

2.1.3.1 Passive Protection

In WTC 1, structural elements up to the 39th floor were originally protected from fire with a spray-applied product containing asbestos (Nicholson, et al. 1980). These asbestos-containing materials were later abated inside the building, either through encapsulation or replacement. On all other floors and throughout WTC 2, a spray-applied, asbestos-free mineral fiber material was used. Each element of the steel floor trusses was protected with spray-applied material. The specific material used was a low-density, factory-mixed product consisting of manufactured inorganic fibers, proprietary cement-type binders, and other additives in low concentrations to promote wetting, set, and dust control. Air setting, hydraulic setting, and ceramic setting binders were added in varying quantities and combinations or singly at the site, depending on the particular application and weather conditions. Finally, water was added at the nozzle of the spray gun as the material was sprayed onto the member to be protected. The average thickness of spray-applied fireproofing on the trusses was 3/4 inch. In the mid-1990s, a decision was made to upgrade the fire protection by applying additional material onto the trusses so as to increase fireproofing thickness to 1-1/2 inches. The fireproofing upgrade was applied to individual floors as they became vacant. By September 11, 2001, a total of 31 stories had been upgraded, including the entire impact zone in WTC 1 (floors 94–98), but only the 78th floor in the impact zone in WTC 2 (floors 78–84).

Spandrels and girders were specified to have sufficient protection to achieve a 3-hour rating. Except for the interior face of perimeter columns between spandrels, which were protected with a plaster material, spray-applied materials similar to those used on the floor systems were used. The thickness of protection on spandrels and girders varied, with the more massive steel column sections receiving reduced fireproofing thickness relative to the thinner elements.

The primary vertical compartmentation was provided by the floor slabs that were cast flush against the spandrel beams at the exterior wall, providing separation between floors at the building perimeter. After a fire in 1975, vertical penetrations for cabling and plumbing were sealed with fire-resistant material. At stair and elevator shafts, separation was provided by a wall system constructed of metal studs and two layers of 5/8-inch thick gypsum board on the exterior and one layer of 5/8-inch thick gypsum board on the interior. These assemblies provided a 2-hour rating. Horizontal compartmentation varied throughout the complex. Some separating walls ran from slab to slab, while others extended only up to the suspended ceiling. A report by the New York Board of Fire Underwriters (NYBFU) titled *One World Trade Center Fire, February 13, 1975* (NYBFU 1975) presents a detailed discussion of the compartmentation features of the building at that time.

2.1.3.2 Suppression

When originally constructed, the two towers were not provided with automatic fire sprinkler protection. However, such protection was installed as a retrofit circa 1990, and automatic sprinklers covered nearly 100 percent of WTC 1 and WTC 2 at the time of the September 11 attacks. In addition, each building had standpipes running through each of its three stairways. A 1.5-inch hose line and a cabinet containing two air-pressurized water (APW) extinguishers were also present at each floor in each stairway.

The primary water supply was provided by a dedicated fire yard main that looped around most of the complex. This yard main was supplied directly from the municipal water supply. Two remotely located high-pressure, multi-stage, 750-gallons per minute (gpm) electrical fire pumps took suction from the New York City municipal water supply and produced the required operating pressures for the yard main.

Each tower had three electrical fire pumps that provided additional pressure for the standpipes. One pump, located on the 7th floor, received the discharge from the yard main fire pumps and moved it up to the 41st floor, where a second 750-gpm fire pump pushed it up to a third pump on the 75th floor. Each fire pump produced sufficient pressure to supply water to the pump two stages up from it in the event that any one pump should fail.