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Major U.S. Cities Using National Standard Fire Hydrants, One Century After the Great Baltimore Fire

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1. Abstract

Fire equipment responding from different cities to the Great Baltimore Fire in 1904 were hampered or rendered useless by the incompatibility of hose and fire hydrant connections. After the Baltimore fire, a national standard for fire hydrant connections was adopted by the National Fire Protection Association. One-hundred years after the Great Baltimore Fire, 18 out of the 48 most populated U.S. cities have installed national standard fire hydrants. Specifications are given for the hose connections on hydrants installed in those 48 cities.

Key Words: fire fighting; fire hoses; fire hydrants; Great Baltimore Fire; Oakland Hills Fire; pumper connection; standards; steamer connection

2. Background

When fire hoses were first manufactured, the threads used to couple them differed among all the manufacturers. The same is true with the fire hydrant connections. Since the first fire hydrant was designed in 1817 by George Smith [1], each design, including hose connection threads, was patented by its manufacturer. Differences in hose connections on the hydrants, both diameters and threads, were part of the design that protected manufacturers from competition. Cities with different hydrant suppliers had fire fighting water supply systems with connections that were incompatible with those in other, sometimes neighboring, communities. History demonstrates that in major urban fires, the inability of fire fighting apparatus from other areas to utilize the water supply, because of incompatible hose connections, was a contributing factor to increased fire damage.

3. The Great Baltimore Fire

The lack of uniform threads is commonly cited as a factor in the massive destruction of the Great Baltimore Fire that started on Sunday afternoon, February 7th, 1904. The fire is believed to have been started by a cigar or cigarette that fell into the basement of the John Hurst & Company building [2].

Engine companies from Washington, DC, transported by train, arrived in Baltimore to assist in fire fighting a few hours after the fire started. Unfortunately, their hoses would not fit Baltimore hydrants due to the difference in threads. The fire continued to claim block after block of buildings in the Baltimore business district as more fire companies arrived from surrounding cities and counties, Altoona, Annapolis, Chester, Harrisburg, New York, Philadelphia, Wilmington, and York. Some of the responding fire companies' hoses fit the Baltimore hydrant connections; others did not [3].

The Great Baltimore Fire was finally put out thirty hours after it started. Despite the 1,231 firefighters, 57 engines, nine trucks, two hose companies, one fireboat, and one police boat used, the fire claimed 1,526 buildings in an area of seventy city blocks. A total of 2,500 businesses,

banks, etc were lost in the fire. Fortunately there was only one life lost. Firefighter James McGlennen died few days after the fire of injuries sustained while fighting the fire [2].

(a)

(b)

Fig. 1: (a) Picture of one fire engine battling the fire during the Great Baltimore fire. (b) Close-up of the lower right corner of picture 1a showing a 1904 Baltimore hydrant. The tallest object in the background is the cover of the hydrant that is right in front of it. The cover is removed to expose the hose connection of the fire hydrant. (Courtesy of the Baltimore Sun)[4]

4. The Establishment of a National Standard Hydrant

In the process of establishing fundamental standards and planning basic research programs, the National Bureau of Standards (NBS), now the National Institute of Standards and Technology (NIST), encountered in late 1904 the same incompatibility of hose couplings that firefighters had during the Baltimore fire. One evening, while trying to put out a small fire, Franklin Durston, a NBS employee, found out that the hoses in the North and South Buildings of NBS could not be coupled because of different threads.

Several months prior to the NBS fire, a study by Albert Merrill, an NBS employee, revealed that there were about 600 sizes and variations in fire-hose couplings across the country [3]. The National Board of Fire Underwriters and the National Fire Protection Association (NFPA) advocated a national standard of threads for hoses and fire hydrant outlets before the Great

Baltimore Fire, but it received little support. In 1905, an NFPA committee established a standard diameter and number of threads per inch for hose couplings and fire hydrants[*]. The standard was adopted by the National Fire Protection Association, the National Board of Fire Underwriters, the Associated Factory Mutual Fire Insurance Companies, the International Association of Fire Chiefs, the American Water Works Association and many other organizations [5]. The 1905 NFPA Standard specified that fire hydrants have 2.5 inch-hose connection nozzles with 7.5 threads per inch, and 4.5 inch-engine suction (or pumper) connection nozzles with 4 threads per inch [5]. These specifications remain as the current standard for fire hydrants. By 1914, only 287 of the 8,000 cities and towns in the US had fire-hose couplings and hydrant outlets conforming to the standard. By 1917, 897 cities agreed to adopt the standards, but only 390 were using them. Every year the number of cities with standard hydrants and fire-hoses was increasing. By 1924, the number was 700 cities. Some of the cities made the change only after they experienced their own major fire.

5. The 1991 Oakland Hills Fire

On Sunday, October 20, 1991, the nation experienced another urban fire disaster in Oakland, California, the worst involving loss of lives and properties since the great San Francisco earthquake and fire of 1906 [6]. The fire started in a wooded area above State Highway 24 near the Caldecott Tunnel [6]. The fire grew rapidly due to the high speed and dry "Santa Ana" winds from the east. Engine companies from the surrounding fire departments were called immediately. Firefighters and commanders encountered many problems, among them incompatibility of hose and hydrant connections. Those engines having the 2.5 inch (standard) hose couplings could not connect to the 3 inch couplings on Oakland fire hydrants at the time. The fire claimed the lives of 25 people including a police officer and a firefighter [7]. In

[*] Fire hose and couplings have historically and are still widely expressed using units of inches (diameter) and threads per inch. Since most users of fire hose are familiar with these traditional units and for the sake of clarity, inch-based descriptors are used throughout this report rather than converting traditional units to SI units.

(a)

(b)

Fig. 2: Pictures of Standard Fire Hydrants (a) Side view of a three-nozzle hydrant showing the main nozzle or pumper connection (4½" diameter with 4 threads per inch), and one of the two small hose nozzles or hose connections (2½"diameter with 7½ threads per inch), (b) Front view of a two-hose and one- pumper nozzles hydrant. (Reuter: Mike Hassler)

addition, about 150 people were injured, and almost 2,450 single-family homes and 437 apartments were destroyed. The cost of the damage was approximately $1.5 billion [7]. After the fire all of the fire hydrants were replaced with hydrants using national standard specifications for the hose connections.

6. National Standard and Non-standard Hydrants in Use

It is surprisingly difficult to assess the specifications for fire hydrants in use in major U.S. cities without direct on-site measurement. No central source of hydrant specification data exists. After many contacts with fire departments, fire marshals, and local government authorities around the country, it appears that the best sources of specification data are records kept by manufacturers of fire hydrants. The hydrant specifications of most of the cities in Table 1 were obtained with the cooperation of Mueller Company, a major fire hydrant manufacturer. The company agreed to share information from its records for this study. For some of the cities not included in Muller Company records, individual contacts with fire departments and departments of water services or

public works were made to determine the specifications. In addition, chapter members of the Society of Fire Protection Engineers (SFPE) volunteered to provide hydrant connection measurements in their areas of the U.S. where needed.

In order to verify the hydrant specifications of every city in Table 1, a letter and a copy of Table 1 were sent to the fire chief of each city in the table. Each chief was asked to verify the hydrant specifications of their city and contact NIST to either confirm or correct the data in the table. Some city fire departments had to be contacted again by means of emails and phone calls. The responses helped us make some corrections to the original data. The verified data is listed in Table 1 below.

Most of the major cities in the U.S. do not have standard fire hydrants and fire-hose couplings. In fact, only 18 out of the 48 most populated cities have both small hose and pumper connections on fire hydrants that comply with the NFPA standard. A standard fire hydrant has two 2.5 inch-hose connection nozzles with 7.5 threads per inch, and one 4.5 inch-pumper connection nozzle with 4 threads per inch. The hose connection nozzle, compared to the pumper connection nozzle, has a lower discharge pressure and can be used directly to fight fires. The pumper connection nozzle, on the other hand, is connected to the engine that provides water to hoses mounted on the fire truck. Among the cities having national standard fire hydrants is Baltimore that progressively standardized its hydrants after the great 1904 fire. Oakland, California also changed its hydrants to national standards after it experienced the disastrous fires in 1991.

About 40 major cities have at least national standard hose connections on their hydrants. Most of these cities have a 4 inch-pumper connection with 4 threads per inch on their hydrants instead of the national standard pumper connection. The hydrants of these cities comply partially with the national standard specifications. Other cities, such as New York, Oklahoma City, and New Orleans have standard pumper connections (or steamer connections) and non-standard hose connections. The remaining 5 of the 48 cities have no standard connections (neither a pumper nor a hose connection) on their hydrants. Among those cities is Chicago, IL, which has only 4.5 inch-pumper connections with 6 threads per inch. The hydrants in Phoenix, AZ have two 2.375 inch-hose connections with 6 threads per inch and one 3.75 inch-pumper connection with

City (greatest to least populated)	Hose connection		Pumper Connection	
	Diameter (inch) NS = 2 ½	Thread (threads/inch) NST= 7 ½	Diameter (inch) NS = 4 ½	Thread (threads/inch) NST = 4
New York City, NY	2 3/8	8	NS	NST
Los Angeles, CA	NS	NST	4	4
Chicago, IL	-	-	4 ½	6
Houston, TX	NS	NST	NS	NST
Philadelphia, PA	NS	NST	NS	NST
Phoenix, AZ	2 ½	6	4	6
San Diego, CA	NS	NST	4	4
Dallas, TX	NS	NST	4	4
San Antonio, TX	NS	NST	4	4
Detroit, MI	NS	NST	3 ¾	6
San Jose, CA	NS	NST	4	4
Indianapolis, IN	NS	NST	4 ½	6
San Francisco, CA	3 & 3 ½	3	3 & 3 ½	3
Jacksonville, FL	NS	NST	NS	NST
Columbus, OH	-	-	4	6
Austin, TX	NS	NST	4	6
Baltimore, MD	NS	NST	NS	NST
Memphis, TN	NS	NST	4	7
Milwaukee, WI	NS	NST	NS	NST
Boston, MA	NS	NST	NS	NST
Washington, DC	NS	NST	4	4
El Paso, TX	NS	NST	4	6
Seattle, WA	NS	NST	4	6
Denver, CO	NS	NST	4 ½	6
Nashville-Davidson, TN	NS	NST	NS	NST
Charlotte, NC	NS	NST	4	6
Fort Worth, TX	NS	NST	4	4
Portland, OR	NS	NST	NS	NST
Oklahoma City, OK	2 ½	6	NS	NST
Tucson, AZ	NS	NST	NS	NST
New Orleans, LA	2 ½	6	NS	NST
Las Vegas, NV	NS	NST	4	4
Cleveland, OH	2 ½	8	4 ¼	6
Albuquerque, NM	NS	NST	NS	NST
Kansas City, MO	NS	NST	4	4
Virginia Beach, VA	NS	NST	NS	NST
Atlanta, GA	NS	NST	NS	NST
Sacramento, CA	NS	NST	NS	NST
Oakland, CA	NS	NST	NS	NST
Mesa, AZ	NS	NST	NS	NST
Tulsa, OK	NS	NST	4	4
Omaha, NE	NS	NST	NS	NST
Minneapolis, MN	NS	NST	NS	NST
Miami, FL	NS	NST	4	7
Colorado Springs, CO	NS	NST	4 ½	6
St. Louis, MO	NS	NST	NS	NST
Wichita, KS	NS	NST	4	4
Santa Ana, CA	NS	NST	4	4

Table 1: Tabulation of Fire Hydrant Connection Specifications for the 48 largest cities in the U.S. (Cities with national standard hydrants in **Bold** font)

6 threads per inch. The city of San Francisco, CA, has two different hydrant designs. One design is a low-pressure hydrant with two 3 inch outlets with 3 threads per inch. The second design is a high-pressure hydrant with three 3.5 inch outlets with 3 threads per inch. The city of Columbus, OH, has hydrants with only 4 inch-pumper connections with 6 threads per inch. Cleveland, OH, has hydrants with two 2.5 inch-hose connections with 8 threads per inch and a 4 inch-pumper connection with 6 threads per inch. Hydrants installed in fire districts outside of but near major cities are generally national standard. Despite the great variety of hydrant designs, adjacent fire districts can be called upon for mutual assistance in case of a major fire. Fire districts next to areas with different hydrant specifications carry adaptors to their equipment to connect to a variety of hydrants. For example, the fire districts near the Maryland/District of Columbia line carry adaptors because DC hydrants have 4 inch-pumper connections while the surrounding Maryland counties have national standard hydrants.

Using the data in Table 1, Figure 3 below shows an overview of the extent to which the largest 48 cities in the U.S. have adopted the national standard specifications for fire hydrants.

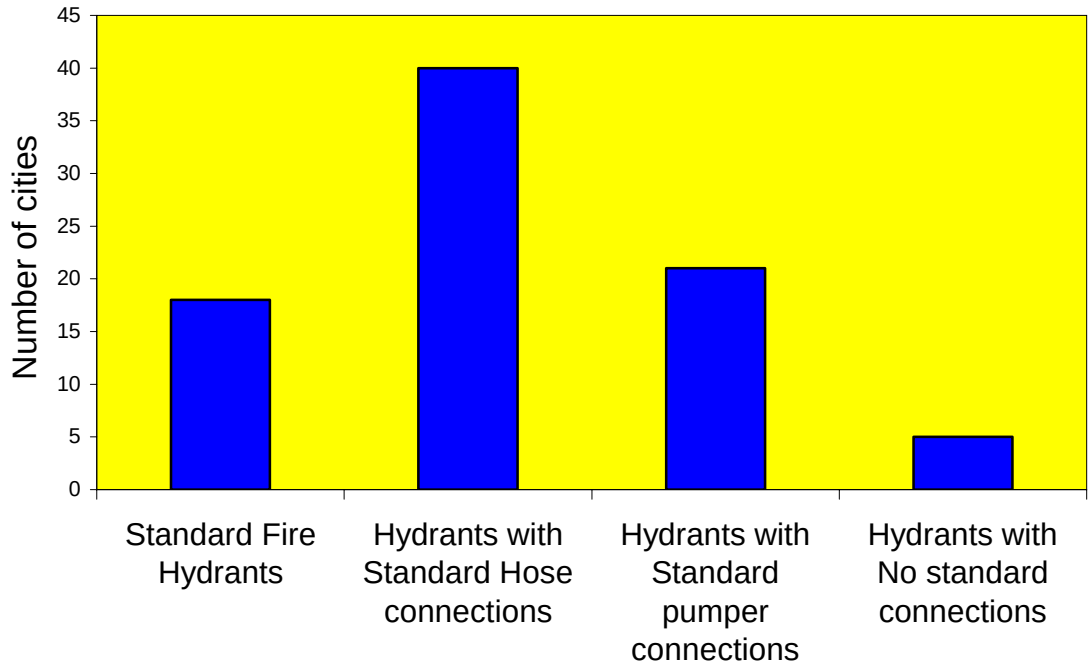

Figure 3: The number of cities with the different kinds of connections.

7. Summary

This study reveals that 100 years after the Great Baltimore fire many of the major cities in the United States do not have national standard hydrants. Although all hydrants use standard pipe diameter and thread combination, the sizes are not always in agreement with the national standard for hydrant connections. Almost all hydrants have national standard hose line connections (smaller diameter outlet). Most major cities do not have national standard pumper connections (larger diameter outlet). Today, it is common for fire engines to carry adaptors that make connections with all hydrants in areas where equipment may be used.

8. Acknowledgements

We would like to acknowledge the major contribution of Randy Molby from the Mueller Company in Decatur, IL. Mr. Molby provided the hydrant specifications of most of the cities in Table 1. We would like to thank Morgan Hurley and all the SFPE members who helped us obtain hydrant specifications of some of the cities in Table 1. We also want to thank Mike Hassler of the Milwaukee School of Engineering for the pictures of fire hydrants, Joelle M. Fishkin from the International Association of Fire Chiefs (IAFC) for the assistance in contacting fire chiefs of all the cities in Table 1. We greatly appreciate the input of all the fire departments and city water services.

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