2010

KOREAN FIRE DATA

KFPA

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December 2011

KFPA
KOREAN FIRE PROTECTION ASSOCIATION

FOREWORD

We are pleased to issue the revised edition of the English booklet entitled "Korean Fire Data" which offers an outline of Korean fire statistics during the year 2010 and fire cases in 2010.

The first edition was published in 1997 in accordance with the "The agreement of cooperation between NFPA (National Fire Protection Association) and KFPA (Korean Fire Protection Association)." It was probably the first Korean fire related statistics in English which made the way for disseminating of information throughout the world including USA. Since then, the revised editions have been issued annually.

In year 2007 the renovation of nationwide fire incident statistics, 「Korea National Fire Incident Classification System」, had gone into effect, therefore numbers of fire incidents in fire statistics has increased because the new statistics began to include fires with no property loss. Also the Classification rule has been changed since 2007.

In year 2010, fires were decreased by －11.5%(-5,455 fires) in numbers, civilian death toll by －25.7%(-105), civilian injuries by －21.9%(-444), and property loss by +5.9%.

Most severe fire incident was at a nursing home which ended up with 10 deaths and 17 injuries. Also there was a fire in a high-rise condominium which ended up with 7 injuries and 5.7 billion won. You can see the fire reports for these cases.

We hope this document serves not only to deliver the current Korean fire data but to reduce fire disasters globally.

Acknowledgements

The KFPA gratefully thanks fire departments, National Emergency Management Agency and National fire data system for these precious data.

For more information about the Korean Fire Protection Association, visit www.kfpa.or.kr or call 82-2-3780-0322.

Copies of this report are available from:

Korean Fire Protection Association.
Research & Investigation team
35-4, Yeouido-dong, Yeungdeunpo-gu. Seoul, Republic of Korea
www.kfpa.or.kr
e-mail: hryu@kfpa.or.kr
phone: 82-2-3780-0322
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CONTENTS

FIRE LOSS IN KOREA

Source : *『Fire Statistics Yearbook 2010』*
by the National Emergency Management Agency of the Republic of Korea

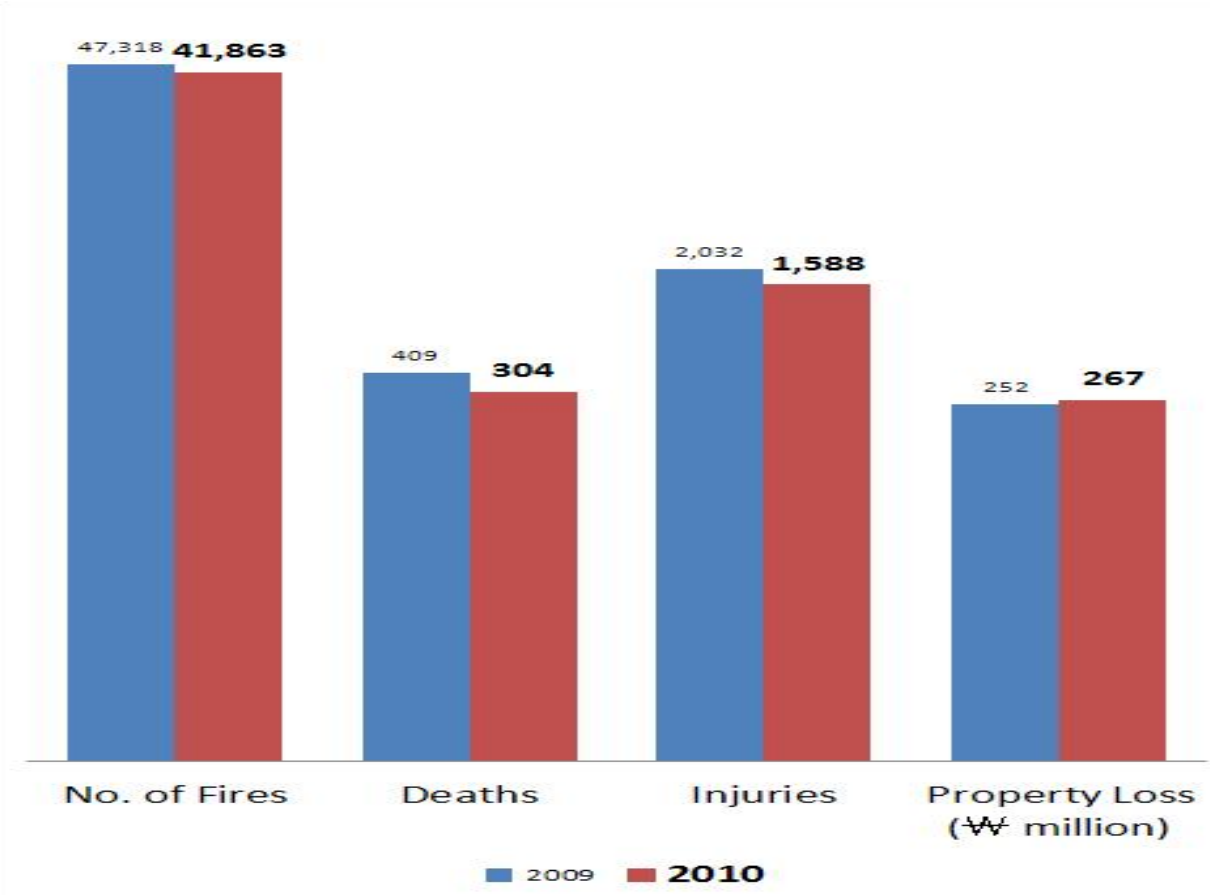
Overview

I. Overview of 2010 Korea Fire Experience

	2010	2009	Change in number	Change in percentage
No. of Fires	41,863	47,318	-5,455	-11.5
Deaths*	304	409	-105	-25.7
Injuries	1,588	2,032	-444	-21.9
Property Loss (₩ million)	266,776	251,853	14,923	+5.9

※ Note :1. 1,130 KRW is worth 1 USD(as of Dec 1, 2011) approximately, the same shall apply hereinafter.
2. The Property loss values in this report are not adjusted for inflation hereinafter.
3. Casualties include civilians and fire fighters.

* Death after 72 hours or less by the injury from fire.



2009, 2010 fire experience

41,863 fires were reported in Korea during 2010.

○ down 11.5% from 2009

○ 304 fire deaths

○ 1,588 fire injuries

○ ₩ 266 billion in property damage, up5.9% from 2009

10,509 fires were reported in Residential structure.

○ down 10.7% from 2009

○ 199 fire deaths

○ 749 fire injuries

○ ₩ 53 billion in property damage

5,788 fires were reported in transportation(vehicle, train, ship, aircraft)

○ 18 fire deaths

○ 109 fire injuries

○ ₩ 23.8 billion in property damage

2,209 fires were reported in wildland.

○ 5 fire deaths

○ 24 fire injuries

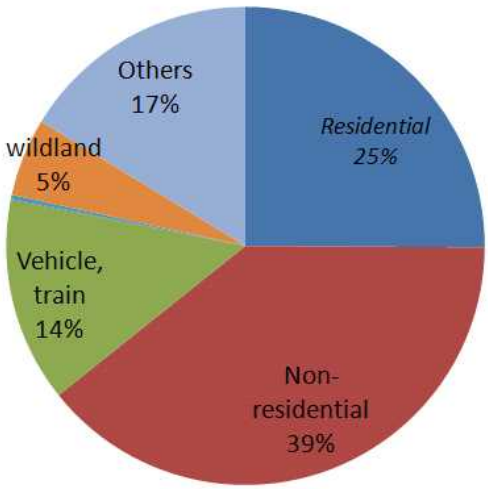
○ ₩ 1.4 billion in property damage

Ⅱ. Fires and Property Loss by type

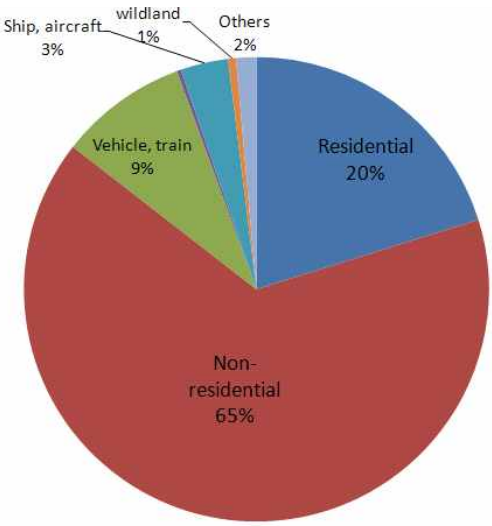
Type	Fire		Property loss[1,2](₩)		Death	Injury
	No.	Percent change from 2009	₩	Percent change from 2009		
Total	41,863	-11.5	266,776,332	5.9	304	1,588
Residential	10,509	-10.7	53,768,644	8.0	199	749
Non-residential	16,395	-0.5	174,378,854	3.5	76	622
Vehicle, train	5,788	-3.3	23,797,217	-1.5	18	109
Explosive, Gas industry	30	-40.0	777,147	12.0	1	15
Ship, aircraft	112	-20.0	8,843,930	427.9	0	9
Wildland	2,209	-47.1	1,457,022	-52.2	5	24
Others	6,820	-21.8	3,753,518	-7.3	5	60

[1] No adjustment was made for inflation in the year-to-year comparison.

[2] This includes overall direct property loss to contents, structure, a vehicle, machinery, vegetation or anything else involved in a fire. It does not include indirect losses, e.g., business interruption or temporary shelter costs.

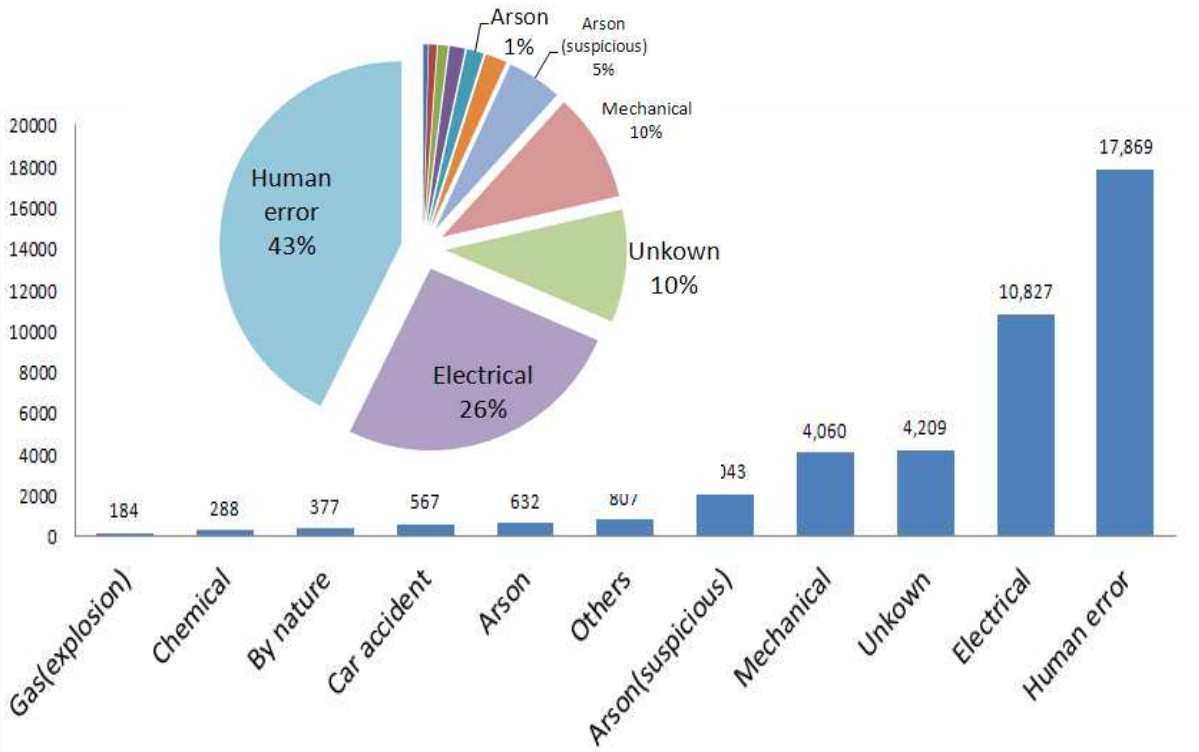


Percentage(No. of fires)



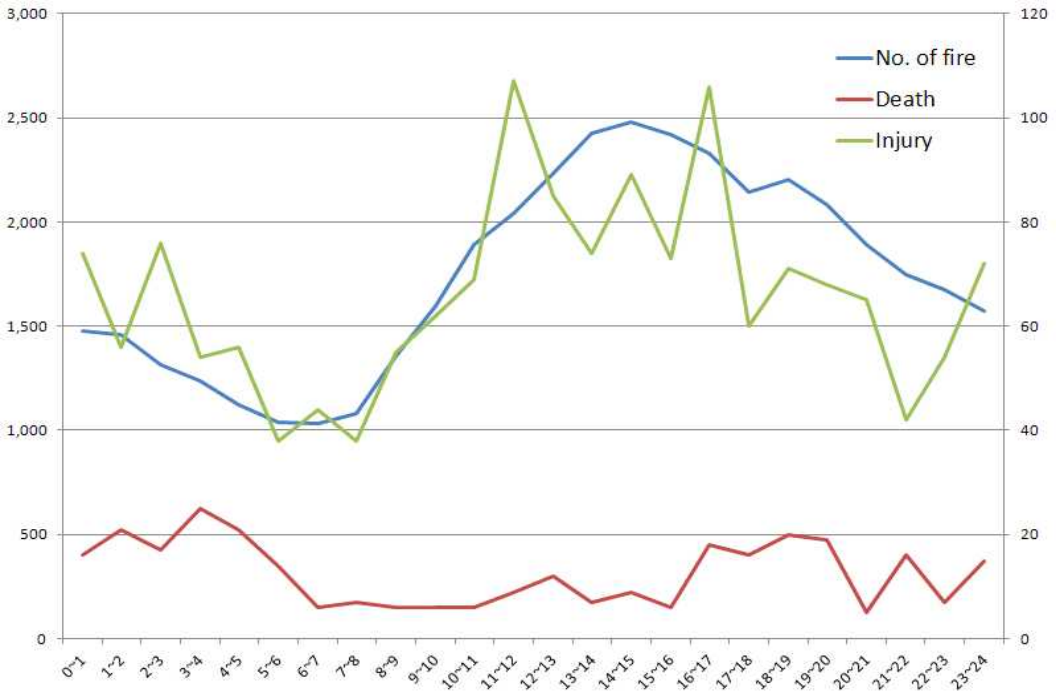
Percentage(Property loss)

Ⅲ. Fires by causes



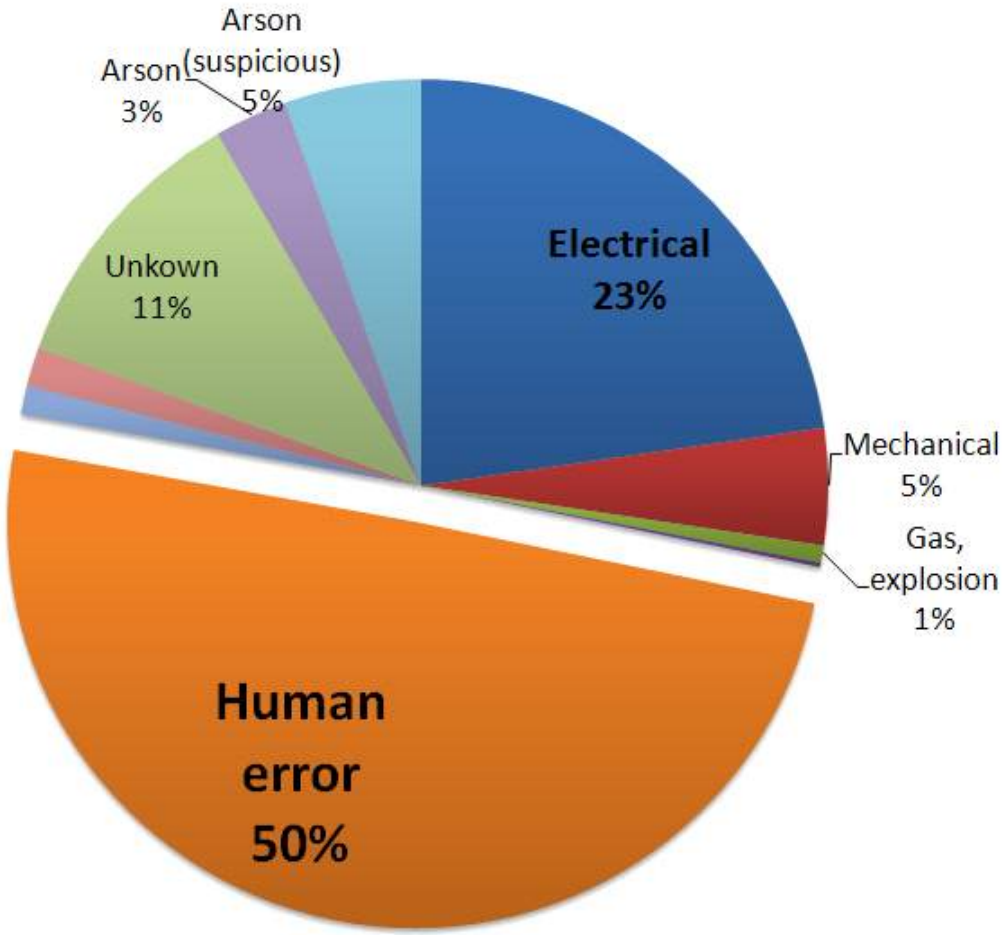
Cause	No.	Death	Injury	Casualty /fire	Property loss	loss/fire
Total	41,863	304	1,588	0.05	266,776,332	6,372.60
Gas (explosion)	184	5	106	0.6	1,794,674	9,753.70
Chemical	288	0	28	0.1	4,698,075	16,312.80
By nature	377	0	0	0	1,709,715	4,535.10
Car accident	567	8	21	0.05	3,791,317	6,686.60
Arson	632	53	130	0.29	4,245,609	6,717.70
Others	807	4	51	0.07	5,892,610	7,301.90
Arson (suspicious)	2,043	27	92	0.06	8,746,627	4,281.30
Mechanical	4,060	3	70	0.02	23,245,995	5,725.60
Unkown	4,209	102	317	0.1	106,035,112	25,192.50
Electrical	10,827	48	225	0.03	66,383,201	6,131.30
Human error	17,869	54	548	0.03	40,233,397	2,251.60

Ⅳ. Fires by time



Time	No. of Fires	Deaths	Injuries	Property loss
total	41,863	304	1,588	266,776,332
0~1	1,476	16	74	11,479,339
1~2	1,462	21	56	14,720,023
2~3	1,313	17	76	13,568,205
3~4	1,239	25	54	12,150,123
4~5	1,120	21	56	11,815,753
5~6	1,038	14	38	8,416,720
6~7	1,034	6	44	9,842,448
7~8	1,082	7	38	7,779,666
8~9	1,356	6	55	8,322,035
9~10	1,597	6	62	9,216,552
10~11	1,894	6	69	11,641,478
11~12	2,040	9	107	19,340,236
12~13	2,232	12	85	11,216,310
13~14	2,427	7	74	11,018,432
14~15	2,481	9	89	11,606,722
15~16	2,417	6	73	9,857,569
16~17	2,329	18	106	10,136,672
17~18	2,145	16	60	6,989,603
18~19	2,205	20	71	11,504,628
19~20	2,086	19	68	10,902,335
20~21	1,891	5	65	12,619,913
21~22	1,746	16	42	9,156,314
22~23	1,678	7	54	13,962,075
23~24	1,575	15	72	9,513,181

Ⅴ. Causes in Residential Occupancy

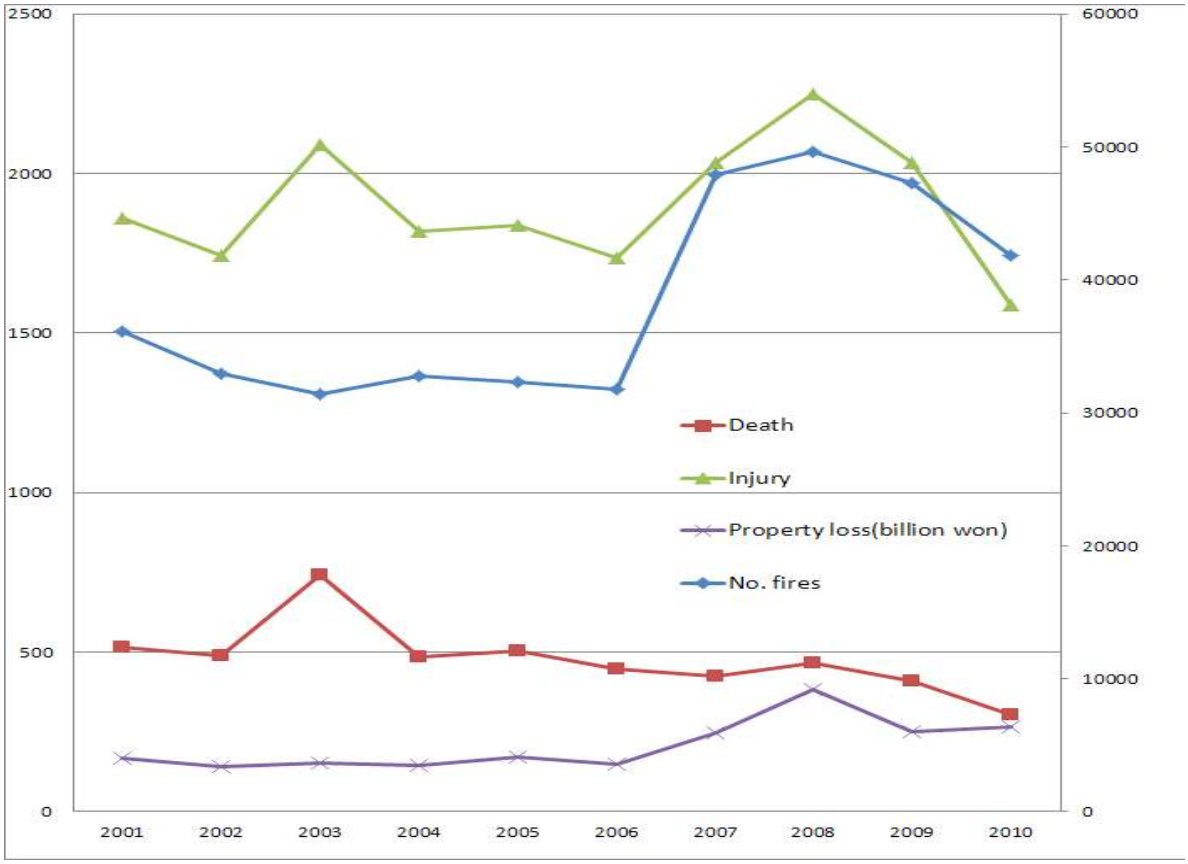


Cause	No. fires	Death	Injury	property loss
Total	10,509	199	749	53,768,644
Electrical	2,388	29	111	18,451,976
Mechanical	487	0	12	2,337,779
Gas Explosion	71	4	51	612,395
Chemical	19	0	2	2,389,037
Human error	5,214	37	247	12,198,816
Natural	120	0	0	478,510
others	161	3	12	822,029
Unkown	1,172	73	187	12,437,783
Arson	305	33	71	1,767,697
Arson (suspicious)	572	20	56	2,272,622

Firstly, Human error accounted for a half of home fires. Secondly, Causes from Electricity(eletrical failure or malfunction) accounted for 23%. Human factors are Abandoned or discarded material, Heat source too close, Playing with heat source and so on.

Fire experience analysis

Ⅰ. Fire experience during 2001-2010

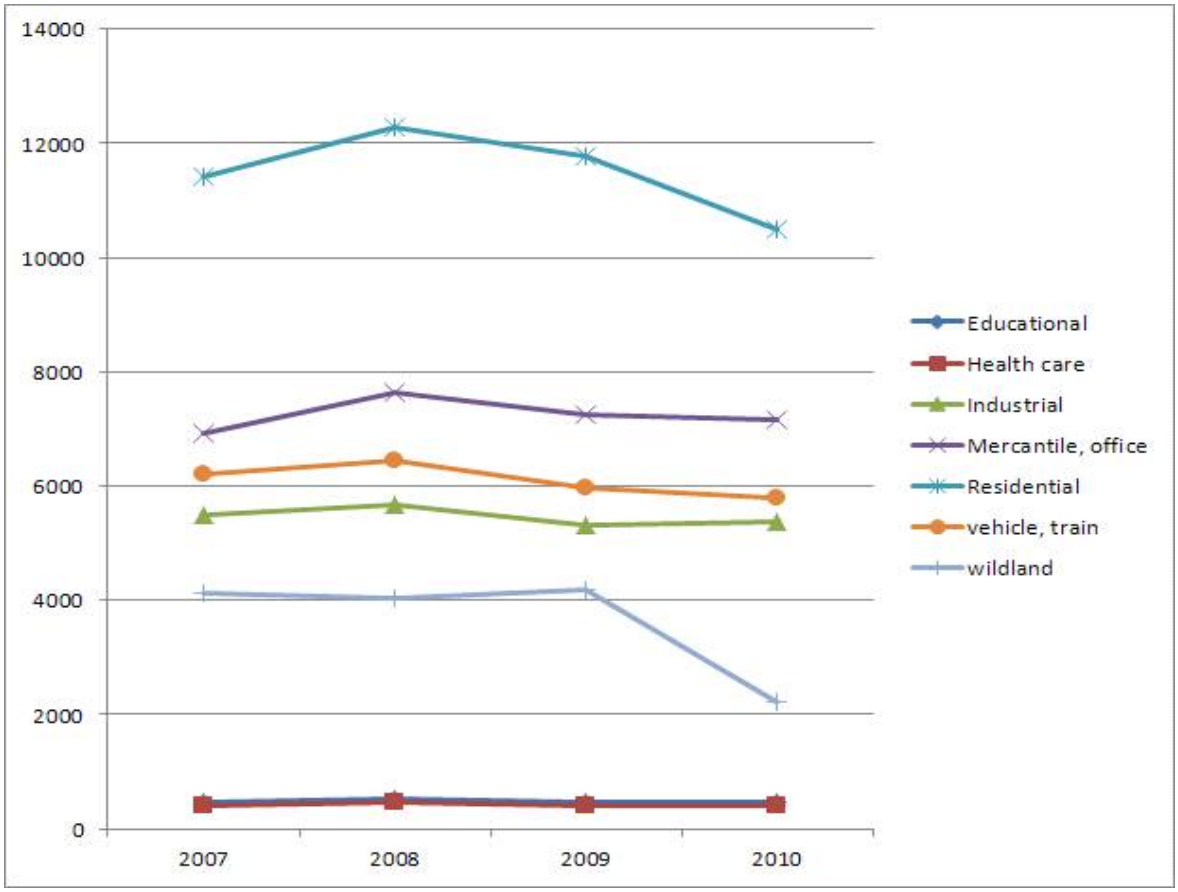


Year	No. fires	Death	Injury	Property loss (billion won)
2001	36,169	516	1,860	169.8
2002	32,966	491	1,744	143.4
2003*	31,372	744	2,089	151.6
2004	32,737	484	1,820	146.6
2005	32,340	505	1,837	171.4
2006	31,778	446	1,734	150.8
2007**	47,882	424	2,035	248.4
2008	49,631	468	2,248	383.1
2009	47,318	409	2,035	251.9
2010	41,863	304	1,588	266.8

* In 2003, Dague subway arson fire resulted in 192 deaths.

**Since 2007, No. of fires uprised because fires with no loss has been sumed.

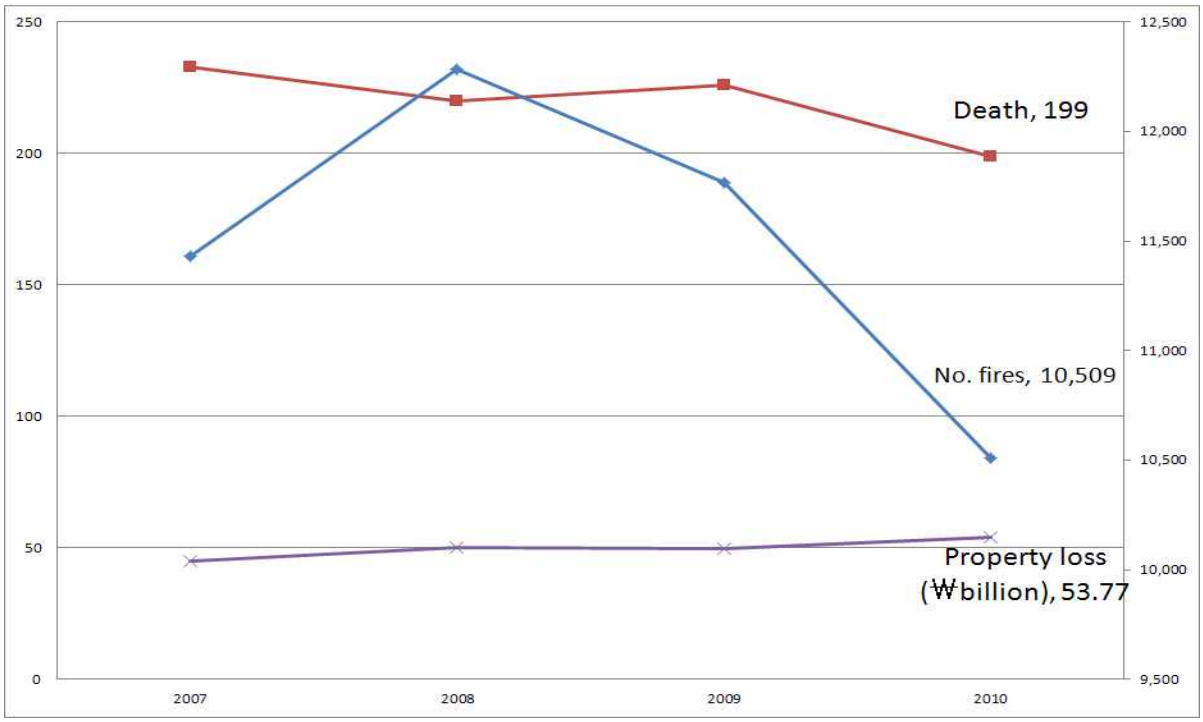
Ⅱ. Fires by Property type, 2007*-2010



Type	2007	2008	2009	2010
Complex	495	437	412	432
Cultural asset	6	8	4	7
Educational	478	534	468	471
Health care	397	458	404	404
Industrial	5,500	5,677	5,306	5,384
Mercantile, office	6,924	7,626	7,259	7,160
others	11,964	11,685	11,107	9,091
Residential	11,430	12,283	11,767	10,509
ship, aircraft	129	127	140	112
Transportation facility	211	323	289	296
vehicle, train	6,220	6,449	5,983	5,788
wildland	4,128	4,024	4,179	2,209

*In year 2007 the renovation of nationwide fire incident statistics, 「Korea National Fire Incident Classification System」, had gone into effect, therefore this report analyzes occupancy fire trend since 2007.

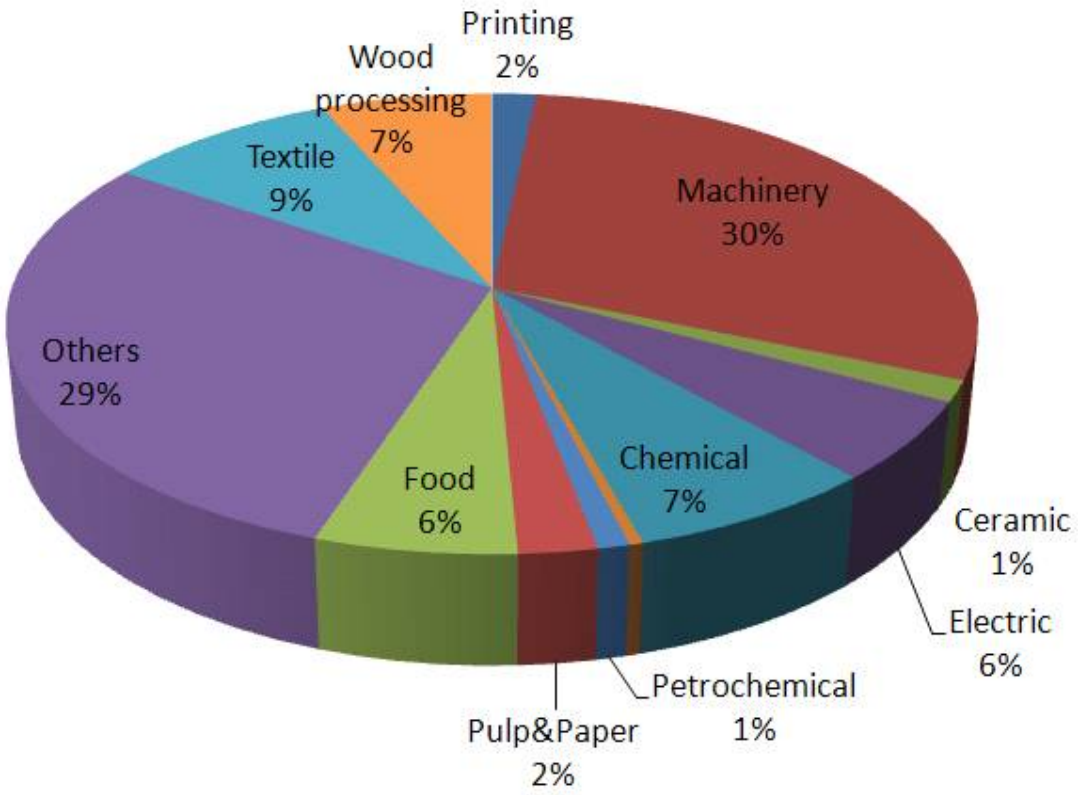
Ⅲ. Residential (Houses & Apartment), 2007~2010



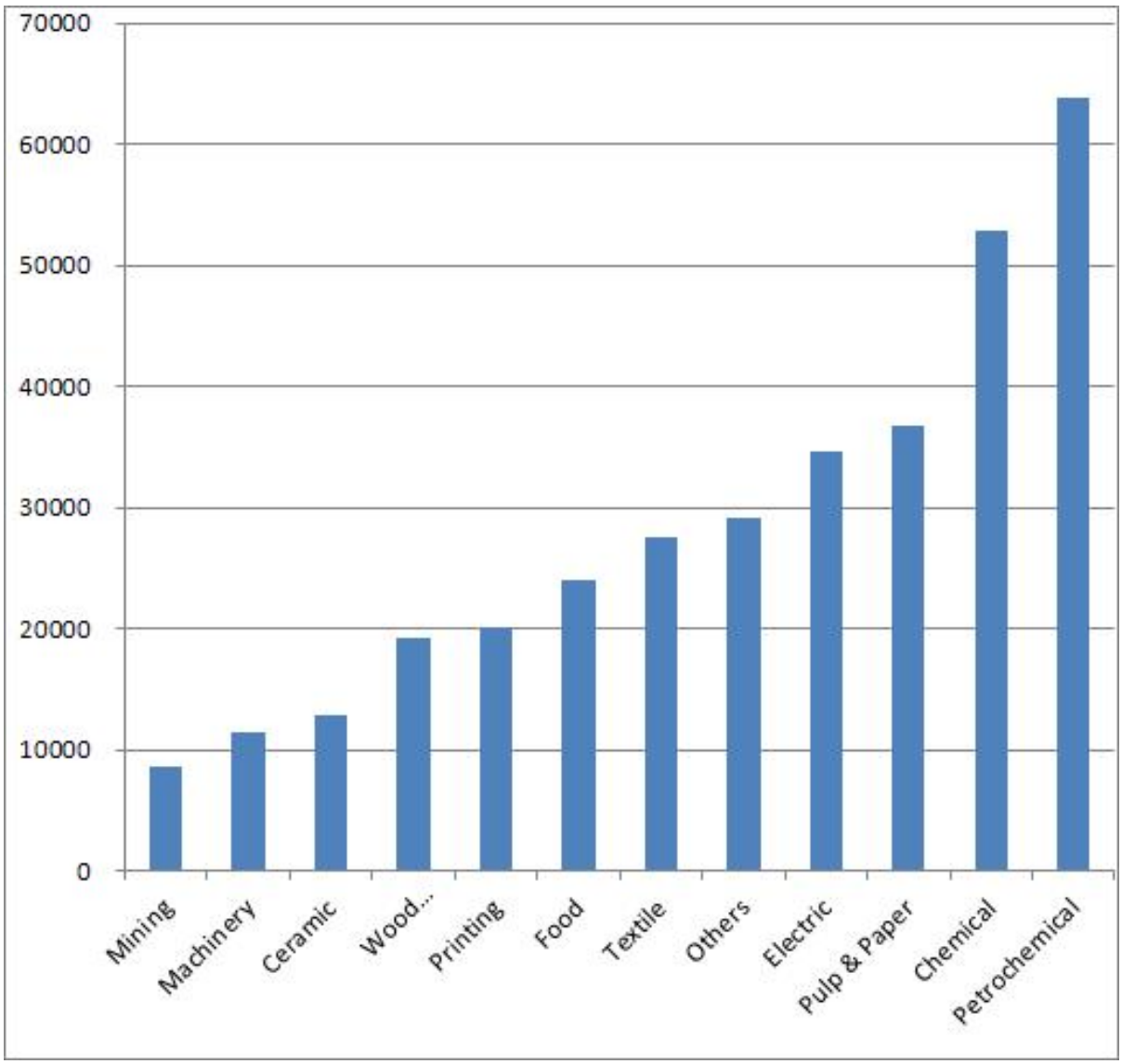
Year	No. fires	Death	Injury	Property loss (₩thousand)
2010	10,509	199	749	53,768,644
2009	11,767	226	854	49,792,818
2008	12,283	220	917	50,070,305
2007	11,430	233	833	45,062,377

In all, fires in the residentila occupancy fires (one- and two-family homes including apartments) resulted in 199 civilian deaths, 65.4% of all death in 2010. However, home fire deaths decreased steadily.

Ⅳ. Fires by Industry classification, 2007-2010



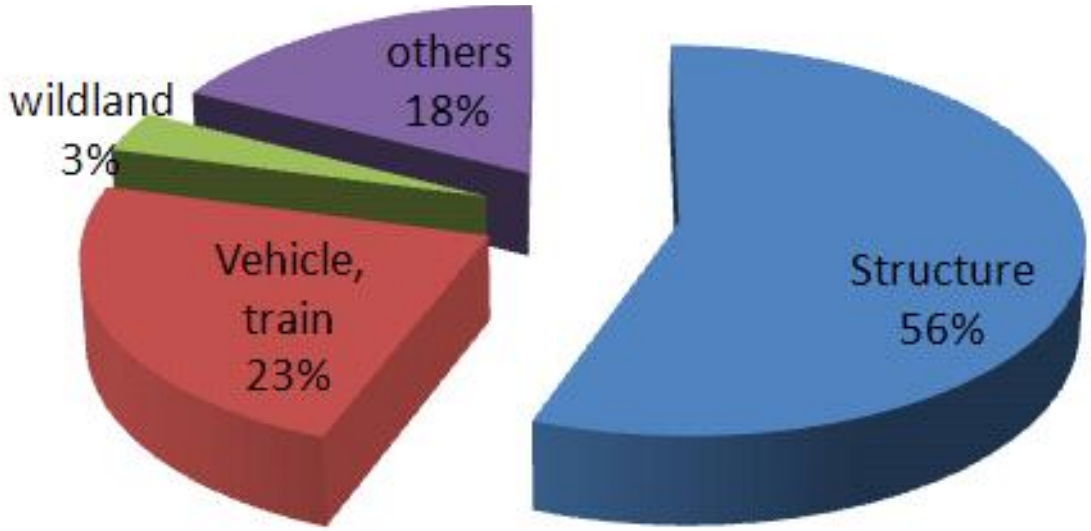
Industry	No	Fire	Injury	Property loss (thosand won)	loss/a fire
Total	10,363	54	663	257,413,716	24,839.70
Printing	177	0	14	3,560,506	20,115.90
Machinery	3,068	12	163	34,863,769	11,363.70
Ceramic	154	0	5	1,988,834	12,914.50
Electric	580	2	66	20,133,197	34,712.40
Chemical	756	4	90	39,925,107	52,811.00
Mining	41	0	3	355,782	8,677.60
Petrochemical	95	2	33	6,058,342	63,772.00
Pulp&Paper	235	0	7	8,632,576	36,734.40
Food	603	7	26	14,514,184	24,070.00
Others	3,037	21	212	88,574,929	29,165.30
Textile	930	5	24	25,646,724	27,577.10
Wood processing	687	1	20	13,159,766	19,155.40



Property loss per fire by industry

Korea fire departments were reported to 10,363 fires in industrial and manufacturing properties in 2007-2010.
Property loss per fire is highest in Petrochemical industry.

Ⅴ. Arson, 2007-2010

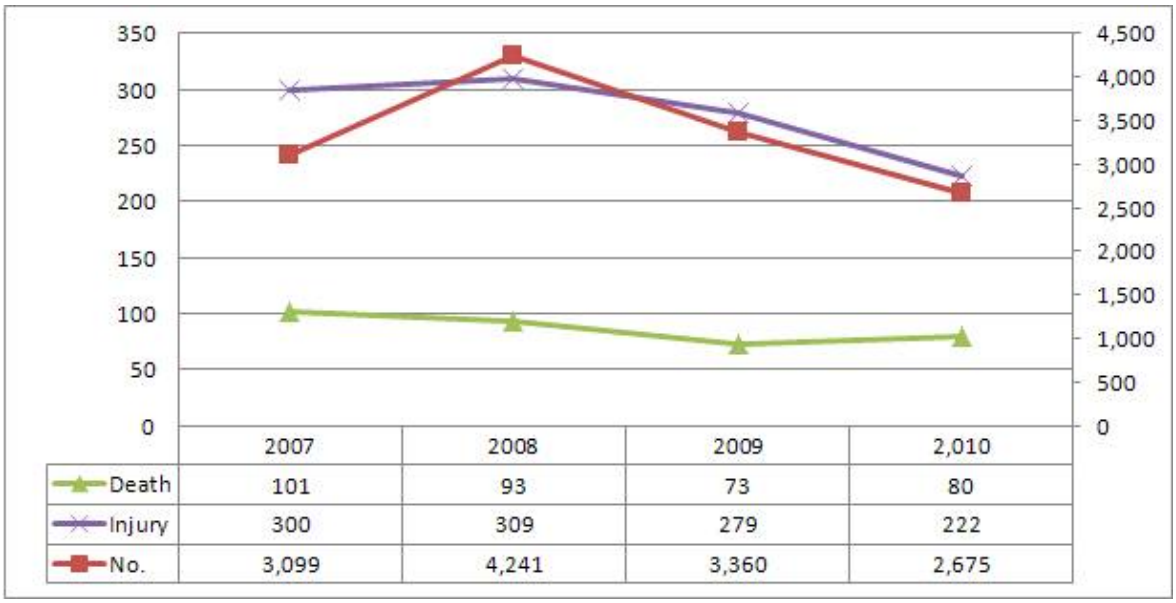


No of Arson fire by type, 2007-2010.

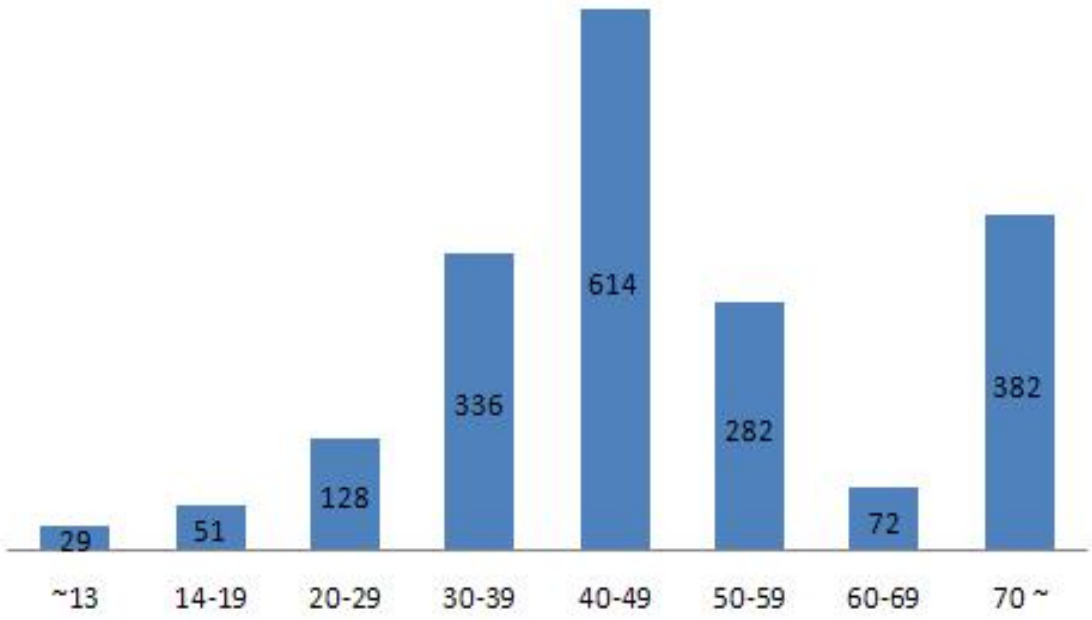
Type	2010	2009	2008	2007
Structure	1,592	1,748	2,315	1,787
Vehicle, train	588	829	1,003	699
wildland	68	164	149	76
others	422	611	770	530

*: including fires by suspicion of arson

During 2007~2010, 13,351 intentional fires were reported to fire departments. These fires were associated with losses of 347 fire deaths, 1,110 fire injuries.

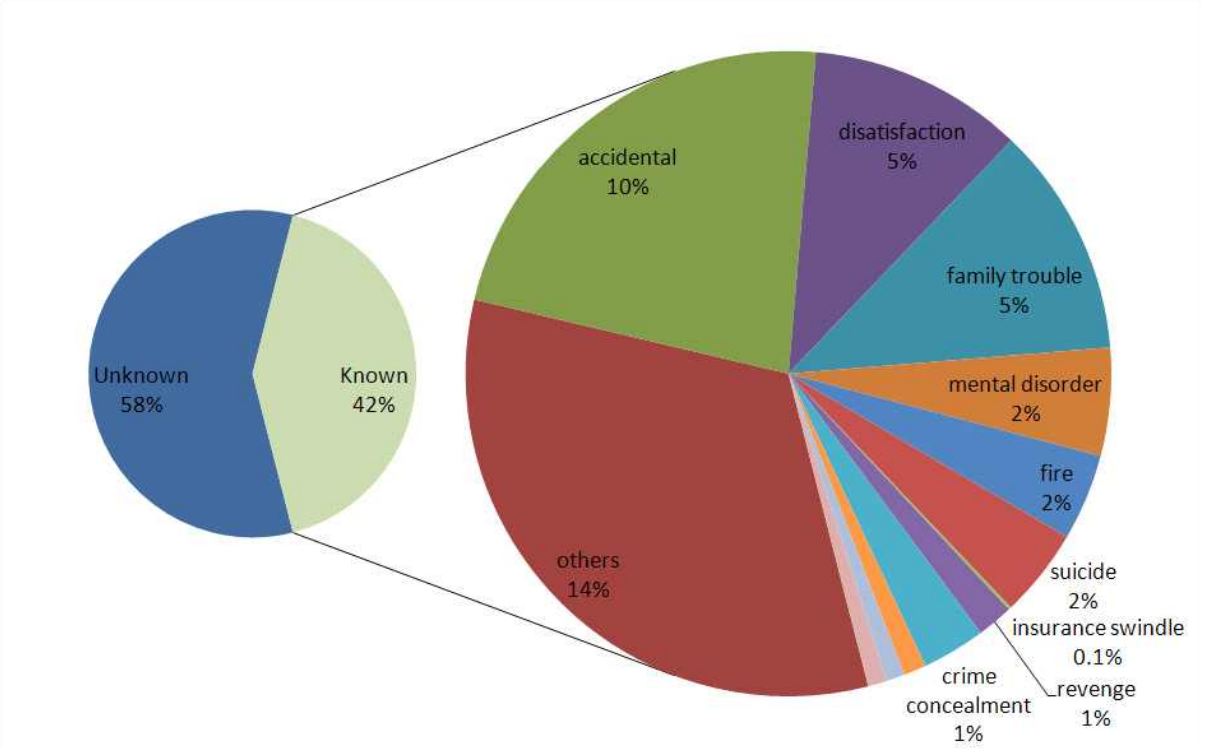


Casualties by Arson(2007~2010)



Arson fire No. by Arsonist's age group.(excluding Unknown cases) 2007-2010

In 2007~2010, over 70% of Known arson fires were by over the age of 40.

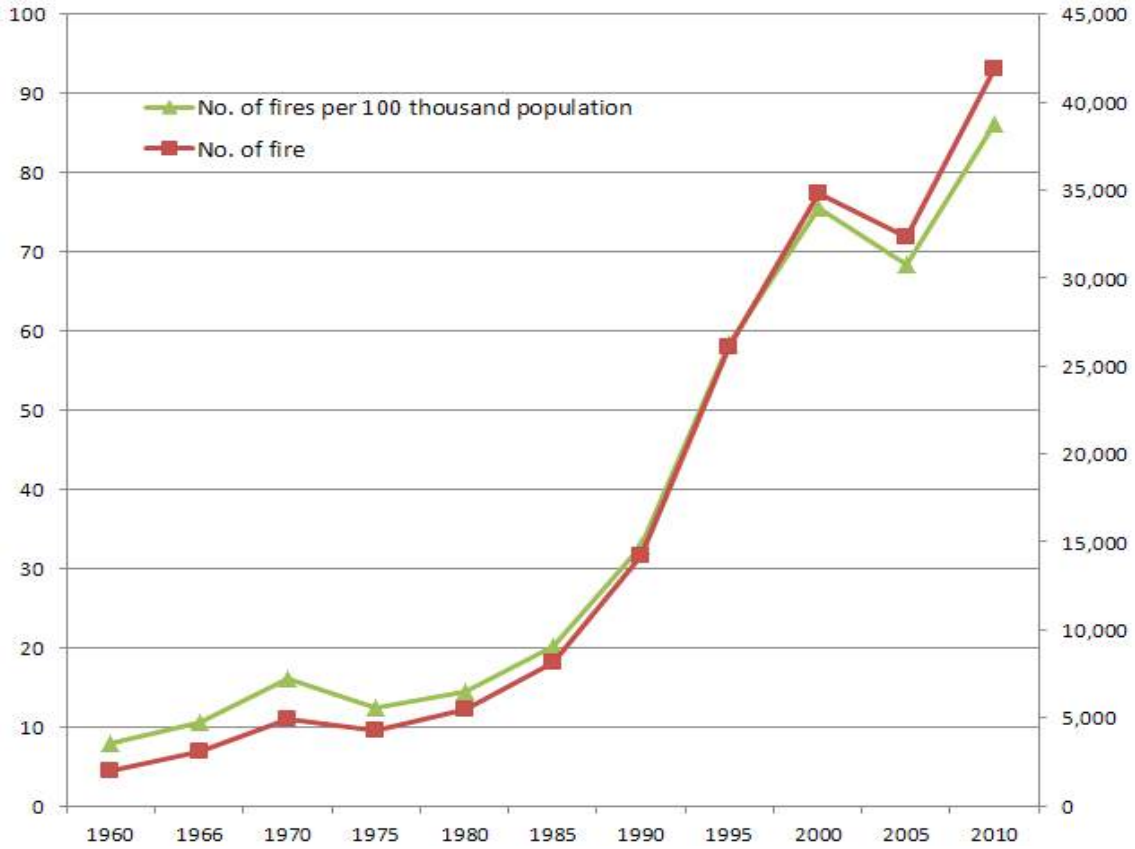


Motive of arson, 2007~2010

Motive	Residential	Non-residential	Vehicle	Total
Total	3,933	3,509	3,119	12,894
Unknown	1,739	2,051	2,024	7,366
Others	523	535	398	1746
Accidental	364	345	264	1211
Family trouble	493	67	40	618
Disatisfaction	202	162	126	576
Mental disorder	202	51	15	289
Suicide	139	40	44	238
Fire	125	64	23	232
Crime concealment	49	30	86	170
Revenge	15	51	14	97
Antagonism to Community	9	20	18	60
Liability	11	28	7	50
Protest	0	11	17	50
Insurance swindle	0	6	1	7

Fire trend

Ⅰ. Fire experience, 1960~2010

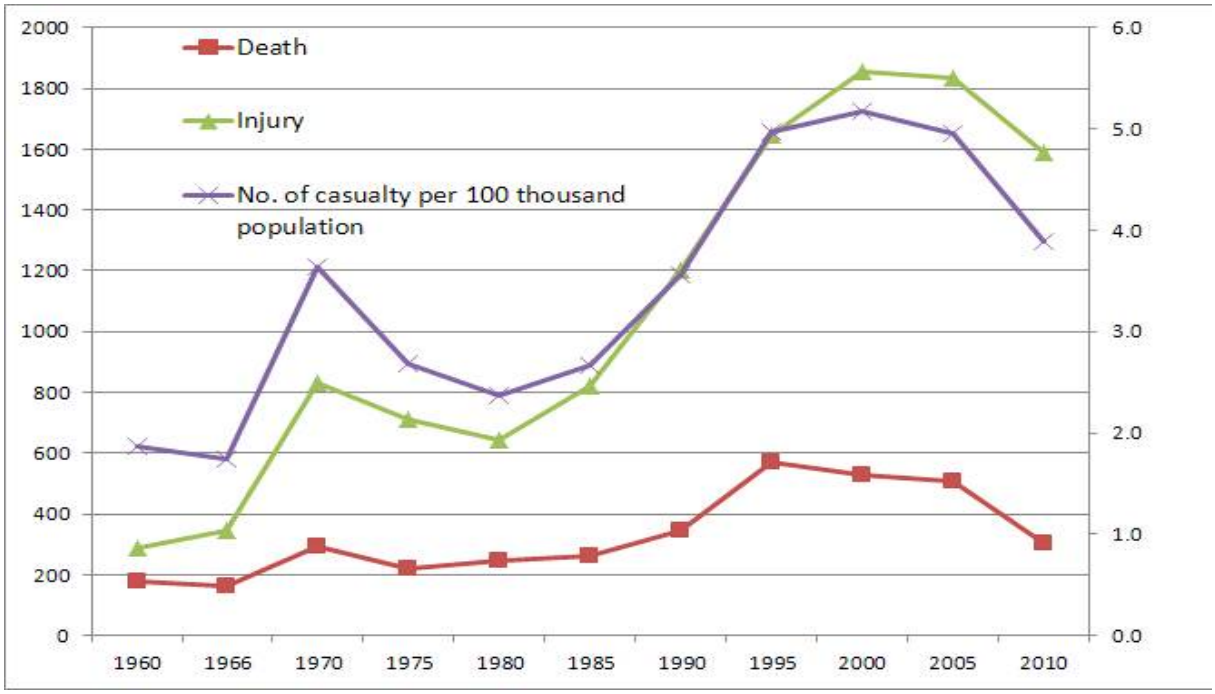


Fire trend in No of fire, 1960~2010

Year	No. of fire	No. of fires per 100 thousand population
1960	1,946	7.8
1966	3,077	10.6
1970	4,969	16.1
1975	4,259	12.3
1980	5,438	14.5
1985	8,137	20.1
1990	14,249	32.8
1995	26,071	58.4
2000	34,844	75.5
2005	32,340	68.4
2010	41,863	86.2

For the 1960-2010 period, the number of Fires per 100 thousand population has ranged from a low of 7.8 in 1960 to 86.2 in 2010 for an overall increase of 1,030%. There was consistent pattern going up until 2005.

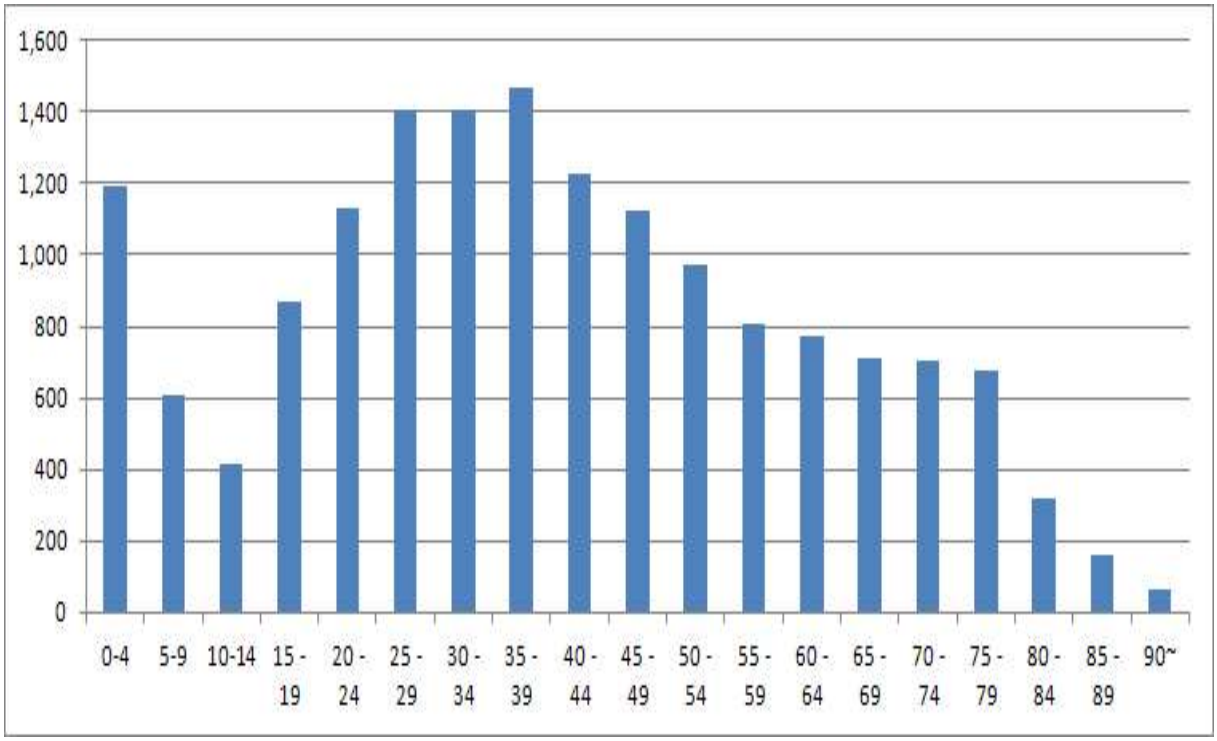
Ⅱ. Death and Injury by Fires, 1960-2010



Year	Death	Injury	No. of casualty per 100 thousand population
1960	180	287	1.9
1966	165	343	1.7
1970	294	830	3.6
1975	219	710	2.7
1980	247	641	2.4
1985	260	820	2.7
1990	348	1200	3.6
1995	571	1648	5.0
2000	531	1853	5.2
2005	505	1837	5.0
2010	304	1588	3.9

For the 1960-2010 period, the number of civilian injuries per 100 thousand population has ranged from a low of 1.9 in 1960 to 3.9 in 2010 for an overall increase of 105%. There was consistent pattern going up until 2005.

Ⅲ. Fire Death by Age*, 1983-2010

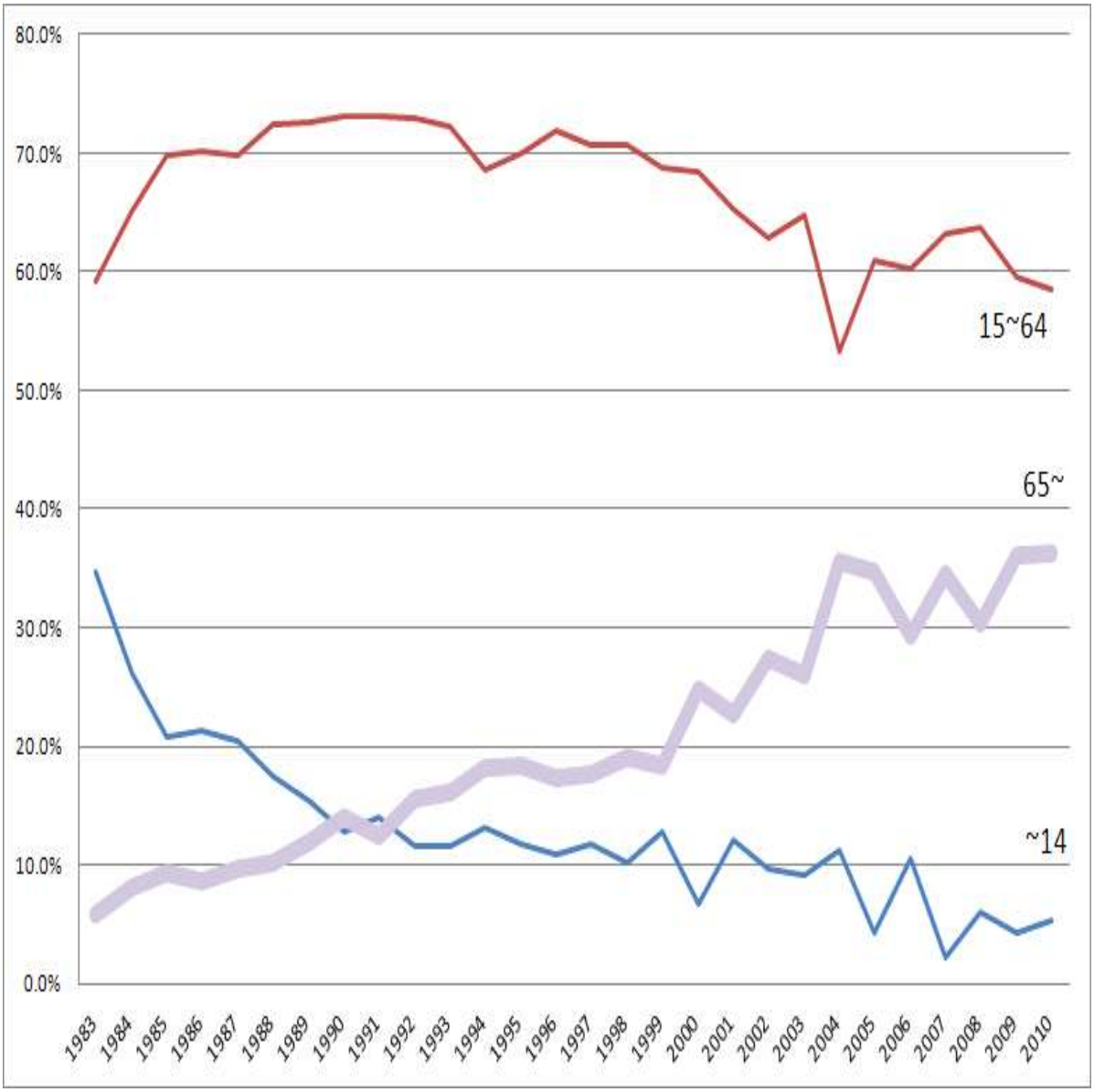


Age	No. of death**	Age	No. of death
0-4	1,192	50 - 54	970
5-9	611	55 - 59	805
10-14	413	60 - 64	770
15 - 19	869	65 - 69	710
20 - 24	1,130	70 - 74	707
25 - 29	1,405	75 - 79	676
30 - 34	1,406	80 - 84	320
35 - 39	1,466	85 - 89	163
40 - 44	1,227	90~	66
45 - 49	1,122	Total	16028

*Source from Bureau of statistics

**Death Data from Bureau of statistics are a little different from the data of NEMA.

Ⅳ. Fire experience by Age group, 1983~2010



Trend, Fire death by age group, Youth(~15), Middle(15~64), Old(65~)

Population of 65 or more account for 11% of total population, but 37% for death by fire.

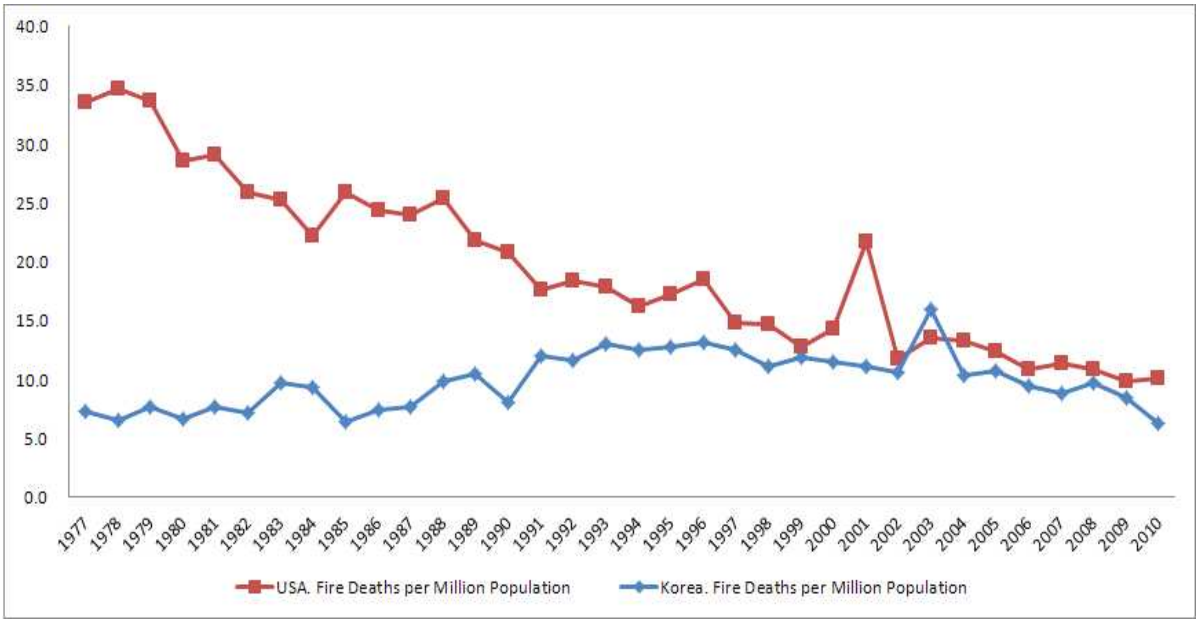
Age 65 or more population	1960	1970	1980	1990	2000	2010
%	2.9	3.1	3.8	5.1	7.2	11

No. of fire death, 1983-2010

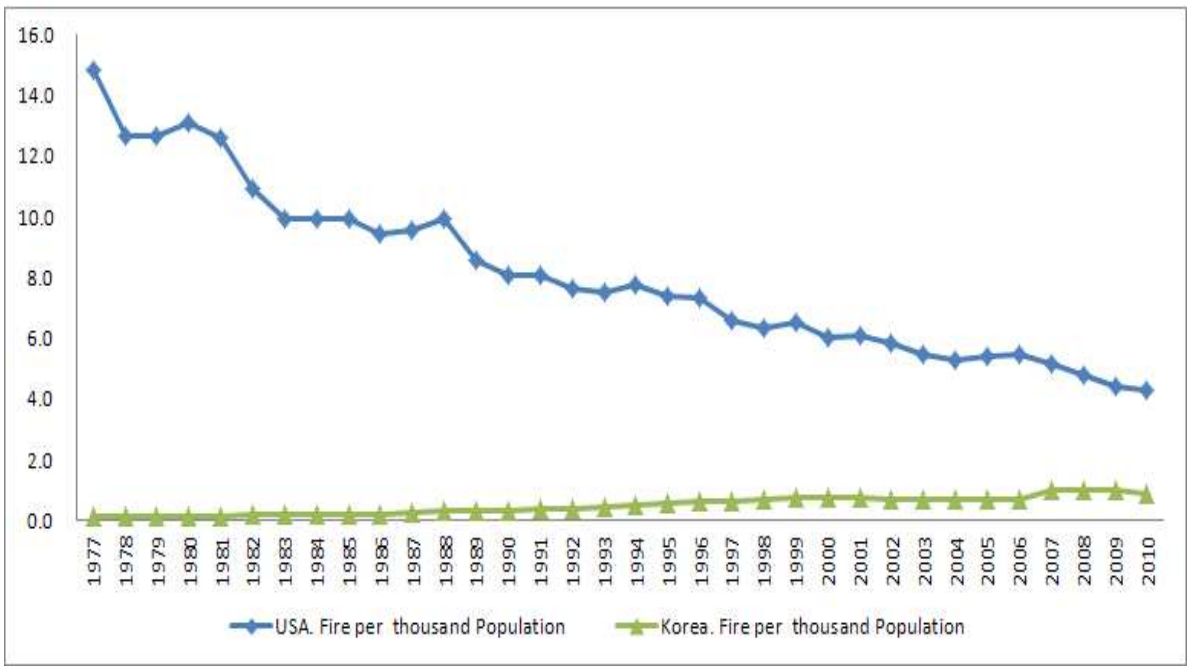
Age / Year	~14	15 ~ 64	65~	Total
1983	209	356	35	601
1984	167	414	52	636
1985	103	347	46	497
1986	129	426	52	607
1987	115	392	54	561
1988	118	487	68	673
1989	114	535	88	737
1990	75	428	82	585
1991	79	412	70	563
1992	87	551	117	755
1993	103	640	142	885
1994	106	552	146	804
1995	100	599	157	856
1996	89	587	141	817
1997	93	562	140	795
1998	61	420	113	594
1999	84	450	120	654
2000	40	408	148	596
2001	73	396	138	607
2002	54	349	152	555
2003	63	447	180	690
2004	42	198	132	372
2005	19	270	154	443
2006	42	241	117	400
2007	7	199	109	315
2008	19	204	97	320
2009	10	137	83	230
2010	15	163	101	279

International comparison

Ⅰ. Fire experience, US and Korea



Fire Death per Million population, US vs. Korea



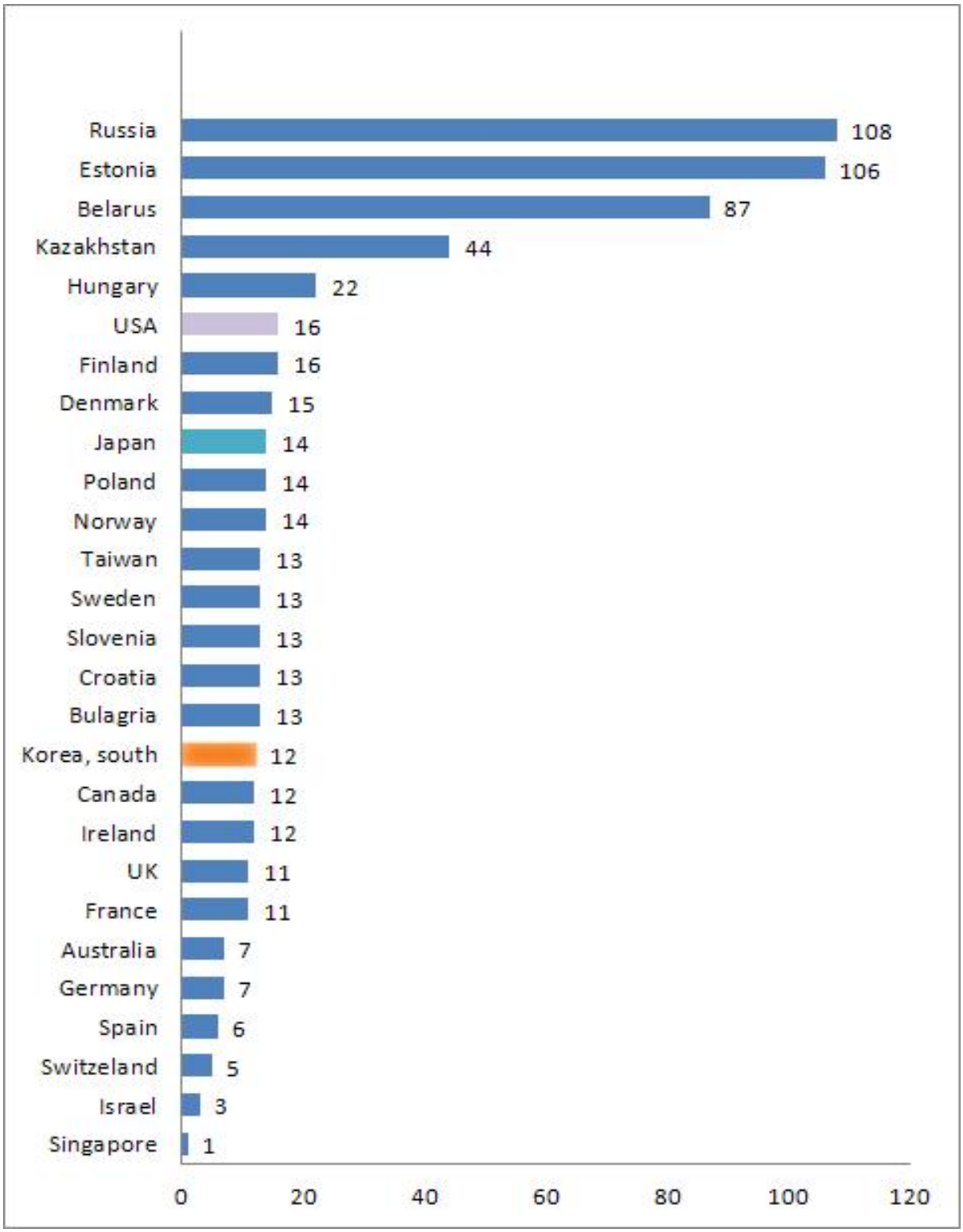
No of fire per Million population, US vs. Korea

For fire death per population, There was consistent pattern going down in USA. In Korea, there was slight pattern going up until 2005.

Year	USA*		Republic of Korea	
	Fire Deaths per Million Population	Fire per thousand Population	Fire Deaths per Million Population	Fire per thousand Population
1977	33.6	14.8	7.2	0.1
1978	34.6	12.7	6.5	0.2
1979	33.7	12.6	7.7	0.2
1980	28.6	13.1	6.6	0.1
1981	29.1	12.6	7.7	0.2
1982	25.9	10.9	7.1	0.2
1983	25.3	9.9	9.7	0.2
1984	22.2	9.9	9.3	0.2
1985	25.9	9.9	6.4	0.2
1986	24.3	9.4	7.5	0.2
1987	23.9	9.6	7.7	0.2
1988	25.4	9.9	9.8	0.3
1989	21.9	8.6	10.4	0.3
1990	20.8	8.1	8.0	0.3
1991	17.6	8.1	12.0	0.4
1992	18.4	7.6	11.6	0.4
1993	17.8	7.5	13.0	0.4
1994	16.2	7.8	12.5	0.5
1995	17.2	7.4	12.8	0.6
1996	18.5	7.3	13.1	0.6
1997	14.8	6.6	12.5	0.7
1998	14.6	6.4	11.1	0.7
1999	12.8	6.5	11.9	0.7
2000	14.3	6.0	11.5	0.8
2001	21.7	6.1	11.1	0.8
2002	11.7	5.8	10.5	0.7
2003	13.5	5.5	15.9	0.7
2004	13.3	5.3	10.3	0.7
2005	12.4	5.4	10.7	0.7
2006	10.9	5.5	9.4	0.7
2007	11.4	5.2	8.9	1.0
2008	10.9	4.8	9.7	1.0
2009	9.8	4.4	8.5	1.0
2010	10.1	4.3	6.3	0.9

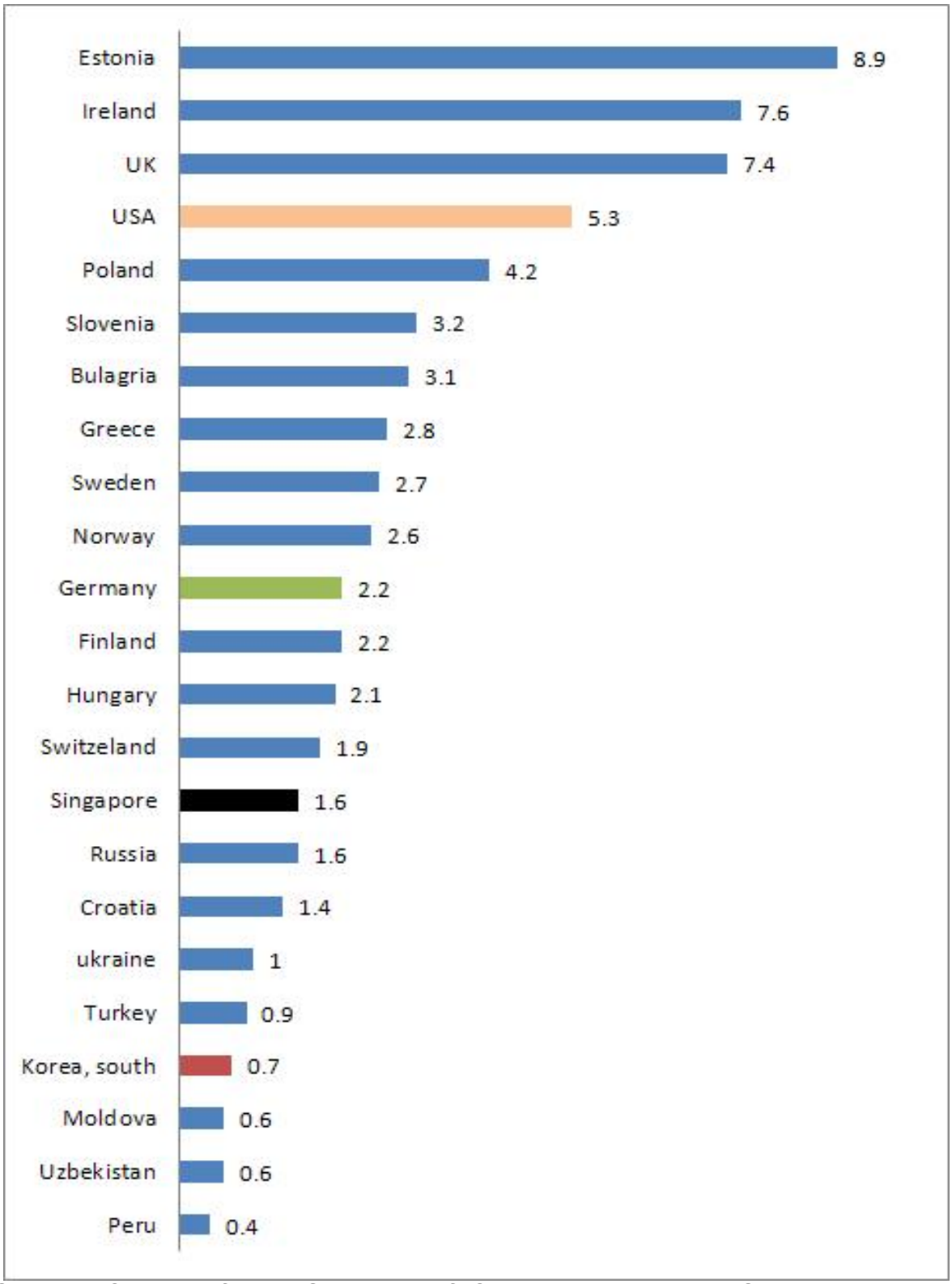
*Source: FIRE LOSS IN THE UNITED STATES DURING 2010 by NFPA

Fire Deaths Around the World, per Million Population, 1993 - 2002*



*Source: CTIF Center of Fire Statistics, Fire Statistics, No. 10, 2004, Table 5

No. of fires per 1000 population Around the World, 2004



Source: Centre of Fire Statistics of CTIF - World Fire Statistics 2006 - Report №. 11, Fig.2)

FIRE INVESTIGATION REPORT

Fire in a nursing home

Fire in a nursing home

Ⅰ General Information

❍ Date and time of Fire: About 04:10 AM, 12 Nov. 2010, Friday
❍ Structure: Steel-concrete slabs, One building, Two-story
❍ Casualty: Death 10, Injured 17 (including serious dementia and stroke patients, etc.)
❍ Room of ignition: Office on the first floor
❍ Point of origin: Around the panel board in the office on the first floor
❍ Ignition source: Electric fault (suspicious)

Ⅱ Building detail

❍ Building permission

The nursing home for the Aged owned by Pohang-city was built as the district Office of Jecheol-dong in 1973; its use was changed to a Facility for the Aged and Infants on 5 Sept. 2007 (Date of Permission: 5 Sept. 2007; Approval of use: 26 Dec. 2007), and has since been used as the nursing home for the Aged since March 2008. The nursing home has leased its office free of charge for 10 years from Pohang-si; it has 36 persons including 27 members and 8 social workers.

❍ Facility layout

- Approval of use: 26 Dec. 2007
- Total building floor area: 387.42 ㎡

	first floor	second floor
Area (㎡)	197.32	190.1
Use	2 Dorm rooms for the aged, 1 Office, 1 Storage, 1 Restroom, 1 Boiler room, and Hall	5 Dorm rooms for the aged, 1 Restroom, and Hall

Ⅲ The fire

❍ Staff response, Fire department Notification and response

Upon the outbreak of fire, Ms. ○○(social worker), who was sleeping in the hall on the first floor, woke up because of the smell of smoke and found fire and smoke in the office. She then asked the guard of nearby POSCO Institute of Technology (about 50m from the Indeok nursing home) to report the fire, came back to the nursing home, and rescued one elder who had woken up. She tried to go into the building again, but could not do so because of heavy smoke. Thus, she waited for the firefighters instead. After Ms. Choi's report, the guard of the POSCO Institute of Technology called a firefighter of the POSCO Institute of Technology (not the fire station); the firefighter confirmed the fire and reported to 119.

<Time line>

- About 04:15: Ms. ○○ reported the fire to the guard of the POSCO Institute of Technology.
- About 04:15: The guard reported to the fire department of the POSCO Institute of Technology.
- About 04:24: Reported to the Pohang Nambu Fire Station
- About 04:29: The advance team arrived.
- About 04:40: Suppressed the fire
- About 04:54: Extinguished the fire completely

* It took nine minutes for Ms. ○○ to report to the guard of the POSCO Institute of Technology and for the Pohang Nambu Fire Station to be informed.
* Distance from the Pohang Nambu Fire Station to the Indeok nursing home for the Aged: About 2.8km

❍ Cause and Origin

When the advance team of the Pohang Nambu Fire Station arrived at the scene of fire at 04:29, the flames were not that big, and a great deal of black smoke was being emitted from the entrance in the front of the building.
The fire broke out around the panel board (one at the top and the other one at the bottom) installed in the opposite direction diagonally from the

door of the office on the first floor and burned the office on the first floor and the ceiling and the upper wall in the main hall. A great deal of toxic smoke coming from the chairs and wooden structure in the office permeated the dorm room on the first floor through the main hall.
There were minimal traces of burn in the dorm room on the first floor, but the ceiling and wall got very sooty.
There was nothing to report with regard to the point of ignition or cause of ignition in other areas except the inner panel board in the office on the first floor.

Facility layout

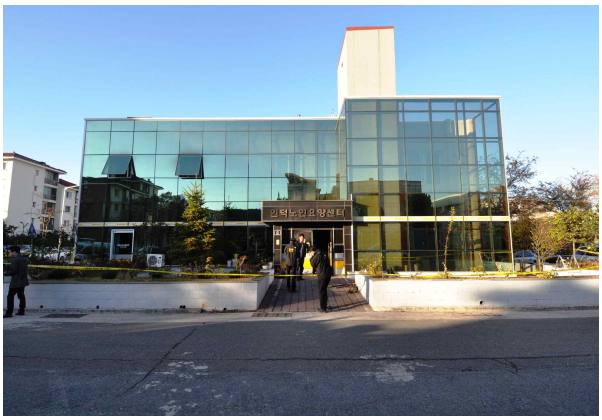


Fig 1. Front of the nursing home

Fig 2. the back and on the right

Fig 3. Fire scene of the office on the first floor

Fig 4. Fire scene of the entrance on the first floor

Fig 5. Office on the first floor, panel board combustion

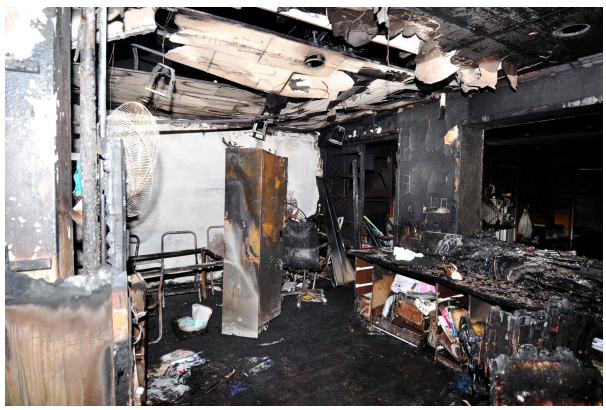


Fig 6. Office on the first floor, entrance

Fig 7. Fire scene around the panel board in the office (The mark is the position of the panel board.)

Fig 8. Fire scene of the conductor entrance of the panel board (suspicious ignition point)

○ Fire growth and Spread

The Indeok nursing home for the Aged was constructed with steel-concrete slabs and is a two-story building. The fire broke out in the panel board in the office on the first floor, burned down the office furniture (desks, bookshelves, chairs, etc.), and spread outside. The burning of the main hall was not severe, however.

Two dorm rooms on the first floor had no traces of burn; one window was destroyed, and the top, wall, and bedding were scorched.

The first floor and the second floor were divided by the fire door installed in the entrance toward the second floor from the hallway on the first floor. During the fire, the fire door was closed; thus, the toxic smoke and soot that spread into the living room on the second floor was minimal.

Fig 9. Around the entrance of the first dorm room on the first floor

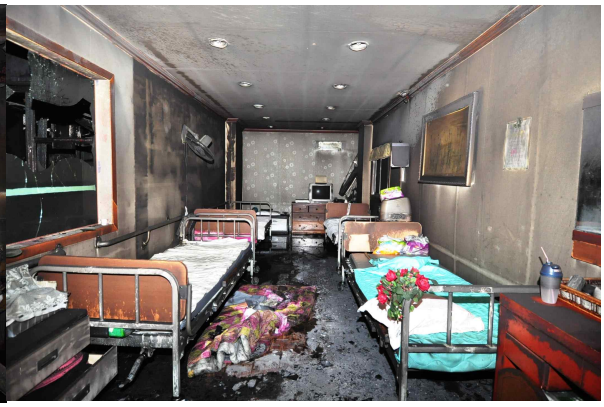


Fig 10. Inside of the first dorm room on the first floor

Fig 11. Aaround the entrance of the second dorm room on the first floor

Fig 12. Inside of the second dorm room on the first floor

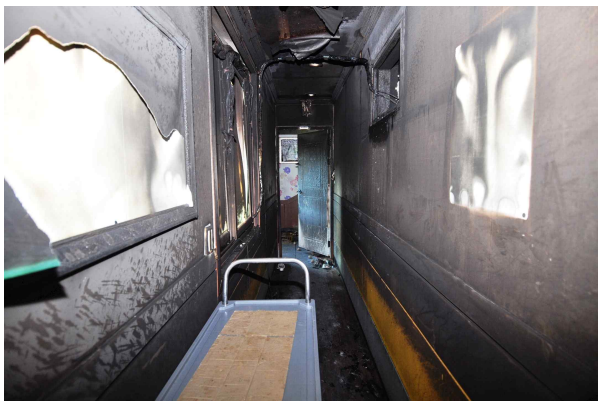


Fig 13. Hallway to the first floor and the second floor

Fig 14. Around the door to the hallway on the first floor

Fig 15. Around the dorm room on the second floor

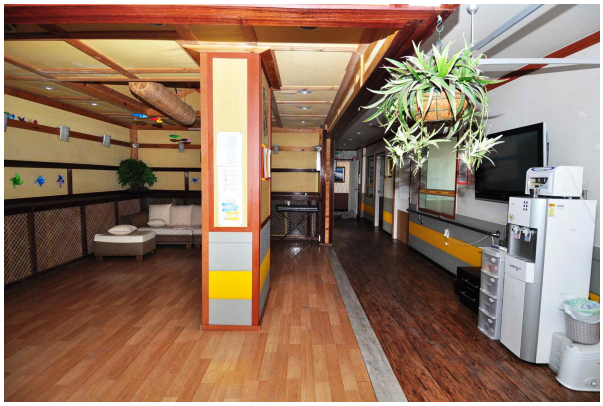


Fig 16. Dorm room main hall on the second floor

❍ Evacuation routes

There are two entrances at the front (one at the center, the other on the left) on the first floor, one entrance connecting to the outside through the storage at the back, and one entrance at the stairs on the second floor. Actually, there was only one available entrance at the center of the building front -- the left entrance was located toward the hallway, and there was no exit light in the entrance at the back. Since there were two more doors to the outside, it was an obstacle to evacuation.

Though there was a door (made of aluminum poles) between the stairs to the first floor and the hallway on the second floor, it was designed to close at the stairs on the first floor. Thus, it could serve as an obstacle to evacuation, too, during a fire.

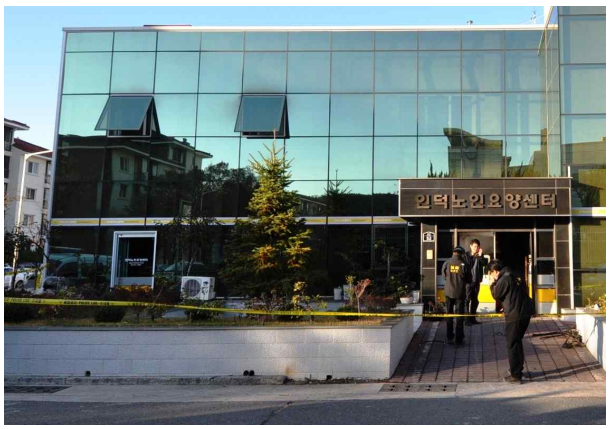


Fig 17. Two entrances at the front .

Fig 18. One entrance at the back of the building

Fig 19. Left entrance at the front of the building

Fig 20. Switchgear of the left entrance at the front

Fig 21. Door at the stairs to the first floor from the second floor

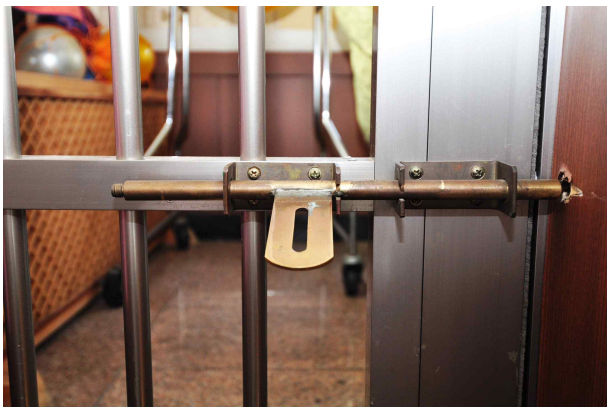


Fig 22. Designed to open and close on the stairs on the first floor

Ⅳ Casualties & Damage

A total of 27 elderly persons including serious dementia and stroke patients who cannot move well had lived in the Indeok nursing home for the Aged. In particular, the first floor was for the invalid.
11 elderly persons were sleeping on the first floor, and 10 of them died. The cause of death was suffocation by toxic smoke. There were 16 persons sleeping on the second floor, but no one was hurt.

Ⅳ Disccusion

○ **Delayed initial report**

It took nine minutes for Ms. Choi to report the fire to the security office of nearby POSCO Institute of Technology (about 4:15 AM) and for the district fire station to be informed accordingly. When the district Pohang Nambu firefighters arrived at the scene of fire, it was about 04:29 AM, which was about 15~20 minutes later. If the fire was reported directly to the fire station, about 9 minutes could be saved and more lives could be rescued.
Therefore, the social workers working for this kind of facility should have safety consciousness, and they should be trained to act properly in case of fire.

○ Lack of staff

During the fire, because there was just one staff in the facility, it was not possible to evacuate the 27 elderly persons with serious dementia and stroke. Therefore, there should be some kind of system such as the Automatic Notification to fire station in this kind of facility -- including the nursing home – that reports a fire to the district fire station rapidly.

○ Incomplete fire protection system

The current fire code requires that sprinklers be installed in buildings with total floor area of 600 ㎡ or more in this occupancy. In the case of the Indeok nursing home for the Aged, installing the alarm system such as the Automatic Fire Detection System and Emergency Alarm System was not mandatory. If the automatic extinguishing system including sprinklers had been managed properly, the number of casualties might have been smaller. Therefore, the installation of the automatic extinguishing system including sprinklers should be considered because aged men/women would have great difficulty evacuating in case of fire.

○ Insufficient means of egress

During the fire, only the main entrance at the front was available for evacuating from the Indeok nursing home for the Aged. Because the latching device of the left entrance at the front was installed on the upper side of the door, if people on the second floor had come down to the first floor, they would not have been able to evacuate the building. Because, on the stairs between the first floor and the second floor, the latching device was installed in the door that can open and close on the first floor stairs, it could serve as an obstacle to evacuate. Therefore, the door in the emergency exit should be designed and managed to open easily.

FIRE INVESTIGATION REPORT

Fire in a high-rise complex residential building

Fire in a high-rise complex residential building

Ⅰ General Information

❍ Location: Marine City (U-dong), Haeundae-gu, Busan
❍ Date and time of Fire: 11:23 AM, 1 Oct. 2010, Friday
❍ Date and time of report: 11:33:43 AM, 1 Oct. 2010
❍ Casualty: 7 persons (3 residents, 1 firefighter, and 3 residents in the neighboring shopping district (minor injuries))
❍ Direct Property damage: Burnt area 2800.61 ㎡, KRW 5,769,729,000
❍ Room of ignition: Dressing room for men on the pit level (between the third floor and the fourth floor)
❍ Point of origin: Around the electrical outlet in front of the door
❍ Ignition source: Burning of unknown materials by electric spark around the outlet (suspicious)

Ⅱ Building detail

Date of completion: Dec. 2005
Floors: 38 stories aboveground, 4 stories underground
Total building floor area: 68,917.26 ㎡, one building
Occupancy: Basement garage, business use on the 1st~3rd floors aboveground, condominium on the 4th~37th floors (two towers)
Structure: SCR
Height: 140 m

Ⅲ Fire

❍ **Fire department Notification and response**

At 11:34 AM on 1 Oct, a dustman heard “thud” sounds and saw a blaze near the superviser’s office while segregating garbage in the recycling area of the pit level. He reported to his fellow workers, tried to extinguish the fire, but left the site rapidly. According to the on-the-spot survey, the recycling area in the pit level and the entrance to the supervisior’s office were razed by the fire. Thus, these places were considered to be the point of initial ignition. The fan, vacuum cleaner, and floor cleaner around the entrance of the superviser’s office burned down. According to Mr. OO (dustman), power cords were plugged in a 4-hole outlet. Based on several circumstances, a electrical fault is suspicious.

❍ **Time line**

Fig 1. The building and Haeundae Fire Station

11:21	Fire occurred (reported by a citizen)
11:33	Reported to 119(fire department)
11:36	The response team of the fire department arrived at the scene of fire.
11:44	Started evacuation and lifesaving by the firefighters
12:10	Rescued 10 persons by ladder truck
13:00	Rescued 9 evacuees on the rooftop by helicopter
13:02	Extinguished the origin of fire
18:48	Extinguished completely

○ Fire growth, spread and extinguishment

① The fire occurred inside of the pit level.
② The fire spread to the outer wall through the windows.
③ The fire spread to the rooftop in 21 minutes along the inflammable aluminum panel due to the strong wind, and some residential units on the 37th floor burned down.
④ The big fire was brought under control after 2 PM.
⑤ At 3 PM, a small fire occurred again.
⑥ About 6:49 PM, the fire was extinguished completely.

❍ Details of fire spread

The fire started in the pit level, stayed on the outer wall aluminum panels, and continued spreading upward forming a “V”-shape vertically along the outer walls of the twin tower. The thermal insulator of the aluminum panel around the outer wall was believed to have spread the fire upward.

The outer wall was made of aluminum composite panel, and its core material was polyethylene. Therefore, when the outer panel was exposed to high-temperature thermal current (including flames), the temperature rose. This melted the aluminum on the surface of the panel, the core material of the panel started to be pyrolyzed, and flammable gas was generated. During combustion, high-temperature gas was spread to the upper side of the outer wall, and the aluminum and polyethylene melted. As a result, the fire spread from the 4th floor--the origin of fire--to the 38th floor rapidly in 20 minutes.

The reasons the fire spread so rapidly were the strong wind from the sea and the shape of the outer wall of the building.

Because the face of the outer wall receded by “ㄷ”-shape, when the thermal current moved upward, the descent of temperature was relatively slow compared to the open area, and the upper side of the high-temperature area tended to expand. Moreover, the radiant heat transfer surged because the “ㄷ”-shaped faces were opposite each other. For these various reasons, the fire spread rapidly.

❍ Suppression and evacuation

Total labor involved: 668 persons (firefighters: 170; volunteer firefighters: 90; police: 350; others: 58)

60 fire engines, 2 extension ladders, 12 breakdown vans, 15 ambulances, and 5 helicopters

Rescued persons: 37

Evacuated persons: 80

IV Casualties & Damage

The burnt area inside the building was 1,134 ㎡, and the outer wall from the 4th to the 38th floor burned down. Four persons sustained minor injuries, and the damage was pegged at KRW 769,729,000.

fig. 2

fig 3

Fig. 2, 3 At 12:07, the emergency bridge burned down, and the fire spread upward. (The emergency bridge was damaged, and fragments of glass and outer wall aluminum panel fell to the lower floors.)

Damaged outer wall on the top

Damaged ignition point and outer wall

Fig. 4 Damage

IV Discussion

1. Problems

Using combustible outer wall panels

There is no restriction on using combustible materials for outer walls in Korea. Thus, such kind of panel could be used. Because the aluminum panel used on this building had small weight and good processability, when applied to high-rise building, it has benefits in terms of weight and cost. The figure below shows the structure, which is fixed to the concrete wall.

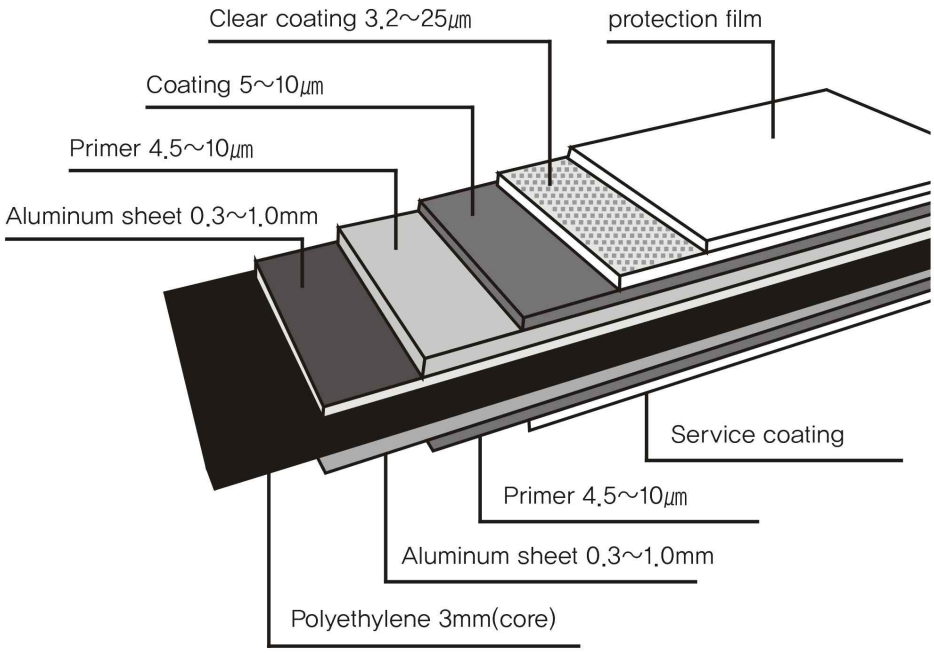


Fig. 5 The configuration of Aluminum panel structure

As shown in Fig. 5, core material is inflammable polyester and is coated with aluminum and others for aesthetics, strength, and weather resistance. Because these aluminum sheet and coatings are thin, and the melting point of aluminum is about 660 °C, this panel is not fire-resistant. Moreover, because it has high thermal conductivity, the ignition temperature of polyethylene is 350~400 °C. In other words, it ignites easily with exterior heat and burns.
Over 80% of Korea's high-rise buildings are estimated to have these kinds of combustible materials.

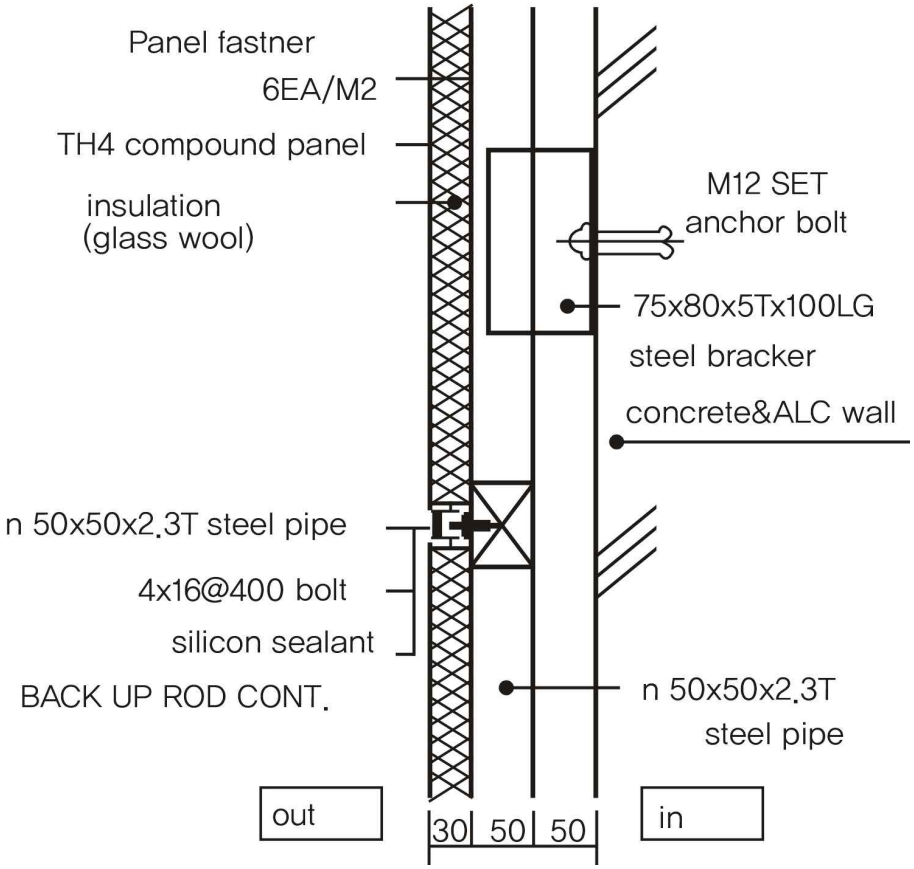


Fig. 6 The configuration of the Outer wall cross-section

Difficulty in evacuation and rescue

For this fire, because buildings with less than 50 stories had not been classified as super high-rise building, there was no need to secure the refuge area in a middle floor as of the building code 2010. Thus, ladder trucks could not access the 16th~49th floors. In this case, fortunately, the casualties and damage were small, and some people on the top floor were rescued by a helicopter. The higher the building is, the more load on the body due to the prolonged distance for evacuation. Therefore, installation of an emergency elevator could be considered for evacuation.

Management

The original use for the pit level is for electrical equipment and machines. Thus, the requirement for the firefighting equipments was eased. Since this space was used as garbage recycling area, the load of combustibles and risk elements by humans increased, which led to the fire. Furthermore, the fire was recognized too late, and the initial response was inadequate.

Firefighting

Structurally, it was not possible to enter the pit level from the emergency stairs because of the building structure modification; there was also no fire protection water supply on the top floor. Neither was the emergency elevator available for firefighting.

2. Improvement

Supplementing related fire & building code

① Making the use of incombustible materials as finishing materials for the high-rise building compulsory
② Securing the refuge area floor for buildings with 31~50 stories
③ Making the installation of a fire protection system in the pit level compulsory

Intensifying the firefighting procedures

① Training on how to use the helicopter and ladder truck, training on adapting to the local circumstances
② Evacuation training and training on extinguishing fire in the early stage
③ Intensifying the residents' training and preventive action: Safety check on high-rise building, training on how to use the fire extinguisher, fire safety education

Appendix

Fire Loss in the Republic of Korea, 1948-2010

Year	NO. of fires	Casualty	Death	Injury	Property loss
1948	1,928	1,542	659	883	88
1949	4,286	782	352	430	79
1950	730	413	157	256	45
1951	1,553	414	124	290	565
1952	2,566	684	177	507	965
1953	2,453	610	136	474	19,827
1954	2,286	507	168	339	1,716
1955	1,332	440	149	291	685
1956	1,341	278	109	169	1,303
1957	1,150	320	146	174	1,568
1958	1,547	292	112	180	1,708
1959	1,558	321	143	178	1,619
1960	1,946	467	180	287	9,391
1961	2,355	397	122	275	2,254
1962	2,174	487	150	337	212
1963	1,904	303	103	200	321
1964	2,617	544	154	390	297
1965	3,141	468	143	325	799
1966	3,077	508	165	343	521
1967	3,482	716	226	490	831
1968	3.909	774	198	576	1,513
1969	4,181	1,010	201	809	1,556
1970	4,969	1,124	294	830	2,063
1971	4,412	1,112	354	758	2,186
1972	3,749	1,119	259	860	1,621
1973	4.159	1,058	245	813	1,539
1974	3.901	1,125	284	841	16,865
1975	4,259	929	219	710	6,064
1976	4,712	884	221	663	8,376
1977	5,363	1,059	259	800	4,457
1978	5,648	1,080	236	844	8,454

Year	NO. of fires	Casualty	Death	Injury	Property loss
1979	5,711	1,097	283	814	8,851
1980	5,438	888	247	641	8,262
1981	5,851	999	291	708	13,248
1982	6,822	971	276	695	13,153
1983	7,725	654	381	273	12,843
1984	8,562	1,331	372	959	13,844
1985	8,137	1,080	260	820	15,409
1986	8,453	1,188	306	882	11,375
1987	10,144	1,474	321	1,153	14,880
1988	12,507	1,550	414	1,136	34,783
1989	12,704	1,519	447	1,072	22,357
1990	14,249	1,548	348	1,200	34,133
1991	16,487	1,781	525	1,256	44,218
1992	17,458	1,747	510	1,237	52,675
1993	18,747	1,777	573	1,204	51,890
1994	22,043	1,879	555	1,324	132,624
1995	26,071	2,219	571	1,648	100,746
1996	28,665	2,223	589	1,634	113,147
1997	29,472	2,195	564	1,631	121,712
1998	32,664	2,284	505	1,779	159,721
1999	33,856	2,370	545	1,825	166,426
2000	34,844	2,384	531	1,853	151,972
2001	36,169	2,376	516	1,860	169,750
2002	32,966	2,235	491	1,744	143,447
2003	31,272	2,833	744	2,089	151,590
2004	32,737	2,304	484	1,820	146,634
2005	32,340	2,342	505	1,837	171,374
2006	31,778	2,180	446	1,734	150,792
2007	49,318	2,459	424	2,035	248,417
2008	49,318	2,716	468	2,248	383,142
2009	47,318	2,444	409	2,035	251,852
2010	41,863	1,892	304	1,588	266,776.

This is published as the Agreement of Cooperation between KFPA and NFPA. Please feel free to contact Research & investigation team of KFPA if you have any inquires. (E-Mail hryu@kfpa.or.kr, Tel 82-2-3780-0322, Fax 82-2-3780-0329)

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E-Mail kfpa@kfpa.or.kr//
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