

Recommended Practice for Drilling and Well Servicing Operations Involving Hydrogen Sulfide

API RECOMMENDED PRACTICE 49
THIRD EDITION, MAY 2001

REAFFIRMED, JANUARY 2013



AMERICAN PETROLEUM INSTITUTE

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Upstream Segment

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FOREWORD

This recommended practice was prepared by the API Subcommittee on Oil and Gas Well Drilling and Servicing Involving Hydrogen Sulfide. This standard is under the administration of the American Petroleum Institute Upstream Department's Executive Committee on Drilling and Production Operations.

It is intended that these voluntary recommended practices serve as a guide to promote and maintain integrity of oil and gas well drilling and servicing facilities and operations in the interest 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 drilling and servicing 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 well drilling and servicing 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 changing. 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)" have 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.

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Suggested revisions are invited and should be submitted to the standardization manager, American Petroleum Institute, 1220 L Street, N.W., Washington, D.C. 20005.

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Recommended Practice for Oil and Gas Well Drilling and Servicing Operations Involving Hydrogen Sulfide

0 Introduction

The petroleum industry, through many years of research and operating experience, has developed guidelines and standards 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, have contributed to successful and safe operations. Effective response to emergencies requires prior planning. Good engineering practice (engineering and administrative controls) dictates that operations 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 well drilling and servicing operations involving hydrogen sulfide. These operations include well drilling, completion, servicing, workover, downhole maintenance, and plug and abandonment procedures conducted with hydrogen sulfide present in the fluids being handled. Coverage of this publication is applicable to operations confined to the original wellbore or original total depth and applies to the selection of materials for installation or use in the well and in the well drilling or servicing operation(s). 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.

This standard addresses personnel training, personnel protective equipment, contingency planning and emergency procedures, classification of locations, materials and equipment, operations, rig practices, special operations, offshore operations, characteristics of hydrogen sulfide and sulfur dioxide, and evaluation and selection of hydrogen sulfide monitoring equipment.

2 References

2.1 STANDARDS

The following standards contain provisions which, through reference in this text, constitute provisions of the 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.

API

Bull E1	<i>Generic Hazardous Chemical Category List and Inventory for the Oil and Gas Exploration & Production Industry</i>
Bull E4	<i>Release Reporting for the Oil and Gas Exploration and Production Industry as Required by the CWA, CERCLA, and SARA Title III</i>
Spec 5CT	<i>Specification for Casing and Tubing</i>
Spec 5D	<i>Specification for Drill Pipe</i>
Bull 6J	<i>Testing of Oilfield Elastomers, A Tutorial</i>
RP 7G	<i>Drill Stem Design and Operating Limits</i>
RP 14C	<i>Analysis, Design, Installation, and Testing of Basic Surface Safety Systems on Offshore Production Platforms</i>
RP 14F	<i>Design and Installation of Electrical Systems for Fixed and Floating Offshore Petroleum Facilities for Unclassified and Class I, Division 1, and Division 2 Locations</i>
Spec 16A	<i>Specification for Drill Through Equipment</i>
Spec 16C	<i>Specification for Choke and Kill Systems</i>
RP 53	<i>Blowout Prevention Equipment Systems for Drilling Wells</i>
RP 54	<i>Occupational Safety for Oil and Gas Well Drilling and Servicing Operations</i>
RP 67	<i>Oilfield Explosives Safety</i>
RP 500	<i>Recommended Practice for Classification of Locations for Electrical Installations at Petroleum Facilities Classified as Class I, Division 1 and Division 2</i>
RP 505	<i>Classification of Locations for Electrical Installations at Petroleum Facilities Classified as Class I, Zone 0, Zone 1, and Zone 2</i>
Std 2015	<i>Safe Entry and Cleaning of Petroleum Storage Tanks</i>
RP 2201	<i>Procedures for Welding or Hot Tapping on Equipment in Service</i>
Spec 6A	<i>Specification for Valves and Wellhead Equipment</i>

ACGIH¹

	<i>Threshold Limit Values (TLVs) for Chemical Substances and Physical Agents and Biological Exposure Indices</i>
IES RP7-1990	<i>Practice for Industrial Lighting</i>
Z88-2	<i>Practices for Respiratory Protection</i>

¹American Conference of Governmental Industrial Hygienists, Kemper Meadow Center, 1330 Kemper Meadow Drive, Cincinnati, Ohio 45240.

EPA²

EPA/600/8	<i>Health Assessment Document for</i>
E86/026A	<i>Hydrogen Sulfide</i>
40 CFR	<i>Part 264, Subpart D, Contingency Plans and Emergency Procedures</i>
40 CFR	<i>Part 302, Designation, Reportable Quantities, and Notification</i>
40 CFR	<i>Part 355, Emergency Planning and Notification</i>
40 CFR	<i>Part 370, Hazardous Chemical Reporting: Community Right-to-Know</i>

ISA³

S12.15	<i>Performance Requirements for Hydrogen Sulfide Detection Instruments</i>
RP12.15	<i>Installation, Operation, and Maintenance of Hydrogen Sulfide Detection Instruments</i>

NACE⁴

MR0175	<i>Sulfide Stress Cracking Resistant Materials for Oilfield Equipment National Response Team</i>
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NRT-1⁵

	<i>Hazardous Materials Emergency Planning Guide</i>
	<i>Technical Guidance for Hazards Analysis, Emergency Planning for Extremely Hazardous Substances</i>

NFPA⁶

NFPA 70	<i>National Electrical Code</i>
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NIOSH⁷

74-111	<i>Criteria for a Recommended Standard for Occupational Exposure to Sulfur Dioxide (GPO No. 017-033-00029)</i>
77-158	<i>Criteria for a Recommended Standard for Occupational Exposure to Hydrogen Sulfide (GPO No. 017-033-00217-7)</i>

2.2 REGULATIONS

The following regulations are subject to revision, and users should determine the latest version to ensure compliance.

²U.S. Environmental Protection Agency, 401 M Street, S.W., Washington, D.C. 20460.

³Instrument Society of America, 67 Alexander Drive, P.O. Box 12277, Research Triangle Park, North Carolina 27709.

⁴NACE International, 1440 South Creek Drive, P.O. Box 218340, Houston, Texas 77218-8340.

⁵U.S. National Response Team, c/o EPA, MC 5101, 401 M Street, S.W., Washington, D.C. 20460.

⁶National Fire Protection Association, 1 Battery March Park, Quincy, Massachusetts 02269.

⁷National Institute of Occupational Safety & Health, 4646 Columbia Parkway, Cincinnati, Ohio 45226.

Bureau of Mines (DOI)⁸

30 CFR	<i>Chapter 1, Subchapter B, Part II, Subpart H, Respiratory Protection Devices</i>
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Coast Guard (DOT)⁹

33 CFR	<i>Parts 140 to 146: Emergency Evacuation Plans for Manned OCS Facilities</i>
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DOT¹⁰

49 CFR	<i>Part 178, Subpart C, Shipping Container Specifications</i>
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MMS (DOI)¹¹

30 CFR	<i>Parts 250 & 256, Oil, Gas, and Sulphur Operations in the Outer Continental Shelf</i>
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OSHA¹²

29 CFR	<i>Part 1910.38, Employee Emergency Plans and Fire Prevention Plans</i>
29 CFR	<i>Part 1910.120, Hazardous Waste Operations and Emergency Response</i>
29 CFR	<i>Part 1910.134, Respiratory Protection Standard</i>
29 CFR	<i>Part 1910.146, Permit-Required Confined Spaces</i>
29 CFR	<i>Part 1910.1000, 321 Air Contaminants</i>
29 CFR	<i>Part 1910 Subpart I, Personal Protective Equipment</i>
29 CFR	<i>Part 1910.1200, Hazard Communication Standard</i>

2.3 OTHER REFERENCES

1. Poda, George A., "Hydrogen Sulfide Can Be Handled Safely," *Archives of Environmental Health*, Vol. 12, 795–800, June 1966.

2. 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.

3. Pasquill, F., *Atmospheric Diffusion*, Second Edition, John Wiley & Sons, New York, NY, 1947.

4. Slade, D. H., *Metrology and Atomic Energy NTIS-TID 24190 (1968)*, National Technical Information Service (NTIS), U.S. Department of Commerce, Springfield, VA 22161.

5. Wilson, D. J., "Release and Dispersion of Gas from Pipeline Ruptures," Department of Mechanical Engineering, University of Alberta, Edmonton, Canada.

⁸U.S. Department of Interior, available from U.S. Government Printing Office, Washington, D.C. 20402.

⁹U.S. Department of Transportation, available from U.S. Government Printing Office, Washington, D.C. 20402.

¹⁰U.S. Department of Transportation, available from U.S. Government Printing Office, Washington, D.C. 20402.

¹¹U.S. Department of Interior, available from U.S. Government Printing Office, Washington, D.C. 20402.

¹²Occupational Safety and Health Administration, U.S. Department of Labor, Washington, D.C. 20402.



Documents

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6. Jann, P. R., "Evaluation of Sheltering In Place," *Journal of Loss Prevention in the Process Industry*, Vol. 2, No. 1, January. 1989, pp 33–38.

7. 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.

8. Wilson, D. J., "Stay Indoors or Evacuate to Avoid Exposure to Toxic Gas?," *Emergency Preparedness Digest*, Ottawa, Canada, January–March 1987, pp 19–24.

9. 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, Stanley Precinct., Bootle, Merseyside, England.

10. 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.

11. 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.

2.4 BIBLIOGRAPHY

The following publications contain information related to this subject:

1. API RP 14F, *Design and Installation of Electrical Systems for Fixed and Floating Offshore Petroleum Facilities for Unclassified and Class 1, Division 1, and Division 2 Locations*, API, 1220 L St., NW, Washington, D.C. 20005, 1999.

2. API RP 55, *Recommended Practices for Conducting Oil and Gas Producing and Gas Processing Plant Operations Involving Hydrogen Sulfide*, API, 1220 L St., NW Washington, D.C. 20005, 1995.

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

4. NIOSH, *Recommended Standard for Occupational Exposure to Hydrogen Sulfide*, available from US Government Printing Office, Washington D.C. 20402.

5. 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, Ohio.

6. Texas Railroad Commission Rule 36, *Oil, Gas, and Geothermal Resources Operations Hydrogen Sulfide Areas*, Texas Railroad Commission, Austin, Texas.

3 Acronyms and Abbreviated Definitions

The following acronyms and abbreviations are used in this publication:

3.1 ACRONYMS

ACC	acceptable ceiling concentration
ACGIH	American Conference of Governmental Industrial Hygienists
ANSI	American National Standards Institute
API	American Petroleum Institute
BOP	blowout preventer
CAS	Chemical Abstract Service
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CGA	Compressed Gas Association
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
EPCRA	Emergency Planning and Community Right-to-Know Act
FR	Federal Register
HAZWOPER	Hazardous Waste Operations and Emergency Response
H ₂ S	hydrogen sulfide
IDLH	Immediately Dangerous to Life or Health
ISA	Instrument Society of America
LEL	lower explosive limit
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
NRTL	Nationally 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
ppm	parts per million
RCRA	Resource Conservation & Recovery Act
REL	recommended exposure level
RFI	radio frequency interference
ROE	radius of exposure
RP	Recommended Practice(s)
RQ	reportable quantity



Documents

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SARA	Superfund Amendments and Reauthorization Act
SCF	standard cubic feet
SERC	State Emergency Response Commission
SO ₂	sulfur dioxide
SSC	sulfide stress cracking
STEL	Short-Term Exposure Level
TLV	threshold limit value
TPQ	threshold planning quantity
TWA	time weighted average

3.2 DEFINITIONS

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

3.2.1 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 time period and up to a concentration not exceeding the “acceptable maximum peak above the acceptable ceiling concentration for an 8-hour shift”.

3.2.2 action levels: The levels at which the possibility of hydrogen sulfide atmospheric concentrations greater than 10 ppm or sulfur dioxide atmospheric concentrations greater than 2 ppm may be encountered.

3.2.3 breathing zone: Generally, a hemisphere forward of the shoulders with a radius of 6 in. to 9 in.

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

3.2.5 enclosed facility: A three-dimensional space enclosed by more than $\frac{2}{3}$ 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 $\frac{2}{3}$ of the walls, ceiling, and floor be present. Refer to API RP 500 and RP 505.

3.2.6 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.

3.2.7 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.

3.2.8 hydrogen sulfide: Chemical formula is H₂S. A flammable, toxic gas that is heavier than air and sometimes found in fluids encountered in oil and gas producing and gas processing operations.

3.2.9 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 ACGIH has established 300 ppm or greater of H₂S as an IDLH exposure.

3.2.10 inadequately ventilated: Ventilation (natural or artificial) that is not sufficient to prevent the accumulation of significant quantities of toxic or inert gases such that a hazard is created.

3.2.11 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 specific gases or vapors 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.

3.2.12 permissible exposure limit (PEL): TWA concentrations that must not be exceeded during any 8-hour work shift of a 40-hour work week. PELs are subject to change.

3.2.13 shall: Indicates the “recommended practice(s)” has universal applicability to that specific activity.

3.2.14 shelter-in-place: The concept of providing the public protection from exposure to toxic gas or vapor releases to the environment by having residents stay indoors until emergency evacuators arrive or the emergency is over.

3.2.15 short term exposure limit (STEL): A 15-minute TWA exposure that should not be exceeded at any time during a workday.

3.2.16 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.

3.2.17 special operations: any service performed on or in a well other than the normal drilling or service operations that are accomplished in their entirety by a drilling or servicing rig.

3.2.18 sulfur dioxide: Chemical formula is SO₂. A toxic product of combustion of hydrogen sulfide, normally heavier than air.

CAUTION: Inhalation at certain concentrations can lead to injury or death. Refer to Appendix B.

3.2.19 temporary safe haven: Refer to “shelter-in-place” (3.2.14).