

# SMOKE DETECTORS AND LIFE SAFETY

BY WILLIAM F. CRAPO

**S**INCE SMOKE DETECTORS FIRST APPEARED ON the shelves of stores in the 1970s, they have been heralded as the single most effective means of reducing deaths from fire. It has been close to a quarter of a century since low-cost smoke detectors have been introduced, and we are now looking at the question, Do smoke detectors really work? The National Fire Protection Association (NFPA) says they do. In fact, the NFPA claims smoke detectors are as much as 40 to 50 percent effective in preventing the loss of life by fire. But, how are these claims possible when from 1977 to 1997 there was a 45.3 percent reduction in the number of home fires but only a 42.7 percent reduction of fatalities in home fires? This article addresses the apparent discrepancy and other issues pertaining to the relationship of smoke detectors to life safety.

## THE PROBLEM

NFPA data show a decline in the number of "home" fires—from 723,500 in 1977 to 395,500 in 1997, representing a decline of 45.3 percent over 21 years. During the same time frame, fatalities in home fires fell from 5,856 to 3,360, accounting for only a 42.7 percent decline. At best, this means that the life loss from home fires is directly proportional to the reduction in home fires. It could be that the only people who didn't die in fires over the 21-year period were those who didn't have fires in the first place. This opinion is actually borne out when we look at the fatality rate for each year in question. In 1977, there were 8.11 fatalities for every 1,000 fires; in 1997, there were 8.5 fatalities for every 1,000 fires. With data like these, how can we claim smoke detectors are helping?

NFPA's data show that of all home fires that occur in the United States, 56.1 percent occur in homes with smoke detectors and 43.9 percent in homes without detectors. From these data, the NFPA further determined that fatalities occur in homes without smoke detec-

tors about twice as frequently as in homes with smoke detectors. This is where the 40 percent to 50 percent improvement in life safety figure comes from. But, there is a major flaw!

What isn't taken into account is the fact that the most recent NFPA estimates indicate that as many as 93 percent of all homes currently have at least one smoke detector. This means that the 56.1 percent of all home fires that occur where smoke detectors are present is disproportionately spread among 93 percent of the population, for a relative risk of 0.6. Even more important is the fact that the seven percent of the population that has *no* smoke detectors suffers an alarmingly disproportionate 43.9 percent of home fires, for a relative risk of 6.22.<sup>2</sup> To put it another way, the relative risk for people in homes without smoke detectors is 10.4 times that for people in homes with smoke detectors.

## IS FIRE SAFETY CONSCIOUSNESS A FACTOR?

The question then becomes, if the 93 percent of the population that has smoke detectors accounts for just over half of the home fires, could there be a positive relationship between the installation

**THE RELATIVE RISK FOR PEOPLE IN HOMES WITHOUT SMOKE DETECTORS IS 10.4 TIMES THAT FOR PEOPLE IN HOMES WITH SMOKE DETECTORS.**

of smoke detectors and fire safety awareness? After all, how else can we account for the fact that 93 percent of the population accounts for only just over half of all home fires? NFPA data fail to account for any possibility that homeowners who install and maintain smoke detectors are more fire safety conscious and thus are less likely to have a fatal fire in the first place. Instead, *all* the credit for the lower fatality rates in the 93 percent of homes with smoke detectors is in effect given to the smoke detectors.

## THE STUDY

This study is aimed at answering two primary questions: (1) Do smoke detectors actually improve the chances of surviving a fire? and (2) Are people who install and maintain smoke detectors more fire safety conscious? While arriving at the answers to these questions, I also uncovered some unexpected but interesting information, which is presented near the end of this report.

Statistics from the National Fire Data Center (NFDC) in Emmitsburg, Maryland, were primarily used for this study. Unfortunately, the Center's reliable database goes back only a few years. However, I was able to make some interesting analyses based on the information

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## Smoke Detectors and Life Safety

Spreadsheet-Table 1a

Year	Not Reported					Detectors in Room and Operated					Detectors Not in Room and Operated				
	Incidents	Injuries	Rate	Fatalities	Rate	Incidents	Injuries	Rate	Fatalities	Rate	Incidents	Injuries	Rate	Fatalities	Rate
1987	25586	1560	61.02	295	11.54	10328	767	74.26	35	3.39	11764	1209	102.60	66	5.60
1988	30758	1834	59.83	302	9.82	10845	758	69.89	48	4.43	11834	1197	101.15	77	6.51
1989	31642	1849	61.60	311	9.93	12628	1006	79.68	51	4.04	12814	1257	98.10	68	5.15
1990	28097	1888	67.20	331	11.76	11757	996	84.72	44	3.74	12080	1322	109.44	65	7.04
1991	29716	2013	67.74	362	12.16	12414	997	80.31	54	4.35	12701	1436	113.08	79	6.22
1992	28477	2154	75.64	291	10.22	13540	1097	81.02	56	4.26	13343	1435	107.55	73	5.47
1993	29026	2098	72.26	347	11.95	15442	1131	73.24	63	4.08	14227	1536	107.66	78	5.48
1994	28875	2119	73.39	359	12.43	15639	1211	77.43	54	3.45	14023	1492	106.40	71	5.06
1995	29158	2120	72.71	353	12.11	14951	1114	74.51	64	4.28	13413	1331	99.23	75	5.59
1996	30151	2113	70.08	343	11.38	15948	1096	68.72	50	3.14	13493	1324	98.12	73	5.41
	4898	658	134.62	71	14.53	6706	904	134.80	46	6.86	4393	826	142.50	51	11.61
	5700	749	131.40	88	15.09	6977	796	114.09	40	5.73	4443	818	184.11	64	12.15
	5900	827	167.12	95	16.10	6576	879	114.16	42	4.90	5433	899	159.95	44	8.10
	5609	962	171.60	66	11.77	6570	1070	111.81	51	5.33	6113	778	127.27	36	5.89
	6992	707	101.26	60	6.59	6926	1054	119.42	42	4.76	5729	795	138.77	20	3.49
	7394	810	109.55	53	7.17	9306	911	97.90	47	5.05	5972	757	126.76	24	4.02
	30454	2218	72.83	366	12.02	17034	1671	98.10	61	4.78	16177	1835	113.43	117	7.23
	39458	2593	70.85	368	10.64	17822	1554	87.20	68	4.84	16277	2015	123.79	131	8.05
	35816	2940	82.55	457	12.83	20990	1976	94.14	96	4.57	16134	2305	127.11	123	6.78
	34063	3116	91.42	357	10.47	23110	2167	93.77	109	4.72	19456	2213	113.74	109	5.80
	36140	2627	76.22	413	11.43	23777	2168	91.16	106	4.46	19142	2126	111.06	95	4.96
	37545	2923	77.85	398	10.55	25253	2007	79.48	97	3.64	19465	2081	108.91	97	4.98

Spreadsheet-Table 1b

Year	Detector in Room or in Bedroom, Did Not Work					Detector Not in Bedroom or in Room, Did Not Work					Detector Small or Detector Not Operated				
	Incidents	Injuries	Rate	Fatalities	Rate	Incidents	Injuries	Rate	Fatalities	Rate	Incidents	Injuries	Rate	Fatalities	Rate
1987	3945	324	82.13	42	10.65	10823	787	72.72	68	6.28	4023	62	15.41	0	0.00
1988	4842	396	81.78	40	8.26	10600	802	75.66	62	5.85	3839	63	16.41	4	1.04
1989	5104	478	93.65	56	10.97	11345	810	71.40	61	5.38	4136	83	20.06	2	0.48
1990	4616	455	98.57	38	8.23	10317	808	78.32	69	6.69	3447	74	21.47	1	0.29
1991	4957	510	102.88	51	10.29	11125	955	85.84	77	6.92	3907	95	24.32	1	0.26
1992	5362	487	90.82	53	9.88	11428	963	84.27	84	7.35	3972	110	27.69	4	1.01
1993	5543	524	94.53	37	6.68	11950	1028	86.03	69	5.77	4122	101	24.50	1	0.24
1994	5615	545	97.06	67	11.93	11401	961	84.29	89	7.81	3945	96	24.33	4	1.01
1995	5160	451	87.40	58	11.24	11029	864	78.34	56	5.08	3525	80	22.70	4	1.13
1996	5593	465	83.14	42	7.51	10663	832	78.03	84	7.88	3749	96	25.61	1	0.27
	2404	369	153.49	18	7.49	2804	366	130.53	19	6.78	1013	54	53.31	1	0.99
	3202	345	107.75	30	9.37	2845	255	89.63	8	2.81	1076	35	32.53	2	1.86
	3473	435	125.25	30	8.64	3500	424	121.14	16	4.57	1402	69	49.22	1	0.71
	3730	484	129.76	42	11.26	3795	456	120.16	28	7.38	1498	76	50.73	1	0.67
	3163	387	122.35	42	13.28	3383	369	109.07	17	5.03	1311	53	40.43	2	1.53
	3430	388	113.12	27	7.87	3405	340	99.85	15	4.41	1468	48	32.70	1	0.68
	6349	693	109.15	60	9.45	13627	1153	84.61	87	6.38	5036	116	23.03	1	0.20
	8044	741	92.12	70	8.70	13445	1057	78.62	70	5.21	4915	98	19.94	6	1.22
	8430	945	112.10	81	9.61	14625	1379	94.29	93	6.36	5309	164	30.89	2	0.38
	9092	971	106.80	95	10.45	15223	1419	93.21	112	7.36	5470	186	34.00	5	0.91
	8323	838	100.68	100	12.01	14412	1233	85.55	73	5.07	4836	133	27.50	6	1.24
	9023	853	94.54	69	7.65	14068	1172	83.31	99	7.04	5217	144	27.60	2	0.38

One- and two-family dwellings. ■ Multifamily dwellings. ■ Total of the two categories.

# Smoke Detectors and Life Safety

Spreadsheet-Table 1c.

Year	No. Detector					Performance Not Classified					Annual Totals				
	Incidents	Injuries	Rate	Fatalities	Rate	Incidents	Injuries	Rate	Fatalities	Rate	Incidents	Injuries	Rate	Fatalities	Rate
1987	69448	5464	78.68	722	10.40	3142	305	97.07	54	17.19	139059	10478	75.35	1282	9.22
1988	66458	5326	80.14	723	10.88	3119	278	89.13	36	11.54	142295	10654	74.87	1292	9.08
1989	63443	5106	80.48	681	10.73	3095	286	92.41	25	8.08	144207	10975	76.11	1253	8.69
1990	56516	4547	80.46	660	11.68	2830	291	102.83	24	8.48	129660	10381	80.06	1252	9.66
1991	56961	4565	80.14	559	9.81	3178	312	98.17	28	8.81	134959	10883	80.64	1211	8.97
1992	54586	4239	77.66	624	11.43	2331	260	111.54	31	13.30	133039	10745	80.77	1218	9.16
1993	53431	4151	77.69	574	10.74	2395	184	76.83	24	10.02	136136	10753	78.99	1193	8.76
1994	50138	3784	75.47	637	12.70	2346	181	77.15	33	14.07	131982	10389	78.72	1314	9.96
1995	45758	3535	77.25	431	9.42	2178	168	77.13	20	9.18	125172	9663	77.20	1061	8.48
1996	44898	3206	71.41	523	11.65	2210	169	76.47	29	13.12	126705	9901	73.41	1145	9.04
	11678	1237	105.93	98	8.39	521	119	228.41	4	7.68	34407	4333	125.93	308	8.95
	11305	1216	107.56	101	8.93	564	102	180.85	14	24.82	36112	4316	119.52	335	9.28
	10216	1164	113.94	63	6.17	636	104	163.52	12	18.87	39136	4971	127.02	303	7.74
	9859	1067	108.23	67	6.80	508	92	181.10	12	23.62	40679	4985	122.54	303	7.45
	7713	786	101.91	46	5.96	476	70	147.06	11	23.11	37583	4221	112.31	240	6.39
	7601	716	94.20	49	6.45	440	71	161.36	3	6.82	39015	4041	103.58	219	5.61
	81126	6701	82.60	820	10.11	3663	424	115.75	58	15.83	173466	14811	85.38	1590	9.17
	77763	6542	84.13	824	10.60	3683	380	103.18	50	13.58	178407	14970	83.91	1627	9.12
	67177	5729	85.28	622	9.26	3814	416	109.07	40	10.49	174095	15854	91.07	1514	8.70
	64445	5306	82.33	691	10.72	2839	352	123.99	43	15.15	173718	15730	90.55	1521	8.76
	53471	4321	80.81	477	8.92	2654	238	89.68	31	11.68	162755	13884	85.31	1301	7.99
	52499	3922	74.71	572	10.90	2650	240	90.57	32	12.08	165720	13342	80.51	1364	8.23

One- and two-family dwellings. ■ Multifamily dwellings. ■ Total of the two categories.

provided. References to national trends are based on NFPA data.

I prepared a spreadsheet (Tables 1a, 1b, and 1c) on which the data was entered, by year, under eight categories:

**Fires under the following conditions:**

- not reported,
- detectors were in the room of origin and operated,
- detectors were not in the room of origin and operated,
- detectors were in the room of origin and did not operate,
- detectors were not in the room of origin and did not operate,
- fire too small to set off detector,
- no detectors present, and
- performance not classified.

Each category has subcategories of number of incidents, number of injuries, injury rate (number of injuries per 1,000 incidents), number of fatalities, and fatality rate. The data were then sorted into three groups: one- and two-family dwellings (yellow), multifamily dwellings (blue), and the total of these two categories (orange). Unless otherwise noted, the data discussed here were taken from the "total" category. In Table 2, "Smoke Detector Performance," are totals for smoke detector data from the four categories of smoke detector performance presented in two composite categories: (1) where smoke detectors operated and (2) where they were present but did not operate. These two categories summarize smoke detector performance.

**DO SMOKE DETECTORS WORK?**

To determine if smoke detectors really work, let's start with the data in the orange-colored group (the combined total of the one-

and two-family and the multifamily dwelling categories).

Table 1c shows that the fatality rate (number of fatalities per 1,000 fires) under the Annual Totals for 1996 column is 8.23. Although this is an average rate and doesn't give specific data, it provides a point of reference. For example, where there were no smoke detectors, the fatality rate was 10.9—24 percent higher than the average fatality rate for 1996. We now know that where smoke detectors were not present, fatality rates in 1996 were significantly higher than the average. More importantly, we now have a figure against which to compare smoke detector performance.

Next, note from Table 2 that where smoke detectors are present *but do not work*, the fatality rate is 7.28, 11.5 percent *below* the average. That is a reduction of 33.2 percent from cases where smoke detectors aren't present. Looking at the spreadsheet (Tables 1a, 1b, and 1c), we see that this general trend is consistent. Is this the evidence needed to prove that people who install smoke detectors *are* inherently more fire safety conscious? If people with smoke detectors weren't more fire safe, we should see the *same* fatality rate in homes with nonworking smoke detectors as in those where smoke detectors are not even present.

From the category (Table 2) where smoke detectors were present and did work, we see that the fatality rate in 1996 was a low 4.34—a full 40 percent lower than in those cases where smoke detectors were present but not operating and an astounding 60 percent lower than where smoke detectors were not present. From these data, we can now verify that smoke detectors are effective. However, it is probably more accurate to say that in homes in which smoke detectors are installed and maintained the fatality rate is only 4.34 vs. a rate of 10.9 where no smoke detectors are present.

# Smoke Detectors and Life Safety

Table 2. Smoke Detector Performance

Year	Smoke Detectors Operated					Smoke Detectors Did Not Operate				
	Incident	Injuries	Rate	Fatalities	Rate	Incident	Injuries	Rate	Fatalities	Rate
1987	22112	1976	89.36	101	4.57	14768	1111	75.23	110	7.45
1988	22679	1955	86.20	125	5.51	15442	1198	77.58	102	6.61
1989	25440	2263	88.95	117	4.60	16449	1288	78.30	117	7.11
1990	23837	2318	97.24	129	5.41	14933	1263	84.58	107	7.17
1991	25115	2433	96.87	133	5.30	16082	1465	91.10	128	7.96
1992	26883	2532	94.19	131	4.87	16790	1450	86.36	137	8.16
1993	29669	2667	89.89	141	4.75	17493	1552	88.72	106	6.06
1994	29662	2703	91.13	125	4.21	17016	1506	88.50	156	9.17
1995	28364	2445	86.20	139	4.90	16189	1315	81.23	114	7.04
1996	29441	2420	82.20	123	4.18	16256	1297	79.79	126	7.75
	11099	1530	137.85	97	8.74	5208	735	141.13	37	7.10
	11420	1614	141.33	94	8.23	6047	600	99.22	38	6.28
	14009	1848	131.92	86	6.14	6973	859	123.19	46	6.60
	15683	1848	117.83	87	5.55	7525	940	124.92	70	9.30
	14555	1849	127.04	62	4.26	6546	756	115.49	59	9.01
	15277	1668	109.18	71	4.65	6835	728	106.51	42	6.14
	33211	3506	105.57	198	5.96	19976	1846	92.41	147	7.36
	34099	3569	104.67	219	6.42	21489	1798	83.67	140	6.51
	39124	4281	109.42	219	5.60	23055	2324	100.80	174	7.55
	42566	4380	102.90	218	5.12	24315	2390	98.29	207	8.51
	42919	4294	100.05	201	4.68	22735	2071	91.09	173	7.61
	44718	4088	91.42	194	4.34	23091	2025	87.70	168	7.28

Illustration 1, "Smoke Detectors and Fatality Rates," indicates the direction the fatality rates are taking in each of the three categories mentioned above (no smoke detector, smoke detectors present and worked, and smoke detectors present but did not work).

The top line (red) indicates the fatality rate for homes without smoke detectors. The straight line through the graph line is a linear trend line. It gives an idea of the degree of increase or decrease of the data in the graph. Where there were no smoke detectors, the trend line is almost level. This indicates that even though the rates were gyrating wildly over the past 10 years, the fatality rate is essentially the same today as it was in 1987. But remember, this is the rate for both one- and two-family and multifamily dwellings.

Line 2 (blue) represents homes in which smoke detectors were present but did not work when the fire occurred. The slope of the trend line indicates a slight increase in the overall rate from 1987 to 1996. The reason for this increase is not known. It is also possible that this increase is so slight as to be insignificant.

The bottom (yellow) indicates home fires in which smoke detectors alerted residents to the fire. Note the overwhelming decrease in the line's slope. Something positive is happening here! In fact, the graph of the data for this category is almost a straight line. How is this possible? Why are smoke detectors more effective today than in 1987?

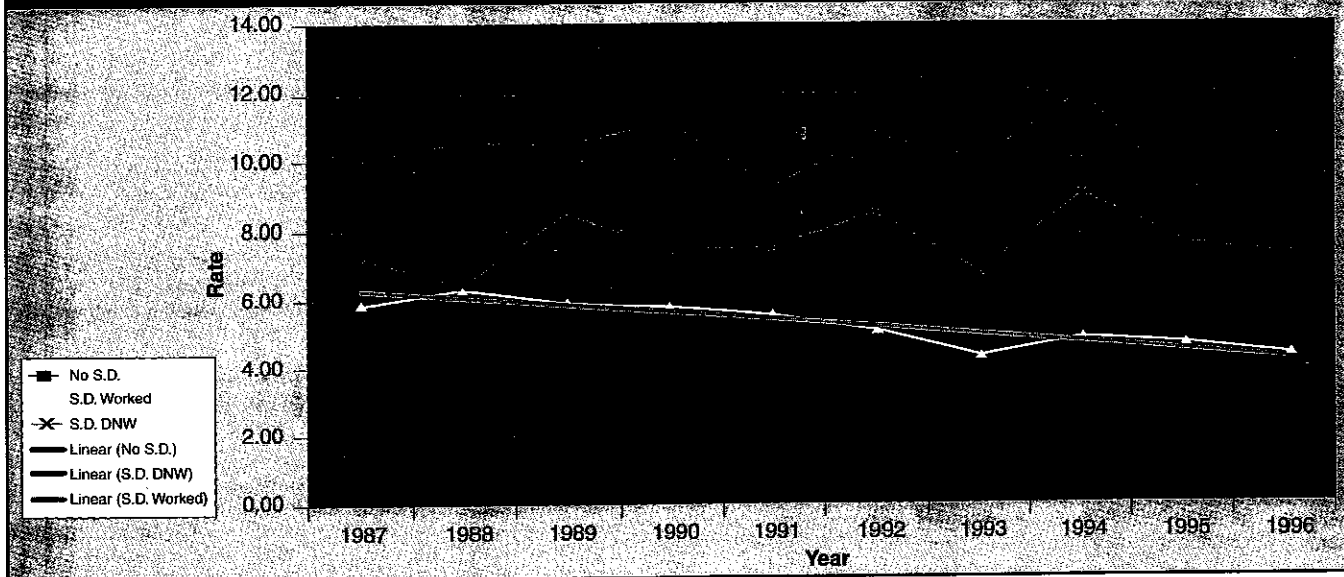
This is easy to explain. Over the years since some jurisdictions have made smoke detectors mandatory, the codes have become increasingly strict. At first, only one detector was required—in the sleeping area, and it could be battery-powered. Later, the detector had to be hard-wired. Then, detectors were required on each floor level; they had to be interconnected and ultimately were required to

have a battery backup. Some recent codes now require that a detector be in every bedroom as well as on each floor level; detectors are also required to be interconnected and to have battery backup. Whatever the reason, smoke detectors are a success story, at least to a degree. But to be most effective, they must be properly maintained.

As recently as 1996, only 26 percent of all home fires occurred in homes with working smoke detectors, according to NFDC data. This gives further support to the theory that *people who install and maintain smoke detectors are much less likely to have a fire than people who do not install smoke detectors.*

Looking closely at the data in the spreadsheet (Tables 1a, 1b, and 1c), we see that the data break down smoke detector performance into four categories—two in which the detectors work and two in which they don't work. In the first category, which represents working smoke detectors, the detectors are actually in the room of the fire's origin (Table 1a). For 1996, the fatality rate was a low 3.84 deaths per 1,000 fires. Where the detectors were working but not in the room of origin, the rate rose to 4.98. This means that even in a home with working smoke detectors, there is a 29.6 percent greater chance of dying in a fire if the fire does not start in a room that has a working smoke detector. In fact, if you compare the rates for these two categories over the 10 years of data provided, you'll see a significant improvement in life safety where the detector is in the room of fire origin. How's that for a good argument for having smoke detectors in every room? It's the most convincing direct evidence I have found that smoke detectors are effective. In fact, of the eight categories of data, the only one that has a fatality rate lower than when the detector is in the room of origin is that where the fire was

Illustration 1. Smoke Detectors and Fatality Rates

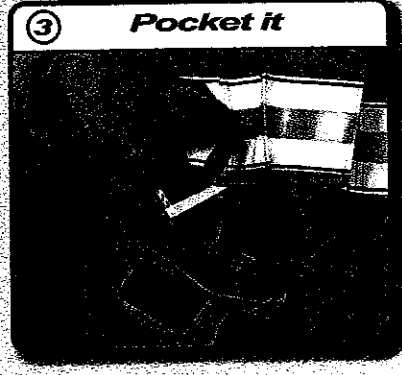
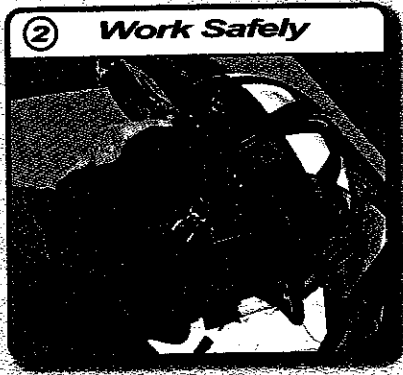
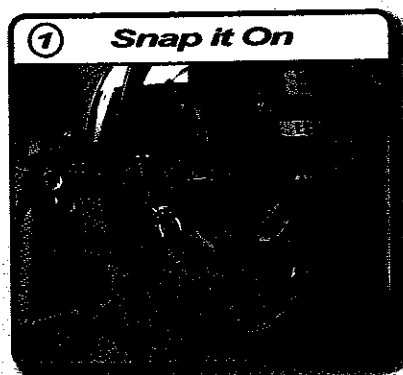


determined to be too small to trigger the smoke detector in the first place.

**ONE- AND TWO-FAMILY VS. MULTIFAMILY DWELLINGS**

Let's look at the data that compare one- and two-family vs. mul-

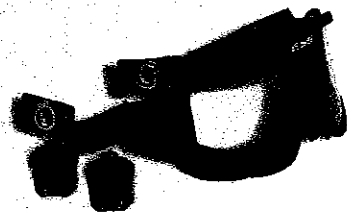
tifamily dwellings (Illustrations 2 and 3, respectively). The data depicted in these graphs are the same as those in the spreadsheet. Looking at Illustration 2 (one- and two-family dwellings), we see that where no smoke detectors are present (blue), there is evidence of an increase (the slope of the trend line goes up) in fatality rates



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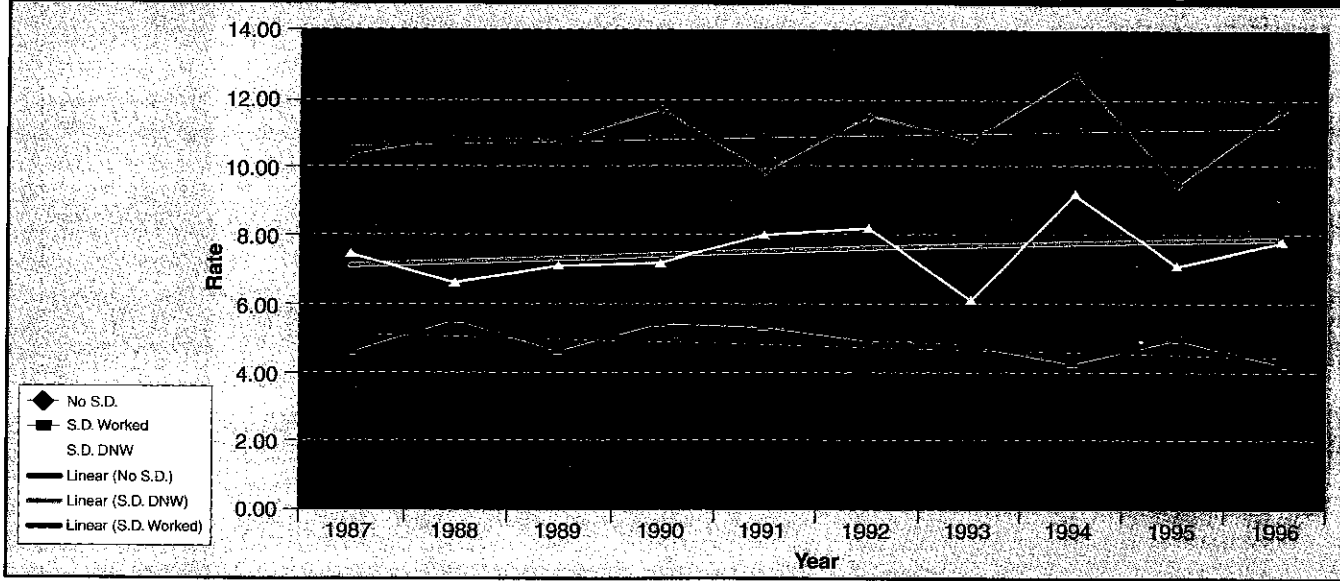
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Illustration 2. Smoke Detectors and Fatality Rates—One- and Two-Family Dwellings



over the 10 years of data. A similar increase is seen where smoke detectors were present but didn't work (yellow). The only category in which an improvement is evident (the slope of the line goes down) is where the smoke detectors actually worked (red). This means that in one- and two-family dwellings, except where smoke

detectors actually work, the situation appears to be getting worse. And, on top of this, the categories in which the fatality rate is getting worse represent 76.7 percent of all one- and two-family dwelling fires.

When we look at the same data over the same time period on the

**When it has to be there, immediately, without challenge, Without excuse,**  
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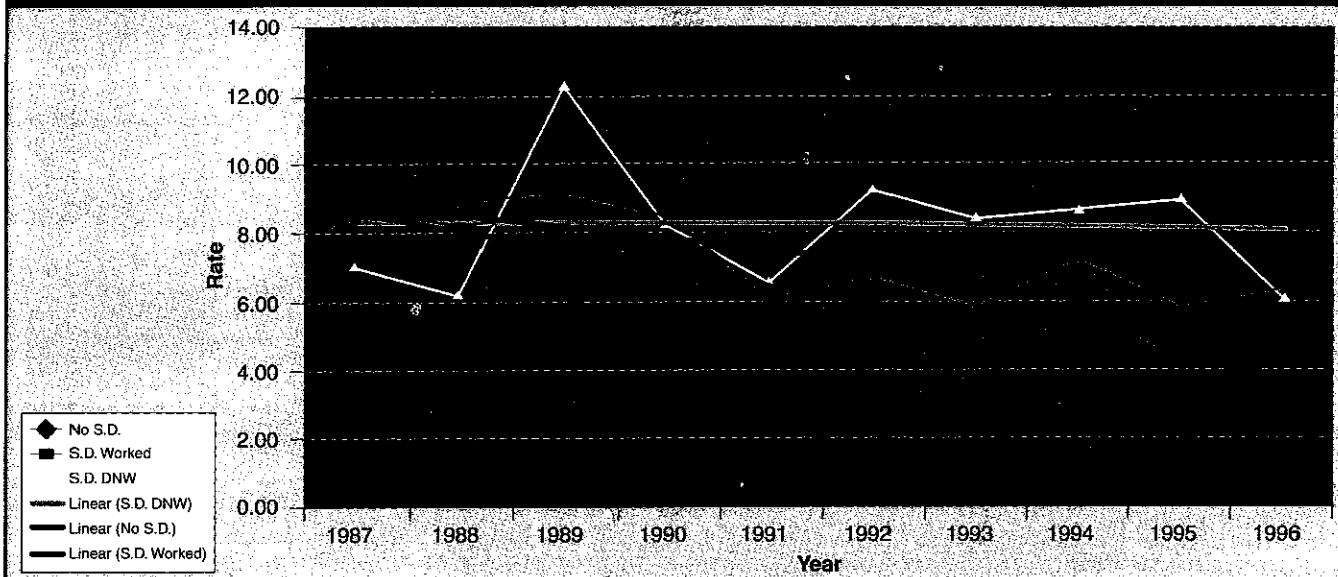
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Illustration 3. Smoke Detectors and Fatality Rates—Multifamily Dwellings



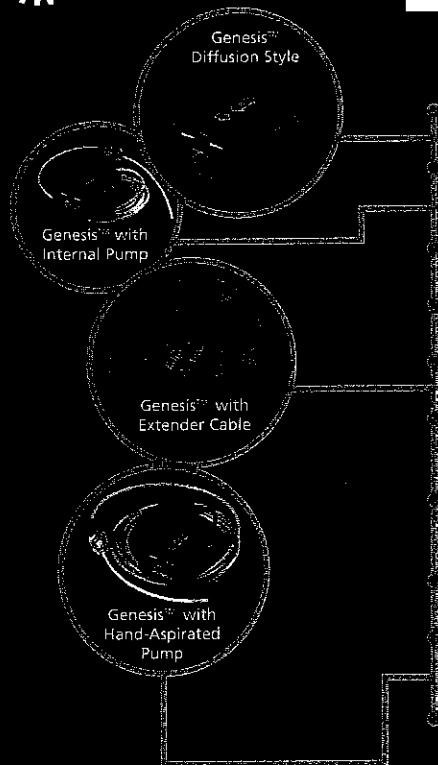
graph for multifamily (Illustration 3), we see a completely different outcome. Every category shows an improvement (a decline in rates). The slightest improvement, but still an improvement, is in the category of smoke detectors present but did not work (yellow). In the other two categories, the reduction in fatality rates is dramatic.

Why have fatality rates significantly gone down in multifamily residences that have no smoke detectors? This same category shows an increase for one- and two-family residential occupancies. The answer that I can determine, from another study I have done recently, is that it is probably attributable to fire prevention efforts in the



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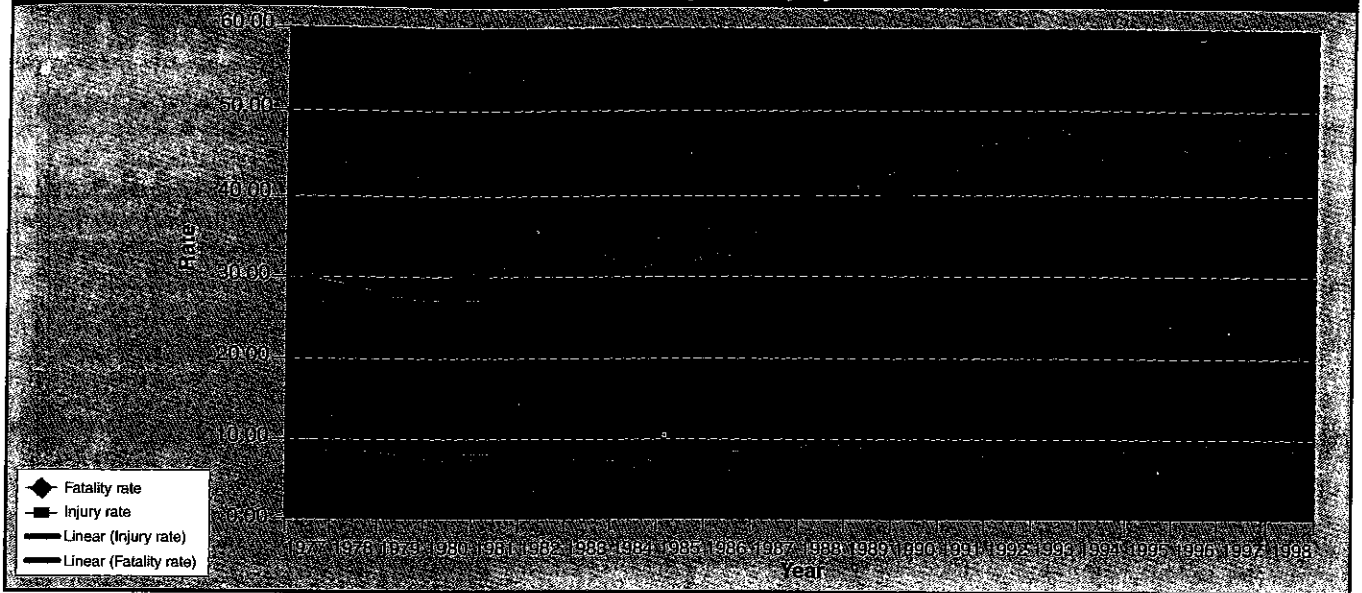
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Illustration 4. Home Fires Fatality and Injury Rates 1977 to 1998



forms of enforcement of building/fire codes, installation of 13-R sprinkler systems, enforcement of strong fire prevention code, and implementation of a vigorous fire inspection program. In short, fire prevention works!

To prove this point, I will briefly discuss the results of the other study to which I referred. I looked at an increase in suppression runs over a seven-year period in a jurisdiction of just under one million people. The increase in suppression runs was compared in relation to the increase in population of the jurisdiction. From 1992 to 1998, the jurisdiction saw a 10.2 percent increase in population and a 15.4 percent increase in suppression runs. (Suppression runs include fires, reports of fires, fires out on arrival, and so on.) I then broke the suppression runs for *buildings only* down into two subcategories: buildings inspected and those not inspected. In the inspected group were all the commercial, industrial, mercantile, multifamily residential, and so on). The group not inspected consisted essentially of one- and two-family dwellings. The group that underwent some type of inspection on a regular basis had a 14.7 percent increase in suppression runs. The group not inspected (one- and two-family dwellings) had an increase of 110.1 percent. No, it's not a typo! In the seven-year period, suppression runs to one- and two-family dwellings increased more than seven times the rate of suppression runs overall and 10 times the rate of the increase in the population.

Before moving on, a warning flag needs to be raised. When discussing the average fatality rates above, I mentioned that the fatality rate where no smoke detectors were present was essentially unchanged since 1987. But now that we have broken that rate down into one- and two-family dwellings and multifamily dwellings, it becomes evident that the fatality rate is actually increasing in one- and two-family dwellings. On top of the increased fatality rate where smoke detectors aren't present, there is also an increase in the fatality rate where smoke detectors are present but don't work. In fact, where smoke detectors are present and don't go off, the fatality rate is increasing *even faster* than where smoke detectors aren't present at all. So, even when we recognize the potential of smoke detectors, we must also note these specific categories in which things are actually getting worse.

## INJURY RATE

By now, you have probably noticed that I have not made any mention of the injury rate. This is for a good reason. Good arguments can be made that we have had success in the reduction of life loss from fire even when the fatality rates show an increase simply because overall numbers have decreased. But when we discuss injuries, no such claim can be easily made. Earlier, I had pointed out that from 1977 to 1997 there was a 45.3 percent reduction in the number of home fires. In 1977, there were 21,640 injuries in home fires. By 1997, there were only 17,300 injuries in home fires. That is only a 20 percent reduction, less than half the reduction in fatalities. If we compare the number of injuries per 1,000 fires to make an injury rate, the real problem begins to appear. In 1977, the injury rate for home fires was 29.91; by 1997, it had increased to 43.74—a 46.8 percent increase. This is a problem that is currently being ignored by the U.S. fire service.

What is more to the point, since this report is about smoke detectors and life safety, is what part do smoke detectors play in the reduction of injuries? When we combine both categories where smoke detectors work, we have an average injury rate of 91.42 injuries per 1,000 home fires in 1996. What probably comes as a surprise to most is that this is the highest injury rate for any category. We can see from Table 2 that in 1996 homes with smoke detectors that didn't work have the *second highest* injury rate—87.7 percent. Where smoke detectors are not present, the injury rate is only 74.71 percent (Table 1c). Once again, it is hard not to perceive a behavioral difference between people who install and maintain smoke detectors and those who don't, even though where injuries are concerned, it is working against them.

Is it possible that people who install and maintain smoke detectors believe they can fight the fire themselves? After all, they were fire safety conscious enough to install the smoke detectors. This, more than anything else, could expose residents to the fire and cause injuries. But, it can't be explained simply by saying this phenomenon is attributed to smoke detectors' alerting residents to the fire in its earliest stages, thus giving them a better chance of fighting the fire themselves. After all, even where smoke detectors are present but don't go off, the injury rate is 17 percent higher than where smoke detectors are not present.

Table 3. Home Fires 1977-1998: Fatality and Injury Rates

Year	Fatalities	Injuries
1977	8.11	29.91
1978	8.51	28.87
1979	7.90	27.03
1980	7.08	26.84
1981	7.59	26.90
1982	7.36	31.25
1983	7.47	33.17
1984	6.73	30.97
1985	8.06	31.64
1986	8.23	32.85
1987	8.52	37.21
1988	9.20	40.99
1989	8.70	40.67
1990	8.91	44.50
1991	7.53	45.80
1992	8.07	45.97
1993	8.12	48.03
1994	7.82	44.46
1995	8.79	45.05
1996	9.68	45.26
1997	8.50	43.74
1998	8.71	45.47

It might be possible to make an argument that a higher injury rate is evident where smoke detectors work because without the detectors the injuries would be fatalities. But this doesn't work when we compare the injury rate with fatality rates where smoke detectors are present but don't go off. As shown above, there is a 33.2 percent better of chance of surviving a fire if a smoke detector is present, *even when it doesn't work*. But the *injury rate goes up* where smoke detectors are present but don't work compared to where no smoke detectors are present.

#### THE NEED FOR BETTER DATA

As mentioned earlier, the primary data for this report were provided by the National Fire Data Center in Emmitsburg, Maryland. If you look at the data closely, you can see trends in various areas. As an example, if looking at the spreadsheet (Table 1c—data from the NFDC), fatality rates given under the Annual Totals column appear to be headed down. However, fatality rates using NFPA data (Table 3 and Illustration 4) appear to be increasing. So, how is it possible that two very credible sources of information are actually in opposition?

The information supplied by the NFDC is an actual count. It also has the major flaw of being an *incomplete* count. In fact, only about 50 percent of all fire departments in the country choose to report data to the NFDC. At this point in the history of the U.S. fire service, it is discouraging that so many departments choose to exclude themselves from a national database. There is no more accurate way of determining how many fires of what category occurred and their related particulars than to have an actual accounting.

On the other hand, the NFPA figures, which are used exclusive-

ly when national data are needed, are an *estimate*. They are, however, the best estimates we have concerning the U.S. fire problem. They are arrived at by combining the information from the NFDC with data from some 3,000 survey forms sent out by the NFPA. But since neither method results in a complete, accurate count, the NFPA must make predictions from the available data. The final figures are a statistically generated *best guess*. They may not be an actual count; but, unfortunately, they are the best statistics we have. This conflict really points out the need for a complete, national count. The NFDC already has a system in place; all we have to do is use it.

#### CONCLUSIONS

The answer to the original question with regard to the effectiveness of smoke detectors is that they are effective. But just how effective is not exactly known. Remember that evidence presented here supports the theory that *people who install and maintain smoke detectors are less likely to have a fire than people who don't have smoke detectors installed*. This answers the second question posed at the beginning of this article. Since the fatality rate is increasing in one- and two-family dwellings, which accounts for about 74 percent of all home fires, it would provide an answer to the question of why fatality numbers have not fallen as fast as the number of fires—in short, *the tremendous benefit of smoke detectors is more than offset by the ever-increasing fatality rate in one- and two-family dwellings where smoke detectors aren't present or don't work*.

Figuring out the reason for higher injury rates in homes where smoke detectors are present is more complicated. The first answer reached is usually that the increased injury rate represents lives saved. But this doesn't "compute" when we realize that a difference in both fatality and injury rates is evident even when smoke detectors are present but don't work. In fact, if we look at the injury rates for 1996, where smoke detectors were present but did not work, the number of injuries per 1,000 fires goes up by 12.9 injuries compared with homes without smoke detectors. But the injury rate only goes up by another 3.7 injuries per 1,000 fires when a smoke detector works. Could this be the smoking gun that proves the injury rate difference is in large part behavioral and not all the result of the smoke detectors' saving the lives? Remember, where smoke detectors are present but don't work, we can't credit the smoke detector with alerting the residents, but we still see notable and credible differences in fatality rates.

Overall, the effectiveness of smoke detectors is evident in saving lives, but this benefit is accompanied by an increased injury rate. Although it may not be possible to quantify an exact benefit figure for smoke detectors, it is clear we need to get them in all residences. States and jurisdictions that currently don't have mandatory smoke detector legislation need to adopt laws mandating smoke detectors in every room except kitchens and utility rooms. And while we are at it, how about a true national (meaning *everyone* has to participate) reporting system? ■

(Editor's note: For information on implementation of the new National Fire Incident Reporting System (NFIRS) 5.0, see page 107.)

#### Endnotes

1. Hall, John R., Jr., *U.S. Experience with Smoke Detectors and Other Fire Detectors*, National Fire Protection Association, Aug. 1996.
2. Relative risk is the percentage of total fires in homes with (without) smoke detectors divided by percentage of homes with (without) smoke detectors—e.g.,  $56.1/93 = 0.6$ .

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