CGA
Compressed Gas Association
The Standard For Safety Since 1913

1ST EDITION

CGA P-93 — 2023

GUIDELINE FOR PIPING FAILURE RATES IN NONTOXIC CRYOGENIC GAS SUPPLY SYSTEMS

PLEASE NOTE:

The information contained in this document was obtained from sources believed to be reliable and is based on technical information and experience currently available from members of the Compressed Gas Association, Inc. and others. However, the Association or its members, jointly or severally, make no guarantee of the results and assume no liability or responsibility in connection with the information or suggestions herein contained. Moreover, it should not be assumed that every acceptable commodity grade, test or safety procedure or method, precaution, equipment or device is contained within, or that abnormal or unusual circumstances may not warrant or suggest further requirements or additional procedure.

This document is subject to periodic review, and users are cautioned to obtain the latest edition. The Association invites comments and suggestions for consideration. In connection with such review, any such comments or suggestions will be fully reviewed by the Association after giving the party, upon request, a reasonable opportunity to be heard. Proposed changes may be submitted via the Internet at our website, www.cganet.com.

This document should not be confused with federal, state, provincial, or municipal specifications or regulations; insurance requirements; or national safety codes. While the Association recommends reference to or use of this document by government agencies and others, this document is purely voluntary and not binding unless adopted by reference in regulations.

A listing of all publications, audiovisual programs, safety and technical bulletins, and safety posters is available via the Internet at our website at www.cganet.com. For more information contact CGA at Phone: 703-788-2700, ext. 799. E-mail: customerservice@cganet.com.

Work Item 19-111
Process Safety Committee

FIRST EDITION: 2023

Contents **Page**

1 Introduction 1

2 Scope 1

3 Definitions 2

4 Hydrocarbon release database sorting methodology 2
4.1 Equipment 2
4.2 Data exclusions 2
4.3 Curve fit 2
4.4 Other components 2

5 Leak frequency determination 3
5.1 Leak frequency equation 3
5.2 Sample calculation 4

6 References 5

Table

Table 1—Equivalent length of various equipment 3

Figures

Figure 1—Hose example 1 4
Figure 2—Hose example 2 4
Figure 3—Hose example 3 4
Figure 4—Hose example 4 4

1 Introduction

Small scale industrial installations for industrial gases have generally been guided by codes and standards that prescribe setbacks to property lines and other safety critical objects by way of tables. These tables are often generated by committee where the basis of the prescriptive requirements can be lost to history.

More recently there is a move to a risk basis for small scale setback requirements. Risk is determined by the consequence of a release multiplied by the probability of such a release. When the full details of a site are documented, a risk-based approach can be taken adding up all potential leak consequences and the probability of each leak. These can then be rank ordered by either range or persons affected and the aggregate probabilities then totaled. Such a detailed process is often referred to as quantitative risk analysis or a QRA.

Large scale industrial sites use QRAs to qualify the risk-based siting. This process requires a detailed understanding of the system layout and component positions. Additionally, failure frequency data is used to characterize the likelihood and size of unintended holes, typically modeled as round holes. This failure data is collected and summarized into component types and size bundles that do not lend themselves to proper modeling smaller scale piping systems.

Many industrial gas systems have smaller scale piping systems and can be in near retail or light industrial areas where available setbacks are much smaller.

Risk-based methodologies such as QRAs require determining both the probability of an unintended release and the consequence of that release. Determining the release probability in a piping system is key in determining a risk profile. Many acceptable datasets exist for piping failure frequencies. This publication is offered as an alternative approach and is intended to offer a simplified means to determining leak frequency for small scale systems using data correlated from the HSE Hydrocarbon Release Database (HCRD) [1].[1] Smaller scale piping in industrial gas installation, as a subset of larger statistical databases, has improved performance beyond the generalized conclusions of broader sample sets. The equations for failure frequencies presented in this publication are based on and appropriately sorted and filtered from the HCRD.

This calculation methodology provides technical guidance and the equation set to determine the leak frequency for the various equipment found within industrial gas installations. Considerations are made for the environment of the piping as it relates to adjacent equipment during maintenance and repair.

For more details on the development of this methodology, see CGA TR-7, *Methodology to Determine Piping Failure Rates for Nontoxic Cryogenic Industrial Gas Supply Systems with Pipe Size Up To 6 Inches* [2].

2 Scope

This publication applies to piping up to and including 6-inch pipe size of 300 series austenitic stainless steels and when the design pressure stress of the pipe does not exceed one half of the basic allowable stress. The use of this publication is intended for light industrial sites. Risks from outside threats to piping, if present, should be considered separately. Near retail or light industrial areas are defined as areas where the size of the piping and major equipment in the designed system are same or larger than any adjacent or neighboring systems. Neighboring or adjacent systems of larger diameter or larger components where the maintenance setbacks or defined risk area overlaps would disqualify the site as near retail or light industrial. Additionally, near retail areas are often inherently closer to the public.

[1] References are shown by bracketed numbers and are listed in order of appearance in the reference section.