



A Publication for AGA Members

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AGA White Paper
Skills and Experience for
Effectively Designing Natural
Gas Systems

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Background

As part of the National Transportation Safety Board's (NTSB) ongoing safety investigation into the September 2018 Merrimack Valley, Massachusetts incident related to over-pressure of a low-pressure natural gas distribution system, the NTSB issued a preliminary Safety Recommendation Report on November 15, 2018 and its final report on September 24, 2019. In its preliminary report, the NTSB recommended that the Commonwealth of Massachusetts eliminate the professional engineer licensure exemption for public utility work and require a professional engineer's seal on public utility engineering drawings¹ and that the natural gas distribution system operator have certain documents or plans sealed by a professional engineer prior to commencing work.² In its final report, the NTSB also recommended that those 31 states with an industrial exemption for natural gas infrastructure projects remove the exemption so that all future natural gas infrastructure projects require licensed professional engineer approval and stamping.³

Following the over-pressure event in Massachusetts, AGA members (referred to as operators within this document) have been reviewing their gas systems to identify any improvements or new practices to incorporate within their pipeline safety programs. To support that effort, on November 26, 2018, AGA issued "Leading Practices to Reduce the Possibility of a Natural Gas Over-Pressurization Event" to provide guidance to operators on leading practices that may further reduce the possibility of an over-pressurization event and enhance pipeline safety.

The purpose of this document is to provide guidance to operators on how to develop, maintain, and enhance the key technical competencies required to safely and effectively perform engineering work functions for natural gas systems. Although professional engineers (PE's) must demonstrate technical competency in the field of engineering, focusing on concepts such as fluid mechanics, thermodynamics, structural mechanics, and responsible charge of work and ethical standards of practice, a PE license by itself is not a substitute for industry-specific experience and first-hand knowledge needed to understand natural gas systems and make decisions related to public safety in this field.

This white paper provides a roadmap for operators to improve and enhance the performance of engineering work or services for the design, construction, and maintenance of natural gas facilities with the goal of reducing risk to public safety. Additionally, this white paper addresses the importance of embedding design approvals within an operator's safety management plans and leveraging a change management process to ensure design changes, reviews, and approvals are in place to minimize the risk of human error.

State legislative bodies and regulatory agencies are also seeking to better understand the natural gas systems within their regions, including the practices and processes employed by operators to ensure public safety. Information in this paper may assist operators to better address how they are equipping employees with the necessary skillset and technical acumen to make informed decisions which will enhance pipeline safety. Operators should continue to comply with applicable state laws and regulations

¹ https://www.nts.gov/investigations/AccidentReports/_layouts/nts.gov/recsearch/Recommendation.aspx?Rec=P-18-005

² https://www.nts.gov/investigations/AccidentReports/_layouts/nts.gov/recsearch/Recommendation.aspx?Rec=P-18-006

³ <https://www.nts.gov/investigations/AccidentReports/Reports/PAR1902.pdf>

regarding PE approval and stamping.

The need to implement every practice and the timing of any implementation of the practices described in this document will vary with each operator based upon the specific environment in which they operate. The actions within this document should be evaluated in light of each operator's system, geographic variables, the operator's independent integrity assessment, risk analysis, and mitigation strategy as well as what has been deemed reasonable and prudent by their state regulators. Therefore, not all of the practices described in this document will be applicable to all operators. As used herein, the term "should" is not mandatory but is to be acted upon as appropriate. This document is not intended to address technical competencies for interstate natural gas transmission pipelines, hazardous liquid pipelines, or production and gathering lines.

The components discussed in this white paper are:

- Foundational Knowledge tiers
- Design Approvals
- Ethical Responsibility
- Management of Change
- Continuous Improvement

Existing Federal Regulations Require Certain Knowledge

Guidance in this document is intended to supplement existing Federal regulations within 49 CFR, Part 192, which prescribe the minimum requirements for certain natural gas system operator personnel to have the appropriate competency and knowledge to design, test and maintain the system in a safe manner (See Appendix A of this White Paper). Operators must comply with the requirements of Part 192 and must periodically demonstrate their adherence to these requirements to both state and federal regulating agencies. State regulators also have the authority to develop additional regulations and requirements in addition to those prescribed within 49 CFR Part 192⁴.

Key Competencies to Further Enhance Pipeline safety

AGA's industry white paper "Intergenerational Transfer of Knowledge⁵" identifies knowledge categories that are critical for job-related functions for natural gas systems. That document also served as a guide for training development for entry-level and intermediate engineers and engineering technicians. To reflect the various levels of complexity in natural gas system design, this paper applies a tiered approach to the ten knowledge categories identified in the 2013 white paper. Operators may also benefit from participating in industry workgroups, training topics, technical committees, and other opportunities for professional and technical development. The workgroups, training topics, and other opportunities listed are not intended to be an all-inclusive list.

Tier 1: Developing a foundational Understanding of Natural Gas Systems

The natural gas industry encompasses industry-specific design, operations, and maintenance requirements that are not generally taught in educational curriculums. The first tier seeks to establish a fundamental understanding of natural gas systems. This includes developing an understanding in the areas of natural gas system design, delivery of natural gas to end users, the operations and

⁴ Massachusetts Natural Gas Pipeline Code", 113.08 Training

⁵ https://www.aga.org/globalassets/safety--standards/intergenerational_transfer_of_knowledge_white_paper.pdf

maintenance of natural gas systems and an overview of federal and state regulations that govern the natural gas industry. AGA believes this step is foundational for all employees that perform critical work functions⁶, including those working on system design.

Tier 2: Improving Knowledge about Operator-Specific Processes and Procedures

The second tier provides operator-specific requirements that address each unique pipeline system and the processes each company utilizes to operate and maintain them. Company procedures take into account regional considerations, and also address regional or state requirements and measures that an operator may perform that are above and beyond the requirements in 49 CFR Part 192. The operator-specific processes may provide guidance on functions such as design, material selection, replacement of pipe facilities, testing, and maintenance. This tier focuses on ensuring employees understand how to perform the work safely, as well as standardizing the communication between cross-functional work groups.

Tier 3: Building Technical Knowledge Acumen

The two tiers outlined above help provide a general understanding of natural gas systems and company specific activities, while the third tier focuses on developing, maintaining, and enhancing technical acumen in system-specific areas of expertise. Fundamental engineering topics are often covered within specific engineering curriculums; however, are not generally specific to the design and operations practices of natural gas pipelines. This system-specific technical acumen may be further enhanced by on-the-job training, attending and participating in industry conferences, attending continuing education courses, obtaining gas-related certifications, or receiving engineering licensure. Operators should encourage formal or informal training, courses, or programs, like those noted above, which continue to develop skills for personnel working on natural gas systems, and for qualified engineers to pursue their professional engineering licensure. These activities mirror the continuing education and experience requirements a professional engineer must meet to maintain their licensure. It is important when considering appropriate Tier 3 technical knowledge that it is specific to the natural gas area of expertise.

Table 1 outlines nine work functions that tie to the knowledge categories identified in the AGA *Intergenerational Transfer of Knowledge* white paper. Associated with each of these work functions are recommendations operators should consider for technical training topics that support and enhance understanding and expertise in that function. The training topics are not intended to be an exclusive list.

⁶ Critical work is defined as work associated with the 10 knowledge categories outlined within AGA's 2013 industry white paper "Intergenerational Transfer of Knowledge"

Table 1: Recommended Competencies

Work Function	Examples of Training Topics	
Pipeline Design and O&M	<ul style="list-style-type: none"> • Applicable regulations • Pipe material selection • Replacement, repair, and installing mains and services • Pipe testing • Requirements 	<ul style="list-style-type: none"> • Uprating • Gas planning and system modelling • Considerations for land, environmental, and regional impacts • Recordkeeping • Joining methods and pipe welding
Corrosion Control	<ul style="list-style-type: none"> • Applicable regulations • Fundamental corrosion control design (coatings, cathodic protection, electrical insulation) • Recordkeeping 	<ul style="list-style-type: none"> • Effectiveness of corrosion control measures in place • Methods, tools, and technologies for monitoring, testing, and mitigation
Equipment and Material Selection/Testing	<ul style="list-style-type: none"> • Applicable regulation • Pipe testing • Recordkeeping 	<ul style="list-style-type: none"> • Understanding of equipment to monitor and control the volume, flow and pressure of natural gas
Telemetry	<ul style="list-style-type: none"> • Applicable regulations • Supervisory Control and Data Acquisition (SCADA) systems and processes 	<ul style="list-style-type: none"> • Managing communication and data from transmitters and remote equipment • Maintenance of equipment
Metering and Regulator Station Design	<ul style="list-style-type: none"> • Applicable regulations • Fundamentals of pressure regulation • Regulator sizing basics • Regulator station configurations • Valves, fittings, and over pressure protection • Odorization and heating of gas 	<ul style="list-style-type: none"> • Fundamental meter sizing and configuration • Customer meter and regulation • Meter auxiliary equipment • Gas quality and gas conditioning • Aerodynamic noise • Gas conditioning equipment
Integrity Decisions	<ul style="list-style-type: none"> • Part 192-Subparts O or P • ASME B31.8S and other standards incorporated by reference • Pipeline threats • Preventative and mitigative actions • Repair methods 	<ul style="list-style-type: none"> • Assessment methods • Assessment Intervals • Data gathering • Risk modeling • Recordkeeping
Development of Engineering and Operation Standards	<ul style="list-style-type: none"> • Overview of regulatory environment • History of gas pipeline safety guidance and regulations • Pipeline inspections and audits • Recordkeeping 	<ul style="list-style-type: none"> • Part 191—Annual Reports, Incident Reports, and Safety-Related Condition Reports • Part 192—Minimum Federal Safety Standards; Subparts A
Control Room Management	<ul style="list-style-type: none"> • Measurement units • Basic pipeline hydraulics • Pipeline model and map • Fundamentals of pressure regulation and compression • 	<ul style="list-style-type: none"> • Abnormal Operating Conditions (AOC) • Supervisory Control and Data Acquisition (SCADA) systems and processes • Incident Command Structure (ICS) • Response to outages • Recordkeeping
Asset Management	<ul style="list-style-type: none"> • Inputs for risk modeling • Identification of and recommended plans for piping and equipment repair or replacement 	<ul style="list-style-type: none"> • Compliance requirements for pipeline system • O&M requirements • Recordkeeping

Ethical Responsibility

The National Society of Professional Engineers (NSPE) Code of Ethics notes that engineers shall only perform services in areas of their competence and hold paramount the safety, health, and welfare of the public⁷. AGA's membership shares this belief and continues to take steps to ensure public safety is at the forefront and contributing to a culture focused on safety. Ethical responsibility is a shared responsibility, and the concepts noted within the NSPE's Code of Ethics should be applied to natural gas pipeline work functions, including functions such as design, construction, operations, maintenance, project management, environmental compliance, mapping, and land rights acquisition.

AGA has identified four key ethical practices for operators when performing work:

- Perform work functions only in areas in which they are knowledgeable by education or experience;
- Acknowledge their errors, use diligence to correct these errors, and not distort or alter facts;
- Do not falsify or misrepresent their education, training, or experience; and
- Stop work or advise their management in situations where these guidelines are not followed.

Design Approvals

The system-specific functions identified in Table 1 above may be performed by employees with varying levels of education and experience. Operators should identify critical engineering and construction plans, as they relate to Table 1, and that these plans be reviewed by an individual (or individuals) responsible for design approvals who:

- Has demonstrated competency in all three tiers of critical work functions;
- Has received a bachelor's or higher degree in engineering and has a minimum of four years work experience in natural gas engineering, operations and design; or
- Has a minimum of 10 years of directly related experience in natural gas system design without an engineering degree.

There may also be certain work functions, such as those identified within AGA's "Leading Practices to Reduce the Possibility of a Natural Gas Over-Pressurization Event" document, where an operator may determine a PE licensure is appropriate for review or approval. AGA encourages its membership, to the extent appropriate and applicable to their natural gas systems, to communicate these requirements with their state regulatory agencies and to delineate these requirements in their processes or procedures.

Operators should ensure that engineering designs are reviewed by an employee who has responsible charge for the design. This assures that all aspects of the project are performed under the supervision and direction of that employee. Design reviews and approvals should be determined based on the complexity of the work, rather than overall project cost. More complex designs or those which may pose a greater risk to the public should include additional reviews and approvals, which may include engagement from senior leaders. The appropriate reviews, approvals, and responsible charge for work should be documented and clearly communicated to employees. Key topics such as design approvals,

⁷ <https://www.nspe.org/resources/ethics/code-ethics>

which could improve public safety and reduce the risk of an over pressure event occurring, should be embedded within an operator's safety management systems. This is further enhanced by implementing a management of change process that improves communication of changes across cross functional teams.

Management of Change

Gas systems are complex and may require communicating across several teams to ensure work is designed and performed safely. Operators should equip their employees with procedures or processes that clearly outline specific roles and responsibilities in addition to work process flows. These procedures or processes also help create an avenue to highlight and evaluate any changes in design, and ensure appropriate reviews and approvals are documented. Significant changes made to designs which have previously been approved should also be included in this review process. Continuing to focus on increasing the rigor of these procedures minimizes the risk of human error and provides a shared accountability for work. AGA members acknowledge this is an area of continuous improvement. Ensuring that personnel work collaboratively, and that accountability is clearly defined, will improve pipeline safety.

Continuous Improvement

AGA's membership believes enhancing pipeline safety is a continuous and iterative process. Operators are steadfastly dedicated to the continued delivery of natural gas in a safe and reliable fashion to the communities they serve. AGA's membership continues to reinforce their commitment to safety and working to find ways to further embed safety across all levels of management, and all work functions. Operators are taking additional steps to bring safety to the forefront and carrying out a company culture focused on safety. This includes enhancing programs or systems which help identify, manage, and reduce the risks to pipeline systems.

Many operators are in the process of implementing pipeline safety management systems (PSMS). An effective PSMS is a journey, not a destination, meaning that the successful implementation of a continuous improvement process as PSMS requires continual reevaluation. With leadership commitment to the concepts provided in API RP 1173 – *Pipeline Safety Management System*, the operators can better understand, manage, and continuously improve their safety efforts at any stage of their operations. This includes reviewing, and, if needed, updating design processes, procedures, employee responsibilities, key competencies required for performing engineering design review, and requiring additional design review for more complex work.

These systems work effectively only if the personnel are educated, trained, and experienced enough to safely and correctly implement its procedures and standards. Operators must ensure that their employees are competent in the applicable functions discussed earlier in this document. Further, operators must educate employees on newly emerging or changing risks to the industry and their systems, opportunities to improve procedures and standards, and the consequences of failing to safely follow procedures and standards.

These programs will vary based on the size and complexity of each operators' unique pipeline system. However, considerations for monitoring the safety and effectiveness of a natural gas system may include:

- Developing processes to collect and review key performance indicators;

- Developing a process for conducting root cause analysis;
- Incorporating lessons learned from incident investigations;
- Developing processes for periodic risk identification, assessment, prevention, and mitigation;
- Reviewing procedures, standards, training, and responsibilities periodically;
- Evaluate asset management plans and update as needed; and
- Assess safety culture and implement enhancements and reinforcements to the applicable workgroups.

Conclusion

Ensuring the safe operation of natural gas systems includes relevant technical expertise, but also requires an operator's knowledge of their specific system. An emphasis on system knowledge, as well as having processes in place to ensure applicable technical expertise, designs review and approvals, and management of change, will have the greatest impact on pipeline safety. The PE licensure demonstrates technical competence in the field of engineering, focusing on concepts such as fluid mechanics, thermodynamics, and structural mechanics, as well as the standard of care and ethics. However, a PE license does not necessarily demonstrate that an individual has the specified system knowledge required to understand natural gas systems and make prudent decisions related to public safety.

AGA and its member companies are committed to improving pipeline safety. This white paper provides guidance on technical competencies, ethical responsibilities required to perform engineering work functions for natural gas systems, and the pursuit of continuous improvement. The various levels of training, competence, experience and continuous improvement discussed in this white paper should serve as a basis for a good dialogue on the path to improved pipeline safety.

Appendix A

Table 2: Examples of requirements for technical competency within 49 CFR, Part 192

192.328(a)(2)(ii)	This section addresses the additional construction requirements for new or existing pipeline segments to operate at an alternative pressure. It specifies that the quality assurance plan for applying and testing field applied coatings to a weld must be <i>“performed by and individual with the knowledge, skills, and ability to assure effective coating application.”</i>
192.615(11)(b)(2)	<i>“Train the appropriate operating personnel to assure that they are knowledgeable of the emergency procedures and verify that the training is effective.”</i>
192.631(h)	Outlines training requirements, including familiarity with procedures, for controllers working in a control room.
192.915(a)	This section address what knowledge is required to carry out an operator’s transmission integrity management program <i>“The integrity management program must provide that each supervisor whose responsibilities relate to the integrity management program possesses and maintains a thorough knowledge of the integrity management program and of the elements for which the supervisor is responsible.”</i>
192.1007	This section address what elements are required for a distribution integrity management plan <i>“An operator must demonstrate an understanding of its gas distribution system developed from reasonably available information.”</i>