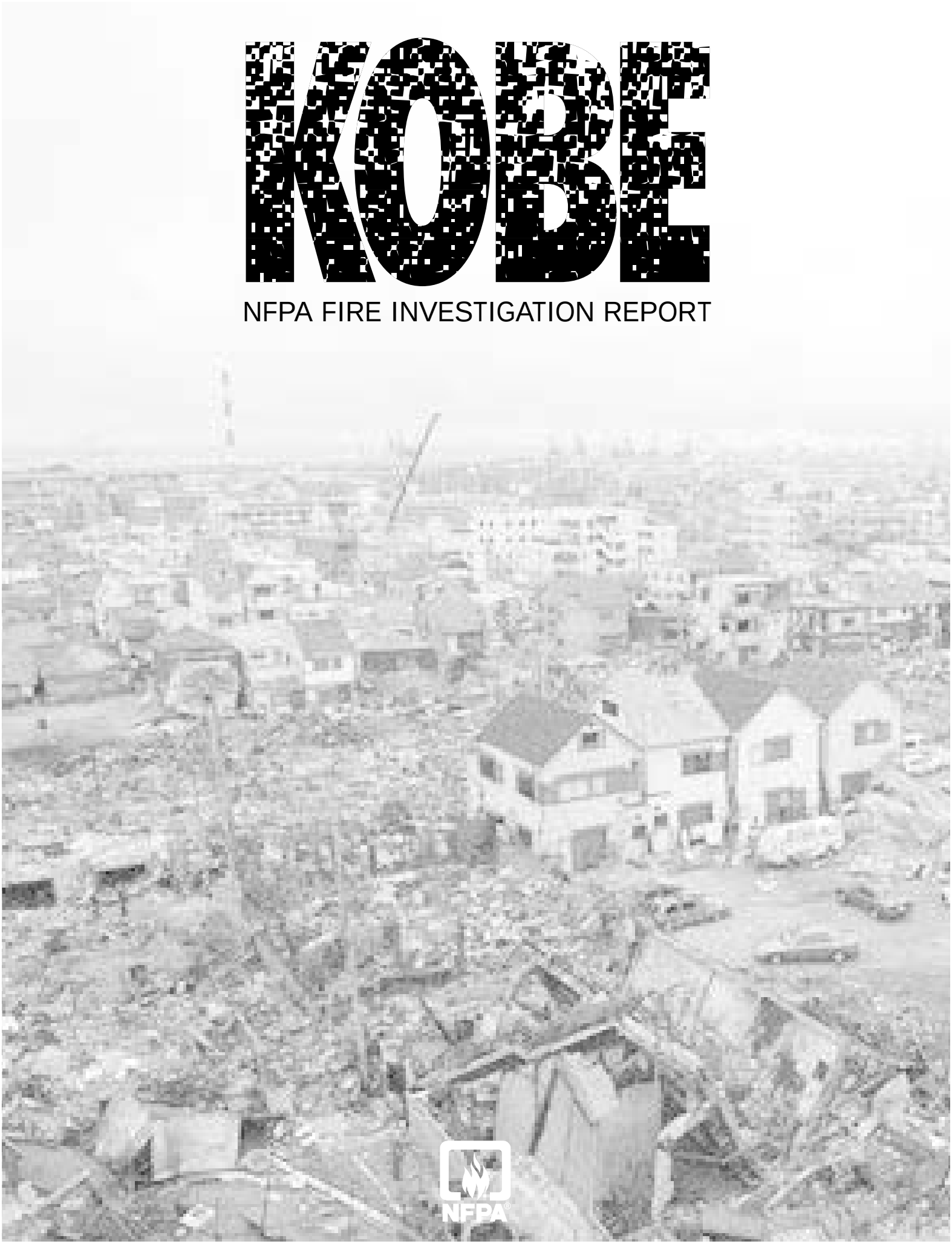
KOBE

NFPA FIRE INVESTIGATION REPORT



1.0 Executive Summary

On Tuesday, January 17, 1995, at 5:46 a.m. (Japan Standard Time), a 20-second earthquake measuring 6.8 on the Richter Scale occurred near the Japanese port of Kobe, about 500 km (311 mi) southwest of Tokyo. The quake, which was an order of magnitude larger than the Northridge Earthquake in January 1994, killed more than 6,000 people, injured at least 30,000, and left more than 300,000 people homeless.[1] More than 100,000 buildings were severely damaged or destroyed by the quake and the fires it caused. 148 separate fires destroyed 6,513 buildings and an area of 624,671 m^2 (0.24 sq mi). The total dollar loss, including damage to buildings, transportation systems, and other portions of the infrastructure, has been estimated between ¥13 trillion and ¥20 trillion (U.S. $147 billion and U.S. $200 billion).

This earthquake was the worst to hit Japan since the 1923 Tokyo-Yokohama earthquake, which had an estimated Richter magnitude of 7.9 and resulted in nearly 143,000 deaths, primarily due to fire. The last Japanese earthquake to kill more than 1,000 people was the Fukui earthquake in 1948.[2]

Several factors influenced the spread of fire immediately after the earthquake and in the days that followed. For example, many of the structures involved were built of lightweight wood or bamboo covered with a thin layer of stucco that was not well secured. Even if a building did not collapse, it often lost its outer layer of stucco. When this happened, the underlying wood materials were exposed, creating a large combustible fuel load.

Many residential structures were not adequately reinforced laterally, which resulted in either significant damage or collapse. When a structure did collapse, it generally left a pile of very combustible material in the street in front of it. Because the streets in the Kobe area are narrow, these piles eventually ran together, resulting in continuous debris from one side of the street to the other. This allowed fires to spread uninhibited.

More than 50 percent of the fires that were identified as having been caused by the earthquake occurred three hours or more after the quake hit. This is significant because a number of these fires can probably be attributed to ignition sources that might have been prevented or controlled. For example, electrical service was sometimes restored without isolating damaged areas. People used open fires to warm themselves or to cook food, and some left candles at shrines. Some fires were started by arsonists.

Unfortunately, the Kobe water supply was compromised very quickly by a large number of breaks in the distribution system that rendered the entire water supply useless within hours. The 971 underground cisterns located throughout the city that were meant to be used for emergency fire fighting operations were either blocked by debris, preventing fire fighting apparatus from reaching them, or they were damaged and lost all their water through leakage.

As for sprinkler systems, local experts say that they are not commonly used. Even when they were, they were often so badly damaged that they were not functional. In one hospital that did have a sprinkler system, the fifth floor suffered a pancake collapse that rendered the entire system inoperable. Many high-rise apartment buildings were equipped with a number of standpipe systems, but the quake frequently offset these buildings at street level by several inches, and it is assumed that the underground piping was severely damaged.

The lack of water supply and the limited access via roadways caused by the widespread structural collapse severely hampered fire fighting operations. In several cases, buildings were saved by citizens who formed bucket brigades to stop fires from destroying them.

One factor that may have actually mitigated the spread of fire after the earthquake was the type of heating system found in many Japanese homes. Japanese families often use kerosene heaters, which they commonly turn off in the evening. Since the earthquake occurred early in the morning, it is assumed that many of the heaters had not been turned back on. This helped reduce the number of potential ignition sources.

Another mitigating factor was the wind speed, which was relatively low at the time of the earthquake and for the three days immediately afterward. This helped to limit the spread of fire.

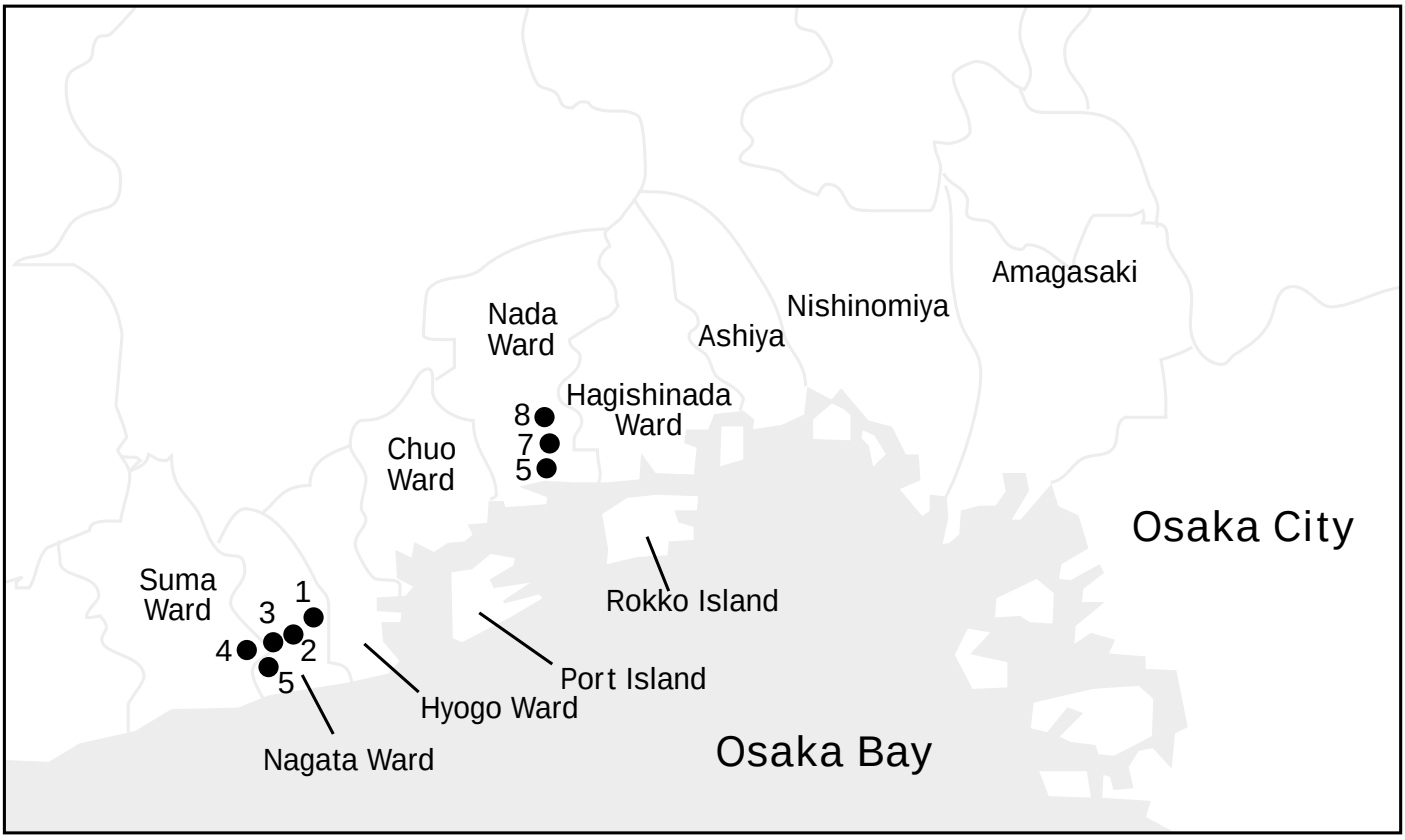
Building design was also a significant factor in limiting fire spread in several instances. Three types of occupancies in particular fared well: gasoline stations, power substations, and schools. In all three, a combination of noncombustible perimeter walls, and a lack of penetrations in the structure or open areas surrounding the building helped limit the spread of fire.

This report deals with the fire and emergency response to the disaster. It is based on a number of sources, including the personal observations of Ed Comeau, Chief Fire Investigator of the National Fire Protection Association's Fire Investigation Department. Comeau spent five days in Kobe as part of a multidisciplinary U.S. team that operates under the auspices of the UJNR (U.S.-Japan Cooperative Program in Natural Resources), coordinated by Dr. Riley Chung of the National Institute of Standards and Technology (NIST). The team's 18 members were drawn from several specialties, including lifelines/geotechnical, buildings, fire, seismology/geology, and transportation. During the site survey, Comeau was teamed with Dan Madrzykowski from the Building Fire Research Institute, a part of NIST. The team obtained a large amount of fire-related information from Dr. Yoshiteru Murosaki, a professor in the Engineering Department of Kobe University, who formed teams of graduate students immediately following the earthquake to survey fire-damaged areas in an effort to ascertain what had happened and to collate the data.

Although this earthquake has been referred to by several different names, including the Hanshin-Awaji Earthquake, the Great Hanshin Earthquake, the Hyogo-Ken Nanbu Earthquake, the South Hyogo Prefecture Earthquake, and the Kobe Earthquake, it will be referred to as the Kobe Earthquake for the remainder of this report.

Table A

Site Number	City	Location	Burned Area(m^2)	Number of Burned Bldgs
1	Kobe, Nagata Ward	Sugawara Market Area	74,043	927
2	Kobe, Nagata Ward	Shin Nagata Station, South	39,570	434
3	Kobe, Nagata/Suma Wards	Mizukasa West Park	106,241	1,164
4	Kobe, Suma Ward	Chitose Small Park	15,542	179
5	Kobe, Nagata Ward	Takahashi Hospital Area	68,850	825
6	Kobe, Nada Ward	Oishiminami, Block 2&3	2,456	24
7	Kobe, Nada Ward	Shikanashita, Block 3	2,398	41
8	Kobe, Nada Ward	Rkko, Block 1&2	19,940	221



SOURCE: NIST