



American National Standard

accepted practices for hydrogen sulfide (H₂S) safety training programs

ANSI Z390.1-1995



AMERICAN SOCIETY
OF SAFETY ENGINEERS

AMERICAN NATIONAL STANDARD

Z390 H2S Training Criteria

DRAFT STANDARD

for

SECOND

LETTER BALLOT

MARCH, 1995

Secretariat

American Society of Safety Engineers

Foreword (This Foreword is not a part of American National Standard
Z390.1-1995)

The charter ~~and standing of~~ for the American National Standards ~~Z390~~ Committee Z390 on Hydrogen Sulfide (H₂S) Training was accredited by the American National Standards Institute (ANSI) on January 1, 1993. The need for this standards activity grew out of a ~~recognized need for~~ recognition for specialized training ~~for~~ dealing with this toxic chemical, above and beyond conventional ~~H~~azard ~~C~~ommunications training, due to numerous fatal accidents involving victims and their would-be rescuers succumbing to the effects of hydrogen sulfide.

Historically, hydrogen sulfide training issues were addressed by only a few industries and the consistency of the training criteria varied greatly from one organization to another. Emphasis placed on student competency may have given way or been sacrificed to meet the immediate timing or financial needs of the organization. For these reasons the standard addresses the individual training criteria which should be incorporated into a comprehensive training course document. These criteria were developed as a result of accepted practices in numerous affected industries. ~~Additionally, consideration~~ Most significantly, emphasis was given to the qualifications and proficiency of individual Hydrogen Sulfide Safety Instructors, as well as student performance-based competency and qualification.

Governmental regulations (see 29 CFR 1910.1200) specify mandatory requirements for training of personnel working with or around toxic chemicals. As a voluntary consensus standard, this document complements those regulations. However, compliance with this standard does not assure compliance with governmental regulations and vice versa.

The Z390 Committee solicits public input that may suggest ~~the need for~~ revisions to ~~this the~~ Standard. Such input should be sent to the Secretariat, American Society of Safety Engineers, 1800 E. Oakton Street, Des Plaines, IL 60018-2187.

This standard was developed and approved for submittal to ANSI by the American National Standards Committee on Hydrogen Sulfide Training, Z390. Committee approval of the Standard does not necessarily imply that all members voted for its approval. At the time of its approval ~~this the standard~~, the Z390 Standards Committee had the following members:

SECTION 1 SCOPE PURPOSE AND APPLICATION

1.1 SCOPE. This standard sets forth accepted practices for Hydrogen Sulfide (H_2S) safety training and instruction of affected personnel to include, but not limited to, minimum informational content of the course; recommended exercises and drills; refresher training requirements; H_2S Safety Instructor qualifications; the properties and characteristics of H_2S ; sources of H_2S and areas of potential exposure; the typical site specific safe work practices associated with H_2S operations; the detection methods for H_2S ; the selection, use and care of ~~personnel~~ personal protective equipment appropriate for atmospheres containing H_2S concentrations above the Threshold Limit Value-Time Weighted Average (TLV-TWA); and rescue techniques and first aid procedures for victims of H_2S exposure.

1.2 PURPOSE. The purpose of this standard is to establish minimum requirements for site specific H_2S safety training programs which will enhance safety in occupational settings where hydrogen sulfide is present or is recognized as being potentially present, above the ~~Threshold Limit Value - Time Weighted Average~~ (TLV-TWA).

1.3 APPLICATION. This standard is recommended for voluntary application in occupational settings where personnel have the potential to be exposed to concentrations of H_2S in excess of the ~~Threshold Limit Value - Time Weighted Average~~ (TLV-TWA) as established by the American Conference of Governmental Industrial Hygienists (ACGIH).

1.3.1 ~~The~~ These requirements/recommendations ~~apply of this standard are applicable~~ when one or more instructors may be utilized as long as the instructor/administrator the instructor/administrator of the course meets the provisions of the standard, even when one or more assistant instructors presenting the course may not comply.

1.3.2 Should any of the provisions of this standard be deemed not applicable, the other requirements/recommendations of the standard shall still apply.

SECTION 2 DEFINITIONS

Shall -	denotes a mandatory requirement.
Should -	denotes an advisory recommendation.
May -	denotes a permissive statement.
Acute Toxicity -	the acute adverse effects resulting from a single dose of or exposure to a substance.
Acute Exposure -	severe, usually critical, often dangerous exposure in which rapid changes are occurring. An acute exposure normally runs a comparatively short course and it's effects are easier to reverse in contrast with a chronic exposure. <u>generally defined as exposure for less than 24 hours. Acute toxicity tests give (1) a quantitative estimate of acute toxicity (LD50) for comparisons to other substances, (2) identify target organs and other clinical manifestations of acute toxicity, (3)</u>

establish the reversibility of the toxic response, and (4) give dose-ranging guidance for other studies.

~~Subacute - an illness or condition that is not quite as serious or as dangerous as the acute phase but may become so if not properly managed~~

Chronic Exposure - ~~repeated exposure to or contact with a toxic substance over a period of time, the effects of which become evident only after multiple exposures. (standard reference sources do not have chronic toxicity definition)~~ long-term or chronic exposures are generally considered when the exposures are longer than 3 months. Chronic toxicity tests are performed to assess the cumulative toxicity effects and carcinogenicity of chemicals.

Contingency Plan - a written document site specific that provides an organized plan for alerting and protecting the public within an area of exposure following the accidental release of potentially hazardous atmospheric concentration of hydrogen sulfide, ~~or sulfur dioxide.~~

Emergency Procedures Plan - an emergency procedures plan is a set part of a broader and more comprehensive Contingency Plan. The emergency procedures plan would include but not be limited to such items as the responsibilities of personnel; the immediate action plan; telephone numbers and communication methods;

location of nearby residences, businesses, schools, churches, medical facilities, emergency response personnel; safety equipment and supplies available, and the evacuation routes. It would outline the immediate steps and actions that would be taken in the event of a major release of toxic material.

Equivalent - means in this standard where instructors, facilities, equipment, course design, etc. provide equal performance.

Instructor/Administrator - ~~hydrogen sulfide safety instructors are persons who have~~ An individual or a corporate entity with an individual who has successfully completed a course in hydrogen sulfide ~~instructor~~ training from an institution or organization offering such courses, or ~~have~~ has received equivalent instruction from a company-designated hydrogen sulfide safety instructor/trainer, or have had equivalent instructor/trainer experience.

Non-Essential Personnel - those individuals who are not required to provide proper and prudent safe operations activities and/or effect control of the hazardous conditions associate with hydrogen sulfide, ~~or sulfur dioxide conditions.~~

Visitor - a non-regularly assigned individual who is visiting the job-site for a short period of time, and who is not required to

provide any of the operational or control activities at the site.

Venting -

the process of discharging a material to the atmosphere through a series of piping and/or venting devices, with the discharge point located a safe distance above the ground and away from work areas, and is designed to facilitate proper and safe dispersion of toxic materials and minimize personnel exposure.

Flaring -

the process of safely burning of the flammable vapors being discharged from a vent piping/line.

SECTION 3 TRAINING CRITERIA (ELEMENTS)

3.1 Physical & Chemical Properties of H₂S

3.1.1 The physical and chemical properties of H₂S, including but not limited to the following, should be discussed as part of the H₂S training as appropriate for the facility.

Synonyms: Sulfureted hydrogen, hydrosulfuric acid, dihydrogen sulfide, rotten egg gas, swamp gas, meadow gas, stink damp, etc.

Chemical Family: Inorganic sulfide

Chemical Formula:	H ₂ S
Normal Physical State:	Highly toxic, colorless gas, slightly heavier than air. Vapor Density (specific gravity) at 59 °F (15 °C) and 1 atmosphere = 1.189 and may collect in low-lying areas or confined spaces.
Autoignition Temperature:	500 °F (260 °C)
Boiling Point:	-76.4 °F (-60.2 °C)
Melting Point:	-117.2 °F (-82.9 °C)
Flammable Limits:	4.3 - 46 percent vapor by volume in air.
Solubility:	Soluble in water and oil; solubility decreases as the fluid temperature <u>of water or oil</u> increases.
Combustibility:	Burns with a blue flame to produce sulfur dioxide (SO ₂), a very irritating gas with a pungent odor. Sulfur dioxide is a colorless gas appreciably heavier than air, with a vapor density (specific gravity) at 32 °F (0°C) and 1 atmosphere = 2.26.

Odor and Warning Properties: Hydrogen sulfide has an extremely unpleasant odor, characteristic of rotten eggs, and ~~is easily~~ may be detected easily but only at low concentrations. ~~However, d~~Due to rapid onset of olfactory fatigue and paralysis (inability to smell) (loss of human sense of smell) ODOR shall not be used as the ~~only~~ ONLY warning for the presence of ~~H₂~~ H₂S.

3.1.2 Incompatibilities and Reactivities

- Contact with strong oxidizers and oxidizing materials may cause fire or explosions. ~~Hydrogen sulfide attacks many metals, which results in the formation of sulfides, and may cause sulfide stress cracking (Hydrogen embrittlement).~~
- H₂S dissolves in water to form a weak acid that can cause corrosion and pitting of metal.
- ~~Almost all~~ Many metals will react with H₂S to form metal sulfides. It may react with iron/~~steal~~ steel to form iron sulfide, which can be pyrophoric (ability to ignite spontaneously upon contact with air).

3.2 Sources of H₂S

3.2.1 Students shall be informed of the following sources of H₂S:

- Natural Sources:

Hydrogen sulfide is produced in nature primarily through the decomposition of organic material by bacteria. It may develop in low oxygen environments such as bogs, swamps and polluted water. The gas also occurs as a natural constituent of natural gas, petroleum, sulfur deposits, volcanic gases and sulfur springs.

- Industrial Sources:

In industrial operations, H₂S is either a product, by-product or waste material. As a by-product, H₂S is often recovered in industrial operations and converted to elemental sulfur or sulfuric acid. (See Appendix A for listing of occupations with potential H₂S exposures re Generation.)

3.3 Human Physiology and Medical Evaluation

3.3.1 *Human Physiology information.* An overview of the respiratory system and the eyes shall be presented. The target organs and body structures subject to the effects of H₂S shall be identified. These include, as a minimum, the following:

- the olfactory nerves;
- the lungs;
- the brain;

the respiratory control center;

and the eyes.

3.3.1 Signs and Symptoms of H_2S Exposure Associated with Acute Toxicity. The signs and symptoms of H_2S exposure associated with acute toxicity shall be presented.

These include:

olfactory paralysis;	excitement;
eye irritation;	coughing;
headaches;	sneezing;
nausea;	irritation of the respiratory tract;
diarrhea;	pulmonary edema;
dizziness;	respiratory arrest;
confusion;	brain damage;
staggering gait;	photophobia; and
cardiac arrest.	

3.3.3 Signs and Symptoms of H_2S Exposure associated with Chronic Toxicity. The signs and symptoms of H_2S exposure associated with chronic toxicity shall be presented.

These include:

- eye irritation
- corneal blistering, pitting, opacity
- headaches
- nausea
- irritation of the respiratory tract

pulmonary edema

anorexia

sleep disturbances

3.3.4 *Variables/Affecting the Symptomatology of H₂S Exposure.* Information concerning variables that determine the symptoms associated with H₂S exposure and the speed of their onset shall be presented. The primary variables are exposure concentration, exposure frequency, duration of exposure, and individual variables.

Individual variables include:

body mass;

overall physical condition;

age;

smoker/nonsmoker;

and personal biochemistry.

3.3.5 *Interaction of Drugs and Alcohol with H₂S.* The presence of alcohol, prescription medications and/or illicit drugs in the body which may result in hyper sensitivity to the effects of H₂S₁ shall be presented.

3.3.6 ~~Medical Evaluation~~ *Medical Evaluation.* The necessity of a medical evaluation in determining whether or not respiratory protection can be ~~effectively~~ utilized effectively shall be discussed (Refer to Appendix C for ANSI Z88.2 and Z88.6.)

3.4 Work Procedures

3.4 Workers involved in operations where hydrogen sulfide may be present should understand that proper work procedures and practices can greatly reduce the potential for accidents. Workers involved in potential H₂S operations, especially ~~supervisors~~, shall be trained in proper safe work procedures.

3.4 Safe work procedures and practices should include but are not limited to:

- conduct site specific safety meetings
- verify that workers are properly trained
- maintain compliance with permit requirements
- provide, at least, one (1) stand-by person qualified to perform first-aid and CPR
- verify that proper safety equipment is available, functioning ~~property~~ properly, and is utilized
- check and remain aware of wind ~~contribution~~ conditions and direction. Start on the upwind side whenever possible when working on equipment
- perform a thorough check of the downwind area prior to the start of any potentially hazardous work activity. Check for personnel and ignition sources
- notify supervisory personnel, when necessary, prior to initiating operations that could involve the release of H₂S
- use the "buddy system" and never work alone in H₂S area

- monitor conditions through implementation of an H₂S detection and/or monitoring strategy
- ventilate work areas, vent or purge lines on vessels prior to beginning work activities
- keep non-essential personnel away from work area
- never take short-cuts

3.5 Personal Protective Equipment

3.5.1 Students should be provided with appropriate training for industry specific items of personal protection equipment.

3.5.2 Emphasis should be placed on respiratory protection training as recommended by current American National Standard Institute (ANSI) standard ANSI Z88.2, "Practices for Respiratory Protection".

3.5.3 Special information should be given on the following:

- Location of Supplied Air Respirators (SAR)
- Location of spare air cylinders, if applicable
- Site specific issues
- Situations that would require respirators
- Limitations & capabilities of positive pressure/full face piece respirators

- Limitations and capabilities of air supplied and air purifying respirators
- Brand/model/size of respirators available

3.6 Use of Contingency Plan and Emergency Response

3.6.1 Students should be taught the purpose of the plan as a logical step-by-step approach to dealing with an emergency.

3.6.2 Students should be familiarized with the content of the plan which may be included as applicable, but not limited to the following:

- Instructions for alerting employees and the public in case of an emergency.
- Procedure for requesting assistance and follow-up action to remove the public from the area of exposure.
- A call list of people to notify in the event of an emergency:
- Plat of area showing location of public areas, location of evacuation routes and assembly places, location of safety equipment, telephones, and if required, radius of exposure.

- List of names and telephone numbers of residents within the area of exposure and the person responsible for any public area.
- Provision for advance briefing of the public within an area of exposure.
- Detailed operating procedures to be followed in an emergency including instruction of specific job assignments for personnel.
- Detailed remedial procedures to be followed in any emergency.
- Emergency medical services available including current names and phone numbers. (Prior contact should be made with designated medical facilities.)
- Location of the contingency plan.

3.7 Burning, Flaring and Venting of H₂S

3.7.1 Students should be made aware that in some affected industries flaring or venting lines would be provided in work places where there is a probability that H₂S would be present in concentrations of more than 15 ppm. This is an engineering control to minimize worker exposure.

3.7.2 Students also should also be made aware that burning of H₂S results in sulfur dioxide (SO₂). Therefore, appropriate training for SO₂ ~~would~~ may be necessary.

3.8 State and Federal Regulatory Requirements

3.8.1 Students should be aware of the importance of understanding the existence of regulatory requirements concerning hydrogen sulfide. There may be differences between regulatory requirements that are adopted and enforced by different agencies.

3.8.2 Numerous ~~A~~gencies exist which reference or provide standards/guidelines concerning hydrogen sulfide. They include but are not limited to:

- a. ~~DOL~~ U.S. Department of Labor, Occupational Safety & Health Administration (OSHA)
- b. State OSHA plans
- c. American Conference of Governmental Industrial Hygienists (ACGIH)
- d. U.S. Department of the Interior Minerals Management Service (~~Department of Interior~~)
- e. U.S. Coast Guard
- f. ~~EPA~~ U.S. Environmental Protection Agency (EPA)
- g. Bureau of Land Management
- h. ~~NIOSH~~ U.S. Department of Health and Human Services, National Institute for Occupational Safety and Health (NIOSH)

- i. Various state regulatory agencies
- j. Environment Canada
- k. Workplace Hazardous Materials Information System (WHMIS)

3.9 H₂S Release Dispersion Models

3.9.1 Students may be apprised that dispersion models should be considered when H₂S concentrations and volume have a potential to impact personnel or the public to the extent that an emergency condition may result from accidental release. Individual industries should conduct an evaluation of their specific H₂S operations to determine if dispersion models are appropriate.

3.9.2 Dispersion models are available for predicting conditions that may result from a release of H₂S. Computer driven H₂S dispersion models have gained acceptance for use in emergency planning. Vapor cloud travel and exposure concentrations over specific time periods may be calculated. The validity of dispersion modeling increases with the accuracy of the H₂S data input into the model.

3.10 Rescue Techniques, First Aid and Post Exposure Evaluation

3.10.1 RESCUE TECHNIQUES

Students shall be trained in proper rescue techniques applicable to their specific work environment. Emphasis shall be placed on the importance of protecting one's self prior to attempting a rescue.

3.10.2 FIRST AID

Students shall be instructed in the importance of activating the emergency medical services system. In addition, students ~~should~~ shall receive appropriate training in rescue breathing and CPR.

3.10 POST EXPOSURE EVALUATION

Students shall be informed that individuals overcome by H₂S shall receive medical approval prior to returning to the workplace.

3.11 Methods of Detection and Monitoring

3.11. Each type of detector and monitor has its own set of capabilities and limitations with which the user(s) ~~must~~ shall be familiar. When training students on Methods of Detection and Monitoring the instructor shall be knowledgeable, and shall place emphasis, on the site specific type(s) of detection and monitoring devices (and sampling strategy) available to or for the benefit of workers. Training shall include an explanation of the warning alarms indications (if applicable) and emergency response procedures associated with the specific type of detection and monitoring devices available to or for the benefit of workers.

3.11.2 Training shall include the following as applicable:

- Type(s) of detector(s) and/or monitor(s) available
- Manufacturer's recommendations
- Purpose(s), suitability, capabilities, limitations, calibration, function testing, placement, use, and maintenance of detector(s) and/or monitor(s) available.

3.12 Engineering Controls

Training should include discussion regarding ~~engineering controls available~~ various worksite alternatives with emphasis placed on site specific engineering controls.

~~Example may include~~ Students should be familiarized with the following:

- Design or remodeling of worksites.
- Enclosed worksites.
 - ✓ Ventilation Equipment
 - ✓ Monitoring Equipment
- ~~Ventilation equipment.~~
- Metallurgical properties of equipment.
- Burning, flaring and venting of H₂S.

• ~~Chemical approaches.~~

- Containment.

- Dispersion

3.13 Transportation of Hydrogen Sulfide Cargoes.

3.13.1 If applicable, students should be made aware of the modes of transportation involving known or potential H₂S hazards such as:

- Maritime
- Highway
- Rail
- Air
- Pipelines

3.14 Emerging Technology

3.14.1 Where applicable, special emphasis should be placed on emerging technologies in the areas of respiratory protection equipment, portable and fixed detection and monitoring devices, as well as the development of chemical treatment technologies that could potentially reduce the presence of H₂S.

3.14.2 The instructor(s) of H₂S training should be required to remain aware of advances in technology.

SECTION 4 INSTRUCTOR QUALIFICATION AND PROFICIENCY

- 4.1 Hydrogen Sulfide Training Instructors/Administrators shall have successfully completed an appropriate H₂S train-the-trainer development course, or by virtue of significant past experience instructing this discipline, the candidate instructor/administrator must be able to demonstrate his/her knowledge of the technical aspects of hydrogen sulfide training and proficiency in training techniques relative to H₂S. Training credentials or certification from a recognized or accredited training authority would constitute qualification under this section.
- 4.2 Qualified H₂S instructors should ensure that the comprehensive outline for their individual course of instruction includes all of the topics covered in this standard. No class should ever be abbreviated in the interest of time or any other conflicting factors.
- 4.3 H₂S instructors/administrators shall conduct a minimum of two (2) H₂S training classes each year. Documentation should be maintained to substantiate evidence of these sessions. Every three (3) years, instructors should attend an H₂S instructor refresher course.
- 4.3.1 The above requirements/recommendations in 4.3 will permit the instructor to receive the most recent technical information, regulatory changes, and updated data on technologies advancements including but not limited to, personal

protective equipment and monitoring or detection devices, medical advancements and instructional techniques.

SECTION 5 DOCUMENTATION AND RECORDKEEPING

5.1 **Program Documentation.** Documentation detailing the content of the training program shall be developed and maintained. This documentation shall include:

- Names of instructors/administrators qualified to teach the program;
- An outline containing the information which must be presented;
- A copy of printed materials supplied to students;
- Titles of audiovisual materials presented to students;
- A description of gas detectors and respiratory protection equipment used in the program;
- A description of hands-on-exercises; and
- A description of the type of proficiency examination.

5.2 **Class Documentation.** A record of training shall be created to include the:

- Name of the instructor;
- Name and address of the training provider(s) with which the instructor is affiliated;
- Name of the student and his/her employer;
- Date of training;
- Duration of training; and
- Model of respiratory and gas detection devices the students are trained to use.

5.3 Certification Card. A certification card should be provided to include the:

- Name of the student;
- Signature of the instructor;
- Date of training;
- Name of the training provider with which the instructor is affiliated;
- Address of the facility where the training record is maintained; and
- Model of respiratory and gas detection devices the student is trained to use.

5.4 Recordkeeping. A copy of program and class documentation and the certification card shall be kept by the training provider with which the instructor is affiliated for, at least, ~~five (5)~~ three (3) years. The student's employer, if different than the instructor's, should also maintain copies of class documentation for, at least, five (5) years.

SECTION 6 STUDENT COMPETENCY AND QUALIFICATION

6.1 Student competency is required at the end of the training in order to receive appropriate qualification. This performance-based competency shall be demonstrated through an evaluation mechanism designed to evaluate the student's understanding of the materials presented throughout the training and use of

demonstrated equipment. Common forms of competency-based evaluation include written, verbal or practical evaluations. Documentation of the student's ability to demonstrate such competency shall be retained as substantive proof.

6.2 Due to the extreme hazard involved in H₂S operations, each individual covered by this standard should complete an annual retraining process.

SECTION 7 TRAINING TECHNIQUE, LANGUAGE AND LITERACY FACTORS

7.1 Hydrogen Sulfide training should be student-oriented and focused on the skills and knowledge required to work safely in an H₂S environment. Each H₂S environment may have differing requirements for safety. The information in Appendix B shall provide a guide in development of H₂S training.

7.2 An approach to structuring a course outline may resemble the guide offered in Appendix C.

SECTION 8 PROTECTION REQUIREMENTS FOR VISITORS

8.1 Attention shall be given to site specific policy concerning evacuation of visitors in the event of an emergency.

8.2 At a minimum these persons shall be briefed on the following:

- Site specific sources of H₂S;
- Health hazards of H₂S;

- Routes of egress;
- Emergency assembly areas;
- Applicable alarm signals;
- How to respond in the event of an emergency.

SECTION 9 RELATED STANDARDS

9.1 This standard is intended for use in conjunction with the following American National Standards or latest revision:

American National Standards Institute, ANSI Z49.1-1988.

"Safety in Welding and Cutting."

American National Standards Institute, ANSI Z88.2-1980.

"Practices for Respiratory Protection."

American National Standards Institute, ANSI Z88.6-1984.

"Physical Qualifications for Respirator Use."

American National Standards Institute, ANSI Z117.1-1989.

"Safety Requirements for Confined Spaces."

APPENDIX A

Magnitude of H₂S Generation

The amount of production of H₂S is affected by several variables including the following:

- Temperature; for every one degree centigrade rise in temperature there is a seven percent increase in production of H₂S.
- High humidity, velocity and turbulence also tend to increase production of H₂S.
- Toxicity is enhanced by the presence of dust and other gases like CO, CO₂, CS₂, NH₃ and SO₂.
- A pH between 6.5 and 7.5 causes maximum generation of H₂S.
- Whereas, highly alkaline industrial waste tends to reduce H₂S.

Occupations with Potential H₂S Exposure

Animal fat and oil processors
Animal manure removers
Artificial-flavor makers
Asphalt storage workers
Barium carbonate makers
Barium salt makers
Blast furnace workers
Brewery workers

Bromide-brine workers
Cable splicers
Caisson workers
Carbon disulfide makers
Cellophane makers
Chemical laboratory workers, teachers, students
Cistern cleaners

Citrus root fumigators	Natural gas production and processing workers
Coal gasification workers	Painters using polysulfide caulking compounds
Coke oven workers	Papermakers
Copper-ore sulfidizers	Petroleum production and refinery workers
Depilatory makers	Phosphate purifiers
Dyemakers	Photoengravers
Excavators	Pipeline maintenance workers
Felt makers	Pyrite burners
Fermentation process workers	Rayon makers
Fertilizer makers	Refrigerant makers
Fishing and fish-processing workers	Rubber and plastics processors
Fur dressers	Septic tank cleaners
Geotherman-power drilling and production workers	Sewage (<u>Waste Water</u>) treatment p l a n t workers
Glue makers	Sewer (<u>Waste Water Treatment</u>) workers
Gold-ore workers	Sheepdippers
Heavy-metal precipitators	Silk makers
Heavy-water manufactures	Slaughterhouse workers
Hydrochloric acid purifiers	Smelting workers
Hydrogen sulfide production and sales workers	Soapmakers
Landfill workers	Sugar beet and cane processors
Lead ore sulfidizers	Sulfur spa workers
Lead removers	Sulfur products processors
Lithographers	Synthetic-fiber makers
Lithophone makers	Tank gagers
Livestock farmers	Tannery workers
Manhole and trench workers	Textile printers
Metallurgists	Thiophene makers
Miners	Tunnel workers
	Well diggers and cleaners
	Wool pullers

APPENDIX B

Training Techniques, Language and Literacy Factors

Every trainer should ask the question: "What is it that the student must be able to do as a result of this training?" This approach is better than creating instructor-oriented training by asking: "What am I going to present?" The information in this section may be used to assist a trainer in preparing an O₂S training course or to aid in evaluating the quality of contractor training programs.

Writing Performance-Based Objectives

The trainer should begin the design of his training materials by writing performance-based objectives that clearly indicate how the student will demonstrate the knowledge or skill. Performance-based objectives generally contain 4 basic components. These are:

Audience - A clear identification of who the objective is written for. Some objectives may be for supervisors, first-line workers, contractors etcetera.

Behavior - This component identifies the actual behavior of how the student will demonstrate the task or knowledge.

Condition - Identify the conditions under which the student will perform the task or demonstration.

Degree - Quantify how often or to what extent the student must be correct. For example, if your evaluation tool is a multiple choice test, identify the passing grade allowed.

The following is a comparison of two training objectives:

Objective 1 - The student will know the hazards of H₂S.

Objective 2 - Given a list of health hazards, confined space entrants will be able to identify the health hazards that occur with exposure to various concentrations of H₂S. The student will demonstrate this knowledge by matching the health effects to a given concentration range. The responses must match the instructor answer key.

In the second objective the four conditions of a performance-based objective are met. It can be seen that when objectives are clearly written, the evaluation tool is also easily determined. Sound objectives are the basis for any type of training program, regardless of the platform. The next section provides an overview of the different modes of training delivery.

Delivery of Training

Training may be delivered in a variety of platforms. Making an appropriate choice will be a function of identifying:

The Audience - Characteristics that you will want to identify regarding your audience include:

Entry Level Knowledge	Age
Interest in the Topic	Gender
Preferred Learning Style	Education Level

The Location - Where is the training to take place? Training limitations on an offshore platform may be very different than those encountered in a land-based operation.

Type of Learning - There are different levels of learning. Knowledge level information, for example reciting health risks, may be conveyed effectively with a book, whereas motor skills, such as donning an SCBA, may require hands-on tutoring.

Resource Constraints - Other limitations such as budget, available development time, or available trainers may drive you toward a particular instruction platform.

Booklets, Brochures and Programmed Learning Texts

Advantages

1. Self-paced
2. Inexpensive to produce
3. Easy to update
4. Able to use in a variety of settings; Very portable
5. A large volume of information can be presented

Limitations

1. Limited interactivity
2. No graphics or motion-based concepts can be covered
3. Not good for complex topics

Instructor-Led Training

Advantages

1. Good for complex issues; Trainer is available to answer questions
2. Inexpensive
3. Instructor can present a large volume of information
4. Instructor is present to ~~asses~~ assess students as they progress in the class
5. Good for demonstration and evaluation of hands-on, motor type skills

Limitations

1. Dependent of skills of the instructor
2. Poor retention of information by students
3. Not self-paced
4. Not good for visual concepts

Video Training

Advantages

1. Good for illustrating visual and motion-based concepts
2. Good at illustrating behavior
3. Useful for affective or "attitude" type objectives
4. Repeat consistency

Limitations

1. Expensive and time-consuming to produce
2. Usually delivery is linear
3. Not very interactive
4. Often used stand alone by trainers to satisfy training requirements

Computer-based Training

Advantages

1. Good for knowledge level objectives
2. Self-paced
3. Interactive
4. Available on demand
5. Consistent delivery of information
6. Visually interesting

Limitations

1. Hardware requirements may be a logistical problem
2. Not good for very complex information
3. Can be costly to develop
4. Students must be comfortable with computers

Interactive Multimedia

Advantages

1. Self-paced
2. Full motion video can be incorporated, lending video advantages
3. Very interactive
4. Good for learners accustomed to advanced technology

Limitations

1. Very expensive to produce
2. Limited off-the-shelf offerings available
3. Hardware requirements may be extensive

Tips for Delivering Good Instructor-led Training

While technology-based training media such as CBT and laser disk programs are very useful, the reality is that most training is still delivered with instructors. The following information is provided to assist in the development and delivery of effective instructor-led training.

Use a Variety of Media

Instructors should use as many different types of presentation aides as possible. These include:

1. Slides
2. Transparencies
3. Flip Charts
4. Demonstration
5. Videos

These graphic aids should be colorful and present consistent visual cues. Slides and transparencies should have colorful, relevant graphics that support the text. If possible, text-only slides should be avoided. Slides with lists should be limited to 5 items or less.

Use Interactive Techniques

Training must involve the student. Use open-ended questions to draw responses from your students. Use flip charts to list student responses. Seeing their responses in writing in front of the class validates the student's answer and creates interest. Develop the student materials so that they involve the class throughout the lecture segments. For example, rather than just telling a class that the permissible exposure limit for H₂S is 10ppm, have a blank in the student manual where they write the number in. Writing information down increases retention.

Use Humor and Creativity

Humor can be effectively used in training classes to break the tedium and increase attentiveness.

Humor used in training classes should follow some simple rules:

1. Humor should be culturally appropriate. Avoid ethnic, religious or political humor.

2. Self-effacing humor can be very effective. Studies have shown that instructors maintain credibility even when using jokes about themselves.
3. Avoid insulting or directed humor.
4. Be sensitive to the audience. A joke about hunting or golf may not play well in a class full of women.

Apply creative thought to the construction of your delivery material and your exercises. Exercises can take on the form of games, allowing drill and practice on information in a fun manner. For example, a trivia-type format for refreshing students on previously delivered information can be very effective and draw students into participating.

Evaluate Training

A training course should be evaluated every time it is delivered to assess quality. Evaluation is divided into four levels:

Level 1 - This is a subjective evaluation by the student of the ~~course~~ course. Questions regarding instructor presentation skills, accommodations, pace, and usefulness of content may be asked.

Level 2 - An in-class assessment of how well the students learned the material. Frequently this is a paper-based test. For motor skills such as donning an SCBA, an instructor critique with the use of a checklist may be a more appropriate level 2 evaluation.

Level 1 - At this level, an assessment is done on whether or not the student has integrated his skills and knowledge on the job. This type of evaluation is usually done by supervisor observation at some point after the training course.

Level 2 - At this level, trainers attempt to determine a return on the training investment. Usually with safety training this is not a straightforward process. It is difficult to estimate the money saved from an accident that does not occur. Some estimation may be possible if a drop in accident frequency occurs after the training and that drop can be attributed to the training.

Language and Literacy Factors

Language

Training should always be delivered in the native language of the student when possible. If not possible, the following conditions should be followed:

1. Ensure that the student is fluent enough to understand the course material.
2. For instruction and exercises, pair a less fluent student with a fluent bilingual.
3. Avoid use of colloquialisms or local expressions. For example, an expression like "up a creek without a paddle" may not be meaningful to someone not fluent in American English.

4. Evaluation instruments, such as tests, may need to be orally administered.
5. Training material should be as visually oriented as possible. For example, use a picture of a respirator next to the word.

Literacy Factors

As with employees who may speak English as a second language, written English literacy may be a problem for some students. If this is determined to be the case, the following conditions must be followed:

1. Student should be able to demonstrate recognition of warning signs and state the intended message.
2. Evaluation instruments, such as test, may need to be orally administered.
3. Responsible persons must determine that the individual does not represent a safety hazard on the job to himself or others.
4. As with second language students, the training should be visually oriented.

APPENDIX C

COURSE TITLE **HYDROGEN SULFIDE (H₂S) CERTIFICATION**

TIME 4 Hours

COURSE DESCRIPTION

Hydrogen Sulfide Certification is designed as a safety awareness program to familiarize students with the dangers associated with working in an H₂S environment. The class is appropriate for entry level through supervisory level employees. The course is required for all employees who have the potential to be exposed to H₂S in excess of the Threshold Limit Value - Time Weighted Average (TLV/TWA) as established by the American Conference of Governmental Industrial Hygienists (ACGIH). Annual refresher training is required.

Course materials include student handouts and a final examination. Delivery is accomplished through lecture, hands-on demonstration of monitors and detectors, student participation and practice, video tape, overheads, and student exercise for donning/doffing the self-contained breathing apparatus.

COURSE OUTLINE

- I. WHAT IS H₂S

- A. Toxicity
- B. Common Names
- C. How is H₂S Formed?

II. COMMON INDUSTRIAL SITES

- A. Petro-Chemical
- B. Petroleum Exploration & Production
- C. Manufacturing
- D. Agricultural

III. PROPERTIES & CHARACTERISTICS OF H₂S

- A. Physical Properties
- B. Chemical Properties

IV. CONCENTRATIONS/TOXIC LEVELS

- A. ACGIH TLV/TWA
- B. OSHA PEL/TWA
- C. Exposure Levels
- D. Toxic Gas Comparisons

V. VIDEO - "Hydrogen Sulfide - A Matter of Life or Death"

VI. H₂S EFFECTS ON INDIVIDUALS

- A. Entry Routes
- B. Susceptibility and Hypersusceptibility

VII. DETECTION AND MONITORING

- A. Personal, Portable & Fixed Monitors and Detectors
- B. Chemical vs. Electronic Instrumentation

VIII. CONTINGENCY & EMERGENCY RESPONSE PLANS

IX A Respiratory Protection

- A. Air Purifying Respirators vs. Air Supplied Respirators
- B. Types of Air Supplied Respirators
 - 1. Self-Contained Breathing Apparatus
 - 2. Airline Respirator with Egress Bottle
 - 3. Escape Pack

- C. Special Problems
 - 1. Corrective Glasses/Contact Lenses
 - 2. Facial Hair
 - 3. Facial Characteristics
- D. Medical Considerations
 - 1. Pulmonary Function Testing
 - 2. Tympanic Membrane
 - 3. Claustrophobia
- E. Maintenance and Inspection
- F. Donning and Doffing Exercise

IX. RESCUE, FIRST AID TECHNIQUES AND POST EXPOSURE EVALUATION

- A. Emergency Rescue
- B. Rescue Breathing & CPR
- C. Medical Follow-Up

X. FINAL EXAMINATION

Complementing the course outlines are the following aids and references:

STUDENT HANDOUT ORIGINALS

1. Class Roster
2. Ten Commandments of Hydrogen Sulfide (H₂S)
3. Case Histories of H₂S Accidents
4. Hazards and Characteristics of H₂S
5. Final Examination
6. Safety Passports

OVERHEADS

1. Ten Commandments of Hydrogen Sulfide (H₂S)
2. Hazards and Characteristics of H₂S (2)
3. Toxicity of Hydrogen Sulfide to Men
4. Toxicity of Various Gases
5. Common Sources of H₂S
6. Industries & Activities with Occupational Exposure to H₂S
7. Methods of Detection
8. H₂S Detection and Monitoring
9. Hydrogen Sulfide Monitors
10. Chemical Detectors (2)
11. Tutweiler Apparatus
12. Electronic Detectors (2)
13. Outline for Developing a Contingency Plan (3)

AUDIO/VISUAL EQUIPMENT REQUIREMENTS

- A. Chalkboard, chalk, eraser or dry-erase marker board, **markers and eraser**
- B. Flip chart ~~w/paper~~ with paper, and markers
- C. Overhead projector and screen
- D. 1/2" VHS player and color monitor
- E. Pointer
- F. 33mm Slide Projector and Screen.

REFERENCES, REGULATIONS AND STANDARDS

- A. Videos - "Hydrogen Sulfide - A Matter of Life or Death"

18 Minutes

Coastal Video Communications Corp.

3083 Brickhouse Court

Virginia Beach, VA 23452

(800) 767-7703

Hydrogen Sulfide

"Don't Let it Get You Down"

Its Industrial Training System Corp.

9 East Stow Road

Marlton, NJ 08053

(800) 727-2487

"One Breath Away"

7 Minutes

Safety Short Productions, Inc.

2960 N. 23rd St.

LaPorte, TX 77571

(800) 458-2236

"The Silent Sniper"

7:35 Minutes

Industrial Training Systems Corporation

9 East Stow Road

Marlton, NJ 08053

(609) 983-7300

"Hydrogen Sulfide Principles"

32 Minutes

IHRDC Video Library Sales

535 Boylston Street

~~Boylston~~ Boston, MA 02116

(617) 536-0202

"Hydrogen Sulfide - HazChem 8"

Distributed by Emergency Film Group

1380 Soldiers Field Road

Boston, MA 02135

800-842-0999

~~ANSI Z-390 Hydrogen Sulfide Training Criteria Standards Committee~~

~~American Society of Safety Engineers (Secretariat)~~

~~1800 East Oakton Street~~

~~Des Plaines, IL 60018-2176~~

~~(708) 692-4121~~

B. Other Related Publications

API RP-55 Recommended Practices for Oil and Gas Producing and Gas

Processing Plant Operations Involving Hydrogen Sulfide

American Petroleum Institute

1220 L Street, NW

Washington, D.C. 20005

(202) 682-8375

ISA RP 12.15 Parts I & II

Instrument Society of America

67 Alexander Drive

P.O. Box 12277

Research Triangle Park, NC 27709

(919) 549-8411

Texas Statewide Rule 36 Hydrogen Sulfide Safety

Texas Railroad Commission

P.O. Box 12967

1701 N. Congress

Austin, TX 78711

(512) 463-7255

29 CFR 1910.134 - Respiratory Protection

29 CFR 1910.146 - Confined Space Entry

29 CFR 1910.252 - Welding Standard

29 CFR 1910.2000 - Hazard Communication

29 CFR 1910.120 - HAZWOPER

29 CFR 1910.20 - Employee Access to Medical Records and Industrial

Hygiene Records

H₂S Release Dispersion Modeling References:

The American Society of Safety Engineers, Professional Safety, May 1990.

Contains a discussion and listing of dispersion models.

EPA 453/R-93-05 Environmental Protection Agency, Office of Air Quality Planning and Standards, Research Triangle Park, 411 West Chapel Hill Street, Durham, NC 27701. The report may also be obtained from the American Petroleum Industry, Washington, D.C., 202/682-8271

"Casarett and Doull's Toxicology: The Basic Science of Poisons;" Fourth Edition, Pergamon Press.