# Annual Report on High Pressure Gas Related Accidents

(2013 version)

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# 1. Introduction

This Annual Report analyzes and evaluates accidents relating to the High Pressure Gas Safety Act that occurred from January to December 2013, with an aim of contributing toward future high pressure gas safety measures.

Note that among high pressure gas-related accidents; this Annual Report excludes those involving general consumers, which pertains to the Act on the Securing of Safety and the Optimization of Transaction of Liquefied Petroleum Gas.

# 2. Accidents relating to the High Pressure Gas Safety Act

The number of accidents relating to the High Pressure Gas Safety Act per year remained around 100 until 1999. Subsequently, it has increased since 2000 and has remained at a high level in recent years. However, fewer accidents occurred in 2013 than in the previous year.

One of the causes of the increase in number of accidents in recent years is the increase in number of theft and loss of containers (hereinafter, “theft and loss accidents”). However, it is difficult to discuss theft and loss accidents by statistically treating them along with explosion, leakage, and other ordinary disasters (hereinafter, “disaster accidents”), because of characteristic differences. Thus, this Annual Report summarizes and analyzes the high pressure gas-related accidents by separating the theft and loss accidents from the disaster accidents.

Also, the accident countermeasures manuals were revised in 2011, resulting in significant changes in the definitions of accidents and items of accident causes. Thus, the analysis and evaluation on accident causes and others below were conducted separately for the years up to 2010 and those after 2011.

## 2.1 Changes in number of accidents and analysis/evaluation

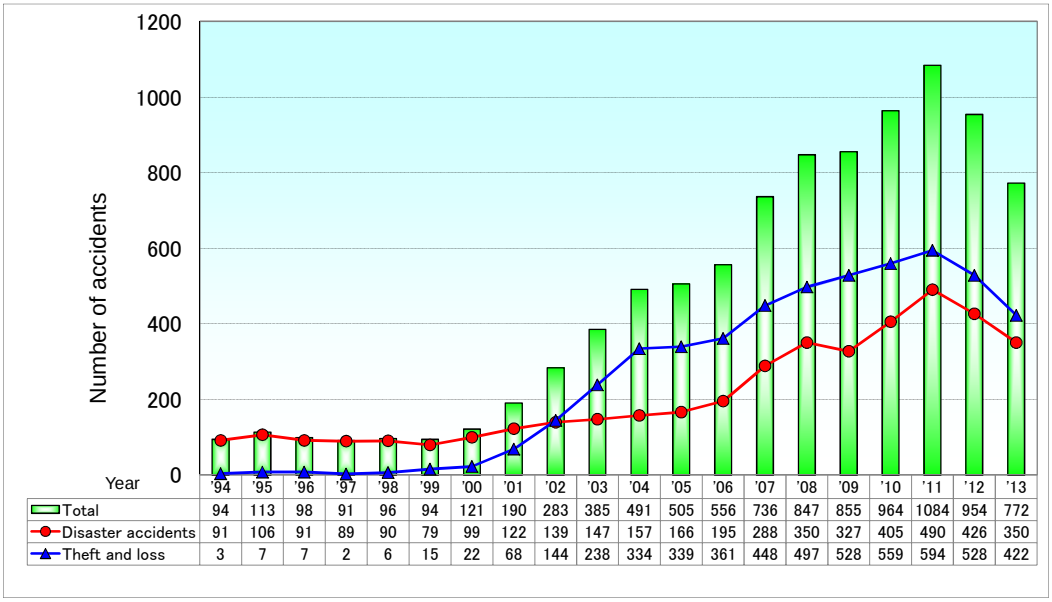
(1) Changes in number of accidents by year

Figure 1 shows the number of the High Pressure Gas related accidents that occurred in the latest two decades (1994 to 2013).

In the last five years, the number of accidents occurring in 2009 was 855, and thereafter 964 in 2010, 1084 in 2011, 954 in 2012, and 722 in 2013. The number of accidents in 2013 was the lowest of these years.

Here, the increase in the number of accidents in 2011 was mainly due to the report of 94 accidents that caused by the Great East Japan Earthquake.

Also to note is that the number of theft and loss accidents was 422 in 2013 and this number was fewer than that of 528 in 2012.




| Year | '94 | '95 | '96 | '97 | '98 | '99 | '00 | '01 | '02 | '03 | '04 | '05 | '06 | '07 | '08 | '09 | '10 | '11 | '12 | '13 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Total | 94 | 113 | 98 | 91 | 96 | 94 | 121 | 190 | 283 | 385 | 491 | 505 | 556 | 736 | 847 | 855 | 964 | 1084 | 954 | 772 |
| Disaster accidents | 91 | 106 | 91 | 89 | 90 | 79 | 99 | 122 | 139 | 147 | 157 | 166 | 195 | 288 | 350 | 327 | 405 | 490 | 426 | 350 |
| Theft and loss | 3 | 7 | 7 | 2 | 6 | 15 | 22 | 68 | 144 | 238 | 334 | 339 | 361 | 448 | 497 | 528 | 559 | 594 | 528 | 422 |

Figure 1 Changes in number of the High Pressure Gas related accidents

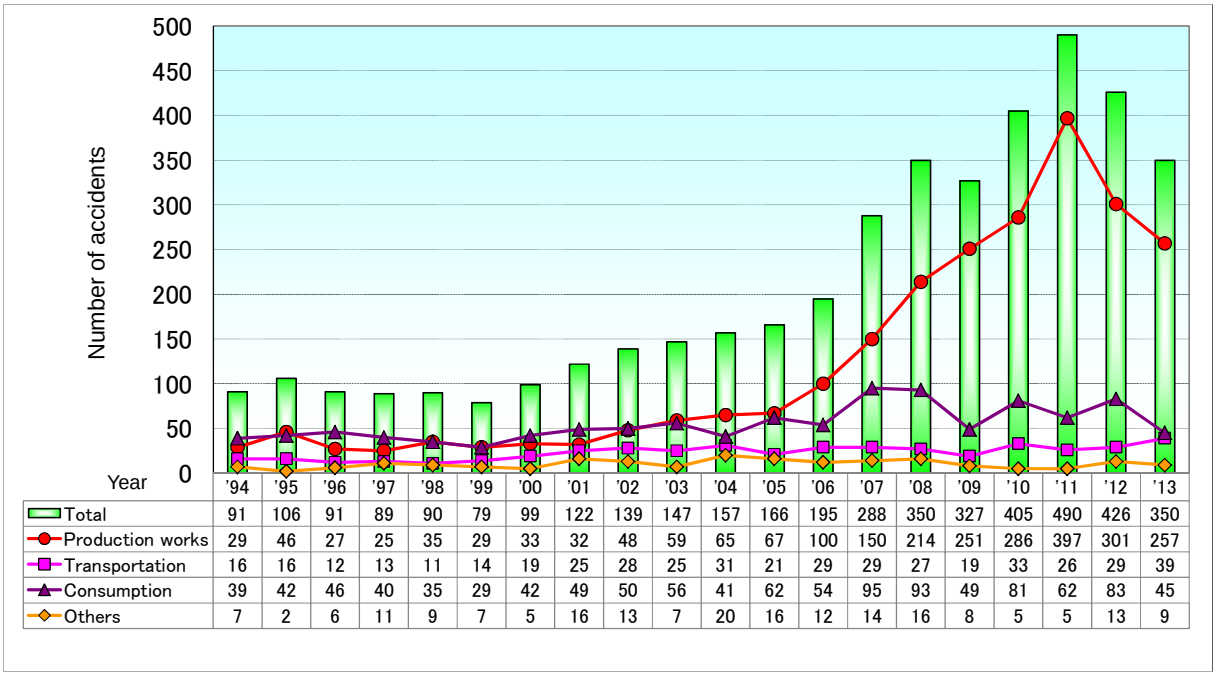
(2) Numbers of accidents by category

From this section onwards, the focal point of discussion is placed on disaster accidents.

Figure 2 shows the results of statistic treatment of the disaster accidents that occurred in the last two decades (1994 to 2013), according to accident categories. A notable feature is that the number of accidents has been on the increase since 2000 even though it had been around 100 accidents every year until 1999.

The breakdown of the 350 disaster accidents that occurred in 2013 shows, in decreasing order, 257 disaster accidents occurring at production works (73%), 45 during consumption (13%), 39 during transportation (11%), and nine others (3%).

As can be seen, the majority of disaster accidents had taken place at production works, and the ratios of accidents in 2013 were fairly similar compared to those during the last five years. Thus, it is clear that accident occurrences at production works have remained at a high level.




| Year | '94 | '95 | '96 | '97 | '98 | '99 | '00 | '01 | '02 | '03 | '04 | '05 | '06 | '07 | '08 | '09 | '10 | '11 | '12 | '13 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Total | 91 | 106 | 91 | 89 | 90 | 79 | 99 | 122 | 139 | 147 | 157 | 166 | 195 | 288 | 350 | 327 | 405 | 490 | 426 | 350 |
| Production works | 29 | 46 | 27 | 25 | 35 | 29 | 33 | 32 | 48 | 59 | 65 | 67 | 100 | 150 | 214 | 251 | 286 | 397 | 301 | 257 |
| Transportation | 16 | 16 | 12 | 13 | 11 | 14 | 19 | 25 | 28 | 25 | 31 | 21 | 29 | 29 | 27 | 19 | 33 | 26 | 29 | 39 |
| Consumption | 39 | 42 | 46 | 40 | 35 | 29 | 42 | 49 | 50 | 56 | 41 | 62 | 54 | 95 | 93 | 49 | 81 | 62 | 83 | 45 |
| Others | 7 | 2 | 6 | 11 | 9 | 7 | 5 | 16 | 13 | 7 | 20 | 16 | 12 | 14 | 16 | 8 | 5 | 5 | 13 | 9 |

Figure 2 Changes in number of disaster accidents by accident category

(3) Analysis and evaluation based on accident causes

Mentioned above, the definitions of accidents and items of accident causes were changed in 2011. Then Table 1 and Figure 3 shows the results of the disaster accidents statistics by causes which occurred during the three years between 2011 and 2013.

Looking at the 350 disaster accidents in 2013, 175 (50%) were caused by inadequate facility maintenance and management, 57 (16%) were caused by inadequate facility design and fabrication defects, and 45 (13%) were caused by human factors, together accounting for 79% of the total.

It is important to take countermeasures against inadequate facility design and fabrication defects, and inadequate facility maintenance and management, as well as human error prevention measures such as education and training.

Table 1 Analysis and evaluation based on accident causes in disaster accidents (2011 to 2013)

| | Inadequate facility design and fabrication defects | | | | Inadequate facility maintenance and management | | | | | | | Organizational defects | | | | Human factors | | | Others | | | | | Grand total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Year | Inadequate design | Fabrication defects | Inadequate construction management | Total | Inadequate corrosion control | Inadequate inspection management | Inadequate inspection | Inadequate transfer management | Inadequate seal management | Inadequate container management | Total | Inadequate organizational operation | Inadequate operational standards | Inadequate information conveyence | Total | Faulty operation and judgment | Inappropriate actions | Total | Natural disaster | Traffic accident | Others | Theft | Total | |
| 2013 | 28 | 10 | 19 | 57 | 65 | 22 | 18 | 21 | 31 | 18 | 175 | 0 | 14 | 1 | 15 | 41 | 4 | 45 | 3 | 17 | 38 | 0 | 58 | 350 |
| 2012 | 35 | 11 | 10 | 56 | 64 | 64 | 8 | 28 | 30 | 11 | 205 | 0 | 13 | 1 | 14 | 69 | 13 | 82 | 11 | 14 | 44 | 0 | 69 | 426 |
| 2011 | 22 | 17 | 11 | 50 | 67 | 66 | 8 | 38 | 28 | 19 | 226 | 0 | 8 | 1 | 9 | 45 | 4 | 49 | 86 | 7 | 63 | 0 | 156 | 490 |
| Total | 85 | 38 | 40 | 163 | 196 | 152 | 34 | 87 | 89 | 48 | 606 | 0 | 35 | 3 | 38 | 155 | 21 | 176 | 100 | 38 | 145 | 0 | 283 | 1266 |

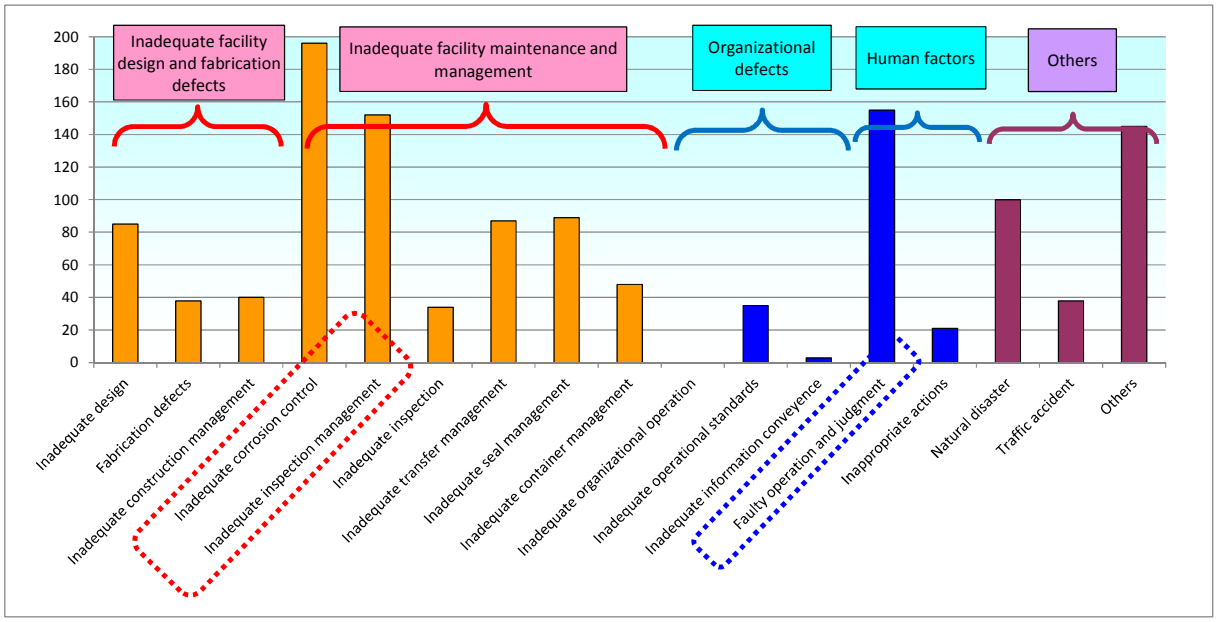



Figure 3 Analysis and evaluation based on accident causes in disaster accidents (2011 to 2013)

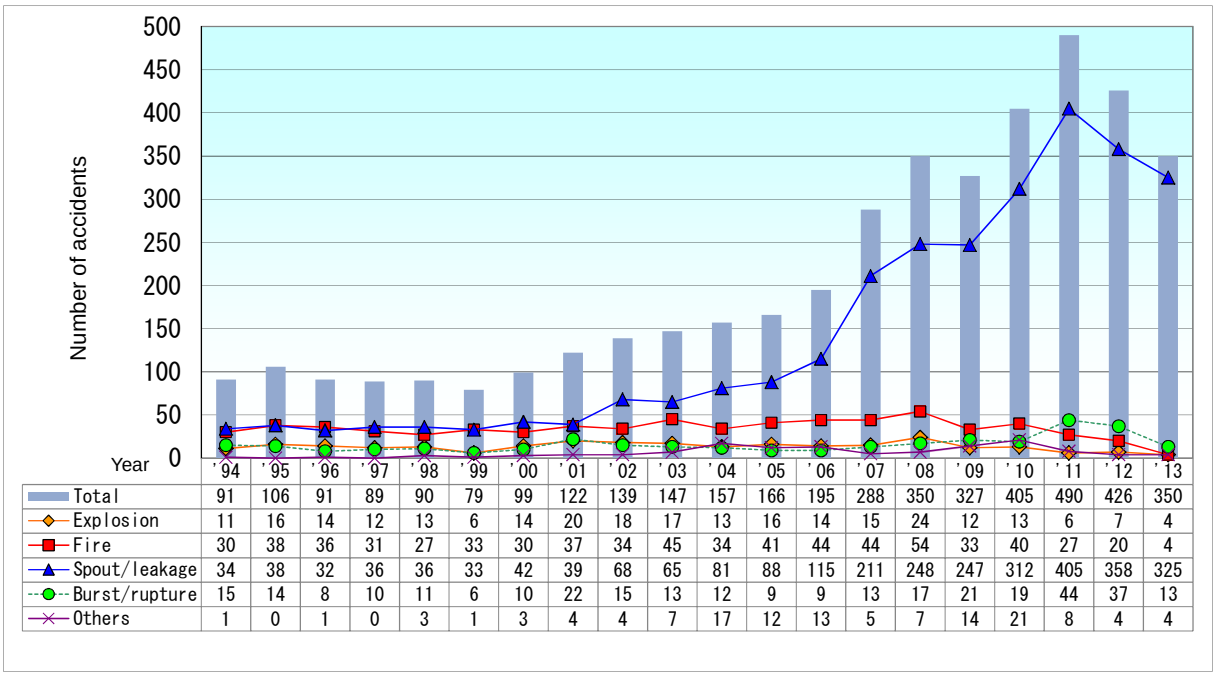
## 2.2 Analysis based on phenomenal categories, human damages, and accident classifications

(1) Analysis based on phenomenal categories

Figure 4 shows the statistical results of the disaster accidents that occurred during the last two decades (1994 to 2013), classified by phenomenon categories.

The number of disaster accidents in 2013 was 350, and looking at accident phenomena, spout/leakage accounted for 325 accidents (93%), burst/rupture for 13 accidents (4%), fire for four accidents (1%) and explosion for four accidents (1%), in that order. The majority of these accidents were spout/leakage.

During the last five years, spout/leakage accounted for 1,647 accidents (82%), burst/rupture for 134 accidents (7%), fire for 124 accidents (6%), and explosion for 42 accidents (2%), in that order.




| | '94 | '95 | '96 | '97 | '98 | '99 | '00 | '01 | '02 | '03 | '04 | '05 | '06 | '07 | '08 | '09 | '10 | '11 | '12 | '13 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Total | 91 | 106 | 91 | 89 | 90 | 79 | 99 | 122 | 139 | 147 | 157 | 166 | 195 | 288 | 350 | 327 | 405 | 490 | 426 | 350 |
| Explosion | 11 | 16 | 14 | 12 | 13 | 6 | 14 | 20 | 18 | 17 | 13 | 16 | 14 | 15 | 24 | 12 | 13 | 6 | 7 | 4 |
| Fire | 30 | 38 | 36 | 31 | 27 | 33 | 30 | 37 | 34 | 45 | 34 | 41 | 44 | 44 | 54 | 33 | 40 | 27 | 20 | 4 |
| Spout/leakage | 34 | 38 | 32 | 36 | 36 | 33 | 42 | 39 | 68 | 65 | 81 | 88 | 115 | 211 | 248 | 247 | 312 | 405 | 358 | 325 |
| Burst/rupture | 15 | 14 | 8 | 10 | 11 | 6 | 10 | 22 | 15 | 13 | 12 | 9 | 9 | 13 | 17 | 21 | 19 | 44 | 37 | 13 |
| Others | 1 | 0 | 1 | 0 | 3 | 1 | 3 | 4 | 4 | 7 | 17 | 12 | 13 | 5 | 7 | 14 | 21 | 8 | 4 | 4 |

Figure 4 Change in number of disaster accidents by phenomenon category

(2) Analysis based on human damages

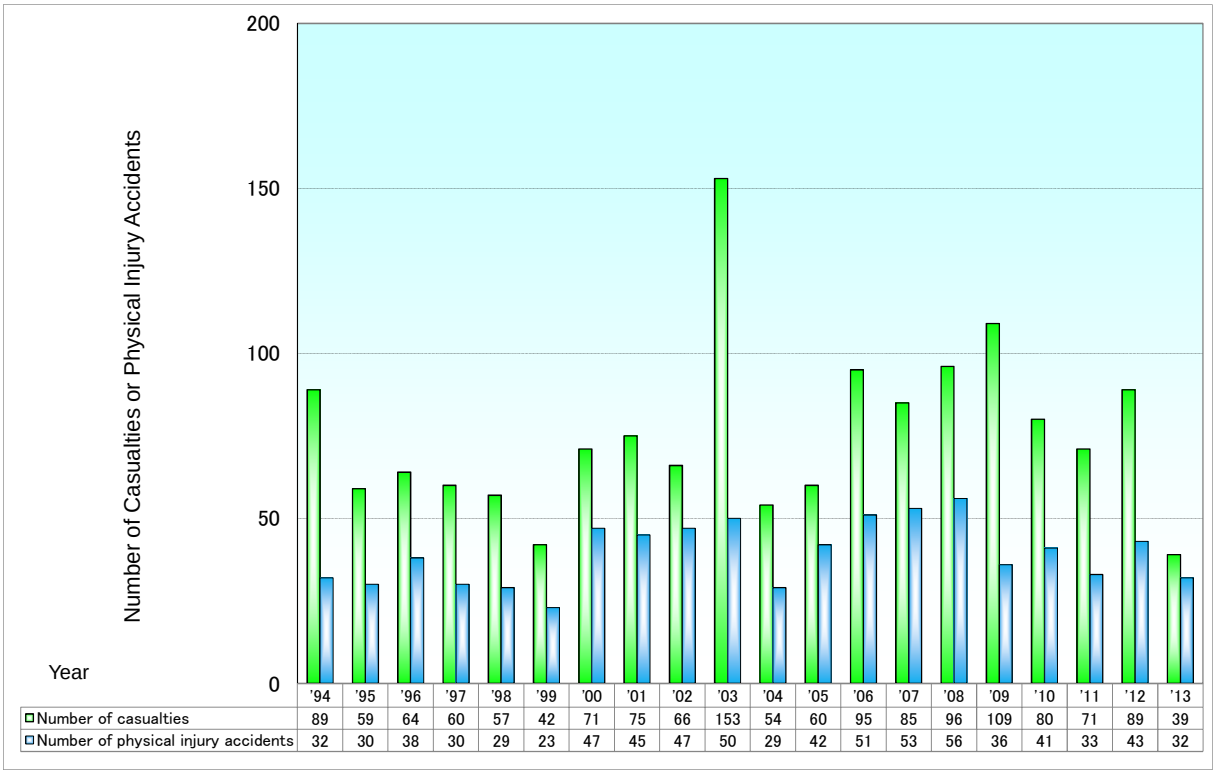
Figure 5 shows the statistical results of the disaster accidents that occurred during the last two decades (1994 to 2013), classified by human damages.

The number of accidents resulting in injury or death was 32 in 2013, accounting for 9% of the 350 disaster accidents. The number of persons suffering injury or death was 39, making the number of casualties per physical injury accident 1.22.

The results of the same calculation for the 1,998 disaster accidents, 185 physical injury accidents, and 388 casualties in the last five years indicate a ratio of physical injury accident of 9% and a number of casualties per physical injury accident of 2.10.

The number of physical injury accidents was 32 in 2013, which was fewer than the 43 that occurred in 2012. The number of casualties reduced to 39 in 2013, fewer than half from 89 in 2012.

The greatest number of casualties per accident in 2013 was three persons, who were injured by two accidents of a liquefied gas leakage from an air separation plant and a LP gas leakage resulting explosion during fusing work of plastics.




| Year | '94 | '95 | '96 | '97 | '98 | '99 | '00 | '01 | '02 | '03 | '04 | '05 | '06 | '07 | '08 | '09 | '10 | '11 | '12 | '13 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Number of casualties | 89 | 59 | 64 | 60 | 57 | 42 | 71 | 75 | 66 | 153 | 54 | 60 | 95 | 85 | 96 | 109 | 80 | 71 | 89 | 39 |
| Number of physical injury accidents | 32 | 30 | 38 | 30 | 29 | 23 | 47 | 45 | 47 | 50 | 29 | 42 | 51 | 53 | 56 | 36 | 41 | 33 | 43 | 32 |

Figure 5 Change in number of physical injury accidents and casualties in disaster accidents

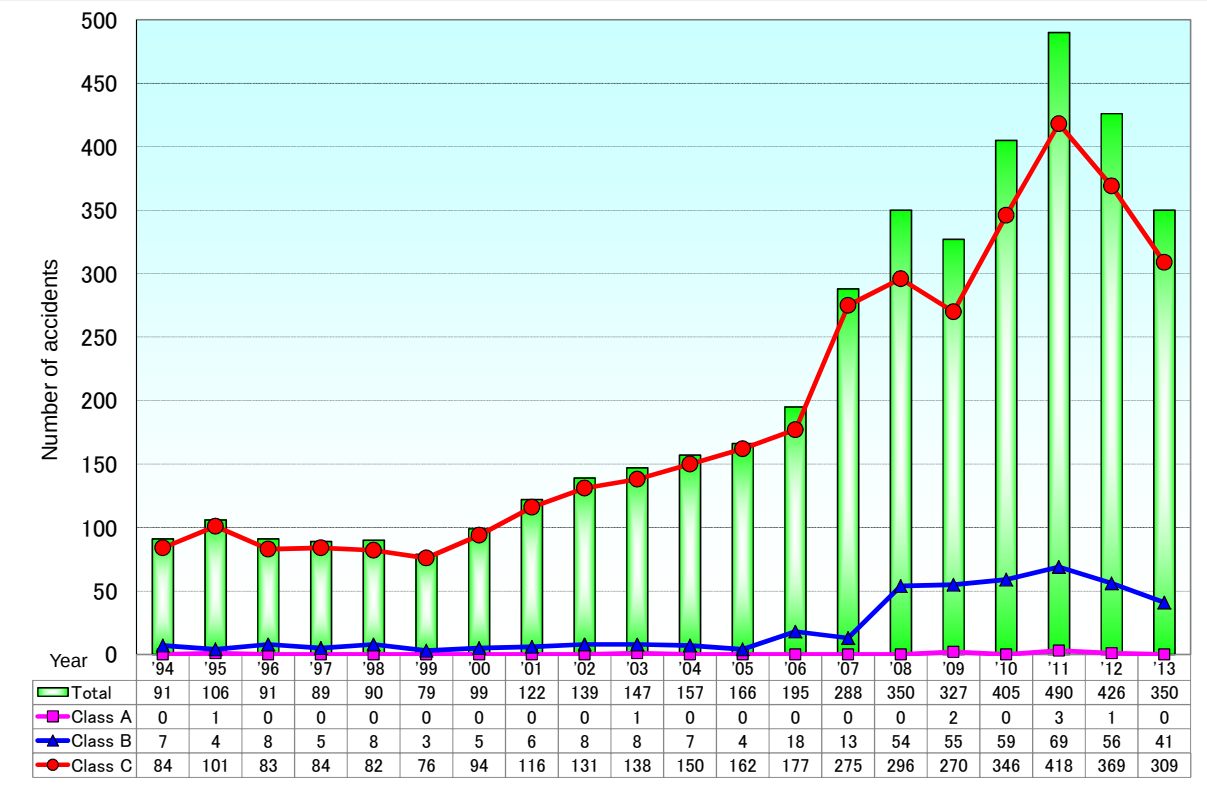
(3) Analysis based on accident classifications

Figure 6 shows the statistical results of disaster accidents that occurred during the last two decades (1994 to 2013), classified by accident classifications.

Although one Class A accidents occurred in 2012, none took place in 2013.

Fewer than 10 Class B accidents took place each year until 2005, which increased to 18 in 2006. More than 50 Class B accidents occurred after in 2008, but reduced to 41 in 2013.

The 41 Class B accidents in 2013 consisted of two cases of death (up to four fatalities), one case greatly affected to the public, and the other38 cases of where two or more Class C accidents occurred repeatedly at the same facilities during one year.




| Year | '94 | '95 | '96 | '97 | '98 | '99 | '00 | '01 | '02 | '03 | '04 | '05 | '06 | '07 | '08 | '09 | '10 | '11 | '12 | '13 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Total | 91 | 106 | 91 | 89 | 90 | 79 | 99 | 122 | 139 | 147 | 157 | 166 | 195 | 288 | 350 | 327 | 405 | 490 | 426 | 350 |
| Class A | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 3 | 1 | 0 |
| Class B | 7 | 4 | 8 | 5 | 8 | 3 | 5 | 6 | 8 | 8 | 7 | 4 | 18 | 13 | 54 | 55 | 59 | 69 | 56 | 41 |
| Class C | 84 | 101 | 83 | 84 | 82 | 76 | 94 | 116 | 131 | 138 | 150 | 162 | 177 | 275 | 296 | 270 | 346 | 418 | 369 | 309 |

Figure 6 Changes in number of disaster accidents by accident classification

Table 1 Definition of classification by degree of loss

| | Contents of loss |
|---|---|
| Class A | (1) Deaths 5 or more<br>(2) Deaths plus serious injuries 10 or more<br>(3) Casualties (death plus injury) 30 or more<br>(4) Direct property damage 500 million yen or more<br>(5) Any accident affecting the public, or which could have developed into a large scale disaster |
| Class B | (1) Deaths 1 to 4<br>(2) Serious injuries 2 to 9<br>(3) Casualties (injury) 6 to 29<br>(4) Direct property damage 100 to 500 million yen<br>(5) Accidents repeatedly occurring at the same works<br>(6) Any accident affecting the public, or which could have developed into a large scale of disaster. |
| Class C | Other than Classes A and B |

### 2.3 Accidents related to the High Pressure Gas Safety Act that occurred in 2013

| Accident title | Explosion of premixing tank | A fatal accident during disposal of residual gas in oxygen cylinder | A fatal accident of nitrogen gas leakage from safety valve during cooling test in LNG tanker |
|---|---|---|---|
| Date | January 7, 2013 | February 23, 2013 | July 10, 2013 |
| Deaths/ serious injuries/ minor injuries | 0/1/0 | 1/0/0 | 1/0/0 |
| Overall toll | 1 | 1 | 1 |
| Substance name | Ethylene, Oxygen, Hydrogen, Nitrogen | Oxygen | Nitrogen |
| Class | B | B | B |
| Primary phenomenon/ secondary phenomenon | Explosion / - | Leakage / blowing away the cylinder | Leakage / others(oxygen deficiency) |
| Situations of handling | During production | During disposal of residual gas | During gas consumption |
| Accident causes (main causes)/ (secondary causes) | Other (Unknown) / - | Faulty operation, faulty judgment / Inadequate handling of cylinders | Faulty operation, faulty judgment / Lack of operation manuals |
| Ignition source | Static electricity | None | None |
| Accident outline | When a student was mixing ethylene, oxygen, hydrogen and nitrogen in a premixing tank to prepare a combustion experiment of mixture gas, the pressure of the tank suddenly increased and bolts which jointed a cover with the tank were broken, and then the cover hit the working student's right side. A part of the experimental equipment got fire at that time. Immediately after the accident, some people who rushed there turned the main valve off, extinguished fire and called the police and fire fighting.<br>From the circumstances, the mixed gas is estimated to have gotten fire and burned due to unknown factor during mixing gas in the tank. The factor is assumed a static electricity because there were no ignition sources on the tank. | Although a worker should open a cylinder valve, however, he turned the valve body by a pipe wrench to release residual gas in an oxygen cylinder. When he turned the valve body more in order to increase the amount of the released gas, the valve body got suddenly blown off by the gas gushing out from the cylinder, and then the cylinder jumped out like a rocket. The cylinder hit another worker working eight meters away from there, and the cylinder flew 13 meters away with him.<br>The cause of the accident is believed that, the cylinder valve got blown off by the gas gushing out from the cylinder, and then the cylinder blew off. | Nitrogen gas was supplied from a tanker truck to a LNG tanker ship for the purpose of cooling test of pipes. The dome house was filled with the nitrogen gas leaked from a defective safety valve at pipes in the tanker ship. A worker entered into the dome house to pick up a tool, and then he died from oxygen deficiency.<br>The cause of the accident is presumed that the dome house could not be assumed to be filled with nitrogen gas through the safety valve during cooling test, though the defect of the valve was found when it was installed. Furthermore, a warning sign "Keep out during cooling test" was showed in front of the dome house, but it seems that it is insufficient to make all workers know the hazard of oxygen deficiency.<br>From now on, all related people have to be educated about the hazard of oxygen deficiency by nitrogen gas, and also have to be informed about prohibition of entry and how to check the oxygen concentration. |