduction and their maintenance, storage, transportation, etc.
- Matters concerning assumption of disaster
- Matters concerning the collection and delivery of information in the case of occurrence of disaster and public relations
- Matters concerning implementation of emergency measures for a disaster
- Matters concerning evacuation during a disaster, traffic regulation, setup of risk cautionary area, etc.

Process of Fire Occurrence at Oil Storage Tank with Floating Roof on







The form discharged from air form chamber
sourced by：FUKADA KOGYO CO.,LTD.

Water Discharge Equipment for Petrochemical Complex Disaster

High Capacity Foam System

- About 20,000–30,000 liters/min.
- 2 units each at 12 blocks nationwide
- Deploy at wide-area combined disaster protection organizations
- For floating roof with a diameter of 34 m or more

大容量泡放射システムによる放水訓練（大阪・和歌山広域共同防災協議会）

Dragon Hyper Command Unit

- About 8,000 liters/min.
- Deploy at fire department headquarters of Yokkaichi City and Ichihara City (planned to deploy at 12 headquarters nationwide by FY2018)
- Loaned by the national government without charge as materials and equipment of emergency fire response teams
- Possible to discharge large quantities of water flexibly

So-called “3 vehicles for petroleum complex fire”

- 2,000–3,000 liters/min.
- Introduced to fire department headquarters and private fire defense organizations at places of business nationwide

(1) Large-scale water tower
Raise a water tower and spray foam from a high place

(2) Large-scale chemical truck
Take water from a fire hydrant, mix with foam fire extinguishing agent, and supply to large-scale water tower

(3) Foam concentrate truck
Supply foam fire extinguishing agent to large-scale chemical truck

***2 vehicles of large-scale chemical and water tower** (vehicle having function of large-scale water tower and large-scale chemical truck) and **foam concentrate truck** are popularized for labor saving.
(No. of minimum required disaster protection personnel 6 persons → 4 persons)

Deployment situation at special disaster protection areas such as petrochemical complexes and other petrochemical facilities (as of Apr. 1, 2015)

	No. of organizations	Large-scale chemical trucks	Large-scale water towers	Foam concentrate trucks	Large-scale chemical and water towers
Public fire department headquarters	92	83	63	90	19
Places of business (private fire defense organizations)	697	62	27	79	71

*Out of 92 public fire department headquarters, 81 headquarters have at least one of the above vehicles.
*Out of 697 specific places of business, 113 places have at least one of the disaster risk reduction materials and equipment mentioned above.

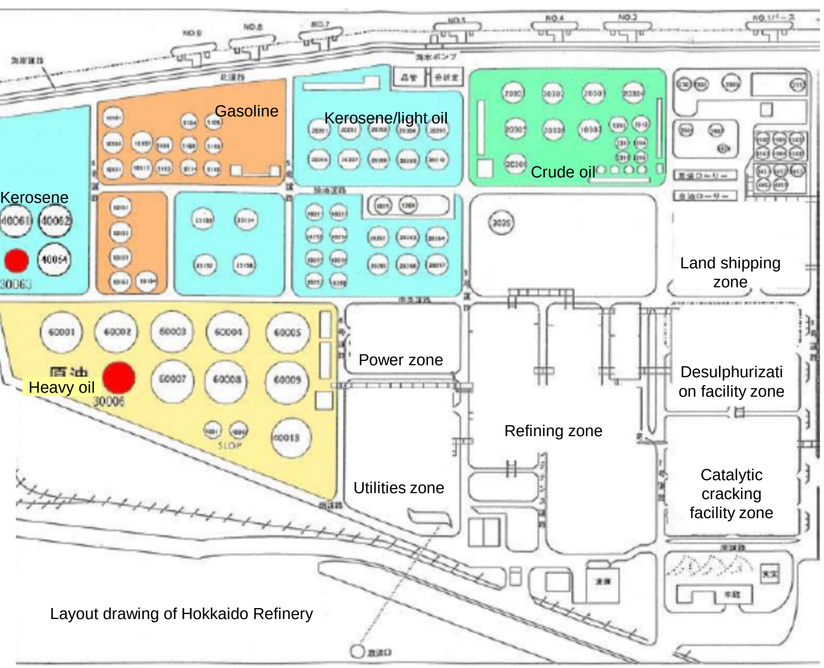
Tokachi off shore Earthquake, September 2003

Idemitsu Kosan Hokkaido Refinery, Outdoor Tank Storage Facility Fire

Background of disaster

Because of the Tokachi-oki Earthquake (M8.0) that occurred around 4:50 p.m. on Sept. 26, 2003, a ring fire broke out at outdoor tank storage facilities (30006) of Hokkaido Refinery of Idemitsu Kosan Co., Ltd. located in Tomakomai.
Two days later, a full surface fire further broke out at different outdoor tank storage facilities (30063). The fire became a large-scale disaster where the Emergency Fire Rescue Team was mobilized on a national level and foam concentrates were procured on a national level.

Direction of photo being taken



Layout drawing of Hokkaido Refinery

Idemitsu Kosan Hokkaido Refinery (1) Crude Oil Tank Fire

Outline of fire (crude oil tank)

<30006 tank>

1. Day and time of fire breakout
Breakout: around 4:51 on Sept. 26, 2003 (Fri.)
Extinguishment: 12:09 on Sept. 26 2003 (Fri.)

2. Place of fire breakout
Three places: around floating roof of 30006 crude oil tank, in surrounding dike, and around the pipe in the north of the tank

3. Outline of facilities where the fire broke out
Floating roof cylindrical tank (FRT: Floating Roof Tank)
Diameter: 42.7 m Height: 24.39 m
Permitted capacity: 32,778 kL (remaining quantity at the time of fire breakout: 31,160 kL)
Name of item of hazardous material: Category IV, Class I petroleum (crude oil)

4. Cause
Sloshing occurred on the liquid surface of the tanks due to relatively long-period strong ground motion, and the floating roof was shaken greatly. This shaking made crude oil in the tank flow over the floating roof and leak into a dike, and combustible vapor was considered to stay on the floating roof or in the dike. Also, crude oil which had flowed over from the floating roof of the tank leaked into the dike via a roof drainpipe, and combustible vapor was also considered to stay in the dike.
As for the ignition source, verification was made on the possibilities of the spark from abrasion and/or impact accompanying the shaking of floating roof, electric spark from instrumentation devices, static electricity and frictional electrification, etc. The fire is more likely to have broken out by a spark generated by the collision between the floating roof and equipment attached to the upper part of the tank accompanying the shaking of the floating roof, or spark from abrasion and impact when the measure hut fell onto the floating roof, which ignited combustible mixture gas on the floating roof.
Also, as for fire near the pipe around the relevant tank, it is more likely to have spread from the fire which broke out in the upper part of the tank through the crude oil leaked from the broken part of the pipe due to the earthquake.
The fire identified in the dike around the relevant tank was also likely to have broken out, judging from the hours when sloshing continued, as a result of overflowing crude oil burning on the upper part of the tank littered on crude oil leaked by the sloshing, and to have spread by the sloshing.

Situation of the tank when the fire broke out. Photo taken from the east side of the tank.

Situation of the area around the dike and pipe when the fire broke out. Photo taken from the west side of the tank.

Situation of a ring fire of the tank where the fire broke out

Idemitsu Kosan Hokkaido Refinery (2) Naphtha Tank Fire

Outline of Outline fire (naphtha tank))

<30063 tank>

1. Day and time of fire breakout
Breakout: around 10:45 on Sept. 28, 2003 (Sun.)
Extinguishment: 6:55 on Sept. 30 2003 (Wed.)

2. Place of fire breakout
30063 naphtha tank

3. Outline of facilities where the fire broke out
Floating roof cylindrical tank (FRT: Floating Roof Tank)
Diameter: 42.7 m Height: 24.39 m
Permitted capacity: 32,779 kL (remaining quantity at the time of fire breakout: 26,874 kL)
Name of item of hazardous material: Category IV, Class I petroleum (naphtha)

4. Cause
The floating roof of the relevant tank completely fell down into oil on the previous day when this fire broke out due to relatively long-period strong ground motion. For this reason, foam for fire extinguishment was sprayed to prevent volatilization of naphtha and conceal the liquid surface of naphtha. However, strong wind on the day pushed foam away toward the south side of the tank and two-thirds of the liquid surface in the north side was exposed to the atmosphere. Because of this, volatilized naphtha flowed over the wind and was diluted with air. Some parts were more likely to enter the combustible range (1.5 vol%–7.6 vol%).
In the verification of various sources of ignition, the possibility of sedimentation electrification remained. This occurs through the electrification of naphtha when foam disappears with the passage of time and water drops generated when foam returns to water sink into naphtha. Generated electric charge is accumulated into foam remaining on the liquid surface and the electric potential of foam rises. Electricity is discharged between this foam and foam of the tank shell plate or foam contacting to the tank shell.
Since the floating roof completely fell down in oil and power sources of accessory equipment were shut down at the time when the fire broke out, the possibility of ignition by such ignition sources as mechanical sparks or electric sparks was denied.

About 20 hours after the fire breakout

About 25 hours after the fire breakout

About 27 hours after the fire breakout

About 43 hours after the fire breakout
(condition of fire being almost extinguished)

High Capacity Foam System

- ○ When the Tokachi-oki earthquake occurred in September 2003, a floating roof was shaken due to long-period strong ground motion and fell into the oil tank. A full surface fire of the tank broke out.
- ⇒ A high capacity foam system was introduced as equipment responding to a full surface fire of floating roof tank.

Naphtha tank fire at Hokkaido Refinery of Idemitsu Kosan Co., Ltd.

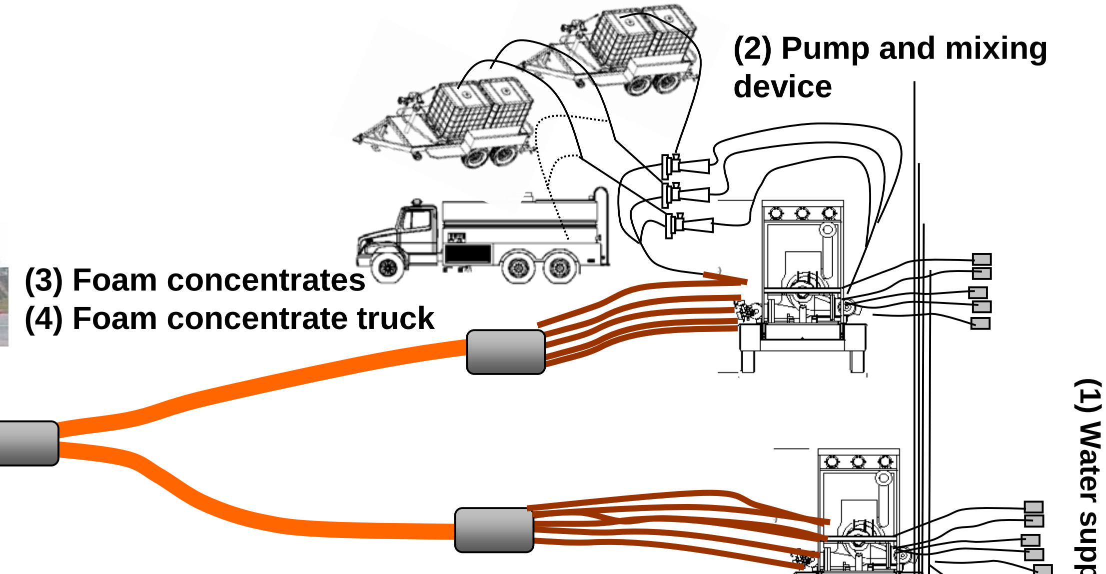
About 20 hours after the fire breakout

About 25 hours after the fire breakout

- ○ Through the revision of the Act on Disaster Prevention in Petroleum Industrial Complexes and Other Petroleum Facilities in 2004, the establishment of wide-area disaster protection organization became possible to support protection activities.
- ○ Two units are deployed in each of 12 blocks in Japan (the deployment was completed in May 2009).

Configuration Diagram of High Capacity Foam System (Example)

- Capability of discharging about 30,000 liters/min. (120 mins at the maximum) (About ten-fold capability compared to general large-scale water tower and large-scale chemical truck)
- (1) Suction seawater with a water pump, (2) Feed water with a water feed pump, (3) Mix foam concentrates and pressurize, (4) Discharge water into a tank from a cannon
- Deploy two units at each wide-area disaster protection organization in 12 blocks nationwide
- Introduce and share maintenance and management costs jointly between places of business

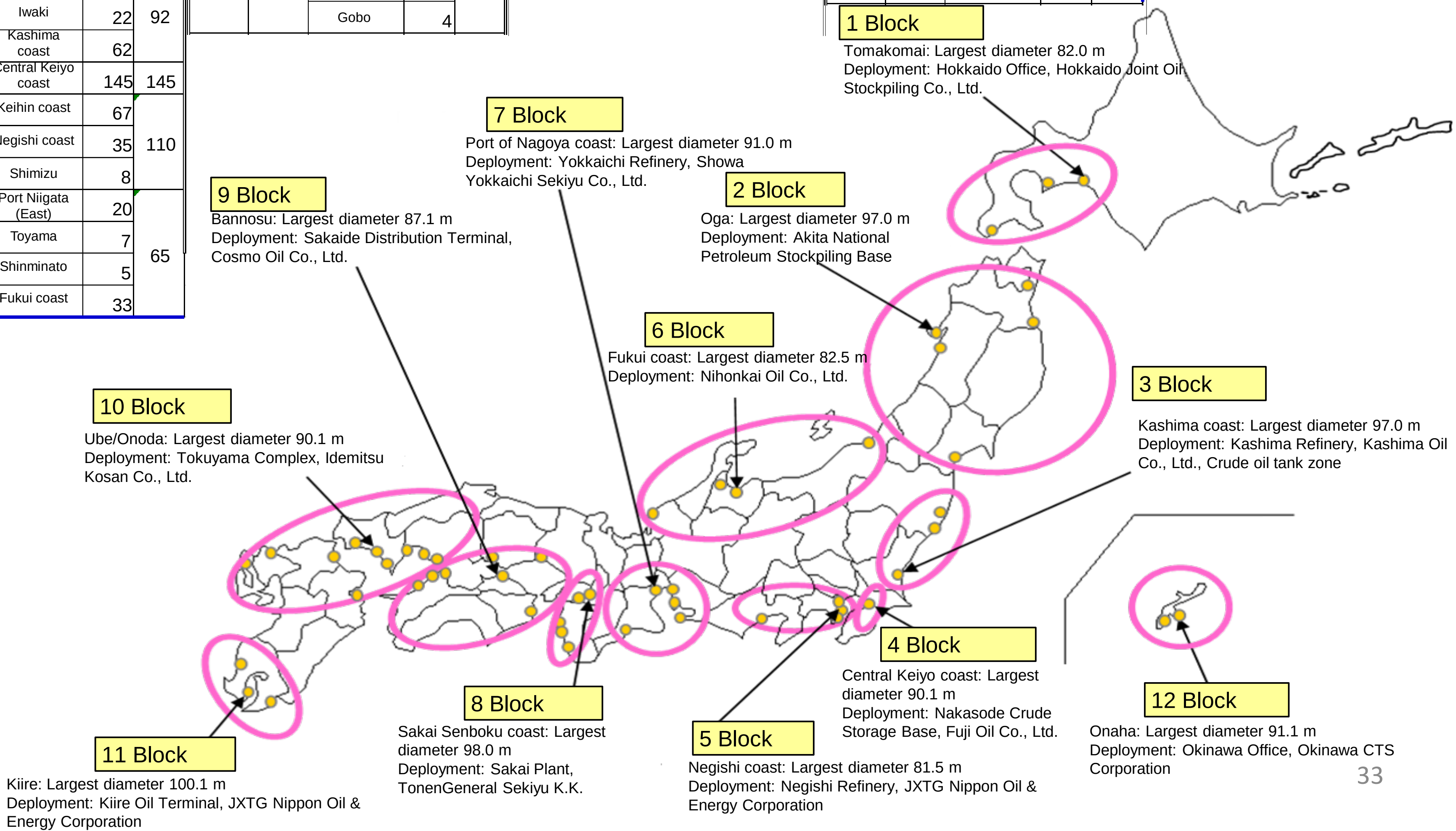


Pressure pump

Allocation of High Capacity Foam Systems

Block	Prefecture	Name of special disaster protection area	No. of units	Total
1	Hokkaido	Tomakomai	108	118
		Muroran	7	
		Shiriuchi	3	
2	Aomori	Mutsu-Ogawara	55	101
		Hachinohe	2	
	Miyagi	Sendai	19	
	Akita	Oga	16	
		Akita	9	
3	Fukushima	Hirono	8	92
		Iwaki	22	
	Ibaraki	Kashima coast	62	
4	Chiba	Central Keiyo coast	145	145
5	Kanagawa	Keihin coast	67	110
		Negishi coast	35	
	Shizuoka	Shimizu	8	
6	Niigata	Port Niigata (East)	20	65
	Toyama	Toyama	7	
		Shinminato	5	
	Fukui	Fukui coast	33	
7	Aichi	Atsumi	13	142
		Kinuura	5	
		Port of Nagoya coast	57	
	Mie	Yokkaichi coast	61	
		Owase	6	
8	Osaka	Sakai Senboku coast	58	125
		Misaki	6	
	Wakayama	Central coast in north Wakayama	7	
		Southern coast in north Wakayama	50	
		Gobo	4	
9	Hyogo	Ako	4	125
	Okayama	Mizushima coast	64	
	Tokushima	Anan	9	
	Kagawa	Bannosu	16	
	Ehime	Namikata	3	
		Kikuma	18	
		Matsuyama	11	
10	Hiroshima	Etajima	2	127
		Nomi	13	
	Yamaguchi/Hiroshima	Iwakuni/Otake	16	
	Yamaguchi	Kudamatsu	6	
		Shunan	34	
		Ube/Onoda	32	
	Fukuoka	Buzen	2	
	Nagasaki	Ainoura	4	
	Oita	Oita	18	
11	Kagoshima	Sendai	4	104
		Kiire	57	
		Shibushi	43	
12	Okinawa	Henza	63	76
		Onaha	13	
	29	50		1,330

(No. of units is the number of tanks with a diameter of 34 m or more)



Deployment Situation of High Capacity Foam Cannons

(As of Apr. 1, 2015)

Area	Name of wide-area combined disaster protection organization and name of combined disaster protection organization	Related prefecture	Maker	Water discharge capability to be furnished	High capacity foam cannons	Maker of foam concentrates
1st area	Hokkaido area wide-area combined disaster protection organization	Hokkaido	Kiuddel	50,000 L/min.	20,000 L/min. × 1 unit 30,000 L/min. × 1 unit	ANSUL
2nd area	2nd area (Tohoku) council for wide-area combined disaster protection	Aomori/Miyagi/Akita	Kiuddel	60,000 L/min.	20,000 L/min. × 1 unit 40,000 L/min. × 1 unit	DIC
3rd area	Joban area wide-area combined disaster protection organization	Fukushima/Ibaraki	Kiuddel	60,000 L/min.	30,000 L/min. × 2 units	DIC
4th area	Central Keiyo coast area combined disaster protection organization	Chiba	Morita	60,000 L/min.	30,000 L/min. × 2 units	DIC
5th area	Kanagawa/Shizuoka area council for wide-area combined disaster protection	Kanagawa/Shizuoka	Morita	50,000 L/min.	25,000 L/min. × 2 units	DIC
6th area	Hokuriku area council for wide-area combined disaster protection	Niigata/Toyama/Fukui	Williams Fire & Hazard Control	50,000 L/min.	25,000 L/min. × 2 units	DIC
7th area	Chukyo area council for wide-area combined disaster protection	Aichi/Mie	Morita	60,000 L/min.	30,000 L/min. × 2 units	DIC
8th area	Osaka/Wakayama council for wide-area combined disaster protection	Osaka/Wakayama	Williams Fire & Hazard Control	60,000 L/min.	30,000 L/min. × 2 units	DIC
9th area	Setouchi area council for wide-area combined disaster protection	Hyogo/Okayama/Tokushima/Kagawa/Ehime	Kiuddel	50,000 L/min.	38,000 L/min. × 2 units	DIC
10th area	West Chugoku/North Kyushu area council for wide-area combined disaster protection	Yamaguchi/Hiroshima/Fukuoka/Saga/Nagasaki/Oita	Teikoku Sen-i	60,000 L/min.	40,000 L/min. × 1 unit 20,000 L/min. × 1 unit	DIC
11th area	South Kyushu council for wide-area combined disaster protection	Kagoshima	Williams Fire & Hazard Control	80,000 L/min.	40,000 L/min. × 2 units	DIC
12th area	Okinawa area wide-area combined disaster protection organization	Okinawa	Williams Fire & Hazard Control	60,000 L/min.	30,000 L/min. × 2 units	DIC

Outline of "Skills Competition for Private Disaster Protection Organizations at Petrochemical Complexes and Other Petrochemical Facilities"

1. Purpose and objective

At a specific place of business, such as a petrochemical complex, etc., a private disaster protection organization furnished with disaster protection personnel and firefighting vehicles is deployed to respond to explosion, fire, and other accidents.
This skills competition has been implemented from FY2014 for the purpose of improving skills and morale of disaster protection personnel by using firefighting vehicles owned by each place of business.

2. Outline

Assuming that a fire broke out in a place of business at an outdoor storage tank storing petroleum, etc., competition of fire extinguishing activities to respond to the situation is carried out by using a large-scale chemical and water tower and foam concentrate truck or a large-scale chemical and water tower and chemical truck. In the evaluation, reliable operation of materials and equipment for disaster risk reduction and safety management, etc. are evaluated, and prejudging through video screening is implemented in the evaluation.

<Scene of FY2016 Skills Competition>

3. Participating organizations

Private disaster protection organizations, which own a large-scale chemical and water tower and foam concentrate truck or a water tower and chemical truck, participate in the competition. 43 organizations recommended by fire department headquarters under respective jurisdiction participated in the competition.

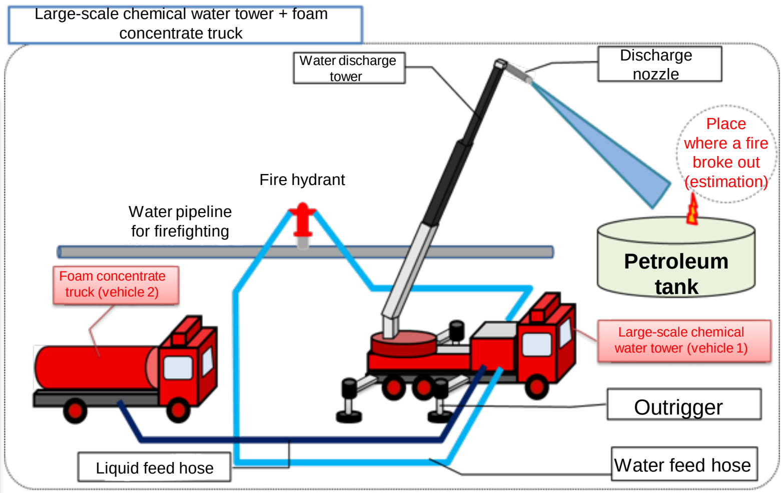
4. Time and place of implementation

During the period of one month before or after the Tsunami Disaster Preparedness Day (November 5), examiners (personnel of Fire and Disaster Management Agency) visit each place of business and implement the skills competition (final) to be performed by participants.

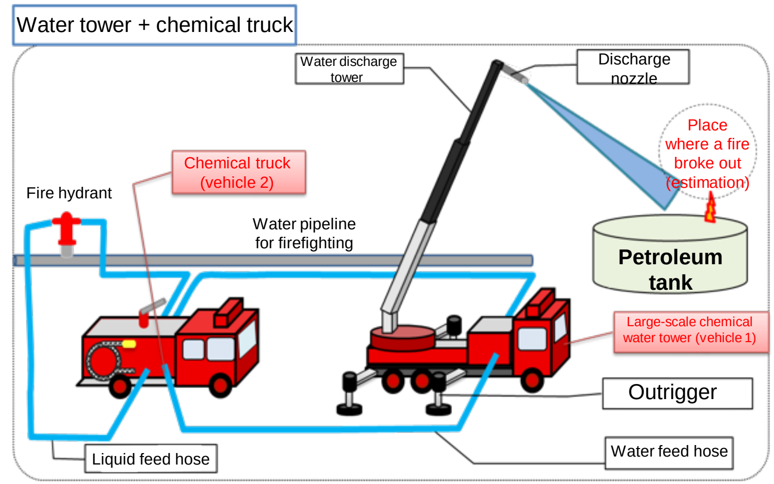
I. Disaster Risk Reduction Measures at Petrochemical Complexes

5. Content of competition

<Water discharging formation pattern A>



<Water discharging formation pattern B>



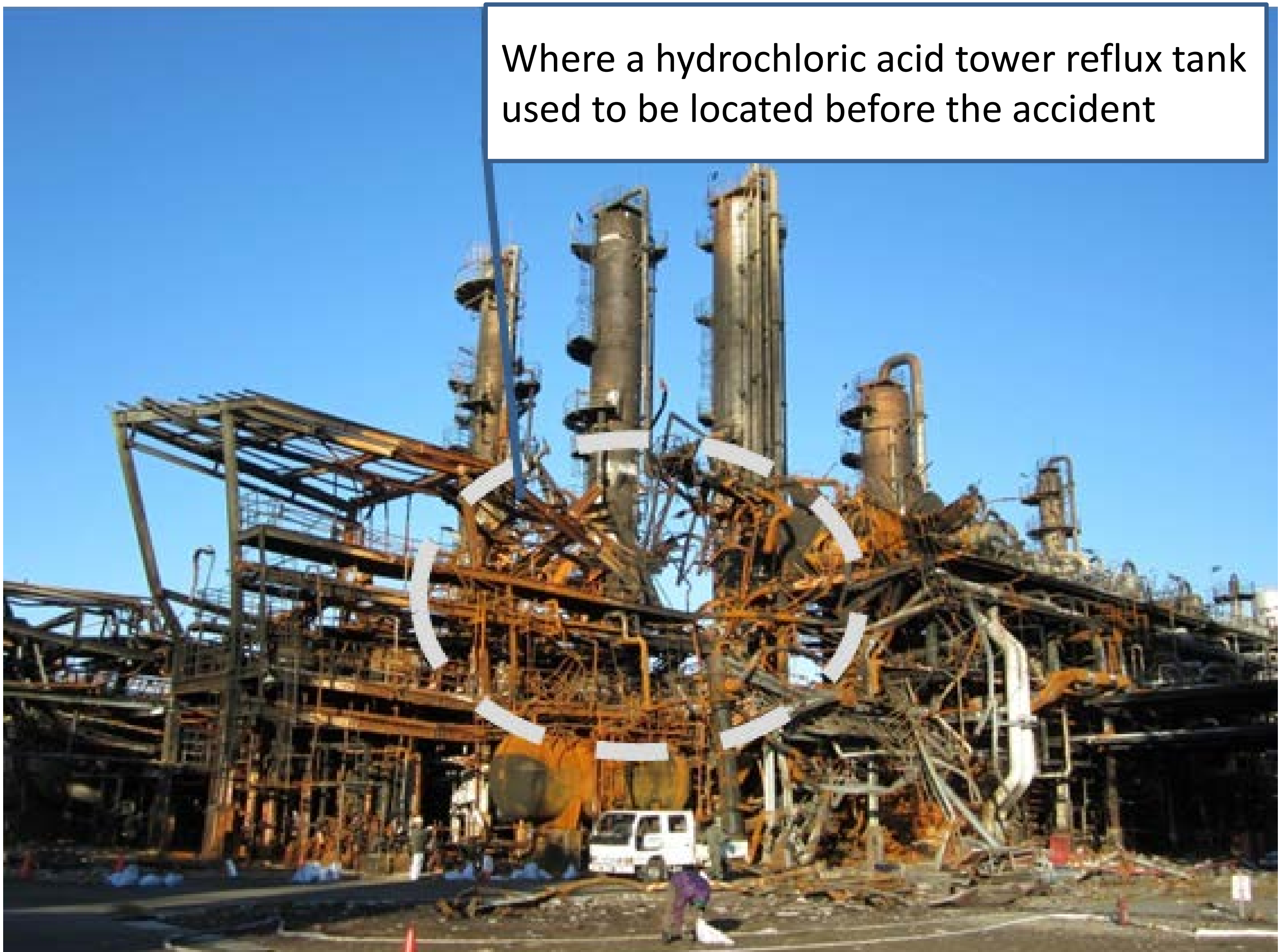
Preparation for water discharge/water discharge

(1) Stabilize a vehicle	Set up an outrigger (vehicle-supporting device) of vehicle (1) and stabilize the vehicle.
(2) Set up water discharge tower	Extend the water discharge tower of vehicle (1) and set up the height so that foam can be sprayed from overhead of an outdoor storage tank
(3) Feed foam concentrates or water	Feed foam concentrates or water depending on type of vehicle (2) on the feeding side (Pattern A or Pattern B).
(4) Discharge water	Mix form concentrates and water in vehicle (1) in case of Pattern A and in vehicle (1) in case of Pattern B and spray expanded foam from a discharge nozzle. *In the competition, foam concentrates are not fed, and only water is fed and discharged.

6. Evaluation and awarding

An evaluation and awarding committee headed by the Commissioner of the Fire and Disaster Management Agency is held on Nov. 17 and decides organizations to be awarded.
Best award: one organization (the Minister for Internal Affairs and Communications Award), Second best award: four organizations (the Minister for Internal Affairs and Communications Award), Encouragement award: 20 organizations (the Commissioner of the Fire and Disaster Management Agency Award), Special award: one organization (the Commissioner of the Fire and Disaster Management Agency Award)

Explosive Fire at Chemical Factory



Explosive Fire at Chemical Factory

Resorcinol Production Instrument

Resorcinol Production Instrument

Corridor between Resorcinol Production Instrument and Cymene Production Instrument

Explosive Fire at Chemical Factory

Whole Picture of Site

Firefighting

Burned Down Fire Engine

Exploded Tank Foundation Part

Sourced by National Research Institute of Fire and Disaster

Petroleum Complex Fire – Jan, 2017

Incident Summary

Chronology

Occurrence: 15:40, Jan 22, 2017
Learnt: 15:47, Jan 22, 2017
Under Control: 08:09, Jan 24, 2017
Full Containment: 08:27, Jan 24, 2017

Evacuation Order

Ordered: 17:20, Jan 22, 2017
– to 2,986 residents of 1,281 households
Lifted：04:10. Jan 23, 2017

Location

Lubrication oil production complex, in Wakayama Prefecture

Casualty

None

Cause of Accident

Assumed that static electricity spark ignited oxygen gas leaked from decayed pipe.

Petroleum Complex Fire – Jan, 2017

Images from Aerial camera

Initial Phase

2 hour past

3 hour past

5.5 hour past

Keys for Successful Operation at Petrochemical Complex Fire, Jan 2017 – No Casualty

Initial Response

1. Grasped the disaster situation immediately after occurrence – the operator properly shared the information on the complex with firefighters
2. Safety management, effective firefighting based on the shared information, securing the space for supportive units to come
3. Quick decision making to call for support to neighboring professional firefighters, self fire service groups and so on
4. Prompt judgement by top management to issue evacuation order, based on the onsite report that explosion could happen
5. Leaders proactively explained the progress of firefighting to evacuated residents.

Preventive Measures

Development and improvement of self safety arrangement, ensuring of risk assessment, utilizing knowledge and experience, no matter which internal or external one, enhancing of capacity buildings

1. Improvement of operator's guidelines for accident – pick up what information to be shared with firefighters, make most of risk assessment result for individual facility, get the self firefighters equipped with such tools as tactic sheet, disaster management map, location map of form fire hydrant and SDS (safe data sheet).

2. Training and exercise for self firefighters – including mutual support coordination with neighboring fire service organizations and firefighting skill competition

Set Up of Information Sharing between Business operator and Fire Services organization

Business operators are required to promptly provide the info of their facilities to firefighter to stop expansion of a disaster and secondary disaster, and swiftly get fire under control.

A new ministerial ordinance makes it compulsory that business operators clarify in their internal rules how to share the information of their facilities with firefighters when an accident occurs – including who is responsible for sharing with firefighters both in and out the business hours.

Business operators are encouraged to predetermine what information to be shared with firefighters, presuming how firefighters make response to accident if it happens

Briefing to Firefighters

Below is the sample of items to be shared with firefighters

1. Possibility of victims inside, location of fire point and situation of facilities around accident site
2. Temperature and pressure of plants – normal time and disaster occurrence time
3. Stored substance and intermediate product
4. Facts to take into consideration for planning firefighting operations – flammable substance, poisonous material and radioactive material, and information for judgement to discharge water or not
5. Location and summary information of store facilities and disaster response facilities in the complex
6. Possibilities that harmful material leakage and scatter adversely impacts the outside of the complex

Requirements the operators should meet for safety

Proper Installment in Safety Management for Better Self Safety

- Top management commitment
- Proper budget and human resources, taking field works' voice seriously
- Close communication beyond sectors for safe operation
- Affiliate companies' safety operation to be secured as well

Robust Risk Assessment

- Risk assessment based on assumption of non-steady operation or emergency situation

Capacity Buildings

- Hand down to the next generations about how comes the accidents happened.
- Capacity building to create core safety managers

Utilization of Info and knowledge

- Utilization and gathering of internal and external info about accidents
- Third party bodies' evaluation and verification

Business umbrella bodies are expected to take following initiatives

- Share the past accident lessons and safety measures among member companies
- Support member companies in safety education and training – e.g. making safety guidelines for members
- Take measures to raise safety awareness – e.g. setting platform where top managements exchange opinions in safety

The ministries related to safety management at petroleum complex gets united to promote the efforts and the measures above – FDMA, Ministry of Health Labour and Welfare, and Ministry of Economy, Trade and Industry.