

CGA G-15—2018

**FLUORINE AND FLUORINE
MIXTURES WITH INERT GASES**

**SECOND EDITION
(Corrected 2/13/2020)**

PREFACE

As part of a program of harmonization of industry standards, the Compressed Gas Association (CGA) has issued CGA G-15, *Fluorine and Fluorine Mixtures with Inert Gases*, jointly produced by members of the International Harmonization Council and originally published by the European Industrial Gases Association (EIGA) as EIGA Doc 140, *Fluorine and Fluorine Mixtures with Inert Gases*.

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.

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 web site, 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 14-008
Specialty Gases Committee

NOTE—Technical changes from the previous edition are underlined.

SECOND EDITION: 2018 (Corrected 2/13/2020)

FIRST EDITION: 2010

© – Reproduced with permission from, the European Industrial Gases Association. All rights reserved.

Contents	Page
1 Introduction.....	1
2 Scope and purpose	1
3 Definitions.....	1
4 Properties of fluorine	3
4.1 Fluorine identification.....	3
4.2 Physical properties of pure fluorine	4
4.3 Chemical reactivity	5
4.4 Toxicity	6
4.5 Routes of exposure	7
4.6 Environmental issues	8
5 Oxidizing/reactivity hazards.....	8
5.1 Introduction to fire and explosion hazards.....	8
5.2 Factors influencing reaction, ignition, and combustion.....	9
6 Control of toxicity hazards	13
6.1 Detection of fluorine leaks	13
6.2 Ventilation.....	14
6.3 Personal protective equipment (PPE)	15
7 Control of oxidizing/reaction hazards	15
7.1 Building/site considerations	15
7.2 Materials of construction of fluorine systems.....	16
7.3 Fluorine system design.....	18
7.4 Equipment selection	20
7.5 Cleaning and passivation of fluorine systems	21
7.6 Compression of fluorine.....	23
7.7 Operating procedures and personnel training	23
7.8 Maintenance procedures	24
8 Cylinder filling	24
8.1 Filling facility considerations.....	24
8.2 Gas containers and associated equipment	25
8.3 Cylinder filling equipment	27
9 Supply to point-of-use	28
9.1 Facility considerations and storage	28
9.2 Gas supply manifolds	28
10 Gas abatement system [28, 29]	29
10.1 Abatement for processing.....	29
10.2 Abatement for emergency release	29
10.3 Basic principles of abatement.....	30
10.4 Dry scrubbers	30
10.5 Wet scrubbers	30
11 Transportation	30
11.1 Land transport	30
11.2 Air transport.....	31
11.3 Sea transport	31
12 Emergency response	31
12.1 Leaks of fluorine	31
12.2 Firefighting.....	32
12.3 First aid measures	32
13 References	33

Tables

Table 1—Physical properties of pure fluorine	4
Table 2—Physical properties of fluorine/nitrogen mixtures (10/90 mol %)—ideal mixture	4
Table 3—Physical properties of fluorine/nitrogen mixtures (20/80 mol %)—ideal mixture	4
Table 4—Regulatory exposure limits for fluorine	6
Table 5—Established LC ₅₀ values.....	6
Table 6—Temperature effects on common metals used for fluorine service.....	10
Table 7—Guidelines for velocity limits in pipelines for fluorine and mixtures > 35%	19
Table 8—Passivation guidelines versus fluorine design conditions.....	23

Figure

Figure 1—Fire triangle	8
------------------------------	---

Appendix

Appendix A—Audit checklist	36
----------------------------------	----

1 Introduction

Fluorine is a highly toxic and oxidizing gas that presents health risks such as poisoning by inhalation and safety risks such as combustion.

Fluorine and fluorine mixtures can be safely handled if equipment is properly designed and maintained, handling precautions are taken, and employees are trained. As a minimum, all personnel shall have access to the safety data sheet (SDS) and be trained in the use of the SDS and other reference material.

2 Scope and purpose

This publication is for suppliers, distributors, and users of gaseous fluorine and mixtures of fluorine with inert gases and handling equipment. This publication is intended for fluorine and mixtures where the resulting fluorine concentrations greater than or equal to 0.5% fluorine are considered to present a risk of reaction due to the oxidizing potential.

This publication provides a good understanding of the potential hazards involved in storage, use, and transportation of compressed fluorine and its mixtures with inert gases and approaches to be taken to minimize the risk of incidents.

The manufacture, purification, liquefaction, and analysis of fluorine or its mixtures with inert gases are beyond the scope of this publication, although the general guidance given is also relevant to these processes.

An audit checklist is located in Appendix A of this publication.

3 Definitions

For the purpose of this publication, the following definitions apply.

3.1 Publication terminology

3.1.1 Shall

Indicates that the procedure is mandatory. It is used wherever the criterion for conformance to specific recommendations allows no deviation.

3.1.2 Should

Indicates that a procedure is recommended.

3.1.3 May

Indicates that the procedure is optional.

3.1.4 Will

Is used only to indicate the future, not a degree of requirement.

3.1.5 Can

Indicates a possibility or ability.

3.2 Technical definitions

3.2.1 Auto-ignition temperature

Temperature at which a substance will spontaneously ignite in a specified oxidant at a given pressure.

3.2.2 Bundle (of cylinders)

Assembly of cylinders that are fastened together and interconnected by a manifold and carried as a unit.

3.2.3 Cylinder

Transportable pressure receptacle having a water capacity that does not exceed 150 L and can be filled with gas under pressure.