

Recommended Practice for Oil and Gas Producing and Gas Processing Plant Operations Involving Hydrogen Sulfide

API RECOMMENDED PRACTICE 55
SECOND EDITION, FEBRUARY 1995

REAFFIRMED, JANUARY 2013



AMERICAN PETROLEUM INSTITUTE

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Upstream Segment

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FOREWORD

These recommended practices were prepared by the API Subcommittee on Production Operations Involving Hydrogen Sulfide. This standard is under the administration of the American Petroleum Institute Exploration & Production Department's Executive Committee on Drilling & Production Practices.

It is intended that these voluntary recommended practices serve as a guide to promote and maintain integrity of oil and/or gas producing and gas processing facilities in the interests of public safety, personnel safety, and protection of the environment. Users of this publication are reminded that constantly developing technology, specific company requirements and policy, and specialized or limited operations do not permit coverage of all possible operations, practices, or alternatives. This standard is not so comprehensive as to present *all* of the recommended practices for oil and gas well producing operations and gas processing plant operations involving hydrogen sulfide. Alternative operating procedures and/or equipment are available and routinely used to meet or exceed recommended practices or performance levels set forth herein. Recommendations presented in this publication are based on industry experience and expertise involving a wide range of operating locations and conditions. Recommendations presented in this publication are not intended to inhibit developing technology and equipment improvements or improved operating procedures. This publication, or portions thereof, cannot be substituted for qualified technical/operations analysis and judgment to fit a specific situation.

There may be federal, state, or local statutes, rules, or regulations requiring oil and gas producing and gas processing operations to be conducted in a safe or environmentally sound manner. Organizations and individuals using this standard are cautioned that requirements of federal, state, or local laws and regulations are constantly evolving. These requirements should be reviewed to determine whether the practices recommended herein and the operations being planned or conducted are consistent with current laws and regulations.

Information concerning safety and health risks and proper precautions with respect to particular materials and conditions should be obtained from the employer, the manufacturer or supplier of that material, or the material safety data sheet (MSDS).

Provisions of these voluntary recommended practices include use of the verbs "shall" and "should", whichever is deemed most applicable for the specific situation. For purposes of this publication, the following definitions are applicable.

Shall: Indicates the "recommended practice(s)" has universal applicability to that specific activity.

Should: Denotes a "recommended practice(s)" 1) where a safe comparable alternative practice(s) is available; 2) that may be impractical under certain circumstances; or 3) that may be unnecessary under certain circumstances.

Suggested revisions to these recommended practices are invited and should be submitted in writing to: Director, Exploration & Production Department, American Petroleum Institute, 700 North Pearl Street, Suite 1840, Dallas, Texas 75201-2845.

Recommended Practices for Oil and Gas Producing and Gas Processing Plant Operations Involving Hydrogen Sulfide

0 Introduction

The petroleum industry, through many years of research and operating experience, has developed guidelines for safe operations under conditions involving hydrogen sulfide. Continuing industry efforts, which include planning, prudent selection and layout of equipment, prudent selection of materials, operating and emergency procedures, specialized safety equipment, and appropriate personnel training are all necessary to ensure successful and safe operations. Effective response to emergencies requires prior planning. *Good engineering practice (engineering and administrative controls) dictates that producing and gas processing systems be designed to minimize exposure of personnel and the public to hydrogen sulfide and sulfur dioxide.*

1 Scope

Recommendations set forth in this publication apply to oil and gas producing and gas processing plant operations conducted with hydrogen sulfide present in the fluids being handled. The presence of hydrogen sulfide in these operations also presents the possibility of exposure to sulfur dioxide from the combustion of hydrogen sulfide. *Refer to Section 4 for applicability of this standard.*

2 References

2.1 STANDARDS

The following standards contain provisions which, through reference in this text, constitute provisions of this standard. All standards are subject to revision, and users are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below.

ACGIH¹

1. *Threshold Limit Values and Biological Exposure Indices (1993-94).*

ANSI²

2. B31.3 *Chemical Plant and Petroleum Refining Piping.*
3. B31.4 *Liquid Petroleum Transportation Piping Systems.*
4. B31.8 *Gas Transmission and Distribution Piping Systems.*
5. CGA G-7.1 *Breathing Air, Grade D.*
6. ISEA 102 *Standard for Gas Detector Tube Units—Short Term Type for Toxic Gases and Vapors in Working Environments.*
7. Z88.2 *Practices for Respiratory Protection.*

API³

8. **BUL E1** *Bulletin on the Generic Hazardous Chemical Category List and Inventory for the Oil and Gas Exploration & Production Industry.*
9. **BUL E2** *Bulletin on Management of Naturally Occurring Radioactive Materials (NORM) in Oil and Gas Production.*
10. **BUL E3** *Well Abandonment and Inactive Well Practices for U.S. Exploration and Production Operations.*
11. **BUL E4** *Release Reporting for the Oil and Gas Exploration and Production Industry as Required by the CWA, CERCLA, and SARA Title III.*
12. **RP12R1** *Recommended Practice for Setting, Maintenance, Inspection, Operation, and Repair of Tanks in Production Service.*
13. **RP14C** *Recommended Practice for Analysis, Design, Installation, and Testing of Basic Surface Safety Systems for Offshore Production Platforms.*
14. **RP49** *Recommended Practice for Drilling and Drill Stem Testing Operations Involving Hydrogen Sulfide.*
15. **RP500** *Recommended Practice for Classification of Locations for Electrical Installations at Petroleum Facilities.*
16. **API 510** *Pressure Vessel Inspection Code: Maintenance Inspection, Rating, Repair, and Alteration.*
17. **RP576** *Inspection of Pressure Relieving Devices.*
18. **RP750** *Management of Process Hazards.*
19. **STD 1104** *Welding of Pipelines and Related Facilities.*
20. **PUBL 2217A** *Guidelines for Work in Inert Confined Spaces in the Petroleum Industry.*

ASME⁴

21. *Boiler & Pressure Vessel Code.*

¹American Conference of Governmental Industrial Hygienists, 1330 Kemper Drive, Cincinnati, OH 45240.

²American National Standards Institute, 1430 Broadway, New York, N.Y. 10018.

³American Petroleum Institute, Publications & Distribution Section, 1220 L Street NW, Washington, D.C. 20005.

⁴American Society of Mechanical Engineers, 22 Law Drive, Box 2300, Fairfield, NJ 07007-2300.



EPA⁵

22. EPA/600/8-86/026A *Health Assessment Document for Hydrogen Sulfide.*

ISA⁶

23. S12.15, Part I *Performance Requirements for Hydrogen Sulfide Detection Instruments.*
24. RP12.15, Part II *Installation, Operation, and Maintenance of Hydrogen Sulfide Detection Instruments.*

NACE⁷

25. MR0175-94 *Standard Material Requirements Sulfide Stress Cracking Resistant Metallic Materials for Oilfield Equipment.*

National Response Team⁸

26. NRT-1 *Hazardous Materials Emergency Planning Guide.*
27. *Technical Guidance for Hazards Analysis, Emergency Planning for Extremely Hazardous Substances.*

NFPA⁹

28. NFPA 70 *National Electrical Code.*
29. NFPA 496 *Purged and Pressurized Enclosures for Electrical Equipment in Hazardous (Classified) Locations.*

NIOSH¹⁰

30. NIOSH 74-111 *Criteria for a Recommended Standard for Occupational Exposure to Sulfur Dioxide (GPO No. 017-033-00029).*
31. NIOSH 77-158 *Criteria for a Recommended Standard for Occupational Exposure to Hydrogen Sulfide (GPO No. 017-033-00217-7).*
32. DHHS 85-114 *NIOSH Pocket Guide to Chemical Hazards.*

⁵Environmental Protection Agency, available from U.S. Government Printing Office, Washington, D.C. 20402.

⁶Instrument Society of America, Box 12277, Research Triangle Park, NC 27709.

⁷National Association of Corrosion Engineers, NACE International, Box 218340, Houston, Texas 77218-8340.

⁸National Response Team, National Oil and Hazardous Substances Contingency Plan GWDR/12, 2100 Second Street SW, Washington, D.C. 20593.

⁹National Fire Protection Association, 60 Batterymarch Park, Quincy, MA 02269.

¹⁰National Institute for Occupational Safety and Health (U.S. Department of Health, Education, and Welfare), available from U.S. Government Printing Office, Washington, D.C. 20402.

PACE¹¹

33. Report 85-5 *Review of Ambient Hydrogen Sulfide Standards in Canada.*

2.2 REGULATIONS

The following regulations are referenced in this standard. All regulations are subject to revision, and users should determine the latest version to ensure compliance.

Bureau of Mines (DOI)¹²

34. 30 CFR Chapter 1, Subchapter B, Part II, Subpart H *Respiratory Protection Devices.*

Coast Guard (DOT)¹³

35. 33 CFR Parts 140, 143, and 146 *Emergency Evacuation Plans for Manned OCS Facilities.*
36. 54 FR 21566, May 18, 1989 *Emergency Evacuation Plans for Manned OCS Facilities.*

DOT¹⁴

37. 49 CFR Part 178, Subpart C *Shipping Container Specifications.*

EPA⁵

38. 40 CFR Part 264, Subpart D *Contingency Plans and Emergency Procedures.*
39. 40 CFR Part 302 *Designation, Reportable Quantities, and Notification.*
40. 40 CFR Part 355 *Emergency Planning and Notification.*
41. 40 CFR Part 370 *Hazardous Chemical Reporting: Community Right-to-Know.*

MMS (DOI)¹⁵

42. 30 CFR Parts 250 & 256 *Oil, Gas, and Sulphur Operations in the Outer Continental Shelf.*
43. 53 FR 10596-10777, April 1, 1988 *Oil, Gas, and Sulphur Operations in the Outer Continental Shelf.*
44. MMS-OCS-1 *Safety Requirements for Drilling Operations in a Hydrogen Sulfide Environment, Outer Continental Shelf (February 1976).*

¹¹Petroleum Association for Conservation of the Canadian Environment, 12002-275 Slater Street, Ottawa, Ontario, Canada L1P-5H9.

¹²Bureau of Mines, U.S. Department of Interior, available from U.S. Government Printing Office, Washington, D.C. 20402.

¹³Coast Guard, U.S. Department of Transportation, available from U.S. Government Printing Office, Washington, D.C. 20402.

¹⁴U.S. Department of Transportation, available from U.S. Government Printing Office, Washington, D.C. 20402.

¹⁵Minerals Management Service, U.S. Department of Interior, 381 Elden Street, Herndon, VA 22070-4817. Available from U.S. Government Printing Office, Washington, D.C. 20402.



45. 47 FR 28888, July 1, 1982 *Safety Requirements for Drilling Operations in a Hydrogen Sulfide Environment, Outer Continental Shelf*. (July 1, 1982).
- OSHA¹⁶
46. 29 CFR Part 1910.38 *Employee Emergency Plan and Fire Prevention Plans.*
47. 29 CFR Part 1910.119 *Process Safety Management of Highly Hazardous Chemicals.*
48. 29 CFR Part 1910.120 *Hazardous Waste Operations and Emergency Response.*
49. 54 FR Part 9294, March 6, 1989 *Hazardous Waste Operations and Emergency Response.*
50. 29 CFR Part 1910.134 *Respiratory Protection Standard.*
51. 29 CFR Part 1910.146 *Permit-required Confined Spaces.*
52. 29 CFR Part 1910.1000 *Toxic and Hazardous Substances (Air Contaminants).*
53. 54 FR 2332, January 19, 1989 *Air Contaminants.*
54. 58 FR 35338, June 30, 1993 *Air Contaminants.*
55. 29 CFR Part 1910.1200 *Hazard Communication Standard.*
- Pipeline Ruptures", Department of Mechanical Engineering, University of Alberta, Edmonton, Canada.
62. Jann, P. R., "Evaluation of Sheltering In Place", *Journal of Loss Prevention in the Process Industry*, Vol. 2, No. 1, Jan. 1989, pp 33-38.
63. MacFarlane, D. R. and Ewing, T. F., "Acute Health Effects From Accidental Releases of High Toxic Hazard Chemicals", *Journal of Loss Prevention in the Process Industry*, Vol. 3, No. 1, January 1990, pp 167-176.
64. Wilson, D. J., "Stay Indoors or Evacuate to Avoid Exposure to Toxic Gas?", *Emergency Preparedness Digest*, Ottawa, Canada, January-March 1987, pp 19-24.
65. Davies, P. C. and Purdy, G., "Toxic Gas Risk Assessments—The Effects of Being Indoors", North Western Branch Papers 1986 No. 1, Institution of Chemical Engineers, Health and Safety Executive, Major Hazards Assessment Unit, St. Annes House, Stanly Precinct, Bootle, Merseyside, England.
66. Glickman, T.S. and Ujrhara, A. M., "Protective Action Decision Making in Toxic Vapor Cloud Emergencies", Center for Risk Management, Resources for the Future, Washington, D. C. 20036.
67. Wilson, D. J., "Variation of Indoor Shelter Effectiveness Caused by Air Leakage Variability of Houses in Canada and the USA", US EPA/FEMA Conference on Effective Use of In-place Sheltering as a Potential Option to Evacuation During Chemical Release Emergencies, Emmitsburg, MD, November 30-December 1, 1988.

2.3 OTHER REFERENCES

56. Poda, George A., "Hydrogen Sulfide Can Be Handled Safely", *Archives of Environmental Health*, Vol. 12, 795-800, June 1966.
57. Ronk, Richard and White, M. K., "Hydrogen Sulfide and the Probabilities of Inhalation Through a Tympanic Membrane Defect", *Journal of Occupational Medicine*, Vol. 25, No. 5, 337-340, May 1985.
58. *Synopsis of Boiler & Pressure Vessel Laws, Rules, and Regulations by States, Cities, Counties, and Provinces (United States and Canada)*, available from Uniform Boiler and Pressure Vessel Laws Society, P. O. Box 1521, Oceanside, New York, NY 11572.
59. Pasquill, F., *Atmospheric Diffusion*, Second Edition, John Wiley & Sons, New York, NY, 1947.
60. Slade, D. H., *Metrology and Atomic Energy* NTIS-TID 24190 (1968), National Technical Information Service (NTIS), U.S. Department of Commerce, Springfield, VA 22161.
61. Wilson, D. J., "Release and Dispersion of Gas from

2.4 BIBLIOGRAPHY

The following publications contain information related to this subject:

- API RP14F *Recommended Practice for Design and Installation of Electrical Systems for Offshore Production Platforms.*
- API RP54 *Recommended Practices for Occupational Safety for Oil and Gas Well Drilling and Servicing Operations.*
- Recommended Standard for Occupational Exposure to Hydrogen Sulfide*, National Institute for Occupational Safety and Health, 125 Baker Drive, Morgantown, WV.
- Texas Railroad Commission Rule 36: *Oil, Gas, and Geothermal Resources Operations in Hydrogen Sulfide Areas*, Texas Railroad Commission, Austin, TX.
- Public Health Service Publication 999-AP-26, *Workbook on Atmospheric Dispersion Estimates*, D. Bruce Tanner, available from U.S. Department of Health, Education, and Welfare, Cincinnati, OH.

¹⁶Occupational Safety & Health Administration (U.S. Department of Labor), available from U.S. Government Printing Office, Washington, D.C. 20402.

GPA 2145-85 *Physical Constants of Paraffin Hydrocarbons and Other Components of Natural Gas*, available from Gas Processors Association, 6526 E. 60th Street, Tulsa, OK 74145.

2.5 ACRONYMS AND ABBREVIATIONS

The following acronyms and abbreviations are used in this publication:

ACC	Acceptable Ceiling Concentration
ACGIH	American Conference of Governmental Industrial Hygienists
ANSI	American National Standards Institute
API	American Petroleum Institute
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
CERCLA	<i>Comprehensive Environmental Response, Compensation, and Liability Act</i>
CFR	<i>Code of Federal Regulations</i>
CWA	<i>Clean Water Act</i>
DC	Direct Current
DOI	U. S. Department of Interior
DOL	U. S. Department of Labor
DOT	U. S. Department of Transportation
EMI	Electromagnetic Interference
EPA	Environmental Protection Agency
ERPG	<i>Emergency Response Planning Guide</i>
FR	<i>Federal Register</i>
HAZWOPER	Hazardous Waste Operations and Emergency Response
IDLH	Immediately Dangerous to Life or Health
ISA	Instrument Society of America
LEL	Lower Explosive Limit
LEPC	Local Emergency Planning Committee
MMS	Minerals Management Service
MSDS	Material Safety Data Sheet
NACE	National Association of Corrosion Engineers
NFPA	National Fire Protection Association
NIOSH	National Institute for Occupational Safety and Health
NORM	Naturally Occurring Radioactive Material
NRTL	National Recognized Testing Laboratory
NTIS	National Technical Information Service
OCS	Outer Continental Shelf
OSHA	Occupational Safety and Health Administration

PEL	Permissible Exposure Limit
PG	Pasquill-Gifford
RCRA	<i>Resource Conservation & Recovery Act</i>
REL	Recommended Exposure Level
RFI	Radio Frequency Interference
ROE	Radius of Exposure
RP	<i>Recommended Practice</i>
RQ	Reportable Quantity
SARA	<i>Superfund Amendments and Reauthorization Act</i>
SCF	Standard Cubic Foot
SSC	Sulfide Stress Cracking
STEL	Short Term Exposure Level
TLV	Threshold Limit Value
TPQ	Threshold Planning Quantity
WPS	Welding Procedure Specification

3 Definitions

For the purposes of this standard, the following definitions are applicable.

3.1 acceptable ceiling concentration: (ACC). The designated level of an air contaminant to which an employee may be exposed at any time during an 8-hour shift, except for a specified time period and up to a specified concentration not exceeding the "acceptable maximum peak concentration" above the acceptable ceiling concentration for an 8-hour shift. Refer to 29 *CFR* 1910.1000 and Appendix A, Par. A.2.

3.2 breathing zone: A hemisphere forward of the shoulders with a radius of 6 to 9 inches. Refer to OSHA Instruction CPL 2-2.20A, March 30, 1984; amended by CPL 2-20A CH-1, October 29, 1984.

3.3 continuous hydrogen sulfide monitoring equipment: Equipment capable of continuously measuring and displaying the concentration of hydrogen sulfide in ambient air.

3.4 emergency response planning guide—level 2: (ERPG-2). The maximum airborne concentration below which it is believed that nearly all individuals could be exposed for up to one hour without experiencing or developing irreversible or other serious health effects or symptoms that could impair an individual's ability to take protective actions. Refer to *Technical Guidance for Hazards Analysis; Emergency Planning for Extremely Hazardous Substances*.

3.5 enclosed facility: A three-dimensional space enclosed by more than two-thirds ($\frac{2}{3}$) of the possible projected plane surface and of sufficient size to allow the entry of personnel. For a typical building, this would require that more than two-thirds of the walls, ceiling, and floor be present. Refer to *API Recommended Practice 500*.

3.6 essential personnel: Those individuals required to

provide proper and prudent safe operations activities and those required to effect control of the hazardous hydrogen sulfide or sulfur dioxide conditions.

3.7 gas detection instrument: An assembly of electrical, mechanical, and chemical components designed to sense and respond continuously to the presence of chemical gases in atmospheric mixtures.

3.8 hydrogen sulfide: Chemical formula is H_2S . A flammable, toxic gas that is heavier than air and sometimes found in fluids encountered in oil and gas producing and gas processing operations. *Inhalation at certain concentrations can lead to injury or death.* Refer to Appendix A.

3.9 immediately dangerous to life and health: (IDLH). An atmospheric concentration of any toxic, corrosive, or asphyxiant substance that poses an immediate threat to life or would cause irreversible or delayed adverse health effects or would interfere with an individual's ability to escape from a dangerous atmosphere. The National Institute for Occupational Safety & Health (NIOSH) considers 300 ppm and 100 ppm to be the IDLH concentrations for hydrogen sulfide and sulfur dioxide, respectively. *API Publication 2217A* specifies an oxygen content of less than 19.5% as oxygen deficient and an oxygen content of less than 16% is considered IDLH.

3.10 inadequately ventilated: Ventilation (natural or artificial) that is *not* sufficient to prevent the accumulation of significant quantities of hydrogen sulfide-air mixtures in excess of 10 ppm.

3.11 length-of-stain detector: A specially designed pump and colorimetric indicator tube detector (length-of-stain), with a supply of detector tubes, that operates by using the pump to pull a known volume of air or gas through a detector tube. The tubes contain chemical reagents that are designed to detect the presence and display the concentration of hydrogen sulfide or sulfur dioxide in the sample. The length of the resultant color band in the tube indicates an instantaneous quantitative concentration of the specific chemical in the sample.

3.12 permissible exposure limit: (PEL). The designated level of any airborne contaminant to which an employee may be exposed. The PEL may be expressed as an eight-hour time weighted average (TWA), a ceiling value, a short term exposure level (STEL), or a skin designation. PELs are subject to change and users should check the latest version of 29 *Code of Federal Regulations* Part 1910.1000 for compliance.

3.13 shall: Indicates the "recommended practice(s)" has universal applicability to that specific activity.

3.14 shelter-in-place: The concept of providing the public additional protection by having residents stay indoors until emergency evacuators arrive or the emergency is over. Refer to references 62, 63, 64, 65, 66, and 67.

3.15 should: Denotes a "recommended practice(s)" 1) where a safe comparable alternative practice(s) is available; 2) that may be impractical under certain circumstances; or 3) that may be unnecessary under certain circumstances.

3.16 sulfur dioxide: Chemical formula is SO_2 . A toxic product of combustion of hydrogen sulfide. This gas is heavier than air. *Inhalation at certain concentrations can lead to injury or death.* Refer to Appendix B.

3.17 threshold limit value: (TLV). The maximum airborne concentration of a substance to which, it is believed that, nearly all workers may be repeatedly exposed day after day without adverse effects, as determined by the responsible committees of the American Conference of Governmental Industrial Hygienists (ACGIH). Refer to "*Threshold Limit Values and Biological Indices*". "TLV" is a trademarked term of ACGIH. TLVs are subject to change and users should check the latest edition of the forestated reference.

4 Applicability

4.1 PERSONNEL AND EQUIPMENT PROTECTION

In oil and gas producing operations and gas processing plant operations, severity of the environment shall be assessed. As a minimum, the following measures shall be implemented:

a. Personnel protection should be provided if the work area concentration of hydrogen sulfide (refer to Par. 3.8) exceeds 10 ppm eight-hour time weighted average (TWA) or 15 ppm as a short term exposure level (STEL) averaged over 15 minutes (refer to Appendix A); or the work area concentration of sulfur dioxide (refer to Par. 3.16) exceeds 2 ppm as an eight-hour TWA or 5 ppm as a STEL averaged over 15 minutes (refer to Appendix B). Personnel safety provisions of this publication do not apply when:

1. the atmospheric concentration of hydrogen sulfide could not exceed 10 ppm (by volume), or
2. the atmospheric concentration of sulfur dioxide could not exceed 2 ppm (by volume).

b. Equipment and materials shall be selected on the basis of resistance to sulfide stress cracking and corrosion. Refer to Section 8, "Design and Construction Practices", Appendix D, and *NACE Standard MR0175* for recommendations for selection of equipment and materials. The equipment and materials provisions of this publication do not apply when the partial pressure of hydrogen sulfide in the gas could not exceed 0.05 psia or 10 psia in the gas phase of sour crude systems (refer to Appendix D, Par. D.1.1.2).

Some conditions may require extensive personnel safety measures but only the use of conventional equipment and materials; other conditions may require the use of special equipment and materials but only minimal personnel safety

measures; still other conditions may require both.

Throughout this publication, "trigger levels" for various actions are used to ensure safety of employees and the public. These trigger levels have been established considering threshold limit values (TLVs—refer to Par. 3.17). These TLVs are subject to change and users should check the latest edition of *Threshold Limit Values and Biological Exposure Indices* and the latest revision of *29 Code of Federal Regulations* Part 1910.1000, "Toxic and Hazardous Substances", for compliance.

In 1989, the U. S. Department of Labor, Occupational Safety and Health Administration (OSHA) issued updated permissible exposure limits (PELs) for several hundred chemicals, including revised PELs for hydrogen sulfide (10 ppm as an eight-hour TWA or 15 ppm STEL averaged over 15 minutes) and sulfur dioxide [2 ppm as an eight-hour TWA or 5 ppm STEL averaged over 15 minutes (refer to *54 Federal Register (FR)* 2333, January 19, 1989]. A federal court set aside the OSHA 1989 rule (refer to *58 Federal Register* 35338, June 30, 1993).

The American Conference of Governmental Industrial Hygienists (ACGIH) recommends a hydrogen sulfide TLV of 10 ppm (eight-hour TWA) and a STEL of 15 ppm averaged over 15 minutes and recommends 2 ppm as an eight-hour TWA TLV and 5 ppm as a STEL averaged over 15 minutes for sulfur dioxide (refer to *Threshold Limit Values for Chemical Substances and Biological Exposure Indices*).

In the interest of safety and health, this standard recommends use of the ACGIH TLVs (refer to *Threshold Limit Values for Chemical Substances and Biological Exposure Indices 1993-94*) as trigger levels for employee safety (refer to Appendices A and B). Some states have adopted these levels as requirements for personal safety.

Individual employers may set their own trigger levels after review and due consideration of site specific conditions, various regulatory requirements, and material safety data sheet (MSDS) information. Users should check the current status of OSHA PELs, OSHA acceptable ceiling concentrations (ACCs), ACGIH TLVs, and applicable regulatory requirements concerning substances of interest.

4.2 LEGAL REQUIREMENTS

This publication presents recommended practices and precautions deemed pertinent to protect personnel and the public from exposure to potentially hazardous concentrations of hydrogen sulfide and sulfur dioxide. These recommended practices recognize that owners, operators, contractors, and their employees have separate responsibilities that may be contractual in nature. It is not the intent of these recommended practices to alter the contractual relationship(s) between the parties. Some of the practices recommended herein are mandatory by local, state, or federal laws, rules, and regulations. Because of the functional and geographical diversity of these requirements, no attempt has been made in

these recommended practices to designate which are optional and which are required. Furthermore, even if all the practices recommended herein are followed, there still may be existing or future legally imposed laws or regulations which would not be met. *In the event of any omission or conflict between these recommended practices and legally required action(s) the requirements of laws and regulations must control.* Some of the federal regulations pertinent to safe production operations involving hydrogen sulfide are listed in Section 2, "References". Users of this publication shall review these regulations and other federal, state, and local laws to assure appropriate compliance in their specific operations.

4.3 HAZARD COMMUNICATION (WORKER RIGHT-TO-KNOW)

This publication contains important information that is intended as a guide but may not comply in all respects with OSHA's Hazard Communication Standard. Appropriate counsel should be sought to assure compliance with hazard communication requirements for the specific operations. Refer to OSHA rules on hazard communication in *29 Code of Federal Regulations* Part 1910.1200, "Hazard Communication Standard" (*52 Federal Register (FR)* 31877-31886, August 24, 1987).

4.4 COMPREHENSIVE ENVIRONMENTAL RESPONSE, COMPENSATION, AND LIABILITY ACT (CERCLA) AND SUPERFUND AMENDMENTS AND REAUTHORIZATION ACT (SARA) TITLE III (EMERGENCY) PLANNING AND COMMUNITY RIGHT-TO-KNOW)

Environmental Protection Agency (EPA) regulations implementing Title III of the *Superfund Amendments and Reauthorization Act of 1986* (SARA Title III) set threshold levels (threshold planning quantities, i.e., TPQs) for emergency planning at a local level. Both SARA Title III and CERCLA set reportable quantities (RQs) for reporting releases to the environment. The TPQ for both hydrogen sulfide and sulfur dioxide is 500 pounds; RQs for release reporting are 100 pounds for hydrogen sulfide and 1 pound for sulfur dioxide. TPQs and RQs (trigger levels) and the regulations requiring response plans and release reports under both SARA Title III and CERCLA are set forth in *40 Code of Federal Regulations* Part 302, and *40 Code of Federal Regulations* Part 355. Refer to *API Bulletin E-4* for guidance on release reporting requirements. "Trigger levels" for response plan and release reporting requirements are subject to change and users shall check the latest revisions for compliance. SARA Title III also requires submission of periodic and annual reports of information to state and local officials on the presence of hazardous chemicals at production



Documents

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and gas processing facilities. Those regulations are set forth in 40 *Code of Federal Regulations* Part 370, and API has published suggested generic reporting forms (refer to *API Bulletin E-1*) that are acceptable to EPA. Appropriate guidance should be sought to assure compliance with these programs for the specific operations.

4.5 HAZARDOUS WASTE OPERATIONS AND EMERGENCY RESPONSE (HAZWOPER)

OSHA's standard, 29 *Code of Federal Regulations* Part 1910.120, sets requirements for safety and health protection of employees involved in cleanup operations at uncontrolled hazardous waste sites being performed under government mandate; certain hazardous waste treatment, storage, and disposal operations conducted under the *Resource Conservation and Recovery Act* (RCRA); and emergency response to incidents involving hazardous substances. Appropriate guidance should be sought to assure compliance with 29 *Code of Federal Regulations* Part 1910.120 requirements for the specific operations (refer to 54 *Federal Register* 9294-9336, March 6, 1989).

5 Personnel Training

5.1 INTRODUCTION

Operators of oil and gas producing and gas processing operations involving hydrogen sulfide shall alert personnel (including employees, service companies, and contractors) of the possibility of hydrogen sulfide atmospheric concentrations greater than 10 ppm and sulfur dioxide atmospheric concentrations greater than 2 ppm that may be encountered in the performance of their work. All personnel working in an area where concentrations of hydrogen sulfide or sulfur dioxide may exceed the levels stipulated in Par. 4.1.a should be provided with training prior to beginning the work assignment. All employers, whether operator, contractor, or subcontractor, shall be responsible for training and instruction of their own employees. Personnel assigned to work in areas where they may be exposed to hydrogen sulfide or sulfur dioxide shall be trained by a hydrogen sulfide safety instructor, as defined in Par. 5.6.

5.2 MINIMUM TRAINING

The value of training and periodic drills in all oil and gas producing and gas processing plant operations cannot be over emphasized. The uniqueness or complexity of a specific facility or operation will determine the extent of the training (e.g., SARA Title III and HAZWOPER; refer to Pars. 4.4 and 4.5) deemed necessary for the assigned personnel. However, the following elements are considered a minimum level of training for regularly assigned personnel:

- a. The hazards, characteristics, and properties of hydrogen

sulfide and sulfur dioxide (refer to Appendices A and B).

- b. Sources of hydrogen sulfide and sulfur dioxide.
- c. Proper use of hydrogen sulfide and sulfur dioxide detection methods used at the workplace.
- d. Recognition of and proper response to the warning signals for hydrogen sulfide and sulfur dioxide detection systems used at the workplace.
- e. Symptoms of hydrogen sulfide exposure (refer to Appendix A); symptoms of sulfur dioxide exposure (refer to Appendix B).
- f. Rescue techniques and first aid to victims of hydrogen sulfide and sulfur dioxide exposure.
- g. Proper use and maintenance of breathing equipment for working in a hydrogen sulfide and sulfur dioxide atmosphere (theory and hands-on practice, with demonstrated proficiency). Refer to 29 *Code of Federal Regulations* Part 1910.134.
- h. Workplace practices and relevant maintenance procedures that have been established to protect personnel from the hazards of hydrogen sulfide and sulfur dioxide.
- i. Wind direction awareness and routes of egress (refer to Par. 6.7).
- j. Confined space and enclosed facility entry procedures (if applicable).
- k. Emergency response procedures that have been established for the facility. Refer to Section 7, "Contingency Planning Including Emergency Procedures".
- l. Locations and use of safety equipment.
- m. Locations of emergency assembly areas, if so designated.

5.3 ADDITIONAL TRAINING FOR ONSITE SUPERVISORY PERSONNEL

Those personnel assigned supervising responsibilities at the site shall have additional training in the following elements:

- a. Supervisor responsibilities of the contingency plan (refer to Section 7).
- b. Effects of hydrogen sulfide on components of the hydrogen sulfide handling system (i.e., corrosion, embrittlement, etc.).

5.4 REFRESHER TRAINING

A formal recurring training program shall be implemented to maintain proficiency in the elements listed in Pars. 5.2 and 5.3, as appropriate.

5.5 TRAINING VISITORS AND OTHER NON-REGULARLY ASSIGNED PERSONNEL

Prior to entering a potentially hazardous area, visitors and other non-regularly assigned personnel shall be briefed on route(s) of egress, emergency assembly area(s), applicable warning signals, and how to respond in the event of an emergency, including use of personal protective equipment, if re-