CGA

Compressed Gas Association

The Standard For Safety Since 1913

CGA P-56—2014

CRYOGENIC VAPORIZATION SYSTEMS—PREVENTION OF BRITTLE FRACTURE OF EQUIPMENT AND PIPING

SECOND EDITION

PREFACE

As part of a program of harmonization of industry standards, the Compressed Gas Association (CGA) has issued CGA P-56—2014, *Cryogenic Vaporization System—Prevention of Brittle Fracture of Equipment and Piping*, jointly produced by members of the International Harmonization Council and originally published by the European Industrial Gases Association (EIGA) as EIGA Doc 133, *Cryogenic Vaporisation Systems – Prevention of Brittle Fracture of Equipment and Piping*.

This publication is intended as an international harmonized standard for the worldwide use and application of all members of the Asia Industrial Gases Association (AIGA), Compressed Gas Association (CGA), European Industrial Gases Association (EIGA), and Japan Industrial and Medical Gases Association (JIMGA). Each association's technical content is identical, except for regional regulatory requirements and minor changes in formatting and spelling.

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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 web site, www.cganet.com.

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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.

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NOTE—Technical changes from the previous edition are underlined.

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1 Introduction

Cryogenic (or cold) fluids can be inadvertently admitted to process piping and equipment due to the malfunctioning of cryogenic liquid vaporization systems, which can result in catastrophic failure due to brittle fracture. When certain metals, typically carbon steels, become cold they undergo changes in their structure, which makes them less ductile i.e., they become brittle. Other metals such as stainless steels, aluminum, brass, and copper do not exhibit this ductile/brittle transition and remain ductile at low temperatures. This ductile-to-brittle transition can cause an existing defect in a material to propagate to a crack or even start a crack with no additional increase in stress. A brittle failure of an item is more destructive as the crack propagates rapidly and sections of material can become detached, whereas with a ductile failure the material "tears" and the pressure is vented in a more controlled fashion.

2 Scope and purpose

This publication applies to cryogenic liquid supply systems, located either on a customer site or a production site, where cryogenic liquid is vaporized and is then supplied either as the primary or secondary source of gaseous product. This guideline is limited to the prevention of brittle fracture in piping and associated equipment.

The secondary source of supply can be a back-up supply to a production plant when the production plant trips or is shut down, a supplementary supply to meet customer demand where it exceeds the capacity of the production plant ("peak-shaving"), or as a back-up supply at a customer site (e.g., a health care facility).

The principles presented in this publication apply to any low temperature process fluid supply system where the temperature of the fluid is lower than the minimum temperature rating of the piping and/or associated equipment downstream of the vaporizer.

Examples include:

- nitrogen;
- oxygen;
- argon;
- helium;
- hydrogen;
- natural gas;
- methane; and
- ethylene.

The supply systems work by vaporizing cryogenic liquid, typically in response to decreasing pipeline pressure.

Systems are made up from the following:

- A liquid supply from either a low pressure tank and pump arrangement, or directly from a high pressure tank; and
- A vaporization system that could be an ambient air type or one that utilizes an external energy source, e.g., steam, hot water, electricity, direct fired.

Although this publication does not cover the following situations, the techniques listed may be considered for cold embrittlement prevention:

- Air separation and other cryogenic processes with columns, separators, or tanks in which a gas stream from a sump is normally supplied through downstream heat-exchange equipment. Cryogenic processes are assumed to have their own low temperature protection systems (LTPS);