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HYCO PLANT GAS LEAK DETECTION AND RESPONSE PRACTICES

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PREFACE

As part of a program of harmonization of industry standards, the Compressed Gas Association (CGA) has published CGA H-14, *HYCO Plant Gas Leak Detection and Response Practices*, jointly produced by members of the International Harmonization Council.

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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NOTE— No technical information has been changed from the 2018 edition. This reaffirmed edition may include minor editorial changes.

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1 Introduction

HYCO plants are facilities that produce hydrogen, carbon monoxide, or mixtures thereof. These plants are typically operated with feed stocks such as natural gas, refinery off gas, naphtha, and other light hydrocarbons.

Gases from HYCO plants are flammable and can be toxic; therefore, appropriate leak prevention design, monitoring, and response practices shall be applied to ensure personnel and public safety. Leak detection is part of an overall system comprising design aspects, leak detection devices, operating practices, and the response to leak indications.

2 Scope

This publication applies to HYCO plants. Information in this publication may also be applied to facilities, such as trailer fill stations, cylinder fill stations, electrolytic production facilities, or vehicle fueling stations.

This publication covers methodologies for prevention of, detection of, and response to flammable and/or toxic gas leaks that occur within the fence line of these facilities. Typical leak detection technologies are discussed including personal monitoring, fixed monitoring, and specialized detectors for identifying leak location. This publication also addresses the specifics of gas leaks occurring at unmanned or remotely monitored sites.

The leaks discussed in this publication are due to a loss of containment in process piping and equipment. A loss of containment is an unexpected release of process fluid to the atmosphere. A leak of this type is typically through a failed sealing device (e.g., stem packing, flange gasket) or a failure of the pressure boundary (e.g., crack in a weld). Many jurisdictions use the concept of fugitive emissions for leaks that are too small to repair, which are not covered in any detail in this publication due to jurisdictional variances.

This publication does not cover leaks from transportation piping or components leading to flares or process vents. It does not address routine oxygen deficiency and enrichment as these are covered in other harmonized publications (EIGA Doc 23, Safety Training of Employees; EIGA Doc 44, Hazards of Inert Gases and Oxygen Depletion), as well as in CGA P-76, *Hazards of Oxygen-Deficient Atmospheres* [1, 2, 3].¹ It also does not address fire and smoke detection in buildings as these are covered in National Fire Protection Association (NFPA) standards and local building codes.

The reader should determine applicability for facilities other than those described in this publication or for leaks entering the facility from outside of the perimeter.

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.

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

3.1.5 Can

Indicates a possibility or ability.

3.2 Technical definitions

3.2.1 Action level

Condition in which the atmosphere is outside the acceptable range and an operator shall take action to prevent the hazard from escalating.

3.2.2 Alarm level

Condition that results in a warning (alarm) indicating that the atmosphere is outside of the range of normal.

3.2.3 Cross header

Refractory lined pipe that connects the reformer outlet manifold to the inlet of the waste heat boiler.

NOTE—Also known as a transfer header.

3.2.4 Cross-sensitive

Situation in which a sensor designed for a particular target gas reacts to another gas as if that gas were the target (e.g., a carbon monoxide sensor that is cross-sensitive to hydrogen will interpret a hydrogen leak as carbon monoxide).

3.2.5 Fugitive emissions

Emissions that cannot reasonably pass through a stack, chimney, or vent or other functionally equivalent opening [4].

3.2.6 HYCO plant

Facilities which produce hydrogen, carbon monoxide, or mixtures thereof.

3.2.7 Immediately dangerous to life or health (IDLH)

Maximum concentration from which unprotected persons are able to escape within 30 minutes without escape-impairing symptoms or irreversible health effects.

3.2.8 Line stop

Plug that is installed in plant piping, typically while the plant is in operation.

3.2.9 Lower flammability limit (LFL)

Minimum concentration in air of a gas that would burn when ignited.

NOTE—Also known as the lower explosive limit (LEL).

3.2.10 Monitors

3.2.10.1 Fixed monitor

Detection device that is permanently mounted in one (fixed) location and that can be used for detection of one or more fires or gas leaks.

3.2.10.2 Personal monitor

Gas detection device that is worn by personnel or visitors at an operating facility and that transmits warnings via audible and visible signals, such as alarms and flashing lights, when dangerous levels of gas vapors are detected.

3.2.10.3 Portable monitor

Handheld gas detection device that transmits warnings via audible and visible signals, such as alarms and flashing lights, when dangerous levels of gas vapors are detected.

3.2.11 Permissible exposure limits (PEL)

8-hour time weighted average exposure set by the U.S. Occupational Safety and Health Administration (OSHA).

3.2.12 Reportable quantity (RQ)

Minimum amount of hazardous substance which, when known to have been discharged into the environment within a prescribed time limit, is required to be reported to the authority having jurisdiction.

NOTE—In the United States the prescribed time limit is 24 hours and reports are made to the National Response Center in Washington, DC.

3.2.13 Upper flammability limit (UFL)

Maximum concentration in air of a gas that would burn when ignited.

NOTE—Also known as upper explosive limit (UEL).

4 Safety considerations

A HYCO plant produces hydrogen and/or carbon monoxide as products. The feed stocks for a HYCO plant are a variety of light hydrocarbon gases or liquids and sometimes ammonia. These colorless gases or liquids can be flammable and/or toxic. Toxic and flammable gas detectors are commonly used throughout a HYCO plant to warn of potentially dangerous gas leaks or harmful exposure to personnel; they play a valuable role in risk mitigation. Selection of appropriate gas detectors will depend on the gas being detected. Table 1 identifies the key properties of some of the substances most commonly found in HYCO plants. The basic physical characteristics listed in the table affect sensor selection and placement, leak detection, and required personnel behavior in the area of the leak. The operator shall review the safety data sheet (SDS) to understand all of the hazards associated with a specific gas.

Diffusion governs the behavior of gases leaking into the atmosphere. Wind direction, turbulence, leak rate, and the temperature and specific gravity of the leaking gas all have an effect on how the vapor cloud moves away from the leak source. Sensor placement shall take all of these factors into account. In the case of an enclosed space such as a building, the impact of these parameters is obvious. However, some plant areas with limited ventilation can offer similar risk regarding a gas leak. The proximity to occupied buildings should be considered, for guidance see CGA P-64, *Guideline for the Location of Occupied Buildings in Industrial Gas Plants* [5].

Attention shall be paid to the impact of the temperature of the fluid on vapor cloud behavior when assessing the hazards associated with a leak. Cryogenic gases or cryogenic liquid boil off that have specific gravities that are lighter than air can drop due to their low temperatures. Conversely, gases that have normal specific gravities that are heavier than air can rise when heated. A special case of high gas temperature is where a flammable gas mixture is greater than the autoignition temperature and can spontaneously ignite on contact with air. In this case the leak confirmation will often be the presence of a flame.

Unexpected behaviors can occur in the presence of wind or forced ventilation. Wind driven air flowing over an object such as a building or pipe rack can cause eddies downstream, which can form down drafts. These down drafts can cause gases whose normal specific gravity is lighter than air to fall.

Depending on the concentration of the flammable gas in air, the vapor cloud can ignite. Gases with a low threshold of ignition energy (e.g., hydrogen) can ignite due to static sparks generated by flow friction, which is accentuated by flow velocity. Vapor clouds ignited in an open area typically burn as a deflagration. However, if the vapor cloud is confined or is in a congested area, the deflagration can transition to detonation. This vapor cloud behavior shall be part of the risk assessment after the leak is confirmed.

When a gas is both toxic and flammable, the toxicity often dictates the behavior requirement in response to a leak. For example, in the case of carbon monoxide, the point at which the concentration is considered IDLH is approximately 1% of the LFL. The PEL is 0.02% of the LFL.

If a gas detector indicates that the concentration of a toxic gas is greater than the PEL, actions shall be taken to address the hazard before attempting to work in the area (e.g., increased ventilation, appropriate personal protective equipment [PPE], use of breathing air). It is important that the user of the gas detector be aware that the vapor cloud shape is typically irregular and that the concentration is not homogenous. PPE and other mitigations should be identified based on a hazard assessment.

Visitors to the site shall be informed of the hazards associated with any gases or liquids that could be present in the facility along with the appropriate response to any leaks that could occur. Visitor indoctrination shall include