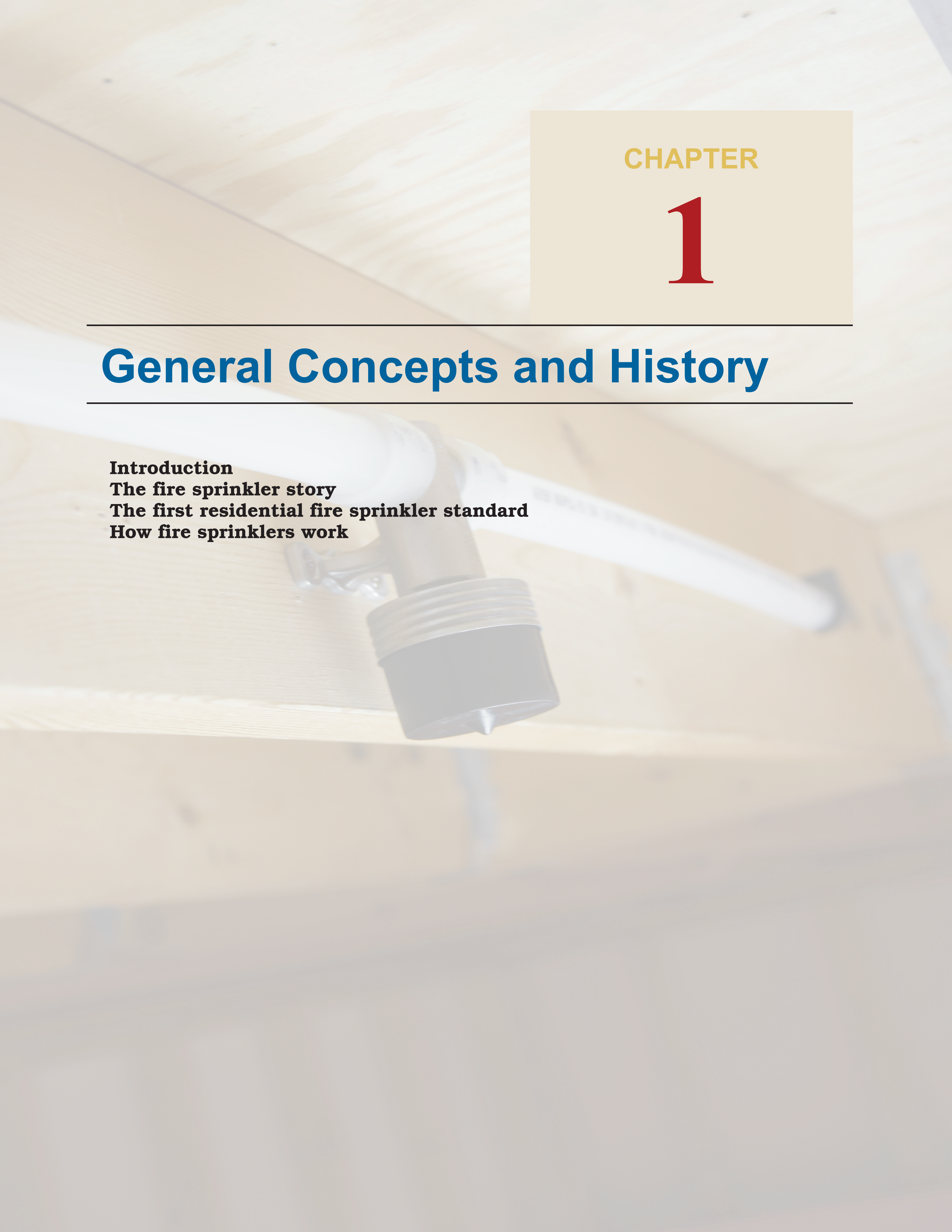

CHAPTER

1

General Concepts and History

Introduction
The fire sprinkler story
The first residential fire sprinkler standard
How fire sprinklers work

Introduction

Residential fire sprinklers save lives where most fire deaths occur—in dwellings. The U.S. Fire Administration reports that 84 percent of fire deaths occur in one- and two-family homes. Fire loss data from communities that require residential fire sprinklers show that they can reduce fire deaths in dwellings to nearly zero. [1, 2, 3]

Residential fire sprinklers may look the same as commercial fire sprinklers, but they are not. They operate much faster than commercial fire sprinklers, and their spray patterns are unique to dwellings. That combination of fast response and unique spray pattern controls dwelling fires when they are small, thus requiring very little water compared to commercial fire sprinklers. Commercial fire sprinkler systems may flow hundreds of gallons per minute, but residential fire sprinkler systems use tens of gallons per minute. Their unique features and low water usage make residential fire sprinklers effective life safety devices.

From Property Protection to Including Life Safety

Automatic fire sprinklers were first used in the late 1800s to protect textile mills and factories. Their excellent record at limiting fire losses prompted insurers to expand their use to other occupancies. Today, fire sprinklers protect occupancies such as shopping malls, schools, hospitals, nursing homes, hotels, apartment buildings and homes.

The National Fire Protection Association (NFPA) published the first standard for fire sprinklers in 1896. It was titled NFPA Pamphlet 13, *Standard for the Installation of Sprinkler Systems*, and its objective was to reduce property loss from fire. However, over time, fire protection experts noted that limiting fire spread also saved lives. Stopping fires when they are small gives occupants more time to exit safely.

By the early 1970s, sprinkler proponents were promoting fire sprinklers in homes. Two things motivated their recommendations. First was the excellent fire control record that fire sprinklers had accrued since their inception. Second was the fact that dwelling fires had begun posing greater threats to occupants—and greater challenges to fire departments.

The threat to occupants was increasing as synthetic materials replaced natural fibers such as cotton and cellulose. Synthetic mattresses, sofa cushions and similar materials burn twice as fast and twice as hot. They also produce greater magnitudes of additional smoke. The faster fire growth reduces the time to flashover, a critical stage of a fire where it suddenly spreads to everything in the room. Flashover severely reduces the odds of anyone in the home surviving.

San Clemente, California became the first city to require fire sprinklers in new homes. San Clemente fire chief Ronny J. Coleman led the initiative for that ordinance adoption in 1982, and he remains a leading advocate of residential sprinklers today. Over the years, hundreds more jurisdictions around the country have followed his lead in protecting dwellings. Recent changes to the *International Residential Code*® (IRC®) are expected to greatly increase the number of homes equipped with fire sprinklers. The 2009 edition of the IRC requires fire sprinklers in all new one- and two-family homes that are built after January 1, 2011. The requirements also apply to townhomes up to three stories in height effective upon the date that the IRC is adopted.

Flashover, the critical point in dwelling fires

For a fire to start, three elements are needed: fuel, heat and oxygen. The fire triangle in Figure 1.1 illustrates how the three elements are related.

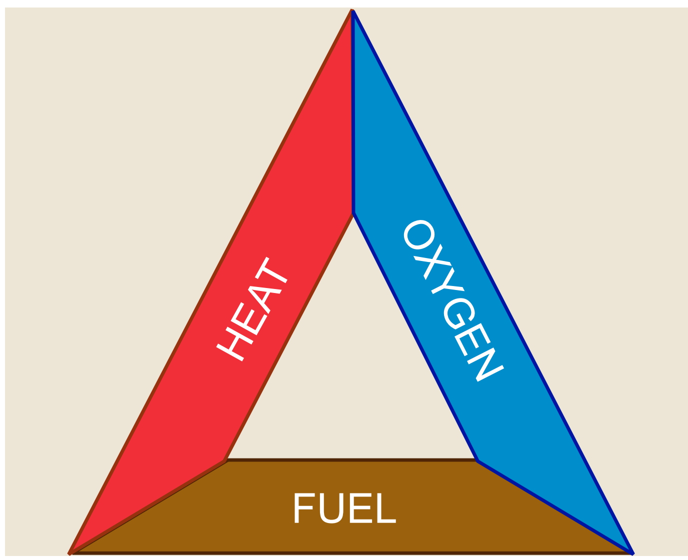

Figure 1.1
Fire triangle

If a fire starts and one of those three elements is removed, the burning will stop. The water spray from fire sprinklers absorbs the heat from a fire. Without enough heat, the fuel will stop burning. Figures 1.2 – 1.5 show the progression of a fire in a room without fire sprinklers.

The fire starts when a heat source such as a cigarette ignites the sofa. The air in the room provides the oxygen. As the fire consumes the oxygen in the air, it emits smoke and carbon monoxide (CO), a toxic and combustible gas. The hot smoke and CO are lighter than the surrounding air and rise toward the ceiling, as shown in Figure 1.3.

The ceiling stops the rising plume of smoke and CO, and the plume spreads laterally toward the walls. The walls stop the lateral spread and force the hot smoke and CO to bank downward, as shown in Figure 1.4.

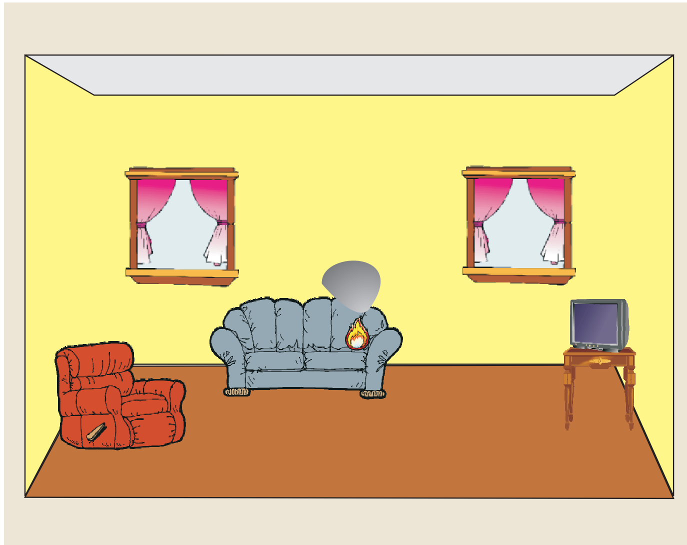

Figure 1.2
Fire ignition on sofa

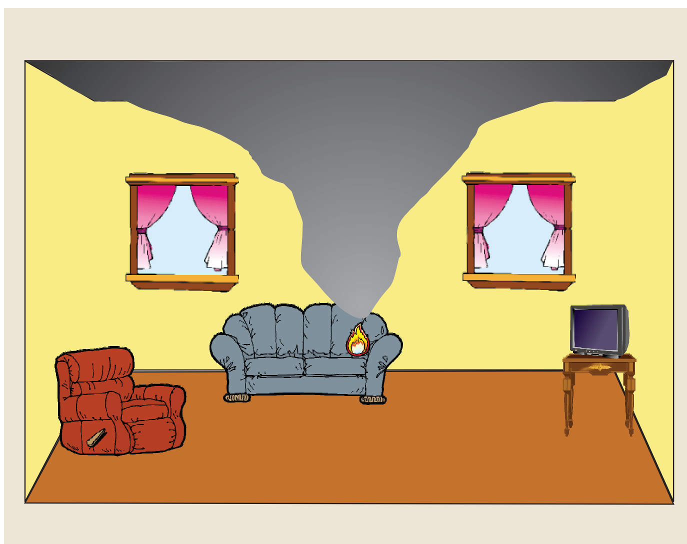

Figure 1.3
Fire plume

As the fire on the sofa grows, it increases the heat in the plume, which can very quickly exceed 1000°F at the ceiling. A ceiling temperature of 1100°F marks a turning point in the fire's growth because at that temperature the CO at the bottom of the smoky layer has reached 600°F, its auto-ignition temperature. The result is a nearly instantaneous wall of flame along the bottom of the smoky layer, as depicted in Figure 1.5.

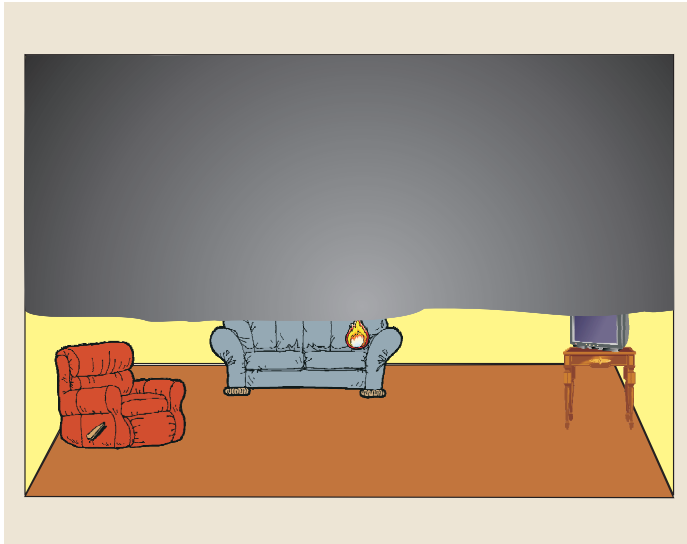

Figure 1.4
Accumulated smoke and CO

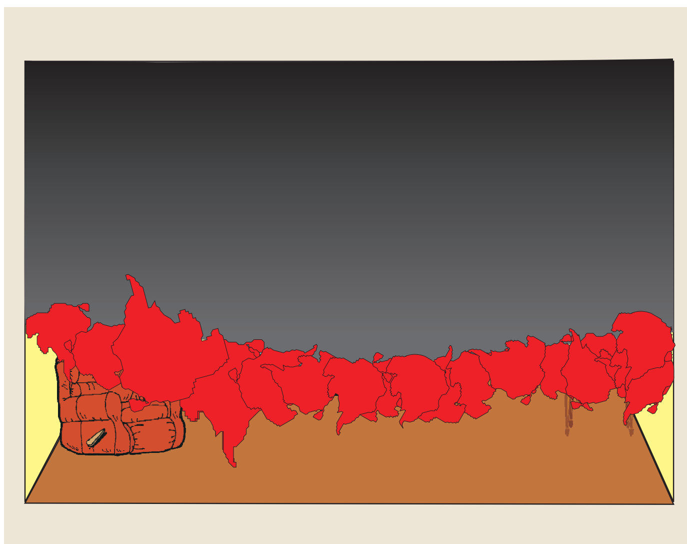

Figure 1.5
Flashover

The burning CO ignites everything in the room at the same time. The massive increase of heat and smoke literally explodes out of the room of origin into adjoining rooms. This stage of the fire is called *flashover*.

The National Institute of Standards and Technology (NIST) compared escape times from house fires before and after the increase of synthetic materials in home furnishings. The study found that escape time in 1975 averaged 17 minutes. By 2003, that average had dropped to just three minutes.[4]