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Safety Regulation for Small LPG Distribution Systems

Committee for a Study on Propane Gas Pipeline Facilities

A Consensus Study Report of

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Preface

In Section 26 of the Protecting our Infrastructure of Pipelines and Enhancing Safety Act of 2016 (PIPES Act of 2016), Congress called for a study on liquefied petroleum gas (LPG) pipeline facilities to

> examine the safety of pipeline facilities that transport or store only petroleum gas, or mixtures of petroleum gas and air, for service to 100 or fewer customers. It will examine (a) federal, state, and local regulatory requirements applicable to these pipeline facilities; (b) techniques and best practices relating to their safe design, installation, operation, and maintenance; and (c) the costs and benefits, including safety benefits, associated with the regulatory requirements and use of the techniques and best practices. Informed by its review, and as appropriate, the committee may make recommendations concerning these regulations, techniques, and practices.

The Pipeline and Hazardous Materials Safety Administration (PHMSA) contracted with the National Academies of Sciences, Engineering, and Medicine (the National Academies) to conduct the study. The study charge is presented in full and discussed in detail in Chapter 1.

To conduct the study, the National Academies convened a nine-member committee of experts whose disciplines cover LPG pipeline operations and safety regulation, transportation safety, subsurface utility engineering, law, public policy, risk analysis, and emergency response, led by Craig E. Philip, Research Professor and Vanderbilt Center for Transportation and Operational Resiliency (VECTOR) Director, Vanderbilt University. The content and findings of the report represent the consensus effort of the members,

who served uncompensated in the public interest. Committee member biographical information is provided at the end of the report.

Committee members convened four times from June 2017 to February 2018. These data-gathering sessions were open to the public and included briefings by PHMSA officials, state pipeline regulators, LPG industry representatives, LPG pipeline installers and operators, and engineers engaged in relevant work. Extensive data collection also occurred between meetings. Appendix D includes the agendas of the meetings.

ACKNOWLEDGMENTS

The committee thanks the many individuals and organizations who contributed to its work.

The PHMSA liaison for the study was Robert W. Smith, who provided contract oversight and handled information requests from the committee. Alan Mayberry, PHMSA Office of Pipeline Safety Associate Administrator, briefed the committee on the study charge. The committee was briefed by the following representatives of U.S. federal and state pipeline safety regulatory agencies: Gary McDonald and Piyali Talukdar, PHMSA; and Neil Pascual, Nevada Public Utilities Commission. The committee appreciates McDonald returning for a second presentation and also recognizes support for the study provided by Blaine Keener and Donald Murphy, PHMSA.

The committee invited speakers from the LPG industry to deliver presentations on matters relevant to the study: Leslie Anderson, Propane Gas Association of New England; Michael Caldarera, National Propane Gas Association; Gregory Dahl, ARB, Inc.; Kim LaPierre and John Minchew, Suburban Propane; Lyndon Rickards, Eastern Propane Gas Association; Ken Teague, Primoris (a division of ARB, Inc.); Christopher Wagner, AmeriGas; and Rufus Youngblood, Ferrellgas.

Experts in engineering, utilities, and fire prevention standards also provided briefings and presentations to the committee: James Anspach, American Society of Civil Engineers; Thomas Crane, Crane Engineering; O. John Jacobus, Jacobus and Associates; and Laura Moreno, National Fire Protection Association.

Finally, the committee thanks the following individuals who were otherwise helpful in identifying issues and providing data and other information: Marty Ahrens, National Fire Protection Association; Robert Clarillos, National Association for Pipeline Safety Representatives (NAPSR); John J. Clementson II, Maryland Public Service Commission; Jim Heeschen, National Fire Data Center; Jean McDowell, McDowell Owens; Michael Schaffer, Poore's Propane; and Joe Subsits, Washington Utilities and Transportation Commission. The committee appreciates the expertise shared

by Ahrens and Heeschen in reviewing the National Fire Incident Reporting System database and the tour for staff of LPG facilities provided by Clementson and Schaffer. The committee particularly values Clarillos's administration of the state pipeline regulator questionnaire to the NAPSR membership.

Micah D. Himmel managed the study and drafted the report under the guidance of the committee and with the assistance and supervision of Thomas R. Menzies, Jr., Director, Consensus and Advisory Studies, Transportation Research Board (TRB) of the National Academies. Anusha Jayasinghe, Amelia Mathis, and Claudia Sauls provided extensive support to the committee in arranging its meetings and in managing documents. Karen Febey managed the report review. Alexandra Briseno, Senior Librarian, TRB, provided general support.

This report was reviewed in draft form by individuals chosen for their diverse perspectives and technical expertise. The purpose of this independent review is to provide candid and critical comments that will assist the National Academies in making each published report as sound as possible and to ensure that it meets the institutional standards for quality, objectivity, evidence, and responsiveness to the study charge. The review comments and draft manuscript remain confidential to protect the integrity of the deliberative process.

The committee thanks the following individuals for their review of this report: Norm Abrahamson, University of California, Berkeley; Norm Abramson, Southwest Research Institute (retired), San Antonio, TX; Michael Bronzini, George Mason University, Fairfax, VA; James Hotinger, Southern Company Gas, Richmond, VA; Jean McDowell, McDowell Owens, Houston, TX; Gregory Noll, GGN Technical Resources, LLC, Lancaster, PA; Ian Savage, Northwestern University, Evanston, IL; Jan Schilling, Advanced Products General Electric Aviation (retired), Liberty Township, OH; and Richard Williams, Suburban Propane (retired), Syracuse, NY.

Although the reviewers listed above provided many constructive comments and suggestions, they were not asked to endorse the conclusions or recommendations of this report, nor did they see the final draft before its release. The review of this report was overseen by Chris T. Hendrickson (National Academy of Engineering), Carnegie Mellon University (emeritus), and Chris G. Whipple (National Academy of Engineering), Lafayette, California. They were responsible for making certain that an independent examination of this report was carried out in accordance with the standards of the National Academies and that all review comments were carefully considered. Responsibility for the final content rests entirely with the authoring committee and the National Academies.

Contents

Summary

Propane and other types of liquefied petroleum gas (LPG) are important fuels for homes and businesses that do not have access to natural gas service. More than 12 million households and businesses use LPG as their primary fuel for heating, including hundreds of thousands of people who use it as secondary fuel for applications such as cooking, gas fireplaces, and backup power generation. In those cases where the fuel is stored on a single user's premises, the storage tank and its piping are not subject to federal regulations that govern the safety of gas distribution pipelines. However, some distribution systems transport LPG from a single tank or set of connected tanks to multiple users in households and businesses for consumption as a primary or secondary fuel. When these multi-user systems serve either 10 or more customers or two or more customers when located in a public place, their operators must comply with federal gas pipeline safety regulations.[1]

Approximately 3,800 to 5,800 multi-user LPG pipeline systems are subject to these federal safety regulations,[2] which are administered by the U.S. Department of Transportation's Pipeline and Hazardous Materials Safety Administration (PHMSA) under the Code of Federal Regulations

[1] Technically, a single-user, private system is subject to federal regulation if part of the system is in a public place. Such a configuration, in which part of a private system is sited off the premises of the system's owner and sole user, would be exceptional and very rare. It was thus not considered relevant for the purposes of this study.

[2] This range is based on the count of regulated multi-user LPG systems from the National Association of Pipeline Safety Representatives at the low end of the range and an estimate of the same by the National Propane Gas Association at the high end of the range.

(CFR) Title 49, Part 192, Transportation of Natural and Other Gas by Pipeline (herein referred to as "Part 192"). Congress requested this study of the means by which LPG pipeline distribution systems are regulated to learn how the Part 192 requirements, in combination with the requirements of state, local, and industry standards, assure that safe practices and techniques are used for the design, installation, operation, and maintenance of systems that serve 100 or fewer customers.[3] Congress asked for recommendations on ways to improve this regulatory regime as it applies to these small systems where appropriate.

A multi-user LPG pipeline system will usually serve dozens, sometimes hundreds, of customers from a pressurized storage tank or tanks that will need to be periodically refilled by truck, in contrast with a natural gas distribution system that will usually serve thousands of customers. To account for these differences in system scale and configuration, and for the particular physical and hazard characteristics of LPG, the federal pipeline safety regulations have special provisions for LPG. Notably, the federal regulations require that operators of LPG pipeline distribution systems comply with the safety codes of the National Fire Protection Association (NFPA) that govern the design, installation, operations, and maintenance of LPG facilities. When an NFPA requirement conflicts with a Part 192 requirement, the federal regulation states that the NFPA requirement will prevail. If a Part 192 requirement has no corresponding NFPA requirement, the LPG pipeline operator must comply with the Part 192 requirement. In addition, many states have their own pipeline safety regulations that apply to LPG systems, and local jurisdictions will often have building and fire codes that control the installation and placement of the tanks and piping, both of which typically incorporate the NFPA requirements. By federal law, state and local requirements cannot be any less stringent than the federal Part 192 requirements. With guidance and funding assistance from PHMSA, states are largely responsible for enforcing the federal regulations in addition to their own.

Because NFPA safety codes are developed and regularly updated specifically for LPG, and because compliance is mandated by federal regulation and often by state and local regulation, the LPG industry has a strong familiarity with the codes. Some operators of LPG pipeline systems—especially smaller ones—claim that strict compliance with the NFPA codes should be viewed as sufficient for ensuring safety and that the additional Part 192 requirements are unnecessary because they were developed with the risks of larger natural gas systems in mind. Dozens of Part 192 requirements must be observed by operators of LPG systems because there is no

[3] Public Law 114-183, enacted June 22, 2016. The Statement of Task, included in the legislative text, can be found in Chapter 1.

corresponding NFPA requirement. Some of these Part 192 requirements are highly targeted and prescriptive, such as a stipulation to use an instrument to test for odorant in gas, while others contain broader mandates, such as a requirement for the development and maintenance of an integrity management program and emergency response plan. The operators of LPG systems question the purpose of Part 192 requirements that are prescriptive when the NFPA code, which is LPG-specific, does not see the same need for them. The operators also question the applicability of some of the broader safety planning and program mandates in Part 192, which they contend are suited for large gas distribution systems and not LPG systems having as few as two users.

With these issues as a backdrop, the study committee commenced an examination of the regulatory requirements for LPG pipeline systems serving 100 or fewer customers. In light of the hundreds of federal, state, and NFPA safety requirements that apply to LPG systems in areas ranging from component design and installation to system maintenance and operations, the committee realized that it could not assess each requirement in an informed and authoritative manner, and thus interpreted its charge more broadly to consist of a review of the overall regulatory framework and its application to small LPG systems.

Moreover, the committee came to learn that such a requirement-by-requirement assessment would have been impractical regardless because of the paucity of data on small LPG systems, including their number, location, condition, and safety performance. Records of LPG incidents do not identify system size, design, and configuration, while records of system condition (e.g., incidence of leaks and damage) are not available for small LPG systems. Without such data, the committee could not have examined the relevance of specific safety regulatory requirements to the range of LPG systems serving 100 or fewer customers, as these systems are not uniform in their installation, design, operations, maintenance, and the like. Only with good data on the setting, design, configuration, and safety performance of small LPG systems would it be possible to assess the applicability of specific regulatory requirements (and of the practices and techniques referenced in those requirements) to the reduction of risk.

To inform the study, the committee met with federal and state pipeline safety regulators, LPG industry representatives and individual operators, and experts in engineering and utilities. The committee sought information on the configuration, design, operations, and use of LPG pipeline systems and reviewed the physical properties and hazard characteristics of LPG, noting similarities and differences with natural gas. The committee also examined pipeline incident and condition data maintained by PHMSA and the U.S. Fire Administration (USFA), and reviewed reports of notable LPG pipeline incidents, some of which were investigated by the National

Transportation Safety Board and the U.S. Chemical Safety and Hazard Investigation Board.

Based on a review of the incident reports submitted by pipeline operators to PHMSA and supplemental reports of incidents submitted by local fire departments to USFA, the committee finds that consequential incidents involving LPG pipeline distribution systems of all sizes are rare. Records of federally regulated LPG systems for the past 30 years indicate an average of less than one incident involving a fatality or serious injury per year; when USFA records are considered for completeness, the number of annual incidents averages in the single digits. However, when they do occur, the consequences of LPG pipeline incidents can be severe, as illustrated by a few specific cases discussed in the report. Because LPG is heavier than air—unlike natural gas—its escape from a pipeline or tank can create special hazards as it can migrate to, and concentrate in, low-lying areas where it can mix with air and explode if ignited. LPG also presents risks during truck delivery and tank filling operations, which do not exist for natural gas systems. These hazards are one reason for the development of LPG-specific NFPA codes and their reference in federal regulation, and they are also a reason for industry efforts to ensure vigilant compliance.

LPG systems that serve 100 or fewer customers are not complex, but their configurations, components, designs, and uses are by no means uniform across systems that can serve as few as two to several dozen customers. The multi-user systems can vary from a single aboveground tank that is connected to customers by several feet of piping to a few connected underground tanks that supply an entire neighborhood through a network of buried service lines. Based on information obtained from the results of a questionnaire administered by the National Association of Pipeline Safety Representatives (NAPSR), whose members are state pipeline regulators, it would appear that most of the multi-user LPG systems that should be subject to federal Part 192 requirements—and thus considered "jurisdictional"—serve fewer than 50 customers and are much more likely to have a number of customers closer to 10 than 100. The NAPSR data, however, show wide discrepancies among states in the number of very small multi-user systems that are identified as being jurisdictional, potentially indicating large geographic variability in the size and uses of LPG distribution systems, differential state application and enforcement of the federal Part 192 regulations, or both. The vast majority of jurisdictional systems with two to nine customers are reported from four states, which may be indicative of states having different views on the risk these very small systems pose and/or interpretations of what constitutes a "public place," which is a determinant of whether systems having fewer than 10 customers are jurisdictional.

Because the PHMSA and USFA data indicate that incidents are rare for all LPG system sizes and that many operators of small systems are

apparently not being identified as jurisdictional and actively compelled by regulators to follow the Part 192 requirements, one might reason that LPG industry claims about the inapplicability of these federal requirements to ensuring the safety of small systems are valid. The committee did not reach this specific conclusion because of the shortage of information on the number of these small systems, their risk characteristics, and their actual level of regulatory compliance. However, the data are sufficient to conclude that most jurisdictional LPG pipeline systems have relatively few customers and are more likely to resemble non-jurisdictional systems that are subject only to NFPA requirements than to the few large jurisdictional systems that have 100 or more customers. It stands to reason that more of the Part 192 requirements developed for natural gas distribution systems will be relevant to the larger LPG systems than to the smaller ones. Indeed, the observed variability among states in the identification of small LPG systems for the enforcement of federal regulations may be indicative of some states viewing these small systems as having a lower safety risk than the larger systems that regulators identify for more enforcement attention.

Whether states are making risk-appropriate choices about how to enforce regulatory compliance by operators of LPG systems is difficult to judge without knowing the full spectrum of demands on their enforcement programs. However, because many small LPG systems are apparently not being identified as jurisdictional, their compliance with federal regulatory requirements is largely unknown and unassured, and their specific size, configuration, design, setting, and other characteristics that may be indicative of their potential risk are not being documented. It is thus difficult to know whether more rigorous enforcement of the federal regulations is warranted for some of the systems and whether that compliance obligation should be eased for some others in cases where they do not have applicable risk factors. A more effective means of identifying and distinguishing among small LPG systems to better align their regulation with risk is warranted. It is with this aim in mind—to inform the development, application, and enforcement of safety regulations commensurate with risk—that the committee makes the following recommendations to Congress and PHMSA.

SUMMARY ASSESSMENT AND RECOMMENDATIONS

Based on the information and assessment in this report, the committee recommends a set of actions aimed at providing more effective regulatory oversight and safety assurance of small LPG distribution systems. These actions are intended to address the following findings and conclusions that raise questions about the efficacy of the current state of regulatory oversight and safety assurance:

1. Responses to the NAPSR questionnaire by state pipeline safety regulators suggest that many small, multi-user LPG systems that should be subject to the federal Part 192 pipeline safety regulatory requirements—that is, "jurisdictional"—are not being identified by enforcement programs, and thus are not being regularly inspected for compliance with these federal requirements.
2. Although the exact reasons for state-to-state variability in the identification of small, multi-user LPG systems for enforcement of the Part 192 regulations could not be ascertained from the NAPSR questionnaire, one possible cause is ill-defined criteria for jurisdictional coverage, especially in what constitutes a public place, which is a determinant of jurisdictional coverage by multi-user systems having nine or fewer customers. It is possible that the observed variability stems from inconsistent interpretation and application of this definitional criterion by system operators and state regulators. Another possible cause is that states differ in their efforts to oversee and enforce regulatory compliance by operators of small, multi-user LPG systems. Some states may perceive a low safety risk from these smaller systems, causing them to allocate fewer resources to their identification and inspection relative to the larger systems. The committee cannot know for sure whether states are making such risk-balancing choices and whether those choices are appropriate given other state enforcement demands.
3. Irrespective of the reasons that many small, jurisdictional LPG systems are not being identified for compliance with federal Part 192 requirements, the result is incomplete information on the number, location, characteristics, condition, and safety performance of these systems, which complicates assessments of their safety risks, how the specific requirements of federal regulations pertain to those risks, and the extent to which the requirements are being complied with and effective in controlling risks.

Given this evidence of variability in regulatory implementation and lack of assurance that many small, multi-user LPG systems are indeed complying with the federal regulations, the committee believes that it would be a mistake to view the current regulatory regime as being operative and that steps should be taken to better identify small multi-user systems to ensure that regulatory requirements and their enforcement are appropriate to the safety risks they present. It is with these safety aims in mind, and out of concern about discrepant implementation of the current regulatory regime, that the committee offers the following recommendations:

Recommendation 1: Congress should direct PHMSA to ensure that the regulatory term "public place" is defined in such a way that regulators and regulated entities alike will uniformly interpret that definition to establish jurisdiction over LPG pipeline systems under CFR Title 49, Part 192, Transportation of Natural and Other Gas by Pipeline.

Recommendation 2: Congress should direct PHMSA to require

- Operators of LPG pipeline systems to report to regulators the location and number of customers served by each of their jurisdictional systems; and
- States to confirm that all identified jurisdictional systems are subject to regular enforcement and inspection activity, which should include a review of operator-reported data on leaks and damage.

Recommendation 3: Seeking the authority and resources from Congress as needed, PHMSA should

- Allow only those states that have confirmed the identification and inspection of their jurisdictional LPG pipeline systems, as recommended above, to seek the agency's permission to implement a waiver program in which a regularly inspected jurisdictional system with fewer than 100 customers is eligible to apply to opt out of any Part 192 requirement the state determines is inapplicable to that system's risk factors, other than the NFPA requirements incorporated by reference in Part 192 and requirements for a Damage Prevention Program (49 CFR § 192.614);
- Stipulate that in addition to having fewer than 100 customers, systems eligible for a waiver should meet certain low-risk profiles as identified by the state with guidance and approval from PHMSA; and
- Require that states periodically seek permission from PHMSA to renew their waiver programs by providing evidence that public safety has not been compromised by the waivers.

CONCLUDING COMMENTS

The committee believes that its recommendations are complementary and will work together to inform sound decisions about the application of regulatory requirements and their enforcement. A commonly understood definition of public place will better ensure the identification of all small, jurisdictional LPG systems by PHMSA and state regulators. A requirement that operators of LPG pipeline systems report the location and number of customers served by their jurisdictional systems will assist regulators in identifying systems for enforcement and inspection activity. The require-

ment to perform such inspections of operator-identified systems on a regular basis should increase the state regulators' familiarity with the characteristics, conditions, and safety performance of the LPG systems, which in turn will assist states and PHMSA in making more risk-informed determinations of regulatory requirements that are most suitable to small LPG systems and deserving of enforcement attention. The recommended authorization of a waiver program is intended to allow states and PHMSA to make such risk-informed determinations about regulatory application and enforcement, as opposed to determinations that are based simply on system size.

1

Introduction and Background

In Section 26 of the Protecting our Infrastructure of Pipelines and Enhancing Safety Act of 2016 (PIPES Act of 2016), Congress called for a study of the regulatory requirements that apply to pipeline systems that distribute liquefied petroleum gas (LPG) to 100 or fewer customers.[1] Specifically, Congress requested that the Transportation Research Board of the National Academies of Sciences, Engineering, and Medicine (the National Academies) convene a committee to review how the regulatory requirements, as imposed and implemented by federal, state, and local government, pertain to these small LPG systems to assure that safe practices and techniques are used for facility design, installation, operation, and maintenance. Informed by this review and taking into account any potential opportunities for limiting federal regulation applicable to smaller systems without reducing safety, Congress asked the study committee to make recommendations on ways to improve the regulatory requirements.

The U.S. Department of Transportation's Pipeline and Hazardous Materials Safety Administration (PHMSA), through its Office of Pipeline Safety, is responsible for administering the federal pipeline safety program, including development and enforcement of regulatory requirements that apply to LPG pipeline facilities serving 100 or fewer customers. The Statement of Task from PHMSA to fulfill the study request is provided in Box 1-1, along with the original legislative text.

This chapter gives background and context for the study. Consideration is first given to how LPG, which consists mainly of propane, is

[1] Public Law 114-183, enacted June 22, 2016.

Box 1-1
Statement of Task

The study committee will examine the safety of pipeline facilities that transport or store only petroleum gas, or mixtures of petroleum gas and air, for service to 100 or fewer customers. It will examine (a) federal, state, and local regulatory requirements applicable to these pipeline facilities; (b) techniques and best practices relating to their safe design, installation, operation, and maintenance; and (c) the costs and benefits, including safety benefits, associated with the regulatory requirements and use of the techniques and best practices. Informed by its review, and as appropriate, the committee may make recommendations concerning these regulations, techniques, and practices.

Legislative Text

PIPES Act of 2016 § 26, Study on Propane Gas Pipeline Facilities

(a) IN GENERAL.—The Secretary of Transportation shall enter into an agreement with the Transportation Research Board of the National Academies to conduct a study examining the safety, regulatory requirements, techniques, and best practices applicable to pipeline facilities that transport or store only petroleum gas or mixtures of petroleum gas and air to 100 or fewer customers, in accordance with the requirements of this section.

(b) REQUIREMENTS.—In conducting the study pursuant to subsection (a), the Transportation Research Board shall analyze—
  (1) Federal, State, and local regulatory requirements applicable to pipeline facilities described in subsection (a);
  (2) techniques and best practices relating to the design, installation, operation, and maintenance of such pipeline facilities; and
  (3) the costs and benefits, including safety benefits, associated with such applicable regulatory requirements and the use of such techniques and best practices.

(c) PARTICIPATION.—In conducting the study pursuant to subsection (a), the Transportation Research Board shall consult with Federal, State, and local governments, private sector entities, and consumer and pipeline safety advocates, as appropriate.

(d) DEADLINE.—Not later than 2 years after the date of enactment of this Act, the Secretary shall submit to the Committee on Transportation and Infrastructure and the Committee on Energy and Commerce of the House of Representatives and the Committee on Commerce, Science, and Transportation of the Senate the results of the study conducted pursuant to subsection (a) and any recommendations for improving the safety of such pipeline facilities.

(e) DEFINITION.—In this section, the term “petroleum gas” has the meaning given that term in section 192.3 of title 49, Code of Federal Regulations, as in effect on the date of enactment of this Act.

used as a fuel and how this use compares to that of natural gas.[2] While the uses of the two gases in fueling home heating systems and appliances are in many ways similar, differences in physical properties have led to different applications and systems for distribution to the consumer. The background discussion explains how these differences, as well as differences in the hazard characteristics of the two gases, have created a need for safety regulations tailored to each gas's pipeline distribution system as well as regulations common to both.

After providing this background, the discussion turns to issues that gave rise to this study, particularly to questions about the desirability of some of the federal regulatory requirements that apply to both natural gas and LPG pipeline distribution systems. The committee's rationale for focusing the study on specific regulatory matters is explained, followed by a discussion of how the committee approached and undertook its work. The chapter ends with an overview of the report's organization.

COMPARATIVE USE AND HAZARD CHARACTERISTICS OF LPG AND NATURAL GAS

LPG refers to a number of hydrocarbon gases in liquid form, including propane and butane. There are three major uses of LPG in the residential and nonindustrial commercial sectors. In homes and business places, it is used to heat space and water, cook, dry clothes, and fuel gas fireplaces and backup electrical generators.[3] On farms, it is used to heat livestock housing and greenhouses, dry crops, and power field equipment and irrigation pumps. At jobsites, it is used to power forklifts, welders, heaters, portable generators, and other mobile equipment. Because the study charge specifies LPG pipeline facilities that serve multiple consumers, residential and nonindustrial commercial consumption is most relevant, as it can involve LPG storage in stationary tanks and piping systems that supply two or more consumers.

As the country's metropolitan regions have expanded and the reach of natural gas pipeline transmission and distribution networks has grown, U.S. homes and businesses that rely on LPG as a primary fuel for heating and cooking increasingly have choices in fuels. However, a feature of natural gas service that has made it desirable for consumer use—convenient, on-demand delivery of a clean-burning fuel—is the same feature that ex-

[2] The report uses LPG when referring to the general class of hydrocarbon gas liquids and their distribution systems and propane when treated distinctly, such as in a discussion of its specific properties.

[3] U.S. Energy Information Administration, "Uses of Hydrocarbon Gas Liquids," Energy Explained, accessed November 8, 2017, https://www.eia.gov/energyexplained/index.cfm?page=hgls_uses.

plains demand for LPG service when delivered through multi-user pipeline distribution systems. Indeed, when viewed simply from the interface with the consumer, LPG and natural gas systems can be almost identical. They each can be used in the same heating systems and appliances with slight modifications and without significant differences in performance. When considered from this vantage point, one might expect to find high degrees of similarity in other aspects of their physical characteristics and supply.

However, despite the similarities between LPG and natural gas at the consumer interface, the two fuels have important differences in physical properties, such as vapor pressure and relative vapor density, that make each more or less desirable for specific applications and that must be taken into account when ensuring their safe supply and use. Because of its high vapor pressure, natural gas (predominantly methane) cannot be practically transported for direct consumer use through means other than a pipeline, as it requires too much tank storage space in its gaseous form. While natural gas must be supercooled to be transported and stored as a space-saving liquid (or kept in a compressed state in very high-pressure tanks),[4] propane liquefies at relatively low pressures: 177 pounds per square inch (psi) of pressure must be applied to keep it as a liquid at 100°F (37.8°C).[5] Propane liquid can therefore be readily trucked to and stored in tanks for use as a fuel at locations lacking access to the natural gas pipeline network. When released from the tank through pressure regulators, propane vaporizes for movement through piping that supplies the consumer.

LPG's portability, therefore, explains its popularity for applications such as a primary and secondary fuel for heating and cooking in residential and commercial areas with no natural gas service, as well as for outdoor grilling. That portability, however, means that LPG service involves the use of systems that do not exist for natural gas service and that create specific safety assurance demands. Those demands include making sure truck transportation and refilling operations are safe and that storage tanks and their associated equipment are properly located, installed, operated, and maintained. Conversely, natural gas service has its own safety challenges that do not apply to LPG service, such as those associated with operating and maintaining a large, and often concentrated, network of distribution mains and service lines.

Flammability, which is the shared physical characteristic that makes natural gas and LPG valuable as fuels, is the main source of the safety

[4] Changing methane from a gas into a liquid requires cooling to temperatures of –260°F (–162°C). When liquefied at these supercool temperatures, natural gas's volume is reduced to 1/600th of its original volume. Reducing volume substantially without cooling can be done by compressing the gas, but this requires very high-pressure tanks, pipelines, and regulators.

[5] As a liquid, propane is 270 times more compact than it is as a gas. One gallon of propane liquid produces more than 36 ft^3 of gas.

challenge. Natural gas will ignite with a spark at concentrations of just 5 percent by volume in air, while propane will ignite with concentrations of just 2 percent. As a result, vapor leaking from either a natural gas or LPG distribution system that enters an enclosed area, such as a poorly ventilated room where vapor can concentrate and mix with air, can result in an explosion.[6] However, a key difference between natural gas and propane is how each behaves when released. When natural gas escapes into a confined space, the highest concentration of gas will move upward as air is displaced from the top down. Because natural gas is lighter than air, it will rise and diffuse rapidly when it reaches an open area. When LPG escapes, it will settle to low places because it is heavier than air. A risk from LPG is that the escaping gas will pool in low-lying, confined spaces such as basements, reaching concentrations that risk a fire or explosion if there is an ignition source.

An additional hazard characteristic for both gases is the lack of odor. Because natural gas and LPG are odorless in their natural state, odorants are usually added to the fuels to alert consumers and responders to vapor escaping from tanks, pipelines, and appliances. Although both gases are susceptible to odor fade, LPG is vulnerable to loss of odorant when refurbished storage tanks are not properly prepared or when rust is present in tanks. The metal surface or rust inside the tank can leach odorant from the gas.

The safety hazards of natural gas and LPG are well known, which is why their storage and transportation systems are regulated and subject to numerous industry safety standards. Because of the similarities between the two gases, including their common use in environments where people live and work, they share many of the same safety requirements, such as the aforementioned gas odorization. Their differences in physical properties and use characteristics, however, also mean that certain regulatory requirements differ. Because LPG distribution systems involve delivery by truck and storage in tanks close to users, they are subject to many federal, state, and local regulatory requirements and industry codes that have no counterparts among natural gas distribution systems. Meanwhile, these latter systems, which are part of larger pipeline networks, have regulations that address system components that have no counterpart in LPG distribution systems, such as compressor stations, supervisory control and data acquisition systems, and the staffing and functioning of central control rooms.

Recognition of these similarities and differences among the two leading fuel gases—spanning their use and hazard characteristics and their distribution and delivery methods—is important for understanding the regulatory concerns that gave rise to this study. These concerns have tended to center

[6] If the gas displaces oxygen in an enclosed space, a suffocation risk can also occur.

on the regulations that apply to both types of gas distribution systems, and whether some of these common regulations are warranted or should be made more applicable to each fuel system's individual use characteristics, hazards, size, components, configuration, and operations.

STUDY SCOPE AND ISSUES

The study committee was asked to examine pipeline systems that deliver LPG to 100 or fewer users, and potentially as few as two users. Tank and piping facilities that provide LPG to a single home or business are outside the scope of this study because virtually none of these single-user systems is subject to federal safety regulation. For reasons explained above, a pipeline distribution system that is intended to serve two to 100 homes and/or businesses is generally suited to LPG service rather than natural gas service, which effectively requires a larger network of connected users to be efficient. Even small municipal natural gas systems that receive gas from a transmission line will have miles of multiple mains and service lines that connect hundreds of customers, and in this respect such a system will have less in common with an LPG pipeline system that has a fraction of these customers. At the same time, however, an LPG pipeline system that serves close to 100 consumers will have characteristics that may be very different than those of an LPG facility that serves only a handful of users with aboveground tanks and piping. The larger LPG system is more likely to resemble a natural gas system inasmuch as both systems will have buried mains and service lines that connect many homes and businesses.

In regulating the safety of gas pipeline distribution systems, PHMSA recognizes similarities and differences among natural gas and LPG systems. PHMSA's regulations governing gas pipeline systems are contained in the Code of Federal Regulations (CFR) Title 49, Part 192, Transportation of Natural and Other Gas by Pipeline (hereafter, "Part 192"). These regulations in particular recognize that LPG systems are configured and operated differently than natural gas systems and have different components, including storage tanks. To account for the distinct characteristics and hazards of LPG systems, the Part 192 regulations incorporate by reference the consensus standards developed by the National Fire Protection Association (NFPA).[7]

NFPA 58, Liquefied Petroleum Gas Code, the most frequently refer-

[7] The codes are developed through a consensus process that meets the requirements of the American National Standards Institute. A technical committee that consists of federal and state regulators, fire service officials, emergency responders, industry, engineering consultants, testing laboratories, insurers, and academic experts develops the codes, which are approved by the membership of NFPA. The process is open to the public, though it is not widely known.

enced code, contains minimum requirements for the safe design, placement, and installation of LPG systems ranging in size from small cylinders to large bulk storage facilities that can exceed 100,000 gallons.[8] NFPA 58 also contains requirements for handling LPG liquid transfer operations, including operator qualifications, maximum filling quantity in containers, and pre-filling inspections to ensure containers are fit for service. In addition, the federal pipeline safety regulations contain references to NFPA 59, Utility LP-Gas Code.[9] However, this code has limited applicability to the LPG pipeline systems of interest in this study because its focus is largely on the construction and maintenance of LPG bulk plants that, for example, receive shipments from railcars and fill trucks for retail delivery.

LPG distribution systems must meet the requirements of Part 192 that apply to all gas distribution systems as well as the NFPA requirements that apply specifically to LPG pipeline facilities. In cases where NFPA requirements conflict with Part 192 requirements, the NFPA requirements prevail.[10] Importantly, if a Part 192 requirement does not have a corresponding NFPA requirement, the operator of the LPG pipeline facility must comply with that Part 192 requirement.

As a general matter, the NFPA codes focus on materials and equipment (e.g., storage tank valves, fittings, pipe and tubing materials), installation procedures, facility siting, and repair methods. The applicable Part 192 regulations cover construction, testing, operation, and maintenance, including the planning of emergency response, the documentation of damage prevention programs, and the implementation of integrity management programs. The respective areas of coverage of the NFPA and Part 192 requirements are discussed in more detail later in the report.

In addition to these federal regulations and consensus standards, most states impose their own safety regulations that apply to gas pipeline distribution facilities. All but a few states have partnership agreements with PHMSA to enforce their state regulations along with the Part 192 requirements and referenced NFPA codes. By federal law, state pipeline safety regulations cannot be less stringent than the Part 192 requirements; however, states can adopt requirements that are more stringent or that cover areas not covered by Part 192. Like the federal pipeline regulations, state regulations also reference the NFPA codes, as do many local government building and fire prevention codes.

Congress has asked the study committee to examine this collection of

[8] National Fire Protection Association, *NFPA 58, Liquefied Petroleum Gas Code* (Quincy, MA, 2004).

[9] National Fire Protection Association, *NFPA 59, Utility LP-Gas Plant Code* (Quincy, MA, 2004). Note, LP-gas is NFPA's abbreviation for LPG.

[10] 49 CFR § 192.11.

federal, state, and local safety regulations and consider specifically whether the requirements contained in them are (1) consistent with best practices and techniques relating to the safe design, installation, operation, and maintenance of LPG systems having 100 or fewer customers and (2) cost-effective when applied to LPG systems having 100 or fewer customers. The committee can only surmise why Congress chose 100 or fewer customers as the threshold for this analysis. To be sure, the number of customers on a system can be relevant to an assessment of whether Part 192, NFPA, and state requirements reflect best practices and techniques, some of which will differ according to the scale of the system. Indeed, Congress may have selected the 100-customer threshold because PHMSA already requires that operators of LPG systems having 100 or more customers go to greater length than operators of smaller systems in documenting their integrity management programs and in reporting on system safety performance and condition.

Another relevant consideration for systems serving 100 or fewer customers is that some of them—unlike larger systems—could have been configured into a series of smaller systems that are exempt from federal regulation, especially those smaller systems with closer to 10 customers. Notably, the federal regulations do not apply to all LPG systems, but only to those having either 10 or more customers or two or more customers when a portion of the pipeline facility is sited in a public place. LPG systems that meet these criteria are subject to federal jurisdiction and thus described by PHMSA as being "jurisdictional." This jurisdictional cutoff can be relevant to assessing regulatory costs because an operator facing a high cost of compliance may choose to avoid this burden by subdividing a larger system into smaller systems that are not regulated. Indeed, the National Propane Gas Association (NPGA), whose members are LPG suppliers, contends that some pipeline systems that would have been configured to serve dozens of customers are being divided into smaller, non-jurisdictional systems to avoid some federal regulatory requirements that are viewed by operators as being too costly or inapplicable.[11] NPGA maintains that careful consideration needs to be given to regulatory compliance costs as they apply to operators of small LPG systems, because a response that leads to more non-jurisdictional systems could result in more LPG deliveries by truck and the added risks associated with product transfer.

The demands placed on regulators also warrant consideration when examining regulatory benefits and costs, particularly the demands associated with enforcing regulations that apply to smaller systems. As documented

[11] National Propane Gas Association, "Propane Jurisdictional Systems: The Need to Review Existing Federal Regulations," accessed August 7, 2018, http://www.npga.org/wp-content/uploads/2018/08/Propane-Jurisdictional-Systems-White-Paper.pdf.

in this report, most LPG pipeline systems serve closer to 10 customers than 100. State pipeline safety agencies that are responsible for regulatory enforcement must make choices about how to allocate enforcement resources among systems, including decisions about whether to concentrate on smaller versus larger systems given their relative risks and the applicability of the regulations to those risks.

STUDY FOCUS

Early in its deliberations when reviewing the study charge, the committee recognized the challenge that the 100-customer threshold would present, not only because of the potential for variability (e.g., in age, configuration, and setting) among systems spanning two to 100 customers, but also because of the possibility that information on the number of these systems and their respective safety performance would not be available. These concerns proved valid, as the committee had little success obtaining the kinds of data that would be needed for meaningful analyses of regulatory costs and benefits even with the assistance of the LPG industry and federal and state regulators.

Also of concern was any implication that the study committee could undertake a comprehensive review of whether all safety requirements imposed on small LPG systems by PHMSA, states, localities, and the NFPA codes are reflective of best practices and techniques. Moreover, the committee determined that such a requirement-by-requirement review would have been impractical because of the paucity of data on these small systems. Incident data that account for LPG system size, as well as configuration and system condition reporting that describes the frequency of leaks and damage related to the effectiveness of regulatory requirements, are entirely unavailable for small systems. Without that data, the applicability of the federal requirements to the range of sizes and configurations for LPG systems cannot be determined. Therefore, the available data have only limited benefit for evaluating the usefulness of the federal requirements for risk management. Only with good data on the location, design, configuration, and safety performance of small LPG systems would it be possible to assess the applicability of specific regulatory requirements, and the best practices and techniques referenced in those requirements, to these systems and the risks they pose.

The committee also recognized that such an exercise would be both impractical, given the large number of such requirements, and inadvisable, given that the NFPA codes are developed by American National Standards Institute–approved consensus committees having far more expertise on LPG hazard, facility, and emergency response matters than this committee could bring to bear. Indeed, it is notable that the NFPA codes are regularly

updated to reflect current safety knowledge and best practices; for instance, the 2017 edition of NFPA 58 was released during the course of this study. Instead, the committee interpreted its charge as being a review of the regulatory regime or framework, but not at the level of individual requirements. What the committee noted, however, is that the federal Part 192 regulations reference the 2004 edition of NFPA 58, suggesting that the challenge of keeping this reference up to date is a matter deserving attention.

As the study committee learned from its discussions with PHMSA officials, benefit–cost analyses are required during the federal rulemaking process and routinely undertaken during development of new federal regulatory requirements. A practical challenge facing the committee, however, is that the study charge implies that benefits and costs should be reviewed for the entire body of regulations that apply to LPG systems having 100 or fewer customers. Here again, the committee determined that such a comprehensive analysis would be impractical given limited data and the hundreds of regulatory requirements that would need to be examined. Nevertheless, an issue that was raised by LPG suppliers who briefed the committee, including NPGA, is that some of the Part 192 regulations were designed for larger natural gas distribution systems and have questionable applicability to small LPG systems. In cases where such inapplicability could be shown, the safety benefit of the regulation could be considered zero. Thus, the identification of any such requirements became a study priority, particularly because of the potential for inapplicable regulations to impose unnecessary compliance burdens on industry, divert enforcement resources from federal and state regulators, and potentially cause LPG facility operators to take avoidance measures that could have safety implications.

STUDY APPROACH

Having determined that the study focus should be on identifying Part 192 regulatory requirements that may have questionable applicability to smaller LPG pipeline systems, the committee proceeded to gather information about the regulatory requirements; the design, use, operations, and hazard characteristics of multi-user LPG pipeline systems; and the prevalence and safety performance of these systems. The committee sought a range of information on the number of LPG pipeline systems by size and location, the safety performance of these systems, and the record of regulatory enforcement and compliance.

These data-gathering efforts produced mixed results. The committee learned that PHMSA does not have an inventory of all LPG jurisdictional systems, although it maintains records of operators of systems with 100 or more customers because they are required to annually report information on their system conditions. To obtain information on the number of LPG

systems serving 100 or fewer customers and their relative sizes and configurations, NPGA shared results from a poll of its members. Additionally, the National Association of Pipeline Safety Representatives (NAPSR), whose members include state pipeline safety regulators, agreed to poll its member agencies for the number of systems in their respective states and to provide information on their enforcement programs and compliance records. The NPGA and NAPSR membership surveys were informative, but not sufficiently comprehensive to estimate the number of jurisdictional systems with precision, much less to stratify system counts by size, configuration, and setting. Indeed, the NAPSR results suggest wide variability among states in the criteria used for classifying LPG systems as jurisdictional.

PHMSA's incident reporting systems were examined to identify incidents involving LPG pipeline systems with 100 or fewer customers and incidents involving delivery trucks. The study committee examined records of fires reported to the National Fire Incident Reporting System (NFIRS), looking for incidents involving smaller LPG pipeline facilities. Unfortunately, neither the PHMSA nor the NFIRS incident reporting systems distinguish pipeline systems by size (i.e., customers served). The reporting data, however, suggest that LPG distribution pipeline incidents are rare events—sufficiently rare that there would be little value in categorizing reported incidents by system size.

Given the data limitations, the study committee recognized that quantitative analyses of individual regulatory requirements would not be possible and that a more productive course would be a review of the requirements and their purpose and applicability based on the data available. Information on major incidents was gleaned from sources other than incident reporting systems, including investigations by the National Transportation Safety Board, the U.S. Chemical Safety and Hazard Investigation Board, and news media narratives. Representatives from the LPG industry, PHMSA, state regulatory agencies, and NFPA briefed the committee, along with technical experts in the fields of utilities and engineering. The review of major incidents illustrates how LPG pipeline releases can present specific hazards, some of which the regulatory interventions are intended to address. The industry and regulator briefings were also invaluable for understanding the safety issues the regulations are intended to address, the regulatory framework and its enforcement at the federal and state levels, and the concerns of LPG system operators.

REPORT ORGANIZATION

The remainder of this report is organized into four chapters. The next chapter provides more background on the uses, configurations, key components, supply, and operations of LPG pipeline distribution systems. The physical

properties and hazard characteristics of LPG and the safety performance of LPG pipeline systems are then discussed in Chapter 3. Chapter 4 outlines the regulatory regime for LPG pipeline system safety, reviews the number and size of systems subject to regulation, and includes the committee's assessment of it. The final chapter provides the committee's advice to Congress and PHMSA on ways to make more informed decisions about the regulation of small LPG pipeline systems.

2

Basic Configurations and Uses of LPG Distribution Systems

This chapter provides an overview of liquefied petroleum gas (LPG) pipeline distribution systems, explaining their various uses and configurations, key components, and supply and operations. The information is presented at a generalized level for background and introductory purposes. More details about how different system operators and configurations are regulated and their specific safety-related requirements are given later in the report.

SYSTEM USES AND CONFIGURATIONS

LPG consists of propane, propylene, butane and its isomer, and mixtures of these hydrocarbon gases. Most of the LPG consumed in the United States is burned as household fuel, generally in areas lacking natural gas pipeline distribution networks or in places where the networks have gaps because of geographic features or insufficient consumer density to justify the pipeline investment. LPG is also used as feedstock for petrochemical plants and to power manufacturing. When used for these large industrial purposes, LPG is usually transported as a liquid in high-pressure, large-volume transmission pipelines, which are not examined in this study. The LPG pipeline facilities of interest in this study are small distribution systems that serve households and mostly small businesses. Because propane is the predominant LPG used in these systems (by itself or in mixtures), "propane" is often used interchangeably with "LPG" in this report, except in instances when references to butane and other LPGs are necessary because of relevant differences in their particular transport, storage, and hazard characteristics.

LPG is a fuel used in 11.8 million homes and 510,000 businesses for space heating, water heating, clothes drying, and cooking.[1] Altogether, about 5 percent of U.S. households use propane as their primary heating fuel.[2] This figure does not include consumers and businesses who buy propane in small volumes (e.g., 5- to 25-gal cylinders) for uses such as outdoor grills, recreational vehicles, portable generators, and forklifts. Compared with the nearly 75 million households and businesses that use natural gas,[3] the number of households and businesses that rely on LPG as their primary source of fuel is small; however, LPG is an important fuel in rural areas and in many suburban locations lacking natural gas service.[4]

Unlike natural gas, which is transported in a compressed, gaseous state through a network of mains and service lines from a central plant to metered consumers, LPG is stored under high pressure as a liquid in containers that are located on or close to the user's premises. When used for primary fuel purposes such as whole-home heating, the containers usually consist of 500- to 2,000-gal steel tanks[5] installed above or below ground and periodically refilled onsite by tank trucks, usually in "bobtails" that hold approximately 3,000 gal. Short service lines transport the LPG from the tank to the building and the user's piping.

A large majority of LPG distribution systems serve single-family homes and individual businesses. These single-user systems are not part of this study because nearly all of them are not regulated as pipeline facilities by the federal government or states (although these systems are usually subject to local building and fire codes governing their placement, design,

[1] U.S. Energy Information Administration, "Residential Energy Consumption Survey (RECS)," accessed December 19, 2017, https://www.eia.gov/consumption/residential/data/2015/index.php?view=characteristics; U.S. Energy Information Administration, "Commercial Buildings Energy Consumption Survey (CBECS) Data," accessed December 19, 2017, https://www.eia.gov/consumption/commercial/data/2012; U.S. Energy Information Administration, "U.S. Number of Natural Gas Consumers," accessed April 30, 2018, https://www.eia.gov/dnav/ng/ng_cons_num_dcu_nus_a.htm. The estimate of residential households excludes households that use LPG only for outdoor grilling.

[2] U.S. Energy Information Administration, "Short-Term Energy Outlook: May 2017," May 9, 2017, https://www.eia.gov/outlooks/steo/report/winterfuels.cfm.

[3] U.S. Energy Information Administration, "U.S. Number of Natural Gas Consumers," accessed April 30, 2018, https://www.eia.gov/dnav/ng/ng_cons_num_dcu_nus_a.htm.

[4] Consumers in urban areas also use LPG to a lesser extent for similar applications. In extremely cold weather, a common end use for LPG is "peak shaving," which supplements natural gas service by injecting LPG diluted with air into natural gas. For areas likely to transition to natural gas service, diluted LPG, a propane and air mixture, has the same heating value as natural gas, making it suitable for users with natural gas appliances.

[5] Tanks are limited in the amount of product that can be introduced to account for LPG contraction and expansion due to fluctuations in temperature and pressure. (National Fire Protection Association, *NFPA 58, Liquefied Petroleum Gas Code* (Quincy, MA, 2004). Tables 7.4.2.3(a)–(c) list the maximum permitted LPG volume.)

and installation). Of interest in this study are multi-user LPG systems that typically serve apartment buildings, small residential developments, resorts, hunting lodges, mobile home parks, strip malls, and the like. Some of these systems serve as few as two or three homes or businesses, while others serve dozens or even hundreds of customers in multiple buildings.

Although most states have multi-user LPG systems, they are more common in some states than others, in part because of regional differences in natural gas access (e.g., limited transmission pipelines to New England and no service on islands such as Puerto Rico and Hawaii) and the prevalence of certain types of businesses and land uses (e.g., states with large numbers of remote resorts and lodges). According to the National Propane Gas Association (NPGA), more than 75 percent of multi-user systems have 50 or fewer users and about 95 percent of newly constructed systems serve fewer than 100 users.[6] Figure 2-1 provides example configurations of multi-user LPG systems serving residential dwellings and businesses.

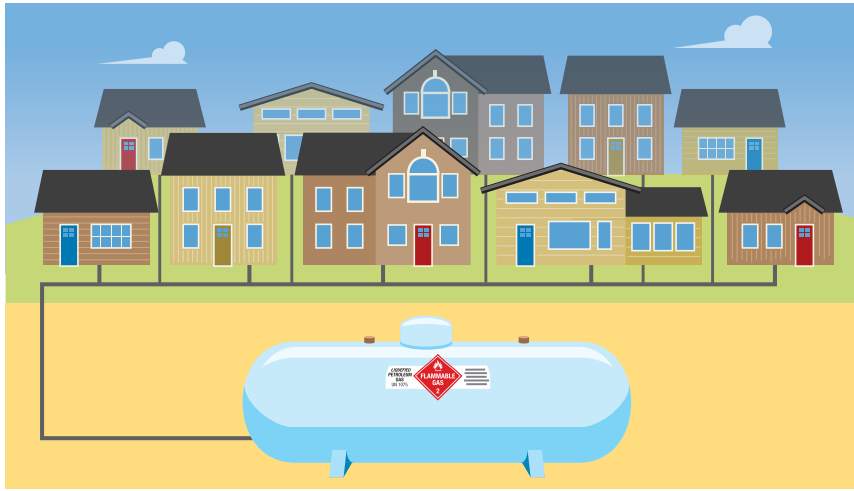
KEY SYSTEM COMPONENTS

The typical arrangement of a multi-user system is for individual end users to have an assigned meter that allows them to pay for the fuel as they use it, rather than in advance at the time of refilling a full tank. The customers served by these systems will usually have steel tanks with capacities of at least 500 gal, but often 1,000 to 4,000 gal, and in rare instances up to 30,000 gal (see Figure 2-2). If more than one tank is used, they are usually located next to one another and connected by manifold piping, thereby providing a common supply source for pipelines leading to the customers. The tanks will be painted or have other coatings to reflect sunlight and prevent atmospheric corrosion, and a mastic (petroleum or coal tar) and cathodic protection may be applied to tanks that are buried underground or mounded.

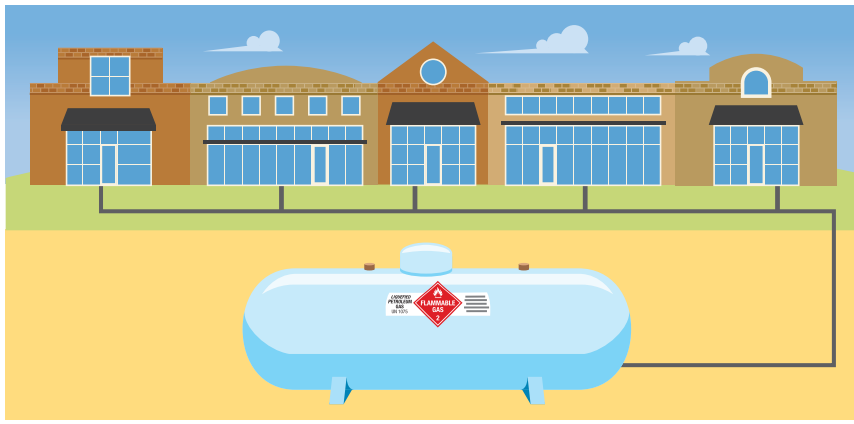
LPG tanks have certain common design features and fittings, many of them standardized as discussed later in this report. Most LPG tanks are designed with a maximum allowable working pressure of 250 pounds per square inch gage (psig; about 18 times atmospheric pressure). The ambient temperature affects the internal vapor pressure of a tank, particularly when located above ground. Thus, in addition to leaving void space (filled to approximately 80 percent of capacity[7]), tanks are equipped with pres-

[6] Michael Caldarera, Lyndon Rickards, and Rufus Youngblood, "National Propane Gas Association: Study on Propane Gas Pipeline Facilities" (June 8, 2017), http://onlinepubs.trb.org/onlinepubs/Propane/Caladeraetal6817.pdf. New LPG systems typically serve up to 30 customers.

[7] See Footnote 5.



a



b

FIGURE 2-1 Multi-user LPG distribution system configurations for (a) residential and (b) commercial applications.

sure relief devices to relieve excess pressure, usually when internal pressure exceeds 250 to 375 psig (see Figure 2-3). The tank will also contain other valves and fittings for gauging fill levels, refilling, and servicing (see Figure 2-4). On some tanks, the installation of wireless communication technology permits remote gauging of fill levels. These components are usually located on top of the tank and covered by a protective dome or lid. Buried tanks have risers that allow service technicians access to the valves and fittings.

Product is withdrawn from the tank on demand by a service valve that connects to a supply line, ranging from ¾ to 4 in. in diameter, but usually

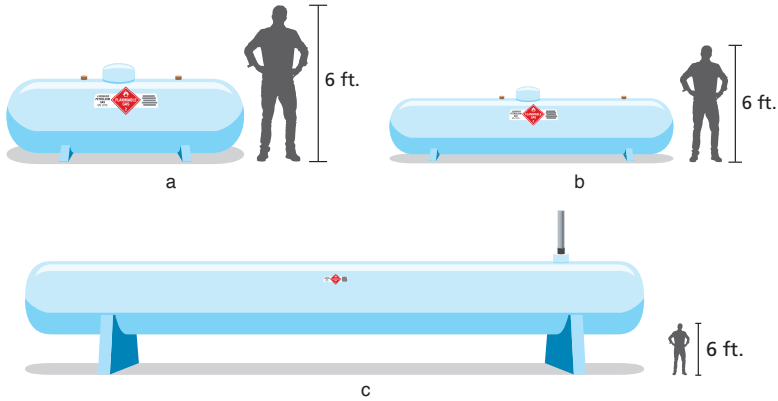


FIGURE 2-2 LPG storage tanks: (a) 500 gal; (b) 1,000 gal; and (c) 30,000 gal.

FIGURE 2-3 Pressure relief valve manifold.
SOURCE: Gary McDonald, "NAS Study on Propane Gas Pipeline Facilities" (June 8, 2017), 28, http://onlinepubs.trb.org/onlinepubs/Propane/McDonald6817.pdf.

not more than 2 in., which is the maximum allowable size of plastic piping. As LPG enters the supply line, its vapor pressure is reduced by a series of pressure regulators. A regulator (called a "first stage" regulator) is installed at the tank to control the service line (inlet) pressure, typically to a level of 10 psig or less, but not more than 30 psig in plastic pipes. Higher pressure could cause the product to re-liquefy (see Figure 2-5) and potentially

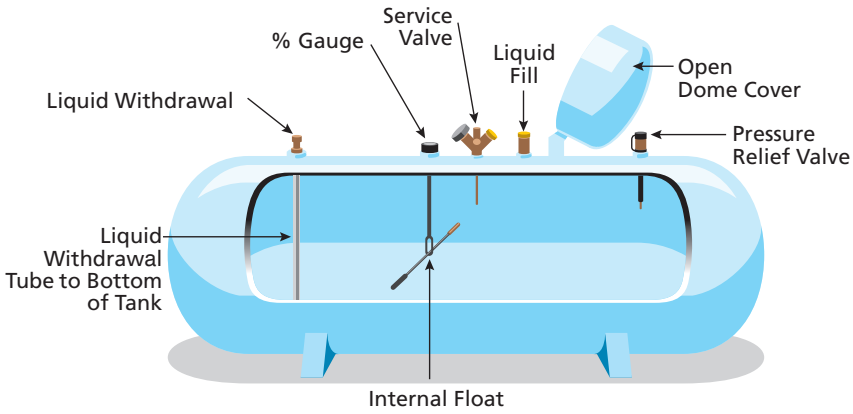


FIGURE 2-4 Stationary LPG storage tank.

rupture the pipe when the ambient temperature increases. A second regulator (the "second stage" regulator) is located close to the building or at each user's meter to further decrease the outlet pressure to a level that can be safely used by household appliances (~0.5 psig).[8] A service line ends at the outlet of the customer meter or at the connection to a customer's piping, whichever is further downstream (, the line ends at the connection to customer piping if there is no meter).[9] A second stage regulator may serve one customer or multiple customers through a meter header or manifold.

The service lines are usually made of plastic, but sometimes made of steel, and can be as short as a few feet, such as when serving adjoining businesses (e.g., strip mall), adjacent homes, or an apartment building. However, the lines can extend for hundreds of yards in larger systems. According to PHMSA data, the length of a service line on a system having 100 or more customers is typically 54 ft.[10] As the number of users and variety of applications increase, so too will the storage capacity of the tanks

[8] Most outlet pressures of second stage regulators are measured in inches water column, such as 11 in. water column, which is about 0.5 psig.

[9] "Definitions," 49 CFR § 192.3, 415, accessed April 24, 2017, https://www.ecfr.gov/cgi-bin/text-idx?SID=eab46322fa6503dd280dde58f10fadda&mc=true&node=pt49.3.192&rgn=div5.

[10] Pipeline and Hazardous Materials Safety Administration, "Gas Distribution, Gas Gathering, Gas Transmission, Hazardous Liquids, Liquefied Natural Gas (LNG), and Underground Natural Gas Storage (UNGS) Annual Report Data," accessed March 23, 2018, https://www.phmsa.dot.gov/data-and-statistics/pipeline/gas-distribution-gas-gathering-gas-transmission-hazardous-liquids. The length of service lines is based on median (53.5 ft) of data from the "Average Service Length" field in large LPG pipeline operators' annual reports on system conditions.

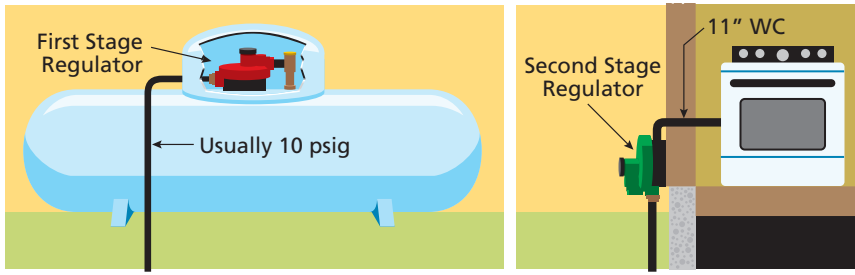


FIGURE 2-5 LPG tank regulator system.
NOTE: WC = water column.

in the systems as well as the likelihood that the tanks will be buried along with their service lines.

Installation of LPG pipelines is typically accomplished using one of three methods: trenching, horizontal directional drilling, or pneumatic piercing. Trenching relies on the use of a backhoe or similar equipment to dig a trench into which the pipe is placed. Horizontal drilling and pneumatic piercing are forms of trenchless excavation technology, which has the advantage of minimizing ground disturbance and disruption to traffic and infrastructure. Standards governing pipeline installation state that when service lines are buried, their burial depth must be at least 12 in. below grade in private property and at least 18 in. below grade in streets and roads.

Although seldom a component in LPG systems with fewer than 100 customers, tanks may be equipped with a vaporizer in colder climates and for high-consumption applications. These devices heat the LPG liquid until it vaporizes without increasing pressure inside the system. The accelerated production of vapor ensures that customers have an adequate supply of fuel during low-ambient temperature when vaporization is suppressed or to supply industrial users.

SYSTEM SUPPLY AND OPERATIONS

In many cases, the LPG supplier is the owner of the tank and service lines leading to the meter. Under these proprietary arrangements, the customer leases the tank and is contractually obligated to purchase propane exclusively from the supplier. In return, the LPG supplier is responsible for inspecting and maintaining the system and is the operator of record from a regulatory standpoint. When the customer owns the tank, an LPG supplier may still be hired to inspect and maintain the system, usually coupled with the customer's purchase of fuel. LPG distribution system configurations can have much in common with master meter systems used for natural gas dis-

TABLE 2-1 Characteristics of Three Major LPG Firms, 2016

Firm	Customers (million)	Propane, Gallons Sold (million)	States with Operations
AmeriGas	1.9	1,100	50
Ferrellgas	1.0	779	50
Suburban Propane	1.1	415	41

NOTE: The fuel reported as sold does not differentiate by type of LPG; the table reflects the terminology used by the firms.
SOURCES: Annual financial reports of AmeriGas and Suburban Propane, 2016; Ferrellgas, https://www.ferrellgas.com/our-company and https://www.ferrellgas.com/media/1167/co-23458.pdf, accessed May 9, 2017.

tribution, whereby the operator of the system purchases gas from a supplier through a single large meter and resells the gas to the ultimate consumer for uses such as heating and cooking.[11] That customer either purchases the gas directly through a house meter or by other means, such as a rental payment that includes all utilities. In a less common scenario, the operator may be neither the supplier nor the customer, such as at mobile home parks where office staff manage the distribution system operations through the use of contractors and bill the mobile home residents for use of fuel.[12]

There are an estimated 3,000 propane suppliers in the United States, many consisting of small, often family-owned, businesses.[13] The three largest suppliers are AmeriGas, Ferrellgas, and Suburban Propane, which operate nationally. These three firms supply about one-third of all LPG consumers. Table 2-1 provides a snapshot of the three firms' customer base, sales volume, and number of states served.

SUMMARY

This chapter described the configurations, components, and use characteristics of the multi-user pipeline systems that distribute LPG to homes and businesses. In these systems—which can have as few as two users or as many as several hundred—LPG is stored under high pressure as a liquid on

[11] Although rare, there are LPG master meter systems.
[12] Neil Pascual, "The National Association of Pipeline Safety Representatives" (Meeting 1, Washington, DC, June 8, 2017), 13, http://onlinepubs.trb.org/onlinepubs/Propane/Pascual6817.pdf.
[13] This figure was provided by NPGA, whose membership consists of 2,300 propane suppliers and is believed to account for about three-quarters of suppliers nationally.

or close to the user's premises. The systems usually consist of one or more storage tanks, a first stage regulator, service lines, a second stage regulator, and a customer meter. The tanks, fittings, and service lines may be located above or below ground, usually the latter as system size increases. Service line lengths tend to be measured in feet or yards, as opposed to the miles of service line found in natural gas systems.

LPG service in a multi-user system is usually metered so that customers pay for the fuel as they use it rather than having to pay in advance for refilling a full tank. The typical commercial arrangement is for the LPG supplier to be the owner of the tank and service lines, and thus responsible for operations and maintenance. Many small- and medium-sized firms serve in this capacity as operators, along with three large national LPG suppliers.

3

Hazard Characteristics and Safety Performance

This chapter describes liquefied petroleum gas's (LPG's) physical properties and hazard characteristics that must be controlled, examines available data on LPG pipeline incidents, and reviews several incidents that stand out from the data. The incident records reported by pipeline operators and maintained by the U.S. Department of Transportation's Pipeline and Hazardous Materials Safety Administration (PHMSA) do not differentiate between smaller and larger systems subject to federal regulation and thus cannot be used to identify only those incidents involving systems serving 100 or fewer customers. The U.S. Fire Administration's (USFA's) National Fire Incident Reporting System (NFIRS) provides a secondary source of records on LPG incidents, but it also lacks identifiers for incidents involving pipeline distribution systems, and thus may include incidents involving single-user systems that are non-jurisdictional (i.e., not regulated by the federal government). An annex to the chapter provides more information on these two databases and their limitations for the purposes of this study. While these limitations complicate assessments of the safety performance of small LPG pipeline systems specifically, the small number of reported LPG transportation incidents generally suggests that industry and government measures are working to assure the safety of LPG pipeline systems. Nevertheless, the events and circumstances that gave rise to the few consequential LPG pipeline incidents that have occurred over the past 30 years show the importance of these measures.

LPG PROPERTIES AND HAZARD CHARACTERISTICS

LPG may contain butane, butylene, isobutane, isobutylene, propane, propylene, or mixes of each compound. Like natural gas, propane and butane are colorless and odorless, and therefore chemical odorants such as ethyl mercaptan are added to LPG to aid in the detection of escaping gas. LPG suppliers may mix propane with other LPGs depending on whether the distribution system is located in warmer or colder climates. While each compound has distinct properties that can lead to somewhat different hazard characteristics, the standardized techniques and practices used for LPG storage and transportation are intended to accommodate the full range of LPGs. Because the small LPG pipeline systems that are of interest to this study are used predominantly for propane with varying concentrations of butane, this chapter focuses on the hazard characteristics and safety performance of propane and propane–butane mixtures when transported by pipeline. Physical properties of propane and butane relevant to their hazard characteristics are summarized in Table 3-1.

As discussed in Chapter 2, end users consume LPG in a gaseous state, but suppliers transport and store it as a liquid through the use of pressure, cooling, or a combination of both. Propane naturally occurs as a gas because it boils at –44°F. However, because butane boils at 31°F, propane mixed with butane can create system performance and safety issues in northern states where low winter temperatures can cause gas to condense in pipelines. Condensation in a gas pipeline can interrupt the fuel flow and feed liquid to gas appliances.[1] In addition, the integrity of a plastic piping system may be compromised by the presence of LPG in a liquid state. If LPG liquid is contained in a plastic line with closed valves, warmer temperatures can cause the liquid to expand and rupture the pipe.

The force exerted by a gas on its container when it transitions from a liquid phase is a function of its vapor pressure. The higher the vapor pressure, the more readily a liquid will evaporate, indicative of volatility. Exerting about tenfold and double the force of atmospheric pressure at sea level, respectively, propane and butane are highly volatile compounds that present flammability hazards in an uncontrolled release. Because of the expansion ratio of liquid propane, 1 ft^3 released from a container will volatilize to create 270 ft^3 of gas.[2] When mixed with air, this release can produce more than

[1] Propane can also condense in pipelines under certain low-temperature and moderate-pressure conditions. For instance, a service line exposed to approximately 20 pounds per square inch gauge (psig) (34.7 psi absolute) of pressure and an atmospheric temperature of –5°F or lower can lead to propane gas condensation. National Fire Protection Association, *LP-Gas Code Handbook* (Quincy, MA: National Fire Protection Association, 2017), 233.

[2] Gregory G. Noll and Michael S. Hildebrand, *Pipeline Emergencies*, 3rd edition (Chester, MD: National Association of State Fire Marshals, 2011), 12.

TABLE 3-1 Select Physical Properties of Propane and Butane

	Propane	Butane
Chemical formula	C_3H_8	C_4H_{10}
Initial boiling point	–44°F	31°F
Vapor pressure, pounds per square inch absolute (psia)		
at 70°F	145	32
at 100°F	218	52
Cubic feet of vapor per gallon (ft^3/gal) at 60°F	36.38	31.26
Relative vapor density (air = 1)	1.50	2.01
Flash point (closed cup method)	–156°F	–76°F
Auto-ignition temperature	871°F	761°F
Flammability limits, lower	2.1%	1.55%
Flammability limits, upper	9.6%	8.6%

SOURCES: National Fire Protection Association, *LP-Gas Code Handbook*, 549–550; National Oceanic and Atmospheric Administration, "CAMEO Chemicals: Liquefied Petroleum Gas," accessed March 20, 2018, https://cameochemicals.noaa.gov/chris/LPG.pdf.

12,000 ft^3 of fuel–air mixture that will extend well beyond the immediate vicinity of the release.[3] As it spreads, this mixture can form an explosive, low-hanging vapor cloud that is visible near the release area, an invisible but ignitable vapor cloud farther way, and flash fire areas just beyond the invisible vapor cloud.[4]

The diffusion of LPG differs from that of natural gas because of differences in their vapor density. Propane and butane, unlike natural gas (mainly methane), are heavier than air. As a result, the two LPGs will sink when released, whereas natural gas, which has about half the relative vapor density of air, will diffuse upward and dissipate if not contained. LPG's higher vapor density can cause it to creep along the ground and concentrate in low-lying areas, as well as migrate through soil in the case of an underground leak. Highly saturated or frozen soil can create a barrier to the dissipation of gas as it travels through the ground.[5] Instead of venting to the atmosphere, the gas may travel along other underground infrastructure

[3] O. John Jacobus, "Odorization of Propane" (Meeting 3, Washington, DC, December 7, 2017), http://onlinepubs.trb.org/onlinepubs/Propane/Jacobus120717.pdf.

[4] Hildebrand, Noll, and National Propane Gas Association, *Propane Emergencies*, 98.

[5] Pipeline and Hazardous Materials Safety Administration, "Operations and Maintenance Enforcement Guidance: Part 192 Subparts L and M," July 21, 2017, 64, https://www.phmsa.dot.gov/sites/phmsa.dot.gov/files/docs/regulatory-compliance/pipeline/enforcement/5776/o-m-enforcement-guidance-part-192-7-21-2017.pdf.

into buildings, such as basements. Because LPG disperses from the spill site relatively slowly and pools, it can retain its potential as a source of fuel for a fire or explosion longer than a similar release of natural gas. Although LPG is not toxic, concentrations of the gas that displace air can also create an asphyxiation risk.

The flammability of LPG arises from multiple properties, including its flammability limits, auto-ignition temperature, burning velocity, and flash point. A vapor with a wider range of flammability limits and lower temperatures associated with its flash point and auto-ignition is considered more flammable.[6] The flammability limits, which describe the range of vapor concentration in air that is supportive of combustion, are low enough for even a 2 percent concentration of LPG to combust. The burning velocity of a fuel describes how quickly a fuel–air mixture will burn and flash back toward the source of ignition, which typically occurs by means of heat, flames, spark, or discharge of static electricity. Because of the high burning velocity of LPG, the flame can travel back to its source of ignition.[7] Also, the flash point for propane and butane occurs at such low temperatures that these fuels would already be present as a mix of vapor and air at a concentration corresponding at least to the lower flammability limit at standard temperature and pressure.

Knowledge of these particular properties and hazards of LPG have informed measures intended to ensure its safety as a common consumer fuel. However, major incidents—including the consequential ones discussed next—do occur at times and reveal the importance of controlling these hazards.

NOTABLE LPG PIPELINE INCIDENTS

Before examining the incident data for evidence of the safety performance of LPG pipelines, a brief review of a few major incidents that have occurred over the past 30 years is helpful because investigations of their causes and consequences—more than analyses of incident statistics—are often the impetus for changes in safety practices, techniques, and standards. While major incidents are rare, the following ones illustrate some of LPG's hazard characteristics, particularly those associated with its diffusion behavior. All but one of the notable LPG incidents occurred on a jurisdictional LPG distribution system; it was included because the circumstances demonstrate the

[6] David Lord et al., "Literature Survey of Crude Oil Properties Relevant to Handling and Fire Safety in Transport" (Sandia National Laboratories, March 2015), 83, http://www.osti.gov/scitech/biblio/1177758.

[7] National Oceanic and Atmospheric Administration, "CAMEO Chemicals: Liquefied Petroleum Gas."

significance of LPG hazard characteristics in a system configuration similar to commercial jurisdictional systems.

Parkers Prairie, Minnesota

On August 5, 1991, an LPG pipeline distribution system ruptured and killed an employee at a delicatessen in Parkers Prairie, Minnesota. According to the incident narrative in a report submitted to PHMSA, the state fire marshal determined that the LPG leaked from a service line outside the store and migrated into the basement where it concentrated before igniting. This downward path of the escaping gas illustrates a hazard of LPG's high density relative to air.

San Juan, Puerto Rico

On November 21, 1996, an LPG pipeline distribution system in a commercial district in San Juan, Puerto Rico, exploded, killing 33 people and injuring at least 69 others.[8] Although the explosion involved a large jurisdictional LPG system, it provides an example of how LPG's high vapor density (relative to air) can create a serious flammability hazard. As of July 2018, this incident was the largest cause of fatalities and injuries resulting from a gas distribution facility in the United States.

The National Transportation Safety Board (NTSB) determined that the propane gas explosion was fueled by an excavation-caused leak, after backfilling and compacting soil over a water line 4 years earlier imposed excessive stresses on the plastic gas service pipe, which later caused the service pipe to fail.[9] The escaping propane migrated downhill along piping through voids in the ground and under a sidewalk until it reached the basement of a six-story building.[10] The gas exploded when sparked by a heating, ventilation, and air conditioning fan motor. In the days preceding the explosion, several individuals reported smelling an odor in the vicinity and inside buildings. Barholes drilled by gas company technicians to detect leaking gas were too shallow to detect the propane that had migrated to lower depths. NTSB concluded that the gas company had inaccurate maps of buried facilities, insufficiently trained employees to test for and respond to reports of potential leaks, and did not have an excavation-damage pre-

[8] National Transportation Safety Board, "Pipeline Accident Report: San Juan Gas Company, Inc./Enron Corp. Propane Gas Explosion in San Juan, Puerto Rico, on November 21, 1996," December 23, 1997, vii, https://ntsb.gov/investigations/AccidentReports/Reports/PAR9701.pdf.

[9] National Transportation Safety Board, 41.

[10] Stephen Barlas, "NTSB Report on San Juan Raises Broader Questions," 39–40, accessed February 1, 2017, http://connection.ebscohost.com/c/articles/325723/ntsb-report-san-juan-raises-broader-questions.

vention program such as a one-call notification system. One-call notification systems are intended to facilitate safe excavation through the use of communications centers that field inquiries from excavators and notify all underground infrastructure operators (who are members of the system) of impending digging.[11]

Snow Hill, Maryland

On September 1, 2002, an explosion killed one person and injured 17 others in a residential neighborhood in Snow Hill, Maryland. A corroded LPG service line is presumed to have leaked the gas that fueled the explosion, though the source of ignition is unknown.[12] Lengthy and heavy rain is believed to have contributed to a ground disturbance that compromised the service line.[13] The operator of the jurisdictional LPG system was a natural gas utility serving the rural Eastern Shore of Maryland.

Two gas utility company employees and several volunteer firefighters responded to a call about the smell of propane at a house where gas had accumulated in the basement after traveling from the ruptured service line. The incident demolished the customer's house, where one of the gas utility employees died. The explosion necessitated evacuation of neighbors from their homes and led to the detection of LPG at three other nearby homes.

Door County, Wisconsin

On July 10, 2006, gas leaking from an underground LPG gas line exploded, killing two people and injuring four others.[14] The explosion, which occurred in a resort community in Ellison Bay, Wisconsin, was fueled by gas leaking from a pipe that had been damaged by excavation 3 days earlier.[15] The utility worker who caused the rupture in the pipe had been installing electrical cables and was unware of the LPG pipeline, which was not located by the local one-call system even though the piping reportedly was installed

[11] "Mandatory Participation in Qualified One-Call Systems by Pipeline Operators," 62 *Federal Register* 61695, https://www.gpo.gov/fdsys/browse/collection.action?collectionCode=FR.

[12] Chris Guy, "Town's Gas Leak Concern Grows," *The Baltimore Sun*, September 9, 2002, http://articles.baltimoresun.com/2002-09-09/news/0209090002_1_snow-hill-propane-gas.

[13] Chris Guy and Jennifer McMenamin, "Snow Hill Residents Cope, Care after Blast," *The Baltimore Sun*, September 3, 2002, http://articles.baltimoresun.com/2002-09-03/news/0209030118_1_propane-explosion-snow-hill-ruth-young.

[14] Pipeline and Hazardous Materials Safety Administration, "Pipeline Incident Flagged Files," accessed April 30, 2018, https://www.phmsa.dot.gov/data-and-statistics/pipeline/pipeline-incident-flagged-files.

[15] Pipeline and Hazardous Materials Safety Administration, "Pipeline Incident Flagged Files."

with tracer wire to enable detection.[16] The LPG migrated underground through porous rock until it reached the crawl spaces of several buildings, where it remained undetected until it ignited in the middle of the night.

Ghent, West Virginia

On September 25, 2008, a propane technician was exchanging an older tank with a replacement tank on a non-jurisdictional system serving a convenience store in Ghent, West Virginia, when a defective liquid withdrawal valve caused propane to escape. After sustaining frostbite from the escaping liquid, the technician sought guidance from another technician by phone but waited 15 minutes before calling emergency responders.[17] During that time, the technician did not evacuate the store. Shortly after firefighters and the second propane technician arrived, the escaping vapor ignited, killing the two propane technicians and two emergency responders, seriously injuring six others, and destroying the store and nearby vehicles.

In its investigation, the Chemical Safety and Hazard Investigation Board concluded that the explosion resulted from several factors, including insufficient hazardous materials training for the technician and the improper installation of the tank adjacent to the outside wall of the store contrary to federal and state regulation.[18] Because of the tank's location, LPG was able to enter the store in large quantities through exhaust vents. The board found that the volunteer firefighters lacked LPG-specific training to know that they should have promptly evacuated the store.

REVIEW OF INCIDENT STATISTICS

The main database containing reports of pipeline incidents in the United States is PHMSA's Pipeline Incident Flagged Files. This database, which dates back to 1986, can be used to track the history of LPG incidents meeting certain consequence thresholds and their reported causes. To provide additional insight into potential safety issues for LPG pipelines, a second PHMSA database is consulted that tracks the annual system condition reports submitted by large LPG operators (those serving 100 or more customers) of their experience with leaks and excavation damage.

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[16] Administrator, "Families, Victims Sue over Door County Explosion," *The Daily Reporter–WI Construction News and Bids*, September 25, 2006, http://dailyreporter.com/2006/09/25/families-victims-sue-over-door-county-explosion.

[17] U.S. Chemical Safety and Hazard Investigation Board, "Investigation Report: Little General Store—Propane Explosion," September 2008, 1–2, 24, https://www.csb.gov/assets/1/20/csbfinalreportlittlegeneral.pdf?13741.

[18] U.S. Chemical Safety and Hazard Investigation Board, "Investigation Report: Little General Store—Propane Explosion."

A concern of the committee is that some incidents involving small LPG systems may not have been reported to PHMSA, and therefore fire records in USFA's NFIRS were also examined.[19] The results of analyses of these databases, which are presented next, suggest that incidents involving LPG pipeline systems are rare. The causal information in the databases, however, is insufficient for drawing conclusions about specific regulatory requirements and their safety contribution.

PHMSA Incident Records

PHMSA's incident records are derived from reports by pipeline operators, which are required to submit reports of jurisdictional system incidents to the National Response Center (NRC) within 1 hour of confirming an incident has occurred.[20] After contacting NRC, operators must submit a detailed report to PHMSA within 30 days. Reporting is required for incidents that involve a fatality or personal injury, estimated property damage of $50,000 or more, or a significant event as determined by the operator.

Because PHMSA has revised its reporting forms and criteria over the years, the records for three periods—2010 to the present, March 2004 through 2009, and 1986 through February 2004—contain some variability in reporting information.[21] The most important difference for the purposes of this study is the lack of a ready means for identifying the type of gas released in incidents reported before 2010. There are also differences among the three reporting periods in the availability of data for the volume of gas released and in the amount of detail on incident causes. Despite the differences, some of this information can be gleaned from a review of the narratives in the individual reports. Incomplete records, however, would resist this type of analysis, as in the case of an incident in 2002.[22] A line-by-line review of the pre-2010 records also allows for discarding records that fall well outside the study scope, such as incidents involving propane torches.

[19] U.S. Fire Administration, "About the National Fire Incident Reporting System," accessed January 25, 2018, https://www.usfa.fema.gov/data/nfirs/about/index.html.

[20] The National Response Center (NRC) is staffed around the clock by U.S. Coast Guard (USCG) personnel and is a part of the federal government's National Response System. USCG jointly leads federal response efforts with the U.S. Environmental Protection Agency if an incident reported to the NRC triggers mobilization of federal resources, which includes approximately a dozen other federal agencies. The NRC website is http://www.nrc.uscg.mil.

[21] Pipeline and Hazardous Materials Safety Administration, "Incident Report Criteria History," May 27, 2014, https://hip.phmsa.dot.gov/Hip_Help/pdmpublic_incident_page_allrpt.pdf.

[22] PHMSA's record for the 2002 incident in Snow Hill, Maryland, contained empty data fields for the narrative and others that initially prevented identification of the type of gas released (Pipeline and Hazardous Materials Safety Administration, "Pipeline Incident Flagged Files;" Chris Guy, "Town's Gas Leak Concern Grows").

Useful information was extracted from the pre-2010 and more recent records; however, PHMSA does not collect incident data regarding certain LPG-specific factors, such as the number of customers served by a system or the size and configuration (that is, aboveground or underground) of the storage tank. It is, therefore, often impossible to determine the size of the system involved in an incident.

Tables 3-2, 3-3, and 3-4 show the number of LPG pipeline incidents reported to PHMSA by operators during each of the three periods, including reports of fatalities and injuries for jurisdictional systems of all sizes. During 1986 to February 2004 (see Table 3-2), 12 incidents were reported in 7 years, including the 1996 San Juan explosion, which accounted for 33 of the 35 fatalities and 42 of the 64 injuries. (The NTSB report indicates that there were as many as 69 injuries.) From March 2004 through 2009 (see Table 3-3), seven incidents were reported, including the Door County explosion that accounted for both fatalities and four of the six injuries reported. During this reporting period, PHMSA also began collecting data on the number of persons evacuated in response to gas pipeline incidents. The Door County incident was responsible for half of the individuals evacuated. For the reporting period 2010 to 2017, zero fatalities and 10 injuries from LPG pipeline incidents were reported.

Figure 3-1 shows the causes of the LPG pipeline incidents reported during these three periods combined. Third-party excavation damage was reported for eight incidents; unknown or "miscellaneous" for seven; incorrect operation and other outside force damage for four each; corrosion damage for three; natural force damage for two; and material, welding, or joint failure for one. The 10 incidents reported from 2010 to 2017 included three caused by third-party excavation damage, three by other outside force damage (damage to the meter, vandalism, and fire), three by incorrect operation, and one by natural force damage.

PHMSA Leading Indicator Data

In addition to collecting reports of consequential incidents, PHMSA collects data from operators of large LPG systems (those serving 100 or more customers) on certain leading indicators of safety performance, including reports of leaks, hazardous leaks, and excavation damage.[23] PHMSA defines a "leak" as an unintended release of gas from a pipeline facility, excluding leaks that can be repaired by basic maintenance activity, such as by lubrication or tightening. A more severe "hazardous leak" is defined as

[23] Pipeline and Hazardous Materials Safety Administration, "Gas Distribution, Gas Gathering, Gas Transmission, Hazardous Liquids, Liquefied Natural Gas (LNG), and Underground Natural Gas Storage (UNGS) Annual Report Data."

TABLE 3-2 LPG Incidents Reported to PHMSA, 1986–February 2004

Year	Reports	Fatalities	Injuries	Ignition	Explosion	Total Cost, 2016 Dollars
1986	1	0	2	1	1	$0
1987	0	0	0	0	0	$0
1988	1	0	2	1	0	$0
1989	2	0	0	2	1	$208,780
1990	2	0	0	2	2	$292,135
1991	3	1	1	2	2	$14,593
1992	0	0	0	0	0	$0
1993	0	0	0	0	0	$0
1994	0	0	0	0	0	$0
1995	0	0	0	0	0	$0
1996	1	33	42	1	1	$7,272,252
1997	0	0	0	0	0	$0
1998	0	0	0	0	0	$0
1999	0	0	0	0	0	$0
2000	0	0	0	0	0	$0
2001	0	0	0	0	0	$0
2002	1	1	17	1	1	Unknown
2003	1	0	0	1	1	$579,583
2004	0	0	0	0	0	$0
Total	12	35	64	11	9	$8,367,344

SOURCE: Pipeline and Hazardous Materials Safety Administration, "Pipeline Incident Flagged Files," April 30, 2018, https://www.phmsa.dot.gov/data-and-statistics/pipeline/pipeline-incident-flagged-files.

TABLE 3-3 LPG Incidents Reported to PHMSA, March 2004–2009

Year	Reports	Fatalities	Injuries	Ignition	Explosion	Persons Evacuated	Total Cost, 2016 Dollars
2004	0	0	0	0	0	0	$0
2005	1	0	0	1	1	0	$0
2006	2	2	4	2	2	470	$1,662,856
2007	0	0	0	0	0	0	$0
2008	1	0	0	1	1	5	$789,430
2009	3	0	2	3	3	10	$289,479
Total	7	2	6	7	7	485	$2,741,765

SOURCE: Pipeline and Hazardous Materials Safety Administration, "Pipeline Incident Flagged Files."

TABLE 3-4 LPG Incidents Reported to PHMSA, 2010–2017

Year	Reports	Fatalities	Injuries	Ignition	Explosion	Gas Released, Thousands of Cubic Feet (ft^3)	Persons Evacuated	Total Cost, 2016 Dollars[a]
2010	2	0	0	1	1	354	10	$1,236,411
2011	1	0	1	1	1	18	0	$26,584
2012	1	0	2	1	1	10	0	$14,756
2013	3	0	0	3	3	18.17	0	$48,034
2014	1	0	2	1	1	0.24	0	$11,806
2015	0	0	0	0	0	0	0	$0
2016	1	0	1	1	1	32.2	10	$702,000
2017	1	0	1	1	1	88	0	$13,168
Total	10	0	7	9	9	520.61	20	$2,052,760

[a] Due to a modification in reporting methodology since 2010, property damage and the cost of gas released must be added to compare to the total cost from previous reporting periods.
SOURCE: Pipeline and Hazardous Materials Safety Administration, "Pipeline Incident Flagged Files."

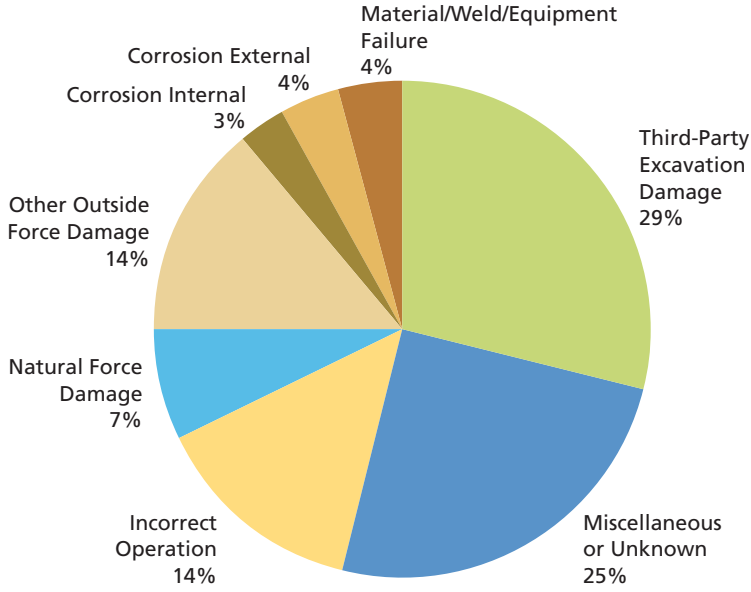

FIGURE 3-1 Causes of incidents in LPG pipeline systems reported to PHMSA, 1986–2017.
SOURCE: Pipeline and Hazardous Materials Safety Administration, "Pipeline Incident Flagged Files."

an uncontrolled release of gas that demands an immediate response to avoid a hazard to people or property.

Figures 3-2 and 3-3 contain data from 2016 on both types of leaks reported in LPG mains and service lines. For both categories of pipeline, excavation damage caused about one-third of leaks, but it figured more prominently in hazardous leaks (accounting for more than three-quarters). Because leaks caused by excavation damage can involve sparks and human exposure, they will often require immediate action, thus requiring classification as a "hazardous leak." Other causes of leaks tend to be time-dependent mechanisms such as corrosion or the failure of a pipe, weld, or joint. These leaks are usually discovered before they present a hazardous situation and are thus more likely to be reported simply as "leaks."

To better understand the causes of excavation damage, PHMSA collects more granular data when operators report excavation-caused leaks. Most reports of excavation damage, as shown in Figure 3-4, are attributed to insufficient one-call practices. Problems relating to one-call systems can stem from an inaccurate registry of pipeline locations, inaccurate marking of

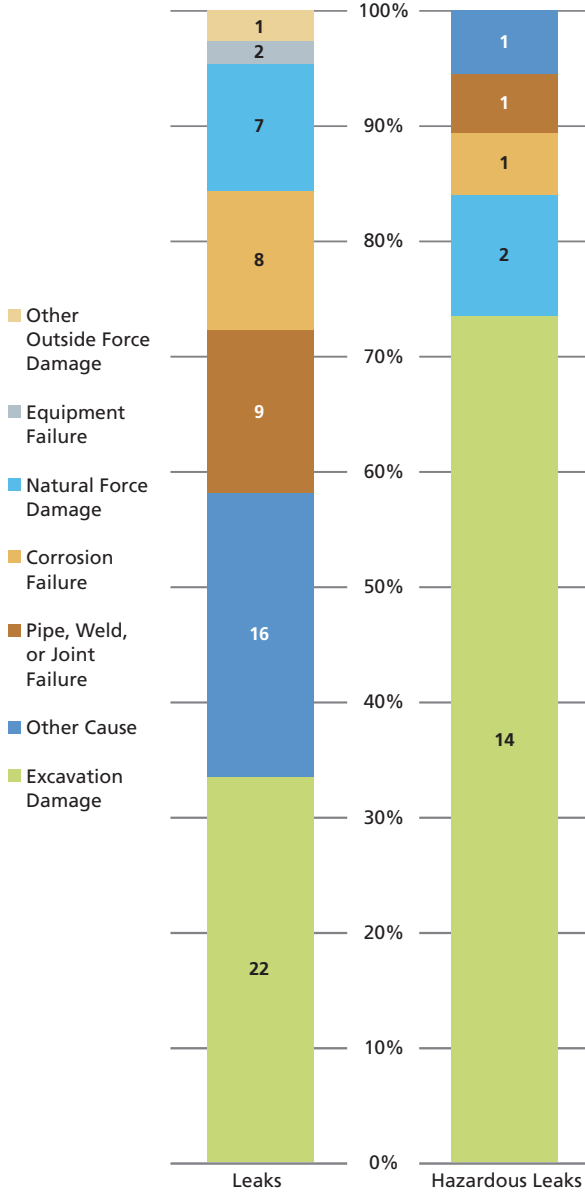

FIGURE 3-2 The share of and count of leaks and hazardous leaks in LPG mains by cause reported to PHMSA for systems serving 100 or more customers, 2016.
SOURCE: Pipeline and Hazardous Materials Safety Administration, "Gas Distribution, Gas Gathering, Gas Transmission, Hazardous Liquids, Liquefied Natural Gas (LNG), and Underground Natural Gas Storage (UNGS) Annual Report Data," accessed January 2, 2018, https://www.phmsa.dot.gov/data-and-statistics/pipeline/gas-distribution-gas-gathering-gas-transmission-hazardous-liquids.

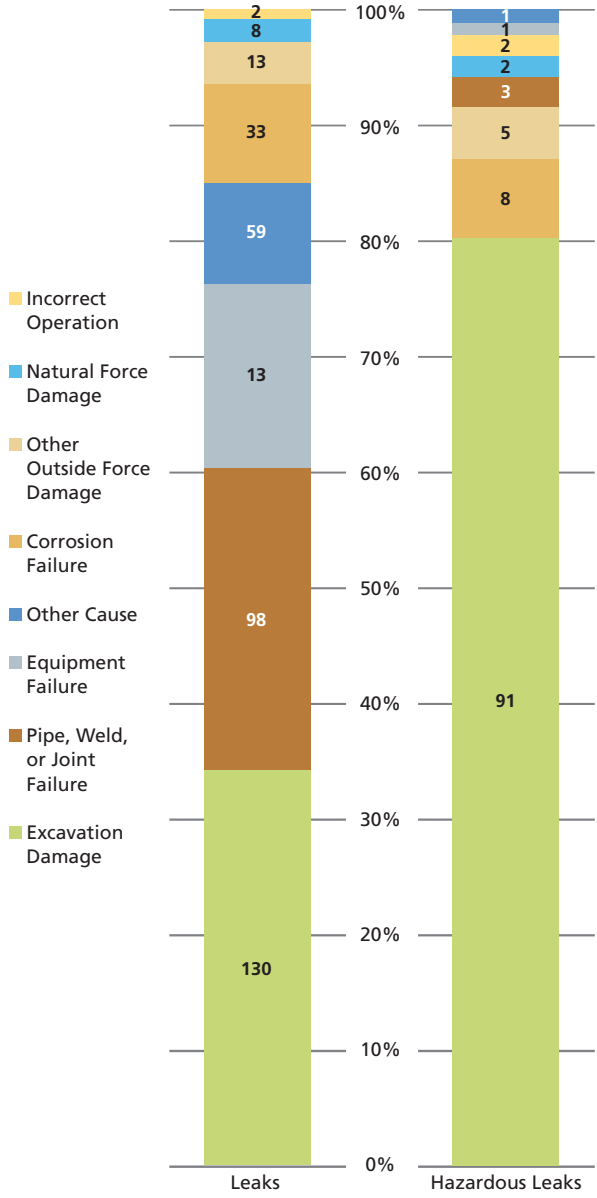

FIGURE 3-3 The share of and count of leaks and hazardous leaks in LPG service lines by cause reported to PHMSA for systems serving 100 or more customers, 2016.
SOURCE: Pipeline and Hazardous Materials Safety Administration, "Gas Distribution, Gas Gathering, Gas Transmission, Hazardous Liquids, Liquefied Natural Gas (LNG), and Underground Natural Gas Storage (UNGS) Annual Report Data."

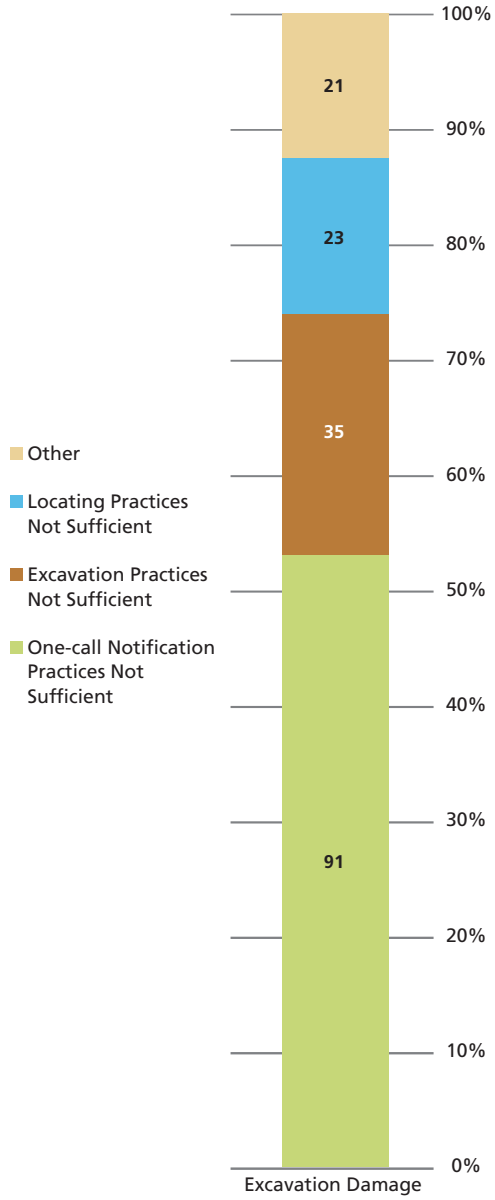

FIGURE 3-4 The share of and count of excavation damage by cause in LPG systems reported to PHMSA for systems serving 100 or more customers, 2016.
SOURCE: Pipeline and Hazardous Materials Safety Administration, "Gas Distribution, Gas Gathering, Gas Transmission, Hazardous Liquids, Liquefied Natural Gas (LNG), and Underground Natural Gas Storage (UNGS) Annual Report Data."

pipelines, inadequate information from an excavator, insufficient notification time, and communication errors. Instances of these problems can lead to poorly informed excavation practices. The Door County LPG pipeline explosion, as noted above, originated with a failure of the one-call system to locate the existing propane pipeline.

National Fire Incident Reporting System

Incident data are reported to the NFIRS, which is maintained by USFA, a division of the Federal Emergency Management Agency. Unlike the incident reports collected by PHMSA from pipeline operators, NFIRS reports originate from fire departments across the United States. The NFIRS reports are also not limited to incidents involving a fatality, injury, property damage, or evacuation. The reports contain information on the nature of the incident, including whether the fire department responded to a fire, medical emergency, hazardous material release, or other type of emergency. In the case of fires, USFA estimates that the NFIRS reporting accounts for about three-quarters of all incidents,[24] because incident reporting is voluntary in some states.[25]

The committee's review of the 2010 through 2016 NFIRS data (which is described further in the chapter's annex) found 49 reports involving fires at LPG distribution pipelines (see Table 3-5).[26] Because USFA estimates that NFIRS records only 75 percent of fire incidents, the 49 reports may be indicative of about 65 incidents nationwide during the 7-year period.[27] However, because determination of whether a pipeline system is jurisdictional is immaterial to the response effort, NFIRS is likely to include reports from jurisdictional pipeline systems and from small non-jurisdictional facilities. At most, the NFIRS data suggest there may be about 10 incidents per year that involve LPG pipeline facilities of all types.

Synopsis of Incident and Leak Data

Available incident data contain too few details to examine the safety performance of small LPG systems specifically. Nevertheless, during more than

[24] U.S. Fire Administration, "Review and Assessment of Data Quality in the National Fire Incident Reporting System," May 2017, 4, https://www.usfa.fema.gov/downloads/pdf/publications/nfirs_data_quality_report.pdf.

[25] U.S. Fire Administration, National Fire Operations Reporting System, "NFIRS Requirements by State Law," 10–11, accessed January 25, 2018, http://www.nfors.org/assets/StateFireData_Requirements.pdf.

[26] Only fire incident data could be reliably extracted from NFIRS because gas releases cannot be differentiated by type of gas in the database.

[27] U.S. Fire Administration, "About the National Fire Incident Reporting System."

TABLE 3-5 NFIRS Data on LPG Pipeline Fires in the United States, 2010–2016

Year	Number of LPG Pipeline Fires	Property Loss	Incident States
2010	7	$320,000	IA, IN, KS, SC, TN
2011	15	$1,270,200	AL, CO, GA, IN, KS, MO, ND, NV, OH, TX, WA
2012	2	$0	MA, WI
2013	4	$0	KY, MI, MN, TX
2014	9	$30,000	AZ, CA, FL, IA, IL, MD, MN, OK, TX
2015	6	$300	CO, FL, GA, ID, PA, WI
2016	6	$0	AL, NC, TX
Total	49	$1,620,500	
Median	6	$300	
Mean	7	$33,071	

SOURCE: U.S. Fire Administration, "Download Fire Data and Data Analysis Tools," June 5, 2018, https://www.usfa.fema.gov/data/statistics/order_download_data.html.

30 years of incident reporting to PHMSA, consequential incidents involving LPG distribution systems of all sizes have been infrequent events, averaging about one incident report per year. No fatalities have been reported since 2006. Supplemental data on LPG incidents involving distribution pipelines, as reported by fire departments to NFIRS, suggest that PHMSA may not be receiving reports of some LPG incidents that do not meet thresholds for consequences or because some pipeline operators are not submitting reports. Here again, it is difficult to know how many of these incidents involve jurisdictional systems having 100 or fewer customers, but it is likely not more than 10 per year.

With so few incidents, it is difficult to identify causal patterns for incidents. The NFIRS data cannot be used to identify incident causes. The most common cause in PHMSA incident data (again, for all LPG systems) is excavation damage. This cause is consistent with information from PHMSA's leading indicators database, which shows that excavation damage is the most common cause of leaks that are reported by operators of larger LPG systems (those having 100 or more customers).

SUMMARY ASSESSMENT

When released inadvertently, LPG behaves differently than natural gas. The high relative vapor density of LPG, which makes it heavier than air, can cause it to creep along the ground or seep underground, which can lead to pooling in concentrations that are within its flammability limits, rather than disperse into the atmosphere like natural gas. Also, because it is stored as a liquid, LPG can expand to 270 times its size as it vaporizes, potentially swelling into a flammable vapor cloud that adds to the risk of handling LPG liquid during transfers, such as from delivery trucks or from one tank to another.

Despite these hazards, LPG pipeline distribution system incidents are rare. PHMSA records of federally regulated LPG distribution systems for more than the past 30 years suggest an average of less than one incident with a fatality or serious injury per year. Incidents reported by fire departments suggest this total could be as high as 10 incidents per year, but with an uncertain portion involving smaller LPG distribution systems. Because consequential incidents are rare, and because of their relatively simple construction and operation, the pipeline systems that distribute LPG are generally viewed as safe. However, the consequences of incidents can be severe.

While the incident statistics offer some insight, the available incident reporting omits basic data such as the size of the storage tank, the number of customers served on a system, and whether the system configuration is aboveground or underground. The absence of such information limits the range of inferences that can be drawn about the safety performance of these systems, especially as it pertains to the effectiveness of any specific regulatory requirements discussed in the next chapter.

Three pipeline incidents illustrate how LPG can behave and present hazards when transported. In Parkers Prairie, Minnesota, in 1991; San Juan, Puerto Rico, in 1996; and Snow Hill, Maryland, in 2002, LPG released from pipeline distribution systems migrated underground, pooled in low-lying areas, and ignited to cause explosions and fires. The number of fatalities in these two incidents was one and 33, respectively. A ruptured LPG pipeline that led to gas traveling through soil before igniting killed two people at a resort in Door County, Wisconsin, in 2006. While the specific factors contributing to these incidents differed, they each involved a lack of familiarity with LPG properties and behavior (the tendency to sink to low areas) and leaks that were undetected while the gas accumulated.

In response to the kinds of hazards demonstrated by these and other serious incidents, the federal government has regulated the safety of LPG pipeline systems for nearly 50 years. Many states also regulate their safety, and LPG-specific safety codes are developed and maintained by the National Fire Protection Association (NFPA). The content and enforcement of these

regulations and standards are discussed in the next chapter, including a discussion of concerns raised by industry about the applicability of some of the federal requirements to the smaller LPG systems given their safety performance and the coverage of the NFPA codes.

ANNEX

With the extensive presentation of data in Chapter 3, this annex provides an additional level of detail for context about the data sources and limitations.

SAFETY DATA SOURCES AND THEIR LIMITATIONS

The data in Chapter 3 provide an overview of incident frequency, types of risks, prevalence of leading indicators for safety performance such as leaks and excavation damage, and fire reporting for liquefied petroleum gas (LPG) pipeline systems. This annex further explains the basis for the qualifications that the committee has offered elsewhere in the report about the three main safety data sources previously introduced: incident data from the Pipeline and Hazardous Materials Safety Administration's (PHMSA's) Pipeline Incident Flagged Files,[28] leading indicators from operators' self-reported annual system condition reporting from PHMSA's Annual Report Data,[29] and fire incident reporting from the U.S. Fire Administration's (USFA's) National Fire Incident Reporting System (NFIRS).[30] Although these data sources contribute to an understanding of LPG pipeline safety performance, they also place limitations on the analysis in Chapter 3.

PHMSA Pipeline Incident and Leading Indicator Data

The PHMSA data for incidents and leading indicators share a few features in common. PHMSA makes both sets of data accessible through its website, which can be reviewed for varying periods of time.[31] Both types of records also use an operator identification number (OPID), which is a unique identifier assigned to pipeline operators by PHMSA, as the key record identifier for incidents and leading indicators. The two datasets are also similar in their absence of commodity-specific records for pipeline distribution systems until after 2009.[32]

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[28] Pipeline and Hazardous Materials Safety Administration, "Pipeline Incident Flagged Files."

[29] Pipeline and Hazardous Materials Safety Administration, "Gas Distribution, Gas Gathering, Gas Transmission, Hazardous Liquids, Liquefied Natural Gas (LNG), and Underground Natural Gas Storage (UNGS) Annual Report Data."

[30] U.S. Fire Administration, "About the National Fire Incident Reporting System."

[31] PHMSA provides the tabular data formatted as spreadsheet files.

[32] Tables 3-2 through 3-4 summarize LPG incidents for three time periods. These periods reflect changes in PHMSA incident reporting forms that progressed to a more granular format. The historical data consequently have limited value for comparison from one period to another. For example, the dataset for 1986–February 2004 omits fields for the type of commodity released, the volume of gas released, number of evacuees, and added details on the number of commercial or residential properties affected in an incident.

For large LPG pipeline systems (i.e., service to 100 or more customers) that submit annual system condition reporting, the use of an OPID for leading indicators obscures important details. The use of an OPID as a key record identifier means that incident and system condition reporting is connected to the operator rather than the LPG system. This feature of the datasets is problematic, especially for leading indicator data. Because one operator generally reports multiple pipeline systems under one OPID and separate reporting for each system is not required,[33] disaggregated data are unavailable to determine system-level characteristics. For instance, the reliance on OPID for annual report data on leading indicators results in aggregation of all systems operated by an LPG operator, so that the record could note thousands of feet of LPG pipeline when each system may only consist of a few hundred feet. Aggregated data also conceal the number of service lines per system, which would otherwise be useful as an approximation for the number of customers per system. Reporting by OPID is less of an issue for incidents because each record describes a specific event and includes information on the incident location.

Another challenge entails the availability of commodity-specific records. PHMSA began recording incidents by the type of commodity involved in 2010, while system condition reporting used for leading indicators became available for LPG in 2015. For incident data on jurisdictional LPG pipeline systems prior to 2010, the dataset lacks a formal marker to identify the type of gas involved in an incident. The committee overcame this issue by reviewing incidents that include LPG-related terms in the "narrative" field of the data.[34] A line-by-line review of the narrative description for each record in the pre-2010 incident dataset yielded the tabulated results in Tables 3-2 and 3-3. Even when applying a filter for these terms, numerous incidents fell beyond the scope of the study. For instance, incident reporting for the period from March 2004 through 2009 was sufficient to determine that seven of the 13 incidents are relevant, while the rest involve propane accessories, such as a propane-fueled turkey fryer.

Importantly, across all reporting periods, when an incident is reported to PHMSA, the record does not reflect certain details relevant to LPG systems, such as the number of customers, size of the storage tanks, or aggregate tank volume.

Leading indicator data began to indicate the type of gas transported by a pipeline system in 2015. However, anomalies appeared in the LPG pipeline system data in that first year. For example, operators reported 44.7 miles of LPG mains with an unknown decade of construction in 2015;

[33] Piyali Talukdar, "Cost-Benefit Analysis at the Office of Pipeline Safety" (August 24, 2017), 17, http://onlinepubs.trb.org/onlinepubs/Propane/Talukdar82417.pdf.

[34] Search terms included "propane," "butane," "LP [gas]," and "LPG."

the equivalent figure for 2016 was 7.9 miles. Likewise, for service lines, 2,057 service lines of unknown decade of construction were reported in 2015, which was followed by 614 service lines reported in 2016. Although it may be reasonable to expect an adjustment period for newly collected information that is self-reported by operators, the reporting irregularities and short timeframe for the collected data warranted caution. Therefore, the committee refrained from drawing many strong conclusions from the leading indicators data.

In addition to the two data sources noted above, the committee sought additional perspectives on LPG pipeline distribution systems. Consultations with the LPG industry yielded extensive information from subject-matter experts for review by the committee. However, the committee was unable to obtain quantitative or statistically meaningful data to analyze that are particular to small LPG systems (i.e., those with fewer than 100 customers). An industry representative indicated that the National Propane Gas Association does not maintain its own incident data on jurisdictional or non-jurisdictional systems. The committee also contacted insurers of LPG operators. Nonetheless, specific information on loss experience or even broad measures of safety were not available from the insurance industry.

Because of the lack of supplemental data on incidents and the committee's interest in ascertaining whether LPG pipeline system incidents may be underreported in the PHMSA database, the committee chose to seek more information on incident rates. The committee's attention turned to incident reporting by firefighters because of the potential flammability of LPG during an uncontrolled release.

NFIRS

The committee reviewed the data available from NFIRS to confirm whether LPG pipeline distribution system incidents were occurring without being reported to PHMSA. However, because NFIRS records no distinction on the size or configuration of an LPG pipeline system, the committee believes that an expansive search query for LPG system incidents would capture too many incidents that would likely fall outside of the study charge (i.e., whether a system is jurisdictional and its size). The narrow focus of the approach used in the search query to explore the NFIRS records prevents the inclusion of extraneous results, such as incidents involving small LPG cylinders used for outdoor gas grills and forklifts. However, the approach used also leaves open the possibility that some number of LPG pipeline system incidents are not included in the statistics in this report. Therefore, the information in Table 3-5 comprises a conservative estimate of LPG pipeline system fire incidents. Moreover, the NFIRS database was queried so as to draw only on data that belong to the set of mandatory reporting fields.

The analysis of NFIRS to establish a count of LPG fires uses the code for "LPG" found in the data field for the type of material contributing most to the spread of the fire coupled with the code for "pipeline distribution system" in the data field for the specific use of the property at an incident site. Selection for these data fields is based on the characteristics used for identifying LPG pipeline distribution systems and on their status as mandatory reporting fields for firefighters when filing reports to NFIRS.[35] By contrast, data fields such as factors that contributed to the growth, spread, or suppression of the fire; on-site materials or products; and stored material are not required items and could introduce uncertainty into the analysis because of inconsistent reporting. Other nonmandatory data fields were considered for the analysis, but were also set aside because, for instance, the item first ignited is vulnerable to confusion because the data field includes four codes that appear nearly identical. By not selecting nonmandatory data fields and avoiding codes that could be easily confused by those submitting incident reports, it is thus possible that more LPG incidents occurred from 2010 to 2016 than are captured in the narrow, though more reliable, criteria used in this analysis.

To potentially supplement PHMSA's leading indicator data, the committee considered pipeline leak data also accessible from NFIRS. However, the relevant code for this data field references an indicator that includes leaks of both natural gas and LPG from distribution pipelines; no method to isolate LPG from natural gas leaks was found.

As noted earlier in Chapter 3, NFIRS incident data represent a subset of all fire incidents. Not only is it probable that the raw data count of 49 LPG fire incidents that occurred from 2010 to 2016 would be scaled up to 65 fires using a standard national estimates technique,[36] inclusion of even more incidents may be possible with refinements to an analysis of NFIRS. Therefore, the committee believes that inclusion of the NFIRS data is reasonable when considering LPG pipeline system incidents, though it is unknown how many of these incidents involve jurisdictional LPG systems.

[35] U.S. Fire Administration, "National Fire Incident Reporting System: Complete Reference Guide," January 2015, A1–A17, https://www.usfa.fema.gov/downloads/pdf/nfirs/NFIRS_Complete_Reference_Guide_2015.pdf. The NFIRS "Complete Reference Guide" includes a sample of its reporting form showing which fields are mandatory.

[36] U.S. Fire Administration, "Review and Assessment of Data Quality in the National Fire Incident Reporting System," 10–11.

4

Safety Regulation and Its Applicability to Small LPG Distribution Systems

This chapter reviews the safety regulatory framework for liquefied petroleum gas (LPG) pipeline distribution systems; the number, location, and size of the systems subject to the regulation; and the concerns raised by the LPG industry about the applicability, safety benefits, and compliance burden of federal regulations imposed on LPG systems serving 100 or fewer customers.

The chapter begins with an overview of the state and local governments' role in administering and enforcing pipeline safety regulations that apply to LPG systems. Although primary regulatory authority rests with the federal government acting through the U.S. Department of Transportation's Pipeline and Hazardous Materials Safety Administration (PHMSA), most states take the lead in regulatory enforcement and can impose their own supplemental safety regulations. The results of a questionnaire circulated by the National Association of Pipeline Safety Representatives (NAPSR) to state pipeline safety regulators are summarized to estimate the number of LPG systems of various sizes that are under federal safety jurisdiction (and thus considered "jurisdictional") and how states identify them for oversight and enforcement in interpretation of federal jurisdictional criteria.

The chapter next considers the structure and coverage of the body of pipeline safety regulations that apply to small jurisdictional LPG pipeline systems, the main component of which are safety codes developed by the National Fire Protection Association (NFPA) and incorporated by reference in federal, state, and local regulations. Instances where the federal regulations supplement the NFPA codes are identified, and the LPG industry's concerns about the value and applicability of the federal requirements to

small jurisdictional systems are considered. The chapter concludes with a summary assessment of the issues raised by industry in light of what is known about these small pipeline systems and the safety benefits of the federal regulatory requirements in question.

STATE AND LOCAL ROLES IN REGULATING AND ENFORCING LPG PIPELINE SAFETY REGULATIONS

The United States has approximately 2.2 million miles of gas distribution pipelines, including those in LPG pipeline systems.[1] The federal government develops and enforces the safety standards that must be applied as a minimum by the operators of pipeline systems. In the case of pipelines that do not cross state boundaries, as typical of LPG distribution systems, state governments are allowed to regulate them as intrastate pipelines contingent on certification from PHMSA.[2] However, states may not establish regulations that would result in a lesser safety benefit than the federal requirements or that conflict with them. States may adopt more stringent safety requirements. In addition, local governments may have a role in regulating the siting and installation of LPG facilities.

PHMSA treats state governments as partners in the enforcement of the federal pipeline safety regulations that apply to LPG and other gas distribution systems. Nearly all states participate in the PHMSA certification program that underpins these partnerships. Certified partner states conduct inspections for more than 96 percent of the 2.2 million miles of all intrastate gas distribution systems.[3] Three states, Florida, Hawaii, and Wisconsin, have not entered into agreements with PHMSA to take safety jurisdiction of LPG systems, which means that federal personnel must conduct LPG inspections and other enforcement activity.

PHMSA provides funding support to cover up to 80 percent of the cost of partner state enforcement activity.[4] In addition, PHMSA supports training programs for state regulators at its Training and Qualifications Center in Oklahoma City. The agency also develops and updates guidance manuals for federal and state officials to use in enforcing pipeline safety

[1] Pipeline and Hazardous Materials Safety Administration, "Gas Distribution, Gas Gathering, Gas Transmission, Hazardous Liquids, Liquefied Natural Gas (LNG), and Underground Natural Gas Storage (UNGS) Annual Report Data," accessed March 23, 2018, https://www.phmsa.dot.gov/data-and-statistics/pipeline/gas-distribution-gas-gathering-gas-transmission-hazardous-liquids.

[2] "Chapter 601—Safety," 49 U.S.C. §§ 60105–60106, accessed January 26, 2018, https://www.gpo.gov/fdsys/pkg/USCODE-2015-title49/html/USCODE-2015-title49-subtitleVIII-chap601.htm.

[3] National Association of Pipeline Safety Representatives, "About NAPSR," accessed June 28, 2018, http://napsr.org/about-napsr.html.

[4] Pipeline and Hazardous Materials Safety Administration, "State Oversight," accessed January 26, 2018, https://www.phmsa.dot.gov/working-phmsa/state-programs/state-oversight.

requirements. This support and guidance is intended in part to bring about a more consistent level of regulatory understanding and enforcement across states. Nevertheless, states will have an interest in mitigating certain hazards that arise in the context of their particular circumstances and conditions. For example, state regulators may inspect a system and its compliance with regulatory requirements with a specific set of hazards in mind, such as extreme temperature fluctuations affecting system pressure levels, snow loads impinging on meters, and coastal air contributing to atmospheric corrosion. As discussed next, the variability in state pipeline safety interests and enforcement emphasis can lead to variability in the treatment of small jurisdictional LPG systems.

JURISDICTIONAL LPG PIPELINE SYSTEMS BY STATE

In the Code of Federal Regulations (CFR) Title 49, Part 192, Transportation of Natural and Other Gas by Pipeline (hereafter, "Part 192") and its implementation guidance, PHMSA defines terms relevant to LPG distribution systems. An LPG "system" "normally consists of a tank storing petroleum gas in liquid form and the appurtenant pipelines and other facilities used by the operator of the system to deliver gas to one or more customers."[5] According to 49 CFR § 192.1(b)(5), an LPG system is not "'jurisdictional'—and thus not subject to federal regulations—if it transports gas to (i) fewer than 10 customers, if no portion of the system is located in a public place, or (ii) a single customer, if the system is located entirely on the customer's premises (no matter if a portion of the system is located in a public place)."

The regulatory definition is thus clear in indicating that a system that serves 10 or more customers is jurisdictional and subject to federal regulation. Even if that system resides entirely on the premises of the 10 customers, it is jurisdictional. The definition is also quite clear in stating that an LPG system is not jurisdictional—and thus exempt from federal regulation—when it involves a single customer as long as the system is located entirely on the customer's premises.

The interpretation of the regulatory definition of a jurisdictional system can become more ambiguous when the system involves two to nine users and is located wholly or partially in a "public place." A system with as few as two users becomes jurisdictional if a portion of that system is located in a public place. The source of this ambiguity is that Part 192 regulations do not define what constitutes a public place. In its *Guidance Manual for Operators of LP Gas Systems*, PHMSA states that a public place is

[5] Pipeline and Hazardous Materials Safety Administration, "Interpretation Response #PI-76-041," July 28, 1976, https://www.phmsa.dot.gov/regulations/title49/interp/PI-76-041.

> a place that is generally open to all persons in a community as opposed to being restricted to specific persons. Examples of public places include churches, schools, and commercial buildings, as well as any publicly owned right-of-way or property frequented by a person.[6]

In trying to determine how many LPG systems are jurisdictional, the committee learned that PHMSA's regulatory definition and guidance leave considerable room for interpretation. Appendix B contains examples of interpretation letters from PHMSA responding to operators regarding the definition of a public place. Although PHMSA's responses in the interpretation letters show consistency at the federal level, the committee observed differences among the states that may be attributed to the interpretation of public place, as discussed in the following review of the NAPSR questionnaire results.

Because PHMSA does not have a count of the number systems that qualify as jurisdictional, the committee sought this information from industry and from state pipeline safety regulators. In querying the National Propane Gas Association (NPGA), the committee was able to obtain some general estimates of the number of LPG jurisdictional systems. NPGA estimates that about half of the 2,300 LPG suppliers (or 1,150) operate jurisdictional systems, on average about five systems each. This would imply approximately 5,750 systems nationally. NPGA further estimates that only about 5 percent of these systems (~300) have more than 100 customers and 75 percent (~4,300) have fewer than 50 customers. These numbers suggest there are about 1,150 systems with 50 to 99 customers.

To supplement the NPGA estimates of small LPG systems and identify those that are subject to federal regulation, the committee asked NAPSR, whose members are state pipeline safety managers, to poll its membership on the number of jurisdictional systems by size (i.e., number of customers). The questionnaire administered by NAPSR is shown in Appendix A. The results, which are summarized next, suggest that the term "public place" is being interpreted differently from state to state. If true, the results imply that the federal regulations are not being applied uniformly to LPG systems having the same characteristics because all but three states have primary responsibility for enforcing the Part 192 requirements.

[6] Pipeline and Hazardous Materials Safety Administration, "Guidance Manual for Operators of LP Gas Systems," viii, accessed August 23, 2018, https://www.phmsa.dot.gov/sites/phmsa.dot.gov/files/docs/training/pipeline/56031/revised-guidance-operators-small-lp-gas-systems-april-2017.pdf.

NAPSR Questionnaire Results

State pipeline safety managers were asked by NAPSR to estimate the total number of LPG jurisdictional systems in the state, including the number serving 100 or more customers, 50 to 99 customers, 10 to 49 customers, and fewer than 10 customers. NAPSR sent the questionnaire to 50 states, the District of Columbia, and Puerto Rico. Pipeline safety managers in 49 states and Puerto Rico reported 3,784 jurisdictional systems of varying sizes. The reported jurisdictional systems are concentrated in 34 states; 16 respondent states declared no jurisdictional systems.[7] Of the 34 states, 28 of those reported jurisdictional systems by four system sizes according to customers served. The system counts from the 28 states—totaling 3,305 systems—are shown in Table 4-1.

An unanticipated result from the questionnaire was the degree of variability among states in the share of their jurisdictional LPG systems having fewer than 10 customers (i.e., systems serving two to nine customers and located in a public place). As presented in Table 4-2, some states reported having large numbers of these very small systems (e.g., Connecticut, Maine, New Hampshire, and Vermont). Yet, other states reported having few—sometimes zero—of the very small jurisdictional systems despite having many larger jurisdictional systems (e.g., California, Delaware, Pennsylvania, and Utah).

This result may be explained in part by state-to-state variability in the use of LPG and in the types of systems installed by users. New England, for instance, has long had limited access to natural gas distribution systems. In the New England states, LPG is a common fuel type, used widely in non-rural areas where there may be a higher likelihood that systems will cross public places. Still, the variability among states in the reported number of jurisdictional systems and in the number of very small systems relative to larger systems raises questions about how states are interpreting PHMSA's definition of a "jurisdictional" system.[8] Indeed, the results of the NAPSR questionnaire suggest that some states are applying a more inclusive definition of public place, while others are treating all LPG systems with fewer than 10 customers as non-jurisdictional or interpreting public place so narrowly that few small systems qualify as jurisdictional.

[7] Puerto Rico is counted among the states reporting jurisdictional LPG systems. Alaska and the District of Columbia did not respond.

[8] An LPG industry representative who briefed the committee raised concern that the Part 192 regulatory language contributes to the variability in interpretation; for example, by pointing to instances where the definition of a service line in the federal regulations can cause a state to regulate a system that is used by a single business as if it is jurisdictional because the system has piping to gas fireplaces in multiple rooms (i.e., rented guest rooms). Kim LaPierre and John Minchew, "Small LP Gas Jurisdictional Systems" (Meeting 2, Irvine, California, August 24, 2017), http://onlinepubs.trb.org/onlinepubs/Propane/LapierreMinchew82417.pdf.

TABLE 4-1 Number of Jurisdictional LPG Pipeline Distribution Systems of Different Size, Reported by 28 States That Provided Size Information, 2017

System Size, Customers Served	Systems	Percentage of Total Systems Reported
Fewer than 10	1,672	49
10 to 49	1,239	37
50 to 99	206	6
100 or more	188	8
Total	3,305	100

SOURCE: National Association of Pipeline Safety Representatives, "Questionnaire to State Pipeline Safety Program Managers on the Regulation of Liquefied Petroleum Gas Distribution Systems," January 2018.

Another possible explanation for the results in Table 4-2 is that some states are not trying, or are finding it difficult, to identify certain jurisdictional systems, particularly the very small ones with two to nine customers. It is plausible that even if all states employed the same definition of a public place, they might not share the same capacity to identify and oversee the systems meeting this definition. It is also plausible that individual states differ in their view about the risk presented by these small distribution systems, and thus in the priority they give to identifying and overseeing them.

Table 4-3 provides additional detail on the 28 states reporting LPG jurisdictional system by size. More than 90 percent of the very small LPG jurisdictional systems that were reported are from just four New England states—Connecticut, Maine, New Hampshire, and Vermont. In addition, these four states reported more than 35 percent of the jurisdictional systems having 10 to 99 customers (see Table 4-3). Collectively, the four states account for 67 percent of the systems reported by the 28 states. Notably, however, the largest number of jurisdictional systems with 100 or more customers are outside New England. California, Delaware, and Texas reported nearly 70 percent of these systems. By comparison, these large jurisdictional systems are virtually nonexistent in New England.

The committee suspects the reporting patterns were caused by a combination of factors, including geographic differences in system types, state-by-state variability in the definition and treatment of jurisdictional systems, differences in the completeness and accuracy of the questionnaire responses, and questionnaire instructions that may have been unclear. The variability in the interpretation of the definition and treatment of jurisdictional systems could explain reporting patterns in the Midwest, Rocky Mountain, and

TABLE 4-2 Smallest Systems as a Percentage of Jurisdictional LPG Pipeline Distribution Systems per State, Reported by 28 States That Provided Size Information, 2017

State	Systems with 2–9 Customers	Total Systems	Systems with 2–9 Customers as Percentage of Total Systems
Arizona	0	6	0
Arkansas	0	3	0
California	69	650	11
Colorado	0	7	0
Connecticut	247	352	70
Delaware	9	102	9
Iowa	0	2	0
Maine	511	623	82
Maryland	10	57	18
Massachusetts	3	11	27
Michigan	9	29	31
Minnesota	1	11	9
Montana	0	5	0
Nevada	5	15	33
New Hampshire	539	832	65
New Mexico	0	6	0
New York	1	4	25
Pennsylvania	0	15	0
Puerto Rico	14	31	45
South Carolina	0	3	0
Texas	11	76	14
Utah	0	34	0
Vermont	233	357	65
Virginia	10	68	15
West Virginia	0	1	0
Wyoming	0	1	0
Total	1,672	3,305	51

SOURCE: National Association of Pipeline Safety Representatives, "Questionnaire to State Pipeline Safety Program Managers on the Regulation of Liquefied Petroleum Gas Distribution Systems."

TABLE 4-3 Number of Jurisdictional LPG Pipeline Distribution Systems per State, Reported by 28 States That Provided Size Information, by System Size, 2017

State	2–9 Customers	10–99 Customers	100 or More Customers	Total
Arizona	0	1	5	6
Arkansas	0	3	0	3
California	69	516	65	650
Colorado	0	1	6	7
Connecticut	247	105	0	352
Delaware	9	48	45	102
Iowa	0	1	1	2
Maine	511	111	1	623
Maryland	10	36	11	57
Massachusetts	3	0	8	11
Michigan	9	18	2	29
Minnesota	1	6	4	11
Montana	0	2	3	5
Nevada	5	8	2	15
New Hampshire	539	292	1	832
New Mexico	0	6	0	6
New York	1	3	0	4
North Dakota	0	0	2	2
Ohio	0	0	2	2
Pennsylvania	0	10	5	15
Puerto Rico	14	16	1	31
South Carolina	0	3	0	3
Texas	11	45	20	76
Utah	0	34	0	34
Vermont	233	123	1	357
Virginia	10	56	2	68
West Virginia	0	0	1	1
Wyoming	0	1	0	1
Total	1,672	1,445	188	3,305

SOURCE: National Association of Pipeline Safety Representatives, "Questionnaire to State Pipeline Safety Program Managers on the Regulation of Liquefied Petroleum Gas Distribution Systems."

Lower Atlantic regions where some states with larger jurisdictional systems report zero very small jurisdictional LPG systems and others report zero jurisdictional systems altogether.

The system counts from the NAPSR survey, combined with the counts derived from NPGA estimates, provide some indication of the number of LPG systems that are jurisdictional. As noted, NPGA estimated 5,750 systems nationally, including approximately 4,300 having fewer than 50 customers, 1,150 having 50 to 99 customers, and 300 having 100 or more customers (see Table 4-4). The NAPSR questionnaire reported close to 3,800 systems from 49 states and Puerto Rico, including about 2,900 having fewer than 50 customers, 200 having 50 to 99 customers, and 260 having 100 or more customers.

Although NAPSR and NPGA differ in totals and are not precise enough for many quantitative purposes, the two sources considered together suggest there are nearly 4,000, but not more than 6,000, jurisdictional LPG systems nationally. They both suggest that a large majority of jurisdictional systems—some 75 to 85 percent—have fewer than 50 customers, and that most have closer to 10 than 100 customers.

With this background on system numbers in mind—and particularly the recognition that many LPG distribution systems are very small in size—the next section takes a closer look at the regulatory requirements governing jurisdictional systems, their oversight and enforcement by states, and the claims that operators have made about the applicability of these systems, especially as they pertain to the smallest systems.

COVERAGE AND APPLICABILITY OF THE REGULATIONS

The Statement of Task calls for a review of federal, state, and local pipeline safety regulations and their applicability to LPG distribution systems serving 100 or fewer customers. As discussed previously, many states regulate the safety of LPG systems, and additionally many local jurisdictions have building and fire protection codes controlling the placement and installation of LPG tanks and piping. While the scores of state and thousands of local standards would have been impractical to examine, PHMSA officials and industry representatives noted that a common feature of both, shared with the federal Part 192 regulations, is reference to NFPA codes.[9] In this section, the report discusses the main elements of the codes, along with the Part 192 requirements that apply to LPG systems when there is no corresponding NFPA code.

[9] It merits noting that states differ in the specific edition of NFPA codes they reference. For example, Oklahoma references the 2017 edition of NFPA 58, while Arizona references the 2001 edition. See Appendix C for a listing of the states and their adopted edition of NFPA 58.

TABLE 4-4 Jurisdictional LPG Systems Reported by 49 States and Puerto Rico to NAPSR by State Pipeline Safety Program Managers and by the NPGA, 2017

	NAPSR		NPGA	
Customers Served	Systems	Percentage, Total	Systems	Percentage, Total
Fewer than 10	1,672	44	4,313[a]	75
10 to 49	1,239	33		
50 to 99	206	5	1,150	20
100 or more	263	7	287	5
Fewer than 100, potentially all sizes	404[b]	11		
Total	3,784	100	5,750	100

[a] NPGA reported this estimate for systems serving fewer than 50 customers.

[b] Six of the 34 states with jurisdictional LPG systems reported their systems as small (fewer than 100 customers) or large (100 or more customers). The table groups the 404 small systems reported by the six states as a distinct category because more granular accounting of these jurisdictional systems is unavailable. The counts from the regulators for Florida, Hawaii, and Wisconsin, which are included within the 404 systems, are estimates.

SOURCES: National Association of Pipeline Safety Representatives, "Questionnaire to State Pipeline Safety Program Managers on the Regulation of Liquefied Petroleum Gas Distribution Systems"; Michael Caldarera, Rufus Youngblood, and Lyndon Rickards, "National Propane Gas Association: Study on Propane Gas Pipeline Facilities" (Meeting 1, Washington, DC, June 8, 2017), http://onlinepubs.trb.org/onlinepubs/Propane/Caladeraetal6817.pdf. NPGA relayed its survey results verbally during the public data-gathering session.

The NFPA codes are specific to LPG and are intended to apply to all types of LPG facilities regardless of number of customers. While the Part 192 requirements exempt nearly all single-user facilities and those multi-user systems that have fewer than 10 customers and do not cross a public place, they too are intended to have broad application across system sizes. Importantly, however, Part 192 regulations are written for all gas distribution systems, not just LPG ones. In cases where there is a conflict in the two sets of requirements, the federal regulations (CFR § 192.11(c)) state that the LPG-specific NFPA codes prevail.[10] In cases where there is a Part 192 requirement but no corresponding NFPA requirement, operators must follow the more generalized Part 192 requirement.

There is no ready way to assess whether a given regulatory requirement should or should not be applied to an LPG system with 100 or fewer cus-

[10] A conflict only exists when an operator cannot comply with a requirement in NFPA 58 and 59 because it conflicts with a requirement in Part 192.

tomers. Such requirement-by-requirement assessments are complicated by the fact that LPG systems with 100 or fewer customers are not uniform in their configurations, design features, and settings. The NAPSR data suggest that a multi-user LPG system is more likely to serve a dozen customers than several dozen customers. The former system could be very simple, possibly involving a single tank and service line that are located above ground, while the latter system will almost certainly involve a buried tank or tanks with underground service lines that cannot be visually identified and inspected. However, even those LPG systems of similar size can have important differences that make a regulatory requirement more or less applicable; for instance, one 50-user system might be compact, serving a single large apartment building, while another might involve a network of service lines that connects a neighborhood of single-family homes.

By and large, the industry representatives who briefed the committee did not raise concern about the applicability of requirements in the NFPA codes. They raised concern, instead, about the desirability of the Part 192 requirements when applied to all LPG systems serving 100 or fewer customers. Additionally, they also noted that PHMSA has not updated the Part 192 reference to the NFPA codes with one of the more recent editions issued since 2004.[11] After a short discussion of the two sets of requirements, these industry claims are discussed.

NFPA Codes

NFPA is a private nonprofit organization that develops and maintains consensus standards for fire prevention and protection. In the case of its LPG codes, NFPA manages the standards development process with technical committees consisting of LPG suppliers, system installers, container and fitting manufacturers, state regulators and fire marshals, insurance underwriters, and consultants with engineering and technical expertise. The LPG codes are typically developed and updated on a 3-year schedule to reflect current technologies, engineering practices, and scientific principles following an American National Standards Institute–certified process. The NFPA codes also incorporate the latest consensus standards from other standard-setting bodies, such as the American Petroleum Institute, American Society of Civil Engineers, American Society of Mechanical Engineers, ASTM International, and Underwriters Laboratories.

[11] Regulators briefing the committee explained that PHMSA had not adopted the 2008 edition of the NFPA codes because of concern regarding revisions to the chapter on operations and maintenance that PHMSA believed would be detrimental to safety. The NFPA codes have been revised since then to address PHMSA's view. Additionally, the pace of the federal rulemaking process has been cited as a factor in updating the edition of the codes referenced in Part 192.

PHMSA has incorporated by reference the NFPA codes since 1970. According to Part 192, a jurisdictional system that transports LPG must meet the requirements of *NFPA 58, Liquified Petroleum Gas Code* (2004 edition), and *NFPA 59, Utility LP-Gas Plant Code* (2004 edition), where applicable. NFPA 58 is most relevant to LPG pipeline distribution systems, as the code contains requirements intended to ensure the safe design, installation, operation, and maintenance of systems used in LPG storage, handling, and transportation. While NFPA 59 is referenced in Part 192 and operators must comply with this code when applicable, it is intended to address safe design and operations for bulk LPG plant facilities. NFPA 59 requirements are not reviewed here because they rarely apply to LPG pipeline distribution systems serving fewer than 100 customers, which are generally supplied by cargo tank trucks from the NFPA 59–governed utility plants.[12]

The main areas of coverage in the 2004 edition of NFPA 58 are outlined in Box 4-1, including examples of the subject matter of Chapters 4 through 7 and 14 and 15, which have the most relevance to LPG pipeline distribution systems. Example requirements include specifications for safe distances between tanks and one another, buildings, adjoining properties, and sources of ignition; maximum system operating pressure downstream of the first stage regulator; pipe and tubing materials and fittings that can be used; tank filling limits relative to holding capacity; and corrosion prevention.

Part 192 Additional Requirements

Box 4-2 summarizes the major provisions of the Part 192 regulations that apply to all gas pipeline systems. The subject matter ranges from materials and design to facility construction, testing, operations, and maintenance. Many of the Part 192 provisions are also met by LPG operators through compliance with NFPA 58, including overpressure protection of the downstream components; corrosion control; component testing and approval

[12] The committee is mindful of concerns raised by industry and regulators that the demarcation between NFPA 58 and 59 poses challenges to pipeline facility operations and enforcement and believes that such issues fall within the purview of NFPA as a matter of policy and expertise. In a notable example, industry representatives and regulators raised the issue of an NFPA code requirement for relief valve testing that can result in an interruption of service to customers. Certain LPG system tanks that generally would be regulated under NFPA 58 based on storage volume as understood for several editions of the code are subject to the purview of NFPA 59 for relief valve testing every 5 years. Consequently, small systems (i.e., aggregate tank storage of 4,000 or fewer gallons) that are considered relatively simple under NFPA code must comply with an NFPA 59 requirement intended for large utility plants. Because these small systems often lack a specialized valve (see Figure 2-3) that is more likely found on a system at a utility plant, testing causes LPG liquid to be vented.

Box 4-1
***NFPA 58, Liquefied Petroleum Gas Code* (2004 Edition), Summary of Content**

Chapter 1:	**Administration**
Chapter 2:	**Referenced Publications**
Chapter 3:	**Definitions**
Chapter 4:	**General Requirements** (e.g., acceptance of equipment and systems, gas odorization, notification of installations)
Chapter 5:	**LP-Gas Equipment and Appliances** (e.g., container service pressure, container markings, appurtenance damage protection, appurtenance materials, pressure relief devices, regulators, gauging devices, piping and tubing, vaporizers)
Chapter 6:	**Installation of LP-Gas Systems** (e.g., location and separation of containers, location of transfer operations, installation of appurtenances and relief devices, regulator installation, sizing and pressure limitations of piping systems, installation of metallic and plastic piping, corrosion protection, emergency shutoff valves)
Chapter 7:	**LP Gas Liquid Transfer** (e.g., filling and emptying containers, hose inspection, venting and purging gas, container filling limits)
Chapter 8:	**Storage of Cylinders Awaiting Use, Resale, or Exchange**
Chapter 9:	**Vehicular Transportation of LP Gas**
Chapter 10:	**Buildings or Structures Housing LP Gas Distribution Facilities**
Chapter 11:	**Engine Fuel Systems**
Chapter 12:	**Refrigerated Containers**
Chapter 13:	**Marine Shipping and Receiving**
Chapter 14:	**Operations and Maintenance** (e.g., written procedures for operator actions if leaks are detected or parameters exceed normal operating limits; written procedures for maintenance, including corrosion control; maintenance and inspection recordkeeping)
Chapter 15:	**Pipe and Tubing Sizing Tables** (e.g., pipe sizing between first and second stage regulators and between second stage regulators and appliances—by pipe material type)

for the pressures in which they will operate; protection from outside force damage; and odorization of the supply product.

Table 4-5 identifies those Part 192 requirements that are not met by compliance with NFPA 58. The table, which was derived from a document developed by PHMSA,[13] lists those Part 192 requirements that do not have a corresponding NFPA 58 requirement. Some of the requirements concern facility designs, components, configurations, and conditions that are not

[13] Pipeline and Hazardous Materials Safety Administration, "Comparison of 49 CFR 192 and NFPA 58, NFPA 59," April 26, 2011.

Box 4-2
Major Provisions of Part 192 Regulations and Example Content

Subpart A—General
§§ 192.1–192.16 Scope, definitions, class locations

Subpart B—Materials
§§ 192.51–192.65 Steel pipe, plastic pipe, marking of material

Subpart C—Pipe Design
§§ 192.101–192.125 Wall thickness, yield strength, temperature rating

Subpart D—Design of Pipeline Components
§§ 192.141–192.203 Fittings, outlets, anchors, pressure limiting devices

Subpart E—Welding of Steel in Pipelines
§§ 192.221–192.245 Procedures, welder qualifications, inspections and testing

Subpart F—Joining of Materials Other Than by Welding
§§ 192.271–192.287 Iron, plastic, copper pipe, inspection

Subpart G—General Construction Requirements for Transmission Lines and Mains
§§ 192.301–192.328 Inspection of materials, installation of pipe in ditch, underground clearance, cover

Subpart H—Customer Meters, Service Regulators, and Service Lines
§§ 192.351–192.385 Location of valves, meter operating pressure, excess flow valve installation, protection from damage

Subpart I—Requirements for Corrosion Control
§§ 192.451–192.491 External corrosion control, protective coating, cathodic protection, monitoring

Subpart J—Test Requirements
§§ 192.501–192.517 Strength test requirements for steel pipeline to operate at a hoop stress of 30 percent or more of SMYS, requirements for service lines, requirements for plastic pipelines

Subpart K—Uprating
§§ 192.551–192.557 Requirements for increasing operating pressure above the previously established maximum pressure

continued

Box 4-2
Continued

Subpart L—Operations

§§ 192.601–192.631	Procedural manual for operations, maintenance, and emergencies; surveillance; damage prevention program; emergency plans; public awareness; maximum and minimum allowable operating pressure; odorization

Subpart M—Maintenance

§§ 192.701–192.755	Patrolling, leak surveys, pressure limiting and regulating stations, valve maintenance

Subpart N—Qualification of Pipeline Personnel

§§ 192.801–192.809	Qualification program and recordkeeping

Subpart O—Gas Transmission Pipeline Integrity Management

§§ 192.901–192.951

Subpart P—Gas Distribution Pipeline Integrity Management (IM)

§§ 192.1001–192.1015	Definitions (including small LPG operator), required elements of an integrity management plan, specification of the lesser requirements for an IM plan if the operator is a small LPG operator, actions to address integrity issues

relevant to LPG pipeline systems, especially small LPG systems that lack the components regulated under certain provisions, such as requirements governing compressor stations, vaults, transmission lines, control room management, and district pressure regulating stations. Others may have relevance to at least some small LPG systems, depending on system features and characteristics, such as requirements governing welding, repair of steel pipe, underground clearance, depth of cover for service lines, external corrosion control, condition surveillance, damage prevention programs, public awareness, and distribution system integrity management. A PHMSA advisory bulletin to industry provides additional guidance on the applicability of Part 192 to LPG systems.[14]

[14] Pipeline and Hazardous Materials Safety Administration, "Pipeline Safety: Reminder of Requirements for Liquefied Petroleum Gas and Utility Liquefied Petroleum Gas Pipeline Systems," 78 *Federal Register* 65427, accessed June 18, 2018, https://www.gpo.gov/fdsys/pkg/FR-2013-10-31/pdf/2013-25837.pdf.

TABLE 4-5 Federal Pipeline Safety Requirements (49 CFR Part 192) Without Corresponding Requirements in *NFPA 58*, *Liquefied Petroleum Gas Code* (2004 edition)

Subpart A—General	§ 192.307 Inspection of materials.	§ 192.613 Continuing surveillance.
§ 192.5 Class locations.	§ 192.309 Repair of steel pipe.	§ 192.614 Damage prevention program.
§ 192.16 Customer notification.	§ 192.315 Wrinkle bends in steel pipe.	§ 192.615 Emergency plans.
Subpart B—Materials	§ 192.323 Casing.	§ 192.616 Public awareness.
Subpart C—Pipe Design	§ 192.325 Underground clearance.	§ 192.617 Investigation of failures.
§ 192.111 Design factor (*F*) for steel pipe.	§ 192.328 Additional construction requirements for steel pipe using alternative maximum allowable operating pressure.	§ 192.620 Alternative maximum allowable operating pressure for certain steel pipelines.
§ 192.112 Additional design requirements for steel pipe using alternative maximum allowable operating pressure.	**Subpart H—Customer Meters, Service Regulators, and Service Lines**	§ 192.623 Maximum and minimum allowable operating pressure; Low-pressure distribution systems.
§ 192.113 Longitudinal joint factor (*E*) for steel pipe.	§ 192.363 Service lines: Valve requirements.	§ 192.627 Tapping pipelines under pressure.
§ 192.115 Temperature derating factor (*T*) for steel pipe.	§ 192.365 Service lines: Location of valves.	§ 192.629 Purging of pipelines. (2)
Subpart D—Design of Pipeline Components	§ 192.377 Service lines: Copper.	§ 192.631 Control room management.
§ 192.144 Qualifying metallic components.	§ 192.379 New service lines not in use.	**Subpart M—Maintenance**
§ 192.150 Passage of internal inspection devices.	§ 192.381 Service lines: Excess flow valve performance standards.	§ 192.703 General.
§ 192.151 Tapping.	**Subpart I—Requirements for Corrosion Control**	§ 192.705 Transmission lines: Patrolling.
§ 192.155 Welded branch connections.	§ 192.452 How does this subpart apply to converted pipelines and regulated onshore gathering lines?	§ 192.706 Transmission lines: Leakage surveys.

continued

TABLE 4-5 Continued

§ 192.157 Extruded outlets.	§ 192.453 General. (1)	§ 192.707 Line markers for mains and transmission lines.
§ 192.165 Compressor stations: Liquid removal. (1)	§ 192.459 External corrosion control: Examination of buried pipeline when exposed.	§ 192.709 Transmission lines: Record keeping. (1)
§ 192.167 Compressor stations: Emergency shutdown. (1)	§ 192.465 External corrosion control: Monitoring.	§ 192.711 Transmission lines: General requirements for repair procedures.
§ 192.169 Compressor stations: Pressure limiting devices. (1)	§ 192.469 External corrosion control: Test stations.	§ 192.713 Transmission lines: Permanent field repair of imperfections and damages.
§ 192.179 Transmission line valves.	§ 192.471 External corrosion control: Test leads.	§ 192.715 Transmission lines: Permanent field repair of welds.
§ 192.185 Vaults: Accessibility.	§ 192.473 External corrosion control: Interference currents.	§ 192.721 Distribution systems: Patrolling.
§ 192.187 Vaults: Sealing, venting, and ventilation. (1)	§ 192.475 Internal corrosion control: General.	§ 192.723 Distribution systems: Leakage surveys.
§ 192.189 Vaults: Drainage and waterproofing.	§ 192.476 Internal corrosion control: Design and construction of transmission line.	§ 192.735 Compressor stations: Storage of combustible materials. (1)
§ 192.203 Instrument, control, and sampling pipe and components.	§ 192.477 Internal corrosion control: Monitoring.	§ 192.736 Compressor stations: Gas detection. (1)
Subpart E—Welding of Steel in Pipelines	§ 192.483 Remedial measures: General.	§ 192.739 Pressure limiting and regulating stations: Inspection and testing.
§ 192.227 Qualification of welders.	§ 192.485 Remedial measures: Transmission lines.	§ 192.741 Pressure limiting and regulating stations: Telemetering or recording gauges.
§ 192.229 Limitations on welders.	§ 192.487 Remedial measures: Distribution lines other than cast iron or ductile iron lines.	§ 192.743 Pressure limiting and regulating stations: Capacity of relief devices. (2)
§ 192.231 Protection from weather.	§ 192.490 Direct assessment.	§ 192.745 Valve maintenance: Transmission lines.

§ 192.233 Miter joints.	**Subpart J—Test Requirements**	§ 192.749 Vault maintenance.
§ 192.235 Preparation for welding.	§ 192.505 Strength test requirements for steel pipeline to operate at a hoop stress of 30 percent or more of SMYS.	§ 192.753 Caulked bell and spigot joints.
§ 192.241 Inspection and test of welds.	§ 192.507 Test requirements for pipelines to operate at a hoop stress less than 30 percent of SMYS and at or above 100 psi (689 kPa) gage.	**Subpart N—Qualification of Pipeline Personnel**
§ 192.243 Nondestructive testing.	§ 192.509 Test requirements for pipelines to operate below 100 psi (689 kPa) gage.	§ 192.801 Scope. (**1**)
§ 192.245 Repair or removal of defects.	§ 192.515 Environmental protection and safety requirements.	§ 192.803 Definitions.
Subpart F—Joining of Materials Other Than by Welding	**Subpart K—Uprating**	§ 192.805 Qualification program.
§ 192.287 Plastic pipe: Inspection of joints.	**Subpart J—Operations**	§ 192.807 Recordkeeping.
Subpart G—General Construction Requirements for Transmission Lines and Mains	§ 192.603 General provisions.	§ 192.809 General.
§ 192.303 Compliance with specifications or standards.	§ 192.609 Change in class location: Required study.	**Subpart O—Gas Transmission Pipeline Integrity Management**
§ 192.305 Inspection: General. (**2**)	§ 192.611 Change in class location: Confirmation or revision of maximum allowable operating pressure.	Subpart P—Distribution Pipeline Integrity Management (IM)

NOTES: Part 192 requirements listed have no corresponding requirement in NFPA 58. Those marked with the numeral one (1) indicate that NFPA 58 does not specifically address the Part 192 requirement. Those marked with the numeral two (2) indicate that NFPA 58 has a corresponding requirement for containers but not pipelines.

SOURCE: Gary McDonald, "Comparison of 49 CFR 192 and NFPA 58, NFPA 59" (Pipeline and Hazardous Materials Safety Administration, 2011), https://www8.nationalacademies.org/pa/projectview.aspx?key=49873.

Presented with this large list of additional Part 192 requirements and lacking all but the most basic information about LPG systems with 100 or fewer customers, the committee was not in a position to assess each requirement individually for applicability. Accordingly, the committee asked LPG industry representatives to provide their views on the Part 192 requirements, including their reasoning for wanting some or all the requirements to be eliminated or eased for systems having 100 or fewer customers. Their response is summarized next.

LPG Industry Concerns About the Applicability of Part 192

As detailed in the Preface, several LPG industry representatives briefed the committee, including officials from NPGA. As noted previously, they raised concern about states applying a varied, and sometimes overly inclusive, interpretation of a public place for determining whether a small LPG system is jurisdictional. They claimed that state-to-state variability in the regulatory treatment of systems creates compliance uncertainty and costs, especially for multi-state operators who must prepare for varied state interpretations.

In addition to this general concern about the treatment of small jurisdictional LPG systems, the industry representatives gave the following examples of prescriptive requirements in Part 192 that they believe are not sensible or add no value to the LPG-specific NFPA requirements:

- Use 50 pounds per square inch gage (psig) as the construction test pressure for plastic piping, which is 20 psig higher than the operating pressure for plastic pipe allowed by NFPA code.
- Use a nonflammable testing material for LPG system leaks, when standard practice has been to use propane to test for leaks.
- Perform odor testing with an instrument, as opposed to only a sniff test as required by NFPA code.

They also questioned the value of and justification for the added compliance cost of several Part 192 requirements to undertake periodic inspections and testing of small LPG pipeline systems, including requirements for

- An annual inspection of atmospheric corrosion and cathodic protection testing,
- An annual inspection of regulator devices and relief and key valves,
- An annual leak survey,
- Quarterly patrolling, and
- Quarterly odorization testing.

They claimed these inspection and testing requirements are excessive in light of common industry practices and NFPA requirements for the

- Inspection of tank and associated equipment condition that occurs during LPG delivery operations,
- Operating test and inspections for system leaks each time a new occupant moves in, and
- Odorization test at LPG transfer (from production to individual transport modes).

One LPG supplier, Suburban Propane, reported that the additional Part 192 inspection and testing requirements increase the cost of operating and maintaining a small jurisdictional LPG system by an average of $1,700 per year.[15] The committee was unable to validate this or other compliance cost information provided by industry.

In addition to these compliance costs, the industry representatives were especially concerned about the cost associated with the personnel training stipulated by Part 192 in Subpart N. They maintained that the NFPA code and most state licensing regulations already require that technicians installing, repairing, and maintaining LPG systems, as well as drivers delivering LPG, have NPGA (Certified Employee Training Program or CETP) or equivalent certification that involves written exams and skill evaluation.[16] They questioned whether the additional Part 192 training and documentation requirements, which include an Operator Qualification Plan and annual qualification of pipe joiners, are needed. Suburban Propane estimated that the average cost of initial training of a technician to meet Part 192 Subpart N is $8,000 more than the cost of CETP training.[17]

Finally, several industry representatives indicated that Part 192 contains several requirements for planning, registration, and documentation that have little applicability to small LPG systems. They questioned the need for all small LPG systems—not just those with large amounts of underground piping—to register for one-call notification systems ("call before you dig") in compliance with Part 192's damage prevention program requirements (§ 192.614). They also questioned the rationale for these small systems to be obligated to create site-specific emergency response plans, liaise with local fire departments, and provide public awareness notifications.

[15] LaPierre and Minchew, "Small LP Gas Jurisdictional Systems." The committee was not in a position to independently verify this number or other compliance costs, or to determine whether these costs were justified by the safety benefits.

[16] National Propane Gas Association, "Certified Employee Training Program (CETP)," accessed April 24, 2018, https://www.npga.org/industry/cetp-certification.

[17] LaPierre and Minchew, "Small LP Gas Jurisdictional Systems."

The Suburban Propane representatives reported that even for very small jurisdictional systems, the labor costs associated with developing and maintaining the added documentation required by Part 192 averaged about $750 per system.[18] The suppliers complained that compliance with these requirements is made more burdensome by variability in state (and sometimes individual inspector) interpretations of what constitutes a compliant plan or program. The variability requires multi-state operators to develop numerous state-specific operations and maintenance manuals, operator qualification plans, and distribution integrity management programs.

In briefing the committee, the national LPG supplier AmeriGas estimated that the average annual cost of complying with all Part 192 requirements ranges from about $4,700 to $7,700 per year per system (adding about 200 person-hours of labor), with the higher end of the range being more applicable to smaller operators that do not enjoy the scale economies of the multi-state LPG suppliers.

Enforcement Experience

Results from enforcement data published by PHMSA and reported in the NAPSR questionnaire provide some insight into the challenges that LPG system operators face in complying with the Part 192 requirements and that regulators face in enforcing compliance.

As noted previously, PHMSA conducts all enforcement of federal regulatory requirements that apply to LPG pipeline distribution systems in the states of Florida, Hawaii, and Wisconsin, because these states do not have enforcement partnerships with the federal agency. Data on PHMSA enforcement actions in these three states from 2011 through 2016 show that more than 85 percent of violations by LPG systems (of all sizes including systems with 100 or more customers) pertained to Part 192 requirements, as opposed to the NFPA code (listed as "Transportation of gas"), as shown in Table 4-6. These results may be indicative of operators finding it difficult to comply with the federal regulations, perhaps because of unfamiliarity with the requirements or uncertainty about how to comply with particular demands, such as those for planning and documentation. It is possible, however, that the results are skewed by PHMSA inspectors having more familiarity with, and enforcement interest in, the Part 192 requirements than the NFPA code. One state, Connecticut, provided the committee with detailed data on its LPG enforcement activities during the same time period (see Table 4-6). It is notable that in this state, where there are many small jurisdictional LPG systems, about half of the enforcement actions were for NFPA code violations, which does not support a conclusion that opera-

[18] LaPierre and Minchew, "Small LP Gas Jurisdictional Systems."

TABLE 4-6 PHMSA Enforcement Actions in Florida, Hawaii, and Wisconsin and in Connecticut by the State's Public Utilities Regulatory Authority, Jurisdictional LPG Pipeline Distribution Systems (all sizes), 2011–2016

	Actions by PHMSA in FL, HI, WI, Total	Actions by State Regulator, CT
Number of jurisdictional LPG systems (all sizes)	~430	352
Enforcement category		
Operation/maintenance	86	122
Corrosion control	46	26
Transportation of gas (NFPA code violation)	28	362
Operations, maintenance, and emergencies procedural manual	19	83
Public awareness	17	3
Integrity management	8	6
Operator qualification	7	27
Reporting	6	0
Damage prevention	4	19
Customer meter/service line	4	8
Joining of materials other than by welding	4	70
Design	2	0
Test requirements	2	15
Welding of steel in pipelines	1	0
Total actions	234	741

NOTES: The count of jurisdictional systems represents an estimate for Florida, Hawaii, and Wisconsin and includes small and large jurisdictional LPG pipeline distribution systems. All 352 systems in Connecticut are small systems serving fewer than 100 customers.
SOURCES: Blaine Keener, "NAS LPG Enforcement 2018-01-29.Xlsx" (Pipeline and Hazardous Materials Safety Administration, January 2018), https://www8.nationalacademies.org/pa/projectview.aspx?key=49873; Bruce Benson, "Connecticut PURA Enforcement Data 20180316.Xlsx" (Connecticut Public Utilities Regulatory Authority, March 2018), https://www8.nationalacademies.org/pa/projectview.aspx?key=49873.

tors find it more challenging to comply with Part 192 than with the NFPA requirements.

Connecticut has an active pipeline safety program, devoting considerable resources to inspecting small LPG pipeline systems. In response to the NAPSR questionnaire, the state reported that it spends about $200,000, or approximately 20 percent of staff time resources, per year enforcing fed-

eral and state regulations applicable to LPG systems. Only one other state, Maine, reported expenditures of this magnitude (~$150,000 per year). Because of the variability in state responses to the NAPSR questionnaire, and to the expenditure-related questions in particular, it is difficult to know how costly and challenging the LPG regulations are to enforce at the state level. Those challenges and costs, of course, are important to know when assessing the benefits and costs of regulations. Inasmuch as the NAPSR questionnaire results discussed earlier suggest that many states do not have a good inventory of their small LPG systems, it is reasonable to conclude that enforcement of both NFPA and Part 192 requirements are spotty for these systems. If regulatory enforcement is indeed spotty—or concentrated in a few states or regions—this raises questions about the practical extent to which small LPG operators are burdened by regulatory compliance.

SUMMARY ASSESSMENT

For several reasons, the committee is not in a position to assess the validity of all of the LPG industry's claims regarding the Part 192 regulations as they apply to small LPG pipeline distribution systems. One reason is that these systems, even though they serve many fewer customers when compared to natural gas systems, are not monolithic, and thus a Part 192 requirement that has limited applicability and safety relevance to the circumstances and configuration of one system may have greater applicability and relevance to another system. There is a paucity of the most basic data on the number of small jurisdictional LPG systems by size, much less the kinds of data needed to profile systems according to characteristics relevant to the risks that individual Part 192 or NFPA 58 requirements are intended to address.

For instance, in its review of the experience of enforcement agencies, the committee observed that responses to the NAPSR questionnaire resist meaningful analysis. Other than the count of LPG systems, the responses include potentially relevant though limited information related to the enforcement experience of state regulators. That is, the responses lack consistency in the use of terminology and specificity in referencing regulatory requirements. To illustrate the disparities among regulators' responses, consider the first question in the NAPSR questionnaire (see Appendix A) that asks, "What are the most common regulatory violations found in inspections of LPG pipeline systems serving 99 or fewer customers?" Responses range from some specific citations of Part 192 requirements and mention of storage tank placement and protection that connote sections, rather than specific requirements, in the NFPA 58 code to "violations are wide spread," "a general lack of understanding of the regulations and how to implement them on a system," and "leak repair issues." That range of language prevents reliable examination of the association between re-

quirements in Part 192 or NFPA 58 and safety benefits even if a chain of causation between violations and incident causes were established. However, with third-party excavation damage and unknown causes comprising the majority of incident causes (see Figure 3-1), there appears to be weak or indeterminate correlation between the operators' operation and maintenance of LPG systems and safety performance.

Another reason is that the committee cannot validate the compliance cost information provided by industry, how widespread these compliance costs are, and whether the costs are reasonable in proportion to the safety benefits of compliance. The data provided by state regulatory agencies suggest wide variability in state enforcement activity and presumably wide variability in the demands placed on operators to comply with Part 192 requirements. Some of the reported costs are difficult to put in context; for instance, it was reported that training of personnel according to Part 192 requirements costs $8,000 per technician beyond the cost required to meet NFPA training requirements. Without knowing how much this added training contributes to the ability of operator personnel to prevent and effectively respond to a safety incident, it is difficult to know whether this is a reasonable or unjustifiably large figure.

Some of the Part 192 requirements that were identified as problematic by industry may be valid, at least with respect to smaller LPG systems, such as those closer to 10 customers than 100. These include annual leak surveys and testing regimes. However, it is not possible to determine whether the Part 192 requirements deemed problematic by the industry are not justified without knowing more about the condition and characteristics of the systems affected. Conversely, some of the industry claims of inapplicability would appear to have questionable validity. For example, a Part 192 regulation cited as problematic is the requirement for operators to register their systems with one-call notification programs (§ 192.614), a requirement intended to prevent excavation damage. As reported in Chapter 3, excavation damage is a leading cause of hazardous leaks in gas mains and service lines (accounting for around 80 percent). While these data are derived from LPG systems that serve 100 or more customers, they are indicative of the risks of outside force damage to underground gas installations. Given the experience with excavation risks, it is difficult to see how a requirement that compels an operator of a buried gas tank and lines to register with a one-call system could be viewed as unreasonable or extraordinary.

Industry representatives cited several Part 192 regulations that require the development and documentation of plans and programs that can be costly to develop and susceptible to the varied interpretations of state regulators responsible for enforcement. The challenge that both small firms and state regulators face in complying with and enforcing regulations that require such management-based plans and programs were well documented

in a recent National Academies of Sciences, Engineering, and Medicine report.[19] While requirements for management systems are often flexible in the sense that they give regulated firms the ability to customize their programs in accordance with their circumstances, they can present implementation challenges for operators with limited technical expertise and can be difficult for regulators to assess consistently.

The requirement that gas pipeline distribution systems implement distribution integrity management programs (DIMPs) is an example of a management-based rule, and one that was cited by LPG operators as problematic for small systems. When extending the DIMP requirement to LPG systems, PHMSA reasoned that because LPG presents unique hazards (heavier than air and will not disperse as readily as natural gas), operators should be expected to put in place more systematic means for identifying and managing risks than the NFPA requires. However, PHMSA recognized that operators of very small systems might not have the resources and technical expertise to comply with the requirements. Accordingly, PHMSA defined a "small LPG operator" as an operator of a system having fewer than 100 customers from a single source[20] and decided that such operators should be subject to more streamlined DIMP requirements, as discussed in Box 4-3.

Some of the issues and concerns that surrounded the debate about the DIMP rule's applicability to small LPG operators are noted in Box 4-4. This particular debate is illustrative of the difficulty the committee faced in assessing the validity of claims made by industry about the inapplicability and burden of some Part 192 requirements. During the decade since DIMP's issuance, efforts have been made by PHMSA, industry, and states to accommodate smaller systems by providing program templates, model plans, and other guidance tailored for small systems.[21] Still, it is possible that despite this guidance and assistance, the Part 192 DIMP requirement may have limited safety benefits, be burdensome to some operators of small LPG systems, and be unevenly enforced by states. To assess this possibility, however, would have required a thorough review of this specific requirement, which was not possible based on the data available to the committee.

Some of the information that the industry provided for analysis in this

[19] *Designing Safety Regulations for High-Hazard Industries* (Washington, DC: The National Academies Press, 2018). https://www.nap.edu/catalog/24907.

[20] Existing regulations have already included this criterion to differentiate between large and small LPG operators in provisions exempting the latter from filing annual condition reports.

[21] Pipeline and Hazardous Materials Safety Administration, "Guidance Manual for Operators of LP Gas Systems"; Pipeline and Hazardous Materials Safety Administration, "Distribution Integrity Management: Guidance for Master Meter and Small Liquefied Petroleum Gas Pipeline Operators," November 2009, https://primis.phmsa.dot.gov/dimp/docs/GuidanceForMasterMeterAndSmallLiquefiedPetroleumGasPipelineOperators_11_09.pdf. These two manuals are examples of guidance tailored for operators of small LPG systems.

Box 4-3
Distribution Integrity Management Program

A DIMP, which is required for gas pipeline distribution systems by Part 192 Subpart P, is intended to ensure the safe performance of a pipeline system through identification of system integrity threats and the development and execution of methods to prevent or mitigate them. Although DIMP requirements are intended to be flexible to allow for customization, a compliant program should include the following seven components that are demonstrated in a written plan with documentation submitted annually to PHMSA:

- Knowledge of system infrastructure (e.g., location, configuration, size of system);
- Identification of threats (e.g., corrosion, excavation damage, other outside force damage);
- Evaluation and prioritization of risk in descending order of likelihood (e.g., excavation damage, corrosion, natural forces);
- Identification and implementation of measures to mitigate risks (e.g., general system monitoring, corrosion protection, one-call notification system);
- Performance measurement (e.g., recording the number of hazardous leaks eliminated or repaired and excavation damage);
- Periodic evaluation and improvement (e.g., revise the identified threats as circumstances change and update mitigation measures accordingly); and
- Reporting of performance measures to PHMSA.

However, as with the Part 192 requirement for annual reporting on system condition (§ 191.11), the DIMP requirement applies differently to smaller LPG pipeline systems. An operator of an LPG system with fewer than 100 customers is required to follow a streamlined version of the DIMP requirements intended to reflect the relative simplicity of the systems. These systems are exempt from having to report performance measures to PHMSA and are subject to less stringent planning and documentation requirements. For example, the regulation (§ 192.1015) stipulates that program documentation should be sufficiently descriptive of the operator's integrity management processes to ensure consistent implementation by operator personnel.[a] PHMSA's implementation guidance to operators and state regulators advises that an operator may provide a written explanation of the processes used to develop and implement each program component, as opposed to the more detailed documentation of program plans and procedures as required for larger LPG systems and natural gas distribution systems.[b]

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[a] Pipeline and Hazardous Materials Safety Administration, "Gas Distribution Pipeline Integrity Management Enforcement Guidance: 49 CFR Part 192–Subpart P," December 7, 2015, 49, https://www.phmsa.dot.gov/sites/phmsa.dot.gov/files/docs/DIMP_Enforcement_Guidance_12_7_2015.pdf.

[b] Pipeline and Hazardous Materials Safety Administration, 49; Pipeline and Hazardous Materials Safety Administration, "Guidance Manual for Operators of LP Gas Systems," April 2017, Appendix 2.3, https://www.phmsa.dot.gov/sites/phmsa.dot.gov/files/docs/training/pipeline/56031/revised-guidance-operators-small-lp-gas-systems-april-2017.pdf.

Box 4-4
Issues Arising in the Debate About Extending DIMP Requirements to Operators of Small LPG Systems

In issuing the DIMP rule in 2009,[a] PHMSA gave its reasoning for extending the requirement to LPG distribution systems. Comments to the rulemaking raised a number of concerns about the applicability of an integrity management rule to small LPG operators. NPGA argued that such operators should be fully exempt from the rule because there would be no benefit from compliance. The industry association claimed that small operators are already sufficiently regulated through the requirements of NFPA 58 and noted that the total quantity of gas that could be released in an accident is limited by the capacity of the tanks, a limitation not shared with natural gas systems.

Conversely, the Connecticut Department of Public Utility Control, the Pennsylvania Public Utility Commission, and NAPSR commented that small LPG operators should not be treated differently. They questioned whether enough is known about these small systems and the risk they pose and maintained that simpler systems would inherently have simpler programs that would not demand substantial resources and technical expertise.

Other commenters—including the Missouri, New Hampshire, and New Mexico state regulators—were supportive of more limited integrity management requirements for small LPG operators. The Arizona Corporation Commission commented that the rule should be prescriptive and simple for small LPG operators because their operators would be overwhelmed by the requirement, potentially leading to noncompliance. The Iowa state regulator argued that a requirement that compels these operators to at least evaluate and prioritize their risk should not be particularly burdensome.

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[a] Pipeline and Hazardous Materials Safety Administration, "Pipeline Safety: Integrity Management Program for Gas Distribution Pipelines," 74 *Federal Register* 63906 (2009), https://www.regulations.gov/document?D=PHMSA-RSPA-2004-19854-0258.

chapter raises questions about the safety benefits conferred by Part 192 requirements when applied to small LPG jurisdictional systems, especially the smallest systems that are jurisdictional but are not being identified by many states for regulatory compliance. Because these systems may be presenting safety risks that have not been documented, it is difficult to know whether more rigorous identification and enforcement is warranted or whether their coverage under Part 192 requirements should be eased. The next chapter considers an approach for making such determinations in a more systematic and informed manner.

5

Summary Review and Advice

Congress called for a study of the regulatory requirements that apply to pipeline systems used to distribute liquefied petroleum gas (LPG) to 100 or fewer customers. Congress wanted to know how these requirements, as imposed and implemented by federal, state, and local authorities, pertain to these small systems and work together to assure that appropriate and safe practices and techniques are used for facility design, installation, operation, and maintenance. Informed by this review, including any potential opportunities revealed for limiting federal regulation applicable to smaller systems without reducing safety, the study committee was asked to advise on ways to improve the application of the regulatory requirements, particularly the federal requirements, where appropriate.

The preceding chapters provide the background and analysis that informed the committee's advice, which is provided in this chapter in fulfillment of the study charge. Chapter 2 describes the basic characteristics and use of LPG distribution systems that are subject to federal safety regulation. Chapter 3 discusses the hazard characteristics of LPG and examines the safety performance of LPG pipeline systems, as indicated by incident data reported to the Pipeline and Hazardous Materials Safety Administration (PHMSA) and others. Chapter 4 describes what is known about the number, location, and size distribution of these pipeline systems and discusses concerns raised by the LPG industry about regulatory requirements that have questionable relevance to, and impose a large compliance burden on, small LPG systems. That chapter concludes with a summary assessment of the issues raised by industry that addresses what is known about these small pipeline systems and the safety effect of the federal regulatory requirements in question.

The review and assessment proved challenging because of the limited data on these small LPG systems, especially data that would allow for the assessment of specific federal regulatory requirements with regard to their safety effects and compliance burden on operators of small systems. After recapping the key points and findings from these earlier chapters, this chapter contains the committee's advice to Congress and PHMSA on ways to make more informed decisions about the regulation of small LPG pipeline systems.

KEY POINTS AND FINDINGS

Characteristics and Use of Small LPG Pipeline Systems

Having relatively few components, the basic LPG pipeline distribution system consists of a stationary aboveground or underground pressurized storage tank, two pressure regulators, service lines, and meters, which connect to one or more user's piping for uses such as cooking, drying, and space and water heating. The tank is refilled periodically by an LPG supplier using a truck dispatched from a bulk storage plant. LPG suppliers consist of many small- to medium-sized firms focused on serving a limited geographic area, as well as three large firms with operations nationwide. Generally, suppliers also act as the operators for these systems on behalf of the users, who contract for service.

LPG distribution systems comprise a small but important portion of the total U.S. energy infrastructure network. They are most prevalent in rural areas and other locations where natural gas connections are unavailable. Although approximately 12 million U.S. customers consume LPG,[1] only a fraction of those LPG customers are connected to federally regulated distribution systems. The overwhelming majority of LPG distribution systems consist of a single source of LPG supply, either as one tank or multiple tanks manifolded together, connected to a single customer; nearly all of these single-user systems are not subject to federal pipeline safety regulations.

The multi-customer systems are intended to provide a more convenient and economical alternative to supplying gas fuel using an individual storage tank housed on each customer's property. The systems serve both residential and business customers, with some serving as few as two customers and others serving hundreds. These distribution systems are small compared to other gas distribution systems. An LPG system with 500 customers would be considered very large, while natural gas systems usually measure their

[1] U.S. Energy Information Administration, "Residential Energy Consumption Survey (RECS)," accessed December 19, 2017, https://www.eia.gov/consumption/residential/data/2015/index.php?view=characteristics. This figure excludes households that use LPG only for outdoor grilling.

customers in the thousands or tens of thousands. Examples of LPG distribution system applications are tract housing subdivisions, condominiums, mobile home parks, resorts, and strip mall shopping centers.

A definitive count of small, multi-user LPG pipeline distribution systems that are subject to federal regulations is not available. Based on the results of a questionnaire administered by the National Association of Pipeline Safety Representatives (NAPSR) and information provided by representatives of the LPG industry, it would appear that there are between 3,800 and 5,800 multi-user systems, most serving fewer than 50 customers and likely to have a number of customers closer to 10 than 100.

LPG Hazard Characteristics and System Safety Performance

When released inadvertently, LPG (be it propane, propylene, butane, or isobutane) behaves differently than natural gas. The higher relative vapor density of LPG, which makes it heavier than air, can cause it to creep along the ground or migrate underground. This can lead to pooling in concentrations that are within LPG's flammability limits rather than dispersing into the atmosphere like natural gas, which is lighter than air. Also, because it is stored as a liquid, LPG can expand to 270 times its size as it vaporizes, potentially swelling into a flammable vapor cloud that adds to the risk of handling LPG liquid during transfers, such as from delivery trucks or from one tank to another. Nevertheless, LPG pipeline distribution system incidents are rare. PHMSA records of federally regulated LPG distribution systems for more than the past 30 years suggest an average of less than one incident involving a fatality or serious injury per year. Incidents reported by operators to PHMSA from 2010 through 2017 include 10 incidents, seven injuries, and approximately $2 million in property damage. No fatalities have been reported since 2006. Incorporating fire events from the National Fire Incident Reporting System with the PHMSA incident data suggests that the number of incidents involving LPG distribution systems averages in the single digits per year.

Because serious incidents involving them are rare, and because of their relatively simple construction and operation, the pipeline systems that distribute LPG are generally viewed as safe. However, the consequences of incidents can be severe. Four incidents involving multi-user pipeline systems illustrate how LPG can behave and present hazards when transported. In Parkers Prairie, Minnesota, in 1991; San Juan, Puerto Rico, in 1996; and Snow Hill, Maryland, in 2002, LPG released from pipeline distribution systems migrated underground, pooled in low-lying areas, and ignited to cause explosions and fires. The number of fatalities in these three incidents was one, 33, and one, respectively. A ruptured LPG pipeline led to gas traveling through soil, igniting, and killing two individuals at a resort in

Door County, Wisconsin, in 2006. While the specific factors contributing to these incidents differed, they each involved a lack of adequate familiarity with LPG properties and behavior (its tendency to sink to low areas) and leaks that were undetected while the gas accumulated.

Safety Regulation and Enforcement

Safety regulation and oversight of LPG pipeline distribution systems is a combined federal and state responsibility, with significant involvement by the National Fire Protection Association (NFPA). PHMSA sets federal minimum requirements for safety, while states have the option of applying an additional overlay, usually administered and enforced by a public utility commission. Federal and state regulations also incorporate standards established by NFPA by reference.

PHMSA regulations are wide-ranging, covering facility design, construction, operations, and maintenance, as well as operator training, integrity management, and public awareness. Some of the regulations pertain to all types and sizes of gas pipeline distribution systems, while others distinguish between small and larger systems, for instance by reducing the number and stringency of requirements for small LPG systems. In the case of intrastate pipelines, including LPG distribution systems, individual states have the authority to impose requirements that are more stringent than those imposed by PHMSA.

Both federal and state regulations of LPG distribution systems rely significantly on NFPA consensus standards, which PHMSA has incorporated by reference into the federal safety standards, namely NFPA 58, Liquefied Petroleum Gas Code, and NFPA 59, Utility LP-Gas Plant Code. The NFPA codes focus largely on the specifications for and installation of the tanks and piping and components such as valves and regulators. They also contain requirements for the safe transport and transfer of LPG liquid. In cases in which there is a conflict in the federal and NFPA requirements, the federal regulations state that the LPG-specific NFPA codes prevail. Notably, the NFPA codes provide few requirements pertaining to system operations and maintenance. PHMSA's regulations are intended to address these aspects of system safety assurance.

PHMSA's regulations are adopted and updated through the federal rulemaking process, while states have their own administrative procedures for developing and implementing their regulations. NFPA manages its standards development process by convening a technical committee every 3 years to ensure that the standards reflect current technologies, engineering practices, and scientific principles. Updates to NFPA standards applicable to LPG systems tend to outpace updates to the applicable federal regulations, which incorporate the 2004 edition of NFPA 58 (now in its 2017 edition).

This is due in large part to the pace of the federal rulemaking process and in part to a concern PHMSA had about a revision to the operations and maintenance chapter in the 2008 edition of the code.

These federal, state, and consensus standards are enforced by PHMSA or state regulators. PHMSA certifies most states to monitor and enforce compliance with federal regulations. These state safety authorities receive grants from PHMSA to support their compliance activities. Nevertheless, there can be considerable variation across states in their enforcement activities due to many factors. In some cases, the variability can be explained by differences in circumstances—for instance, northern and coastal states may place greater emphasis on design criteria for snow loads and prevention of corrosion than state regulators from warmer and noncoastal regions. There can be substantial state-to-state variability in regulatory interpretations, including interpretations of the criteria used for determining when an LPG system is subject to federal regulation.

PHMSA distinguishes a system as being jurisdictional or non-jurisdictional—that is, subject or not subject to federal regulation—based in part on whether the system is in a "public place." While examples of a public place are offered in PHMSA guidance documents, the regulatory definition is not precise. Consequently, several state regulators apply different interpretations of a public place in carrying out their pipeline safety programs. Accordingly, a single national or regional firm operating identical systems will find that they are jurisdictional or non-jurisdictional from one state to the next.

The NAPSR questionnaire results show wide discrepancies among states in the number of very small multi-user systems identified as jurisdictional, which is potentially indicative of large geographic variability in the size and uses of LPG distribution systems, wide variability in state application and enforcement of the federal Part 192 regulations, or both. The most striking result is that nearly all of the systems having two to nine customers were reported from only four states, suggesting considerable variability among states in the interpretation of what constitutes a public place, which is a determinant of jurisdictional status for systems having fewer than 10 customers.

Regulatory Applicability and Industry Concerns

Although the study charge implies an examination of the costs and benefits of the safety regulations governing small LPG pipeline systems, the committee recognized early in its deliberations that a formal cost–benefit analysis of regulatory issues would not be feasible due to data limitations, especially a paucity of information on the number of small LPG systems and the extent to which they vary in size, configuration, and other factors that could

affect their risk. However, the study did surface a number of concerns about the safety regulatory requirements and how they are implemented.

LPG industry representatives raised concerns about the cost burden of complying with many federal requirements that they contend have questionable relevance to small LPG systems already subject to NFPA requirements. Some representatives stated that LPG pipeline operators may be incentivized to divide their systems into smaller units to avoid the jurisdictional threshold, thereby reducing compliance costs and avoiding inconsistent enforcement treatment. State regulators and industry representatives alike expressed concern that a proliferation of storage tanks supplying smaller distribution systems could increase the overall risk profile of LPG pipeline systems, in part because of the need for more LPG liquid transfer operations when refilling tanks. Limited data on the number of small LPG systems by size prevented the committee from assessing these claims and their potential safety impacts.

When asked to identify the federal requirements they believe to be especially burdensome and have questionable safety value when applied to LPG systems having fewer than 100 customers, industry representatives focused on several issues. They pointed to a few prescriptive commands that they claimed added little value in light of the NFPA standards, such as performing odor testing with an instrument, as opposed to less costly methods required by NFPA code. They also questioned the need for some of the federal requirements governing system inspection and testing when the NFPA code addresses these matters in some fashion, including certain requirements for personnel training. They raised concern about federal requirements for planning, registration, and documentation that they believe have little applicability to small LPG systems, such as the obligations to create site-specific emergency response plans, liaise with local fire departments, and provide public awareness notifications to customers every 6 months. They maintained that these required plans and programs can be costly to develop and susceptible to varied interpretations of the state regulators responsible for enforcement.

The committee was not able to assess the validity of these industry claims for a number of reasons, including an inability to examine the impact of individual requirements on the safety of small LPG systems that are characterized by significant heterogeneity in configuration, condition, and setting. Nevertheless, some of the information and analysis in the report raises questions about the safety benefits conferred by the federal requirements when applied to small jurisdictional LPG systems, especially the smallest systems, which are not even being identified by many states for regulatory compliance. Because these systems may be presenting safety risks that have not been documented, it is difficult to know whether more rigorous identification and enforcement is warranted or whether their coverage under

the federal regulatory program should be eased. It is with this purpose in mind—to inform the development, application, and enforcement of safety regulations that align better with the safety risks of small LPG systems—that the committee offers the following advice to Congress and PHMSA.

RECOMMENDATIONS

Based on the information and assessment in this report, the committee recommends a set of actions aimed at providing more effective regulatory oversight and safety assurance of small LPG distribution systems. These actions are intended to address the following findings and conclusions that raise questions about the efficacy of the current state of regulatory oversight and safety assurance:

1. Responses to the NAPSR questionnaire by state pipeline safety regulators suggest that many small, multi-user LPG systems that should be subject to the federal Part 192 pipeline safety regulatory requirements—that is, "jurisdictional"—are not being identified by enforcement programs, and thus are not being regularly inspected for compliance with these federal requirements.
2. Although the exact reasons for state-to-state variability in the identification of small, multi-user LPG systems for enforcement of the Part 192 regulations could not be ascertained from the NAPSR questionnaire, one possible cause is ill-defined criteria for jurisdictional coverage, especially in what constitutes a public place, which is a determinant of jurisdictional coverage by multi-user systems having nine or fewer customers. It is possible that the observed variability stems from inconsistent interpretation and application of this definitional criterion by system operators and state regulators. Another possible cause is that states differ in their efforts to oversee and enforce regulatory compliance by operators of small, multi-user LPG systems. Some states may perceive a low safety risk from these smaller systems, causing them to allocate fewer resources to their identification and inspection relative to the larger systems. The committee cannot know for sure whether states are making such risk-balancing choices and whether those choices are appropriate given other state enforcement demands.
3. Irrespective of the reasons that many small, jurisdictional LPG systems are not being identified for compliance with federal Part 192 requirements, the result is incomplete information on the number, location, characteristics, and safety performance of these systems, which complicates assessments of their safety risks, how the specific requirements of federal regulations pertain to those risks, and the

extent to which the requirements are being complied with and effective in controlling risks.

Given this evidence of variability in regulatory implementation and lack of assurance that many small LPG systems are indeed complying with the federal regulations, the committee believes that it would be a mistake to view the current regulatory regime as being operative and that steps should be taken to better identify small systems to ensure that regulatory requirements and their enforcement are appropriate to the safety risks they present. It is with these safety aims in mind, and out of concern about discrepant implementation of the current regulatory regime, that the committee offers the following recommendations:

Recommendation 1: Congress should direct PHMSA to ensure that the regulatory term "public place" is defined in such a way that regulators and regulated entities alike will uniformly interpret that definition to establish jurisdiction over LPG pipeline systems under the Code of Federal Regulations (CFR) Title 49, Part 192, Transportation of Natural and Other Gas by Pipeline.

Recommendation 2: Congress should direct PHMSA to require

- Operators of LPG pipeline systems to report to regulators the location and number of customers served by each of their jurisdictional systems; and
- States to confirm that all identified jurisdictional systems are subject to regular enforcement and inspection activity, which should include a review of operator-reported data on leaks and damage.

Recommendation 3: Seeking the authority and resources from Congress as needed, PHMSA should

- Allow only those states that have confirmed the identification and inspection of their jurisdictional LPG pipeline systems, as recommended above, to seek the agency's permission to implement a waiver program in which a regularly inspected jurisdictional system with fewer than 100 customers is eligible to apply to opt out of any Part 192 requirement the state determines is inapplicable to that system's risk factors, other than the NFPA requirements incorporated by reference in Part 192 and requirements for a Damage Prevention Program (49 CFR § 192.614);
- Stipulate that in addition to having fewer than 100 customers, systems eligible for a waiver should meet certain low-risk profiles as identified by the state with guidance and approval from PHMSA; and

- Require that states periodically seek permission from PHMSA to renew their waiver programs by providing evidence that public safety has not been compromised by the waivers.

CONCLUDING COMMENTS

The committee believes that its recommendations are complementary and will work together to inform sound decisions about the application of regulatory requirements and their enforcement. A commonly understood definition of public place will better ensure the identification of all small, jurisdictional LPG systems by PHMSA and state regulators. A requirement that operators of LPG pipeline systems report the location and number of customers served by their jurisdictional systems will assist regulators in identifying systems for enforcement and inspection activity. The requirement to perform such inspections of operator-identified systems on a regular basis should increase the state regulators' familiarity with the characteristics, conditions, and safety performance of the LPG systems, which in turn will assist states and PHMSA in making more risk-informed determinations of regulatory requirements that are most suitable to small LPG systems and deserving of enforcement attention. The recommended authorization of a waiver program is intended to allow states and PHMSA to make such risk-informed determinations about regulatory application and enforcement, as opposed to determinations that are based simply on system size.

APPENDIX A

Questionnaire to State Pipeline Safety Program Managers on the Regulation of Liquefied Petroleum Gas Distribution Systems

The National Association of Pipeline Safety Representatives (NAPSR) circulated a questionnaire in November 2017, developed by the study committee, to the member pipeline program managers responsible for safety regulation in the 50 states, the District of Columbia, and Puerto Rico. There were 50 respondents to the questionnaire. Notably, the extensive responses to the third question regarding the number of regulated liquefied petroleum gas (LPG) distribution systems enabled the committee to draw useful insights for the study. For the other questions, the variability in the responses proved a challenge for analysis. The responses to the questionnaire from the pipeline safety program managers are available in the public access file for the study.

QUESTIONNAIRE

1. What are the most common regulatory violations found in inspections of LPG pipeline systems serving 99 or fewer customers?
2. How often are enforcement actions taken against facilities (by jurisdiction status and state)? What relief is sought (i.e., citations, civil penalties, injunctions)?
3. How many jurisdictional systems (as defined by 49 CFR Part 192) exist in your state or are under your safety jurisdiction?
   a. Number of jurisdictional systems:
   b. Number of systems serving 100 or more customers:
   c. Number of systems serving 50–99 customers:

d. Number of systems serving 10–49 customers:
e. Number of systems serving fewer than 10 customers:

4. How many jurisdictional systems are inspected annually?
5. How often are jurisdictional systems inspected?
6. How many non-jurisdictional systems exist in your state (estimate if not known)?
7. How much is expended on enforcement of jurisdictional LPG pipeline facilities?
8. If your agency uses resources to enforce non-jurisdictional LPG pipeline facilities, how much would you estimate is expended on enforcement? Is this expenditure part of the current budget for enforcement of jurisdictional systems?
9. What are the most common types of failure for propane gas systems? Please identify the five most common failure modes.
10. To the best of your understanding, in a scenario where the threshold for qualifying as a non-jurisdictional system were raised to 99, which public agency would become the authority having jurisdiction for these systems with less than 100 customers?
11. When inspecting a facility under your jurisdiction, what documents are facilities expected to maintain compliance with (U.S. DOT; National Fire Protection Association, NFPA). Please note which version of the document; e.g., NFPA 58 2004 versus NFPA 58 2017, NFPA 59.
12. Are there specific changes to the operation/maintenance requirements in Part 192 that the regulators should consider as an alternative to exempting the facilities from Part 192?
13. Would you support the creation of a separate, streamlined inspection program for small LPG facilities? If so, in your estimation, what features must it include to assure safety outcomes consistent with current safety trends and why?
14. The NFPA develops its standards using a well-documented process. Do you have any general governance concerns regarding the process used in the creation or modification of past or current editions of the NFPA 58 standard?

APPENDIX B

Interpretation Letters Regarding the Definition of "Public Place"

Pipeline and Hazardous Materials Safety Administration

Marty Burke
Burke Energy Corporation
1124 North Main
Hutchinson, Kansas 67501

Dear Mr. Burke:

I have asked the Department of Transportation for an interpretation of a "public place" as the term is used in Section 192.11(a). A copy is enclosed.

With this interpretation, it still places you as a gas operator.

Sincerely,

DB
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Mr. Lavern Rinehart
Chief,Deputy Fire Marshal
Pipeline Safety Division
246 South 14th Street
Lincoln, NE 68508

Dear Mr. Rinehart:

This responds to your letter of July 28, 1990, in which you ask for an interpretation of a "public place" as that term is used in Section 192.11(a).

Your letter indicates that your question pertains to a trailer court which is served by a propane gas system with steel mains and services. The main runs from a tank farm across a road and down the middle of another road within the court. The people own the mobile homes and lease the ground from a party who has leased the ground from the Nebraska Public Power District, a public corporation. The lessee permits access to the general public to the lakeside improvement and case on the leased premises. The road on one side of the court has a gas main running underground and is traveled by people coming to and from the lake area. Also, the road is used a federal mail route. In a telephone conversation with a member of my staff, you indicated that the propane system serves seven trailers.

The term"public place" in Section 192.11(a) means a place which is generally open to all persons in a community as opposed to being restricted to specific persons. We consider churches, schools, and commercial building as well as any highway, road or property which is frequented by all persons to be public places under Section 192.11(a).

From your description of the trailer court, it appears that the road where people travel to and from the lake area is a "public place" as set forth in Section 192.11(a) and therefore the entire propane gas system is subject to Part 192.

I trust this has adequately answered your questions.

Sincerely,

George W. Tenley, Jr.
Director
Office of Pipeline Safety

DB
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U.S. Department
of Transportation
Pipeline and Hazardous Materials
Safety Administration

1200 New Jersey Avenue SE
Washington DC 20590

NOV 27 2017

Mr. David Dupuy,
Safety Director
Automatic Propane Gas and Supply
1677 S US Highway. 69
Mineola, TX 75773

Dear Mr. Dupuy:

In a July 25, 2017, letter to the Pipeline and Hazardous Materials Safety Administration (PHMSA), you requested an interpretation of 49 CFR Part 192. Specifically, you requested an interpretation whether the exclusion from Part 192 specified in § 192.1(b)(5)(i) applies to small liquefied petroleum gas systems that serve fewer than 10 customers and are not located in a public place. Also, you asked if the exclusion applies, whether the excluded small regulated liquefied petroleum gas operators would be exempt from the requirements of § 192.1015.

You described your pipeline system as follows:

> The liquefied petroleum gas (propane) systems our company operates are only used to provide liquefied petroleum gas to residential homes located in small neighborhoods / subdivisions. The systems meet the requirement in 49 CFR 192.1(b)(5)(i) for fewer than 10 customers, in most cases only 6 or 7 homes. The LPG piping runs from a 1000 gallon or sometimes two 1000 gallon LPG tanks located in the front yard (both at the same location) of one residential property and transports LPG vapor across residential property within the neighborhood from one home to another. At no point does the piping cross under a road within the neighborhood. The question on our end is whether this would not be considered a "**public place**" and satisfy the rest of the exclusion listed in 49 CFR 192.1(b)(5)(i)? The term public place as taken from a PHMSA manual used to identify and clarify regulations which apply to jurisdictional LP gas operators defines public place as "*a place which is generally open to all persons in a community as opposed to being restricted to specific persons. Churches, schools, and commercial buildings as well as any publicly owned rights-of-way or property which if frequented by persons are public places).*" It is our understanding that one's residential home / property is considered private being restricted to specific persons thus meeting the definition of not being considered a public place. This would satisfy the complete exclusion for all requirements provided in 49 CFR 192.1 as well as absolve the need for an integrity management plan found in 49 CFR 192.1015?
>
> It is not Automatic Propane Gas and Supply's intent to dodge or avoid regulatory compliance, but to ensure our company follows and correctly interprets the regulations

The Pipeline and Hazardous Materials Safety Administration, Office of Pipeline Safety provides written clarifications of the Regulations (49 CFR Parts 190-199) in the form of interpretation letters. These letters reflect the agency's current application of the regulations to the specific facts presented by the person requesting the clarification. Interpretations do not create legally-enforceable rights or obligations and are provided to help the public understand how to comply with the regulations.

provided by PHMSA to ensure the safety of the public. It is our interpretation that "public place" was listed within the regulation to omit small systems in locations such as these. Your assistance and guidance on this matter will be greatly appreciated.

Also, in an August 28, 2017, email, you provided a drawing and pictures of one of your propane tank and service line systems. You described the tanks as below ground and connected to the poly pipe lines that run to the tanks located at the houses.

The regulations in Part 192 prescribe minimum safety requirements for pipeline facilities and the transportation of gas, but do not apply to "Any pipeline system that transports only petroleum gas or petroleum gas/air mixtures to… few than 10 customers, if no portion of the system is located in a public place." 49 CFR § 192.1(b)(5)(i). Because your system is located solely within private property and serves fewer than 10 customers, your system is exempt from Part 192. Therefore, you are not required to comply with the provisions of § 192.1015.

If we can be of further assistance, please contact Tewabe Asebe at 202-366-5523.

Sincerely,

John A. Gale
Director, Office of Standards
and Rulemaking

The Pipeline and Hazardous Materials Safety Administration, Office of Pipeline Safety provides written clarifications of the Regulations (49 CFR Parts 190-199) in the form of interpretation letters. These letters reflect the agency's current application of the regulations to the specific facts presented by the person requesting the clarification. Interpretations do not create legally-enforceable rights or obligations and are provided to help the public understand how to comply with the regulations.

7-25-17

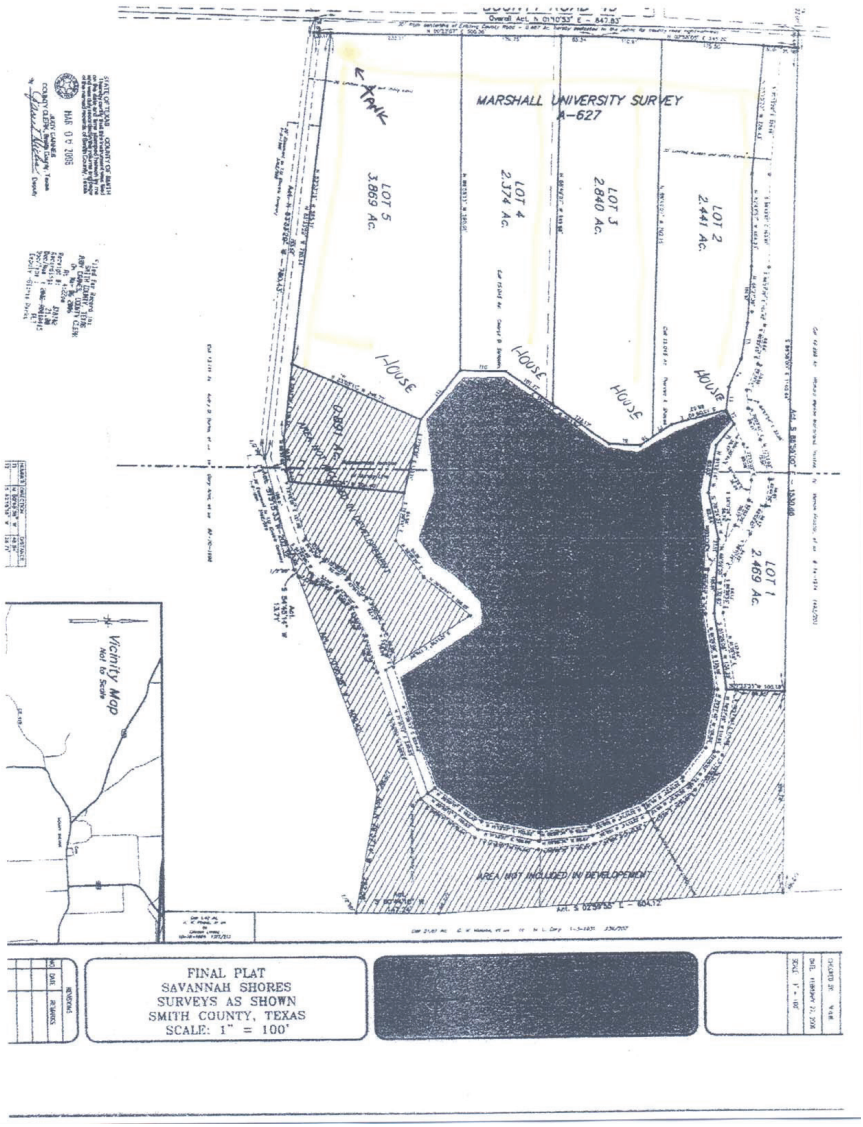
U.S. DOT
PHMSA Office of Hazardous Materials, phmsa.hm-infocenter@dot.gov
Attn: PHH-10
East Building
1200 New Jersey Avenue, SE.
Washington, DC 20590-0001

The following shall serve as a request for an interpretation and further clarification of 49 CFR 192.1, specifically 49 CFR 192.1 (b)(5)(i) and the reference to the term "**public place**" and whether the exclusion applies to the small liquefied petroleum gas systems our company, Automatic Propane Gas and Supply, operates. Also, if the exclusion applies to our systems does this absolve us from the requirements listed in 49 CFR 192.1015 for an integrity management plan even though the section states they are required for small lpg operators (an operator of a liquefied petroleum gas (LPG) distribution pipeline that serves fewer than 100 customers from a single source)?

The liquefied petroleum gas (propane) systems our company operates are only used to provide liquefied petroleum gas to residential homes located in small neighborhoods / subdivisions. The systems meet the requirement in 49 CFR 192.1 (b)(5)(i) for fewer than 10 customers, in most cases only 6 or 7 homes. The LPG piping runs from a 1000 gallon or sometimes two 1000 gallon LPG tanks located in the front yard (both at the same location) of one residential property and transports LPG vapor across residential property within the neighborhood from one home to another. At no point does the piping cross under a road within the neighborhood. The question on our end is whether this would not be considered a "**public place**" and satisy the rest of the exclusion listed in 49 CFR 192.1 (b)(5)(i)? The term public place as taken from a PHMSA manual used to identify and clarify regulations which apply to jurisdictional LP gas operators defines public place as "*a place which is generally open to all persons in a community as opposed to being restricted to specific persons. Churches, schools, and commercial buildings as well as any publicly owned rights-of-way or property which if frequented by persons are public places)".* It is our understanding that one's residential home / property is considered private being restricted to specific persons thus meeting the definition of not being considered a public place. This would satisfy the complete exclusion for all requirements provided in 49 CFR 192.1 as well as absolve the need for an integrity management plan found in 49 CFR 192.1015?

It is not Automatic Propane Gas and Supply's intent to dodge or avoid regulatory compliance, but to ensure our company follows and correctly interprets the regulations provided by PHMSA to ensure the safety of the public. It is our interpretation that "public place" was listed within the regulation to omit small systems in locations such as these. Your assistance and guidance on this matter will be greatly appreciated.

David Dupuy - Safety Director
Automatic Propane Gas and Supply
1677 S US Hwy. 69, Mineola, TX. 75773
Phone: 504-220-1166, Email: dave.dupuy@raymondmartin.com



APPENDIX C

NFPA 58, Liquefied Petroleum Gas Code, Adoption in the United States

Pipeline and Hazardous Materials Safety Administration

State Code Adoption Table November 2016			
State	**Edition of NFPA 58 Adopted**	**Edition of National Fuel Gas Code (NFPA 54) Adopted**	**Edition of International Codes or other Regulations Adopted**
Alabama	2011	2012	
Alaska	1989		
Arizona	2001		NFPA 58 adopted by reference in 2003 IFC
Arkansas	State Code		
California	2011	2012	IFC 2006 (2007 Supplement) refers to 2004 NFPA 58
Colorado	2011	2009	
Connecticut	2011	2012	
Delaware	2014	2015	IFGC (2006); IBC, IMC, IRC (2009)
Florida	2011	2012	2012
Georgia	2008		
Hawaii	2004	2006	
Idaho	2004		
Illinois	2011	2009	
Indiana	2004	None	2006 I-Codes
Iowa	2014	2015	2009 International Fire Code
Kansas	2008	2006	
Kentucky	2011	2009	
Louisiana	2008		
Maine	2011	2012	
Maryland	2011	2012	IBC, IMC, IRC (2009)
Massachusetts	2011	2012	
Michigan	2014	None	2003 Int.'l Residential Code 2006 Int.'l Mechanical Code
Minnesota	2011		2012 IFGC and IMC
Mississippi	2014	2015	
Missouri	2014	2015	
Montana	2008 (by reference through IFC)		2009 International Codes
Nebraska	2001		
Nevada	2014	2015	
New Hampshire	2008	2009	2006 Mechanical Code
New Jersey	2011		2006 IFC, 2009 IFGC
New Mexico	2001		
New York	2008	None	2003
North Carolina	2014	2012 IFGC	2012 ICC applies to all but agricultural and some outdoor applications
North Dakota	2014	2015	
Ohio	2011	None	2009
Oklahoma	Latest (2017)	Latest (2015)	
Oregon	2008		
Pennsylvania	2008	2009	2003
Rhode Island	2004	2009	International Fuel Gas Code
South Carolina	2014	2009	2015 IFC and IFGC
South Dakota	2014		2015 IFC and IFGC
Tennessee	2008	2006	2006 IFGC and IFC
Texas	2008	2006	
Utah	2008	2009	2006 IFC
Vermont	2014	2015	

Virginia	2008	None	IFGC-2009
Washington	2004		
West Virginia	2014	2015	
Wisconsin	2011	2009	
Wyoming	Most Current (2014)		

APPENDIX D

Agendas

Committee for a Study of Propane Gas Pipeline Facilities

First Meeting
June 8–9, 2017
Washington, DC

June 8

10:00 a.m. Briefing on study charge
Craig E. Philip (NAE), *Chair*

10:10 a.m. Origin of the study and sponsor expectations
Alan Mayberry, Associate Administrator for Policy and Programs, Office of Pipeline Safety, Pipeline and Hazardous Materials Safety Administration (PHMSA)

10:25 a.m. Panel Session 1: A review of propane gas pipeline facilities, safety regulations, and data by federal and state regulators
Gary McDonald, Transportation Specialist (Instructor), Inspector Training and Qualifications Division, PHMSA
Neil Pascual, Program Manager, State Pipeline Safety Program, Nevada Public Utilities Commission

1:30 p.m. Panel Session 2: An industry overview of propane system design, construction, operation, maintenance, safety assurance, and perspectives on regulation
Michael Caldarera, Vice President, Regulatory and Technical Services, National Propane Gas Association
Lyndon Rickards, Assistant Vice President, Risk Management, Eastern Propane and Oil
Rufus Youngblood, Director of Safety, Ferrellgas

3:45 p.m. Adjournment

June 9

9:00 a.m. A perspective on setting standards for propane systems
Laura Moreno, Engineer, National Fire Protection Association

10:00 a.m. Adjournment

Second Meeting
August 24–25, 2017
Irvine, CA

August 24

11:00 a.m. Perspectives on benefit–cost analysis in regulatory impact analyses by PHMSA
Piyali Talukdar, Statistician, Safety Data Systems and Analysis Division, Office of Pipeline Safety, PHMSA

1:30 p.m. Panel Session: An industry overview of propane gas pipeline facility design and construction
Gregory S. Dahl, Senior Vice President, ARB Inc.
Ken Teague, Executive Vice President New Business Ventures, Primoris Services Corporation
Kim LaPierre, Technical Training Manager, Suburban Propane
John Minchew, Area Safety Manager, Suburban Propane

4:30 p.m. Adjournment

Third Meeting
December 7–8, 2017
Washington, DC

December 7

9:40 a.m. A regional industry perspective and data from the Propane Gas Association of New England (PGANE) on compliance costs for jurisdictional systems, differences in compliance costs between large and small LPG operators, and incident and other safety data
Leslie Anderson, President and CEO, PGANE
Lyndon Rickards, Assistant Vice President, Risk Management, Eastern Propane and Oil

11:00 a.m. Revisiting Federal Regulations for Small LPG Operators with PHMSA
Gary McDonald, Transportation Specialist (Instructor), Inspector Training and Qualifications Division, PHMSA

1:30 p.m. Panel Session: Safety assurance and incident causation in propane gas pipeline facilities
James H. Anspach, President, American Society of Civil Engineers, Utility Engineering and Surveying Institute
Thomas R. Crane, P.E., President, Crane Engineering
O. John Jacobus, Ph.D., President, Jacobus & Associates
Lyndon Rickards, Assistant Vice President, Risk Management, Eastern Propane and Oil
Christopher Wagner, Director of Safety Compliance and Training, AmeriGas

3:00 p.m. Adjournment

Study Committee Biographical Information

Craig E. Philip (NAE) is Research Professor and Director of the Vanderbilt Center for Transportation and Operational Resiliency (VECTOR). He spent 30 years with Ingram Barge Company, serving as President and CEO from 1993 to 2014. He began his career at Consolidated Rail Corporation and later served with Southern Pacific Railroad, where he was Vice President of their Intermodal Division. He has been actively engaged in transportation and logistics industry leadership, as a past Chairman of the American Waterways Operators, the National Waterways Conference, and the U.S. Chamber of Commerce's Transportation and Infrastructure Committee. He was a member of TRB's Executive Committee and currently serves on the Marine Board. He served on the TRB Committee for a Study of the Domestic Transportation of Petroleum, Natural Gas, and Ethanol. He also served as a U.S. Commissioner of the World Association for Waterborne Transport Infrastructure and on the U.S. Department of Transportation's first National Freight Advisory Committee. He currently serves on the boards of the ArcBest Corporation, Seamen's Church Institute, and the Nashville Civic Design Center. In 2010, he was designated a Distinguished Diplomate by the Academy of Coastal, Ocean, Port and Navigation Engineers, and in 2014 was elected to the National Academy of Engineering. He earned a B.S. in civil engineering from Princeton University and a Ph.D. in civil engineering from the Massachusetts Institute of Technology.

Samuel T. Ariaratnam is Professor and Construction Engineering Program Chair in the Ira A. Fulton Schools of Engineering at Arizona State University. His teaching and research interests are in the areas of underground

infrastructure management and rehabilitation, with a focus on trenchless pipe replacement and underground utility asset management. Previously, he served in the Department of Civil and Environmental Engineering at the University of Alberta. He was also employed as a visiting Assistant Professor at the U.S. Air Force Academy and at the U.S. Army Corps of Engineers Construction Research Laboratories, where he performed research in military construction and strategic planning while a graduate student. He has published more than 250 technical papers in refereed journals and conferences, has co-authored eight textbooks, and is a co-holder of five patents. He is active in professional societies, including the American Society of Civil Engineers (ASCE), where he is Fellow and Chair of the Pipelines Division Executive Board; Distribution Contractors Association; and the North American Society for Trenchless Technology; and is Past Chairman of the International Society for Trenchless Technology. He has received multiple awards, including ASCE's John O. Bickel Award and Arthur M. Wellington Prize; the Young Civil Engineer Achievement Award from the University of Illinois; and an award of recognition from Halliburton Energy Services for contributions to underground technology. He was named to the *Phoenix Business Journal*'s "Forty under 40" list in 2006 and is North American Trenchless Technology Person of the Year in 2012. Dr. Ariaratnam was elected to the Canadian Academy of Engineering in 2018. He is a registered professional engineer in Arizona and Ontario, Canada. He earned his B.A.Sc. from the University of Waterloo, Canada, and his M.S. and Ph.D. in civil engineering from University of Illinois at Urbana-Champaign.

Bruce Benson is Public Utilities Engineer at the State of Connecticut Public Utilities Regulatory Authority, within which he has worked in the Gas Pipeline Safety Unit for more than 20 years. Mr. Benson is a lead agent conducting oversight of pipeline regulations in Connecticut for the Pipeline and Hazardous Materials Safety Administration, including an inspection program involving interstate transmission pipelines, local natural gas distribution systems, LNG plants, and hundreds of propane distribution systems. He coordinates pipeline operator audits for propane distribution systems, operations and maintenance, control room management, operator qualification, and distribution integrity management. He is a member of the National Association of Pipeline Safety Representatives (NAPSR) and Treasurer of the New England Pipeline Safety Representatives. With NAPSR, his activities include serving on a number of committees to update industry guidance, including the American Public Gas Association Security and Integrity Foundation's *Small LP Gas Operator Guide* and *Small LP Gas Operator OQ Guide*. As a Petty Officer, 2nd Class, he served in the U.S. Navy Submarine Force as a nuclear-trained

electronics technician. He earned a B.S. in mechanical engineering from the University of Connecticut.

Robert J. Chipkevich is Principal of Chipkevich Safety Consulting Group, a transportation safety consultancy. He retired in 2010 from the National Transportation Safety Board (NTSB) after more than 25 years of service. He headed NTSB's hazardous materials accident investigation program for 20 years, the pipeline accident investigation program for 15 years, and the railroad accident investigation program for 9 years. As the Director for accident investigations, he assessed hundreds of transportation accidents each year and launched investigation teams to the most serious accidents. While at NTSB, he investigated on-scene many of the most serious hazardous material accidents in the United States across all modes of transportation. He testified before Congress more than a dozen times on transportation safety issues. Prior to becoming a Director at NTSB, he worked for the Federal Highway Administration in Boise, Idaho, and served as Assistant Director of the Motor Carrier Division, Tennessee Public Service Commission in Nashville. He has served on numerous transportation safety committees, including the Federal Railroad Administration Railroad Safety Advisory Committee, the National Association of State Fire Marshals Pipeline Safety Committee, the Flight Safety Foundation, the American Lifelines Alliance, and the Association of American Railroads Tank Car Committee. He was a member on the TRB Committee for a Study of the Domestic Transportation of Petroleum, Natural Gas, and Ethanol. He earned a B.S. in business with a major in transportation from the University of Tennessee.

Sara Rollet Gosman is Assistant Professor at the University of Arkansas School of Law. Professor Gosman specializes in risk and risk-based regulation of oil and gas development and transportation. Her research includes pipeline safety and risk analyses of hydraulic fracturing and pipeline planning, about which she has delivered presentations to PHMSA and at several legal conferences. She teaches courses in oil and gas law and energy policy. Professional activities include membership on PHMSA's Gas Pipeline Technical Standards Committee and the Pipeline Safety Trust's board of directors as Vice President. Previously, she practiced law as a Water Resources Attorney at the National Wildlife Federation and as an Assistant Attorney General in the Environmental Division of the Michigan Department of Attorney General. She earned her A.B. in religion from Princeton University, M.P.A. from the Harvard John F. Kennedy School of Government, and J.D. from Harvard Law School.

Stephanie A. King is Senior Director, Model Development at Risk Management Solutions. Previously, she served as the Director of Risk Analysis at

Weidlinger Associates and before that as Associate Director of the John Blume Earthquake Engineering Center at Stanford University. Her work has focused for more than 25 years on hazard and risk analysis for regional and site-specific applications. She has managed research and development of advanced techniques for characterizing probabilistic damage and loss due to natural and man-made hazards. Professional activities include participation on the American Society of Civil Engineers Technical Council on Life-Cycle Performance, Safety, Reliability, and Risk of Structural Systems and on the American Society of Mechanical Engineers Consensus Committee for the Development of the Risk Assessment and Management for Critical Asset Protection Standard. She has served on several National Academies of Sciences, Engineering, and Medicine committees, including as chair of the TRB project Hazardous Materials Transportation Risk Assessment: State of the Practice. She is a registered professional engineer in California. She holds a B.S. in civil engineering from Arizona State University and an M.S. and a Ph.D. in structural engineering from Stanford University.

Philip J. Oakes is National Program Director at the National Association of State Fire Marshals (NASFM), which represents fire officials responsible for adoption and enforcement of fire safety codes and regulation of natural gas and other pipelines. Mr. Oakes manages NASFM's "Pipeline Emergencies" curriculum and delivers related training on pipeline incident response. After more than 20 years in emergency response and training in Wyoming, Mr. Oakes retired from service as a firefighter, operations chief, trainer, and volunteer ambulance attendant. Mr. Oakes managed fire service training for the Wyoming Department of Fire Prevention and Electrical Safety, where he helped the department achieve accreditation and supported the establishment of the State of Wyoming Fire Academy. The State of Wyoming has recognized his contributions as a hazardous materials incident commander and fire investigator. His professional affiliations include the National Fire Protection Association and Florida Fire Marshals and Inspectors Association. He was also an American Petroleum Institute (API) committee member for the API Recommended Practice for Pipeline Emergency Preparedness and Response. He earned a B.S. in business administration from Columbia Southern University.

April Richardson is Director of Alternative Fuels Safety Department at the Railroad Commission of Texas (RRC). The RRC Commission regulates the oil and gas industry, gas and hazardous liquid pipeline operators, the liquefied petroleum gas (LPG) industry, and other natural resources. Ms. Richardson has worked in the Alternative Fuels Safety (AFS) Department for more than two decades to promote the safe use of alternative fuels, such as LPG, compressed natural gas, and liquefied natural gas. She advises on

regulatory policy for alternative fuels and oversees the inspections and regulatory enforcement programs as well as licensing and certification programs for alternative fuels, including the training program for LPG. Earlier work at AFS included propane facility design review and implementation of the damage prevention program to minimize pipeline risks posed by operators and excavators. Her subject-matter expertise has been recognized through appointments to several National Fire Protection Association (NFPA) committees, including NFPA 58, Liquefied Petroleum Gas Code. She attended Our Lady of the Lake University.

Ross T. Warnell is Owner and Principal at The Propane Doctor, a safety consultancy for the propane industry in Smithville, Missouri. Prior to consulting, Mr. Warnell retired from propane supplier Ferrellgas after nearly 30 years. During his career, he worked as a manager in both retail and safety, retiring as Technical Standards and Procedures Manager, a position focused on propane system operations and safety. He developed safety and technical policies and procedures for facilities and personnel, including materials to comply with federal regulations. He also led in the research and implementation of cathodic protection for underground propane systems and methods to reduce hazards from static electricity. He has been a member of the National Fire Protection Association. He earned a B.A. in economics from Arkansas Polytechnic College.