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Explorative history of fuel gas connectors development and related regulatory standards

Richard Olawoyin*, Charles W. McGlothlin Jr.

Oakland University, Rochester, MI, USA

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ABSTRACT

Fuel gas connectors (FGC) are indispensable in modern building constructions, especially where gas is the primary source of energy for the building. FGC supply natural gas and liquefied petroleum gas (LPG) to appliances in buildings. There are potentially associated hazards with the use of FGC, triggering controversies over the safer choice of material. Safety codes have been established since 1911 to mitigate the potential risks associated with the use of FGC, this paper discusses the development of the codes. These codes are periodically revised to ensure the safety and reliability of all gas powered appliances in households. Subsequent code edition builds on the next, through consensus-based modifications that represent the progressive needs in this area and the most recent information on FGC safety. It was observed that the different modifications in safety requirements for the FGC have largely improved the reliability potentials of the piping systems over the years based on data collection and research. The newer flexible materials offer ease of use and are also found to be relatively safer than the old rigid pipes. Continuous safety assessment of these materials is required to mitigate risks and ensure adequate protection of life, property and the environment.

1. Introduction

Building fires are the leading cause of fire-induced injuries and fatalities. The United State Fire Administration (USFA) reported the national statistics on residential building fires and causalities between 2011 and 2013. It was estimated that there were about 2530 civilian fire fatalities yearly from the 372, 900 residential building fires recorded during the period (USFA, 2015). This indicates that the estimated civilian fatality rate for residential fires was 6 per 1000 compared to 1.2 deaths per 1000 fires for all fire types nationally (USFA, 2012). The civilian fire victims in residential buildings during this period, make up 83% of all fatal fire fatalities (USFA, 2015). Appliance fires accounted for the highest number of civilian fire fatalities per 1000 fatal fires, producing 1351 fatalities per 1000 fatal fires between 2008 and 2010 (USFA, 2012). There was a 20% increase of the determined cause of fatal residential fires between 2008 and 2010 (2.0%) and 2011–2013 (2.4%) (USFA, 2012, 2015). A flammable or combustible liquid, gas or associated piping was reported to be the main contributor in 15,500 of fires from 2007 to 2011 resulting to; 1060 civilian injuries, 200 civilian fatalities and $317 million in direct property damages (NFPA, 2013).

New and existing homes have fuel gas connectors (FGC), which are either; the Corrugated Stainless Steel tubing (CSST), Black Iron Pipes (BIP), or both as the main gas piping system (GPS) in the building. The Most of today's gas operated appliances, make use FGC to supply gas to the appliances as shown in Fig. 1.

Such F_xGC were first introduced in the 1940's to 1950's and were called flexible metal gas connectors. Prior to the 1960's, BIP was more-or-less the exclusive material used to deliver fuel from the GPS behind the wall in a home to gas fueled appliances. However, the rigidity of the BIP presents difficulties for installation and use. The appliances had to remain stationary and it was impossible for consumers to move the appliances for purposes of cleaning under or behind the appliances. The use of the earlier generations of BIP also presented a variety of problems to safety, including; high potential of leaks due to corrosion and the inability to withstand many natural disasters (such as earthquakes and floods). Consequently, the leaks resulting from BIP damage, accounted for many household fires with fatal consequences and quantifiable financial implications. Clearly, the development of alternative FGC was required for higher quality assurance and improved reliability of GPS used in buildings. This necessity led to the development of CSSTs, which

* Corresponding author.
E-mail address: olawoyin@oakland.edu (R. Olawoyin).

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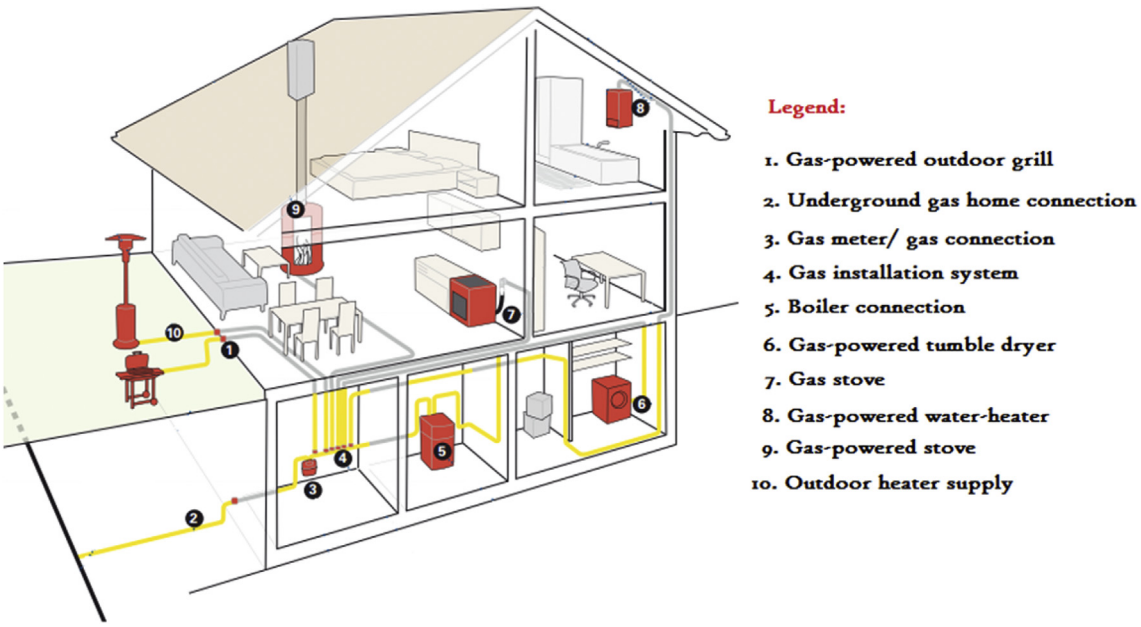

Fig. 1. Functional components with gas pipe system (GPS) applications in a home. *Courtesy,* Witzenmann GmbH.

were first introduced in Japan in the early 1980's to limit gas leaks in BIP during earthquakes. CSSTs are flexible, stainless steel type tubing that are used to supply natural gas and propane to private households, commercial, and industrial buildings. They could be funneled underground, inside wall cavity and even through openings in an attic.

A feasible solution for the rigidity issues with BIP was the development of stainless steel flexible gas connectors (F_xGC) for gas supply to appliances instead of the conventional BIP. F_xGC are used to connect appliances, such as a water heater or range, to the building's GPS (Fig. 2). It is important to note that while F_xGC is considered a piping system, it is primarily used differently from the CSST and BIP distribution systems. While the various GPS mentioned are unique with respect to when they were developed, they each have detailed individualized history of their usage.

The history and the safety improvements made over time to these GPS, are important to the safe use of gas controlled appliances in buildings. History of these piping systems also include the disasters that have occurred due to their misuse, lack of maintenance, incorrect installation, natural disasters, or other types of events that

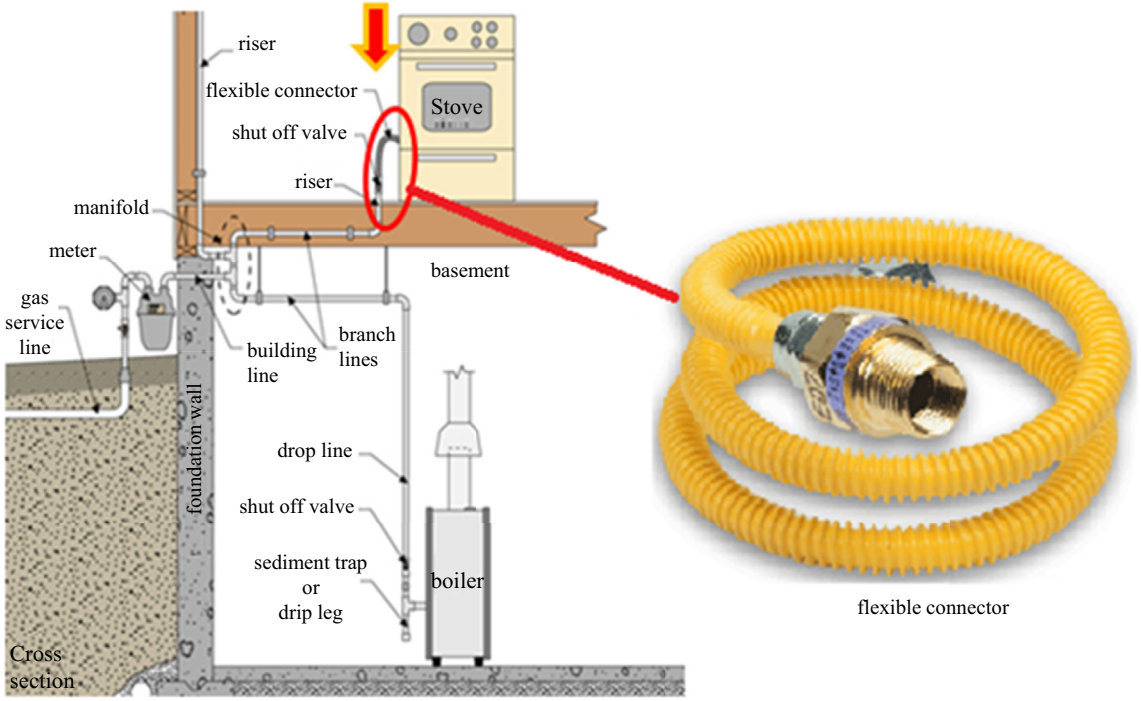

Fig. 2. Illustration showing the configuration of the flexible gas connector (F_xGC): *Courtesy Brasscraft.*