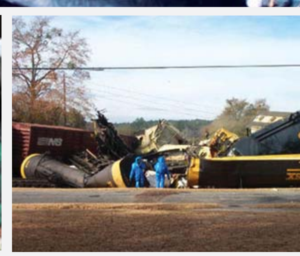
CPWR
THE CENTER FOR CONSTRUCTION
RESEARCH AND TRAINING

# 40-Hour Hazardous Waste Worker

## PARTICIPANT MANUAL

Version VIII, Revised June 2016

# CPWR Registration Form

*(Complete both sides of form)*

## *Course Information:*

| | | | |
|---|---|---|---|
| Course Type: | Date(s): | City: | State: |
| Course ID #: | | | |

## *Student Information:*

| | | |
|---|---|---|
| Name: | | |
| Street Address: | | |
| City: | State: | Zip: |
| Ph (H): | Ph (C): | Email: |

Would you like to receive CPWR emails on construction safety and health issues? ❑ Yes ❑ No

Sex: ❑ Male ❑ Female | Birth Date (mm/dd/yy): _____ / _____ / _____

Race: ❑ White ❑ Black ❑ Hispanic ❑ Asian or Pacific Islander ❑ American Indian or Alaskan Native ❑ Other: ____________________

The last **3** digits of your Social Security Number: X X X – X X – X ___ ___ ___

Employer Name: | Are You An Instructor? ❑ Yes ❑ No

Are You A Union Member? ❑ Yes ❑ No (*If **Yes**, please indicate your craft/trade and local union/district council below*)

| | | | |
|---|---|---|---|
| ❑ Boilermakers | ❑ Bricklayers | ❑ Carpenters | ❑ Electrical Workers |
| ❑ Insulators/Asbestos Workers | ❑ Ironworkers | ❑ Laborers | ❑ Operating Engineers |
| ❑ Painters | ❑ Plasterers/Cement Masons | ❑ Plumbers/Pipefitters | ❑ Roofers |
| ❑ Sheet Metal Workers | ❑ Other *(please specify)*: ____________________ | | |

Local Union/District Council: ____________________

What resources do you most commonly turn to for the latest health and safety information? *(check ( ✔ ) up to 3)*

❑ Union ❑ Trade Association ❑ Government Agency (*please circle:* OSHA, NIOSH, NIEHS, Other) ❑ CPWR

❑ eLCOSH ❑ Internet Search ❑ News Media ❑ Other *(please specify)*: ____________________

## *For Trainer/Office Use Only:*

Pre-Test: ________ Post-Test: ________ Hands-on Training Score: ________ Combined Score: ________

## *Question 1:*

Have you ever done work that required you to be certified for hazardous waste? ❑ Yes ❑ No

- *If **No**, skip and proceed to Question 2*
- *If **Yes**, please list the most recent jobs that required you be certified in hazardous waste:*

| | |
|---|---|
| Employer: __________ | Employer: __________ |
| City, State: __________ | City, State: __________ |
| Type of work: __________ | Type of work: __________ |
| Year(s): | Year(s): |

## *Question 2:*

Have you ever encountered hazardous waste, soil contamination, or other worksite health hazards in the course of your work? ❑ Yes ❑ No

- *If **No**, skip and proceed to Question 3*
- *If **Yes**, please list the most recent jobs that you encountered hazardous waste or contamination:*

| | |
|---|---|
| Employer: __________ | Employer: __________ |
| City, State: __________ | City, State: __________ |
| Type of work: __________ | Type of work: __________ |
| Year(s): | Year(s): |

Please check all that you have been exposed to at work:

| | | | |
|---|---|---|---|
| ❑ Contaminated Soil | ❑ Solvents | ❑ Isocyanates | ❑ Lead |
| ❑ Contaminated Water | ❑ Confined Spaces | ❑ Nanoparticles | ❑ Silica Dust |
| ❑ Beryllium | ❑ Excessive Noise | ❑ Welding fumes | ❑ Asbestos |

❑ Other hazards *(specify):* ____________________

Please check the personal protective equipment provided to you:

❑ Respirator with filters ❑ Respirator with air tank or hose ❑ Chemical resistant gloves ❑ Chemical resistant boots

❑ Chemical resistant suit ❑ Other *(specify):* ____________________

## *Question 3:*

Are you about to do work that requires you to be certified in hazardous waste? ❑ Yes ❑ No

- *If **No**, survey is complete*
- *If **Yes**, please list the job that requires you to be certified in hazardous waste:*

| | |
|---|---|
| Employer: __________ | Type of work: __________ |
| City, State: | |

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# Respirator Medical Evaluation Questionnaire

You will wear several types of personal protective equipment in this class. This equipment includes respirators. The types of respirators you might wear are air purifying, supplied air, or self-contained breathing apparatus (SCBA). There are a number of different protective suits you may wear during the course. One suit type called Level A completely covers you. You may wear this suit as a part of the field exercise. The protective equipment is awkward to wear and heavy. The SCBA respirator weighs 35-40 pounds. Some respirators place an increased demand on your heart and lungs. The suits can make you hot and it is difficult to walk in them.

The OSHA law says your employer must provide a complete physical exam. You need to be cleared to wear this type of protective gear when you do hazardous waste work. Not all jobs on waste sites require the use of the protective gear.

There is no law that requires a complete physical before you get training. It is important that you are in good health when you are wearing the protective gear. It is recommended that you have a complete physical prior to the hazardous materials training.

This confidential screening questionnaire is to help find out if you might have a problem in wearing the protective gear. Please fill out the questionnaire as accurately as you can. Please add any information which you think may be important. This form will be reviewed by a health care professional. If there is anything on the form that you do not understand, please ask about it. If it appears that you may have a health risk, recommendations will be made to decrease that risk. If it is recommended that you not wear the equipment, you will still be able to complete the course. If you do not consider yourself to be in good health, or if you are aware of any reason why you would be unable to use the equipment, please inform one of the trainers. If there is a change in your health while you are attending the course, please let us know. Please be advised that the questionnaire and screening does not take the place of the complete physical required by OSHA prior to hazardous waste work.

1. Today's date: ______________________________

2. Your name: ______________________________

3. Your age (to nearest year): ______________________________

4. Sex (circle one): Male Female

5. Your height: ________ ft. ________ in.

6. Your weight: ________ lbs.

7. Have you worn a respirator? . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . Yes No

   If "Yes", what types? ______________________________

8. Do you *currently* smoke tobacco, or have you smoked tobacco in the last month? . . . . . . . . . Yes No

9. Have you *ever had* any of the following conditions?

   a. Seizures: . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . Yes No

   b. Diabetes: . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . Yes No

   c. Allergic reactions that interfere with your breathing: . . . . . . . . . . . . . . . . . . . . . . . . . . Yes No

   d. Claustrophobia (fear of closed-in places): . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . Yes No

   e. Trouble smelling odors: . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . Yes No

10. Have you *ever had* any of the following pulmonary or lung problems?

   a. Asbestosis: . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . Yes No

   b. Asthma: . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . Yes No

   c. Chronic bronchitis: . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . Yes No

   d. Emphysema: . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . Yes No

   e. Pneumonia: . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . Yes No

   f. Tuberculosis: . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . Yes No

   g. Silicosis: . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . Yes No

   h. Pneumothorax (collapsed lung): . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . Yes No

   i. Lung cancer: . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . Yes No

   j. Broken ribs: . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . Yes No

   k. Any chest injuries or surgeries: . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . Yes No

   l. Any other lung problem that you've been told about: . . . . . . . . . . . . . . . . . . . . . . . . . . Yes No

11. Do you *currently* have any of the following symptoms of pulmonary or lung illness?

   a. Shortness of breath: . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . Yes No

   b. Shortness of breath when walking fast on level ground or walking up a slight hill or incline: . . . . . . . . . . . . . . . . . . . . . . . . . . Yes No

   c. Shortness of breath when walking with other people at an ordinary pace on level ground: . . . . . . . . . . . . . . . . . . . . . . Yes No

   d. Have to stop for breath when walking at your own pace on level ground: . . . . . . . . . Yes No

   e. Shortness of breath when washing or dressing yourself: . . . . . . . . . . . . . . . . . . . . . . . . . Yes No

   f. Shortness of breath that interferes with your job: . . . . . . . . . . . . . . . . . . . . . . . . . . . . Yes No

g. Coughing that produces phlegm (thick sputum): ................................ Yes No

h. Coughing that wakes you early in the morning: ................................ Yes No

i. Coughing that occurs mostly when you are lying down: .......................... Yes No

j. Coughing up blood in the last month: ......................................... Yes No

k. Wheezing: ................................................................ Yes No

l. Wheezing that interferes with your job: ....................................... Yes No

m. Chest pain when you breathe deeply: .......................................... Yes No

n. Any other symptoms that you think may be related to lung problems: ............. Yes No

12. Have you *ever had* any of the following cardiovascular or heart problems?

a. Heart attack: ............................................................ Yes No

b. Stroke: .................................................................. Yes No

c. Angina: .................................................................. Yes No

d. Heart failure: ............................................................ Yes No

e. Swelling in your legs or feet (not caused by walking): ......................... Yes No

f. Heart arrhythmia (heart beating irregularly): .................................. Yes No

g. High blood pressure: ..................................................... Yes No

h. Any other heart problem that you've been told about: ........................... Yes No

13. Have you *ever had* any of the following cardiovascular or heart symptoms?

a. Frequent pain or tightness in your chest: ...................................... Yes No

b. Pain or tightness in your chest during physical activity: ........................ Yes No

c. Pain or tightness in your chest that interferes with your job: .................... Yes No

d. In the past two years, have you noticed your heart skipping or missing a beat: ...... Yes No

e. Heartburn or indigestion that is not related to eating: .......................... Yes No

f. Any other symptoms that you think may be related to heart or circulation problems: .................. Yes No

14. Do you *currently* take medication for any of the following problems?

a. Breathing or lung problems: ............................................... Yes No

b. Heart trouble: ............................................................ Yes No

c. Blood pressure: ........................................................... Yes No

d. Seizures: ................................................................. Yes No

15. If you've used a respirator, have you *ever had* any of the following problems?

a. Eye irritation: ............................................................ Yes No

b. Skin allergies or rashes: .................................................. Yes No

c. Anxiety: .................................................................. Yes No

d. General weakness or fatigue: .............................................. Yes No

e. Any other problem that interferes with your use of a respirator: .................. Yes No

16. Have you *ever lost* vision in either eye (temporarily or permanently)? .................... Yes No

17. Do you *currently* have any of the following vision problems?

| | | | |
|---|---|---|---|
| a. | Wear contact lenses: | Yes | No |
| b. | Wear glasses: | Yes | No |
| c. | Color blind: | Yes | No |
| d. | Any other eye or vision problem: | Yes | No |

18. Have you *ever had* an injury to your ears, including a broken ear drum? ................. Yes No

19. Do you *currently* have any of the following hearing problems?

| | | | |
|---|---|---|---|
| a. | Difficulty hearing: | Yes | No |
| b. | Wear a hearing aid: | Yes | No |
| c. | Any other hearing or ear problem: | Yes | No |

20. Have you *ever had* a back injury? ................. Yes No

21. Do you *currently* have any of the following musculoskeletal problems?

| | | | |
|---|---|---|---|
| a. | Weakness in any of your arms, hands, legs, or feet: | Yes | No |
| b. | Back pain: | Yes | No |
| c. | Difficulty fully moving your arms and legs: | Yes | No |
| d. | Pain or stiffness when you lean forward or backward at the waist: | Yes | No |
| e. | Difficulty fully moving your head up or down: | Yes | No |
| f. | Difficulty fully moving your head side to side: | Yes | No |
| g. | Difficulty bending at your knees: | Yes | No |
| h. | Difficulty squatting to the ground: | Yes | No |
| i. | Climbing a flight of stairs or a ladder carrying more than 25 lbs.: | Yes | No |
| j. | Any other muscle or skeletal problem that interferes with using a respirator: | Yes | No |

22. Other than medications for breathing and lung problems, heart trouble, blood pressure, and seizures mentioned earlier in this questionnaire, are you taking any other medications for any reason (including over-the-counter medications)? ................. Yes No

If "Yes," name the medications if you know them: ______________________________

______________________________________________________________________

______________________________________________________________________

I understand that this information is confidential. The answers are correct to the best of my knowledge.

______________________________ ______________
Signature Date

# CPWR Health & Safety Training Survey

This survey is intended to provide information about the value of health & safety training. At no time will any respondent's identity be linked with any specific answers. Please DO NOT put your name on this survey.

Course: ___________ Date(s): ______________ Location: _________________ Your Craft/Trade: _________________

| How many health and safety training courses have you attended? | 0 | 1 | 2 | 3 | 4 | 5+ |
|---|---|---|---|---|---|---|
| | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |

| | **Please check the box (☑) that best describes you.**<br>**If a question does not apply, please leave it blank.** | Never | Once in a while | Often | Most of the time | Always |
|---|---|---|---|---|---|---|
| 1a. | At your work site, how likely is it for people to stop work if conditions are unsafe? | ☐ | ☐ | ☐ | ☐ | ☐ |
| 1b. | In the last year, how likely were **you** to stop work if conditions were unsafe? | ☐ | ☐ | ☐ | ☐ | ☐ |
| 1c. | Do you feel that health and safety training influenced you? | | ☐ Yes | | ☐ No | |
| 2a. | At your work site, do people move from one task to another because of unsafe work conditions? | ☐ | ☐ | ☐ | ☐ | ☐ |
| 2b. | In the last year, how likely were **you** to move from one task to another because of unsafe conditions? | ☐ | ☐ | ☐ | ☐ | ☐ |
| 2c. | Do you feel that health and safety training influenced you? | | ☐ Yes | | ☐ No | |
| 3a. | At your work site, how likely is it for workers to report an unsafe condition to the foreman? | ☐ | ☐ | ☐ | ☐ | ☐ |
| 3b. | In the last year, how likely were **you** to report an unsafe condition to your foreman? | ☐ | ☐ | ☐ | ☐ | ☐ |
| 3c. | Do you feel that health and safety training influenced you? | | ☐ Yes | | ☐ No | |
| 4a. | At your work site, how likely is it for workers to ask for PPE if they think it is needed? | ☐ | ☐ | ☐ | ☐ | ☐ |
| 4b. | In the last year, how likely was it for **you** to ask for PPE if you thought it was needed? | ☐ | ☐ | ☐ | ☐ | ☐ |
| 4c. | Do you feel that health and safety training influenced you? | | ☐ Yes | | ☐ No | |
| 5a. | At your work site, how likely is it for workers to ask to see an MSDS relating to materials they are working with or around? | ☐ | ☐ | ☐ | ☐ | ☐ |
| 5b. | In the last year, how likely was it for **you** to ask to see an MSDS relating to materials you were working with or around? | ☐ | ☐ | ☐ | ☐ | ☐ |
| 5c. | Do you feel that health and safety training influenced you? | | ☐ Yes | | ☐ No | |
| 6a. | At your work site, how common is it for workers to ask for monitoring of a confined space before entering? | ☐ | ☐ | ☐ | ☐ | ☐ |
| 6b. | In the last year, how likely was it for **you** to ask for monitoring of a confined space before entering? | ☐ | ☐ | ☐ | ☐ | ☐ |
| 6c. | Do you feel that health and safety training influenced you? | | ☐ Yes | | ☐ No | |

***The labor educators and health & safety researchers at CPWR THANK YOU VERY MUCH for your time and cooperation.***

*Revised January 2012*

CPWR THE CENTER FOR CONSTRUCTION RESEARCH AND TRAINING

# DO YOU HAVE A STORY TO TELL ABOUT WORKING IN CONSTRUCTION?

Either about a problem that occurred in the past that might have been prevented if you had safety and health training, or a problem that has been solved or an accident averted because you had training? If so, please provide your name, e-mail and phone number, so that we may talk with you and hear your experiences.

Name: ______________________________

Email: ______________________________

Phone: ______________________________

*Note to Instructor:*
*Please include completed forms with course paperwork to be submitted to CPWR*

**CPWR - The Center for Construction Research and Training**
**8484 Georgia Avenue ■ Suite 1000 ■ Silver Spring, MD 20910**
**(301) 578-8500 ■ FAX (301) 578-4190**

# Answer Sheet

| | A | B | C | D | E |
|---|---|---|---|---|---|
| 1. | ○ | ○ | ○ | ○ | ○ |
| 2. | ○ | ○ | ○ | ○ | ○ |
| 3. | ○ | ○ | ○ | ○ | ○ |
| 4. | ○ | ○ | ○ | ○ | ○ |
| 5. | ○ | ○ | ○ | ○ | ○ |
| 6. | ○ | ○ | ○ | ○ | ○ |
| 7. | ○ | ○ | ○ | ○ | ○ |
| 8. | ○ | ○ | ○ | ○ | ○ |
| 9. | ○ | ○ | ○ | ○ | ○ |
| 10. | ○ | ○ | ○ | ○ | ○ |
| 11. | ○ | ○ | ○ | ○ | ○ |
| 12. | ○ | ○ | ○ | ○ | ○ |
| 13. | ○ | ○ | ○ | ○ | ○ |
| 14. | ○ | ○ | ○ | ○ | ○ |
| 15. | ○ | ○ | ○ | ○ | ○ |
| 16. | ○ | ○ | ○ | ○ | ○ |
| 17. | ○ | ○ | ○ | ○ | ○ |
| 18. | ○ | ○ | ○ | ○ | ○ |
| 19. | ○ | ○ | ○ | ○ | ○ |
| 20. | ○ | ○ | ○ | ○ | ○ |
| 21. | ○ | ○ | ○ | ○ | ○ |
| 22. | ○ | ○ | ○ | ○ | ○ |
| 23. | ○ | ○ | ○ | ○ | ○ |
| 24. | ○ | ○ | ○ | ○ | ○ |
| 25. | ○ | ○ | ○ | ○ | ○ |
| 26. | ○ | ○ | ○ | ○ | ○ |
| 27. | ○ | ○ | ○ | ○ | ○ |
| 28. | ○ | ○ | ○ | ○ | ○ |
| 29. | ○ | ○ | ○ | ○ | ○ |
| 30. | ○ | ○ | ○ | ○ | ○ |
| 31. | ○ | ○ | ○ | ○ | ○ |
| 32. | ○ | ○ | ○ | ○ | ○ |
| 33. | ○ | ○ | ○ | ○ | ○ |
| 34. | ○ | ○ | ○ | ○ | ○ |
| 35. | ○ | ○ | ○ | ○ | ○ |
| 36. | ○ | ○ | ○ | ○ | ○ |
| 37. | ○ | ○ | ○ | ○ | ○ |
| 38. | ○ | ○ | ○ | ○ | ○ |
| 39. | ○ | ○ | ○ | ○ | ○ |
| 40. | ○ | ○ | ○ | ○ | ○ |
| 41. | ○ | ○ | ○ | ○ | ○ |
| 42. | ○ | ○ | ○ | ○ | ○ |
| 43. | ○ | ○ | ○ | ○ | ○ |
| 44. | ○ | ○ | ○ | ○ | ○ |
| 45. | ○ | ○ | ○ | ○ | ○ |
| 46. | ○ | ○ | ○ | ○ | ○ |
| 47. | ○ | ○ | ○ | ○ | ○ |
| 48. | ○ | ○ | ○ | ○ | ○ |
| 49. | ○ | ○ | ○ | ○ | ○ |
| 50. | ○ | ○ | ○ | ○ | ○ |

**SCORE**

**Written** ________

**Verbal** ________

**Please list all scores**

**Read the Following Before You Begin.**

– Make heavy black marks that completely fill the circle.
– Erase clearly any answers you wish to change.
– Make no stray marks on this answer sheet

**Name:** ________________________

**Course Location:** ________________

**I.D. #:** __________________________

# CPWR Trainee Course Evaluation Form

Course: ______________ Date(s): ______________ Location: ______________

*Please check the appropriate box* **(☑)** *after each question.*

| **<u>The instructor(s):</u>** | **Rarely** | | **Most of the time** | | **Always** |
|---|---|---|---|---|---|
| 1. Described the course and lesson objectives clearly. | ☐ | ☐ | ☐ | ☐ | ☐ |
| 2. Explained how the course content applies to my job or trade. | ☐ | ☐ | ☐ | ☐ | ☐ |
| 3. Presented the material clearly, so that I could understand it. | ☐ | ☐ | ☐ | ☐ | ☐ |
| 4. Kept the class focused on the important points. | ☐ | ☐ | ☐ | ☐ | ☐ |
| 5. Reviewed key points. | ☐ | ☐ | ☐ | ☐ | ☐ |
| 6. Gave helpful feedback to the class on the exercises and activities. | ☐ | ☐ | ☐ | ☐ | ☐ |
| 7. Made good use of the student materials / manuals. | ☐ | ☐ | ☐ | ☐ | ☐ |

| **<u>This course</u> helped me to improve my ability to:** | **Very little** | | **Some** | | **A lot** |
|---|---|---|---|---|---|
| 8. Understand the problems of working with hazardous materials or conditions. | ☐ | ☐ | ☐ | ☐ | ☐ |
| 9. Recognize health hazards on the job. | ☐ | ☐ | ☐ | ☐ | ☐ |
| 10. Recognize unsafe work conditions and practices. | ☐ | ☐ | ☐ | ☐ | ☐ |
| 11. Recognize signs and symptoms that may be related to chemical exposure. | ☐ | ☐ | ☐ | ☐ | ☐ |
| 12. Size up whether a job hazard needs me to take immediate action. | ☐ | ☐ | ☐ | ☐ | ☐ |
| 13. Use protective equipment. | ☐ | ☐ | ☐ | ☐ | ☐ |
| 14. Understand my legal rights. | ☐ | ☐ | ☐ | ☐ | ☐ |
| 15. Understand the importance of site safety plans and emergency response planning. | ☐ | ☐ | ☐ | ☐ | ☐ |

*Please turn over to complete side 2* ⇨

**Teaching methods and materials:**

Information in this course was delivered in several different ways. CPWR would like to know how well each of these methods contributed to helping you learn what you needed to know. If any of these methods or materials were not used, please mark n/a for that question.

| | | n/a | Didn't help at all | | Helped some | | Really helped |
|---|---|---|---|---|---|---|---|
| 16. | Lectures | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 17. | Discussions | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 18. | Demonstrations | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 19. | Class exercises | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 20. | Hands-on activities / simulations | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 21. | Course manual | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 22. | Slides / PowerPoint presentations | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 23. | Video / CDROM / DVD | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 24. | Other: ___________________________________ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |

| | | Not at all | | Some | | Completely |
|---|---|---|---|---|---|---|
| 25. | **Overall**, how well did this class meet the objective of helping you to develop the knowledge, skills, and confidence you need to work safely at hazardous waste sites after you receive site specific training? | ☐ | ☐ | ☐ | ☐ | ☐ |

26. How could this course be improved?

______________________________________________________________________

______________________________________________________________________

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***The labor educators and health & safety researchers at CPWR THANK YOU VERY MUCH for your time and cooperation.***

*Revised January 2012*

CPWR THE CENTER FOR CONSTRUCTION RESEARCH AND TRAINING





# 40-Hour Hazardous Waste Worker

## PARTICIPANT MANUAL

Version III, Revised June 2016

THE CENTER FOR CONSTRUCTION
RESEARCH AND TRAINING

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# 40-Hour Hazardous Waste Worker Participant Manual

Ver VIII Revised June 2016

**Disclaimer:**

This training program was developed for CPWR by Michael R. Cooper, CIH, CSP, MPH, and George Newman, BA. The participant manual was produced by Darrell VanWagner, Graphics and Desktop Publishing.


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# Table of Contents

## Introduction

CPWR – The Center for Construction Research and Training conducts research and administers specific types of construction health and safety training for members of our consortium partners, and the North American Build Trades Unions. Our overriding goal in all the training we deliver is to enable and empower these construction workers to recognize potentially unsafe working conditions, and to identify proper ways to eliminate or control those hazards that make conditions unsafe.

However, this in no way ever relieves the employers from their primary responsibility of providing workers a safe and healthful workplace.

The Occupational Safety and Health Administration (OSHA) has written regulations (CFR 1926.65) to make sure that workers at hazardous waste sites are properly protected. These regulations require that contractors plan their work carefully, and that they use the right equipment and work methods. A very important part of the OSHA regulation is that workers must be given either forty hours of training with an additional three days of supervised site-specific training for general site workers on a hazardous waste site, or twenty-four hours with one day of site specific training for TSD and specialized task workers.

This Hazardous Waste Worker Course, developed by CPWR for the Construction Consortium for Hazardous Waste Worker Training, meets all requirements for the initial twenty-four or forty hour training. More importantly, it has been designed to meet your needs. The course has been prepared for building trades workers, by building trades workers, and is meant to be taught by experienced tradespeople.

This course will help you to learn about your legal rights and responsibilities, how to recognize and control hazards, how to obtain information about hazardous materials, and how to use and decontaminate respirators and protective clothing. You will also learn about correct work practices, air and medical monitoring, and emergency response.

The CPWR Hazardous Waste Worker Course has been designed to be clear, direct, and to involve you actively in the learning process.

- Learning objectives, found at the beginning of each chapter, tell you what you will be expected to be able to do after you finish the training
- Brief case studies demonstrate the importance of the information and skills taught.
- The information that you need is stated in clear, non-technical language wherever possible.  Technical or unfamiliar concepts are carefully explained.
- Classroom lectures, demonstrations, and activities help you to be actively involved in the learning process and to become confident in your ability to use what you learn.
- Hands-on workshops give you the opportunity to practice putting on, wearing, and decontaminating protective equipment.
- Your instructors are always available to explain any material that is not clear.

It is CPWR's goal that every trainee leave the Hazardous Waste Worker Course with the basic skills, knowledge and confidence that he or she needs to work safely at hazardous waste sites, and that they will be better able to protect themselves on all their jobs.  With your active participation, we are confident that we will meet that goal.

Students wearing Level A protective suits experience how difficult it can be to communicate.  Here they are receiving instructions for their work assignment in a simulated hazardous waste site.

A CPWR instructor closely monitors not only how well the students accomplish their assigned task, but also observes their safety while wearing this very restrictive equipment.

In addition to class lectures and discussion, students are assigned to solve specific problems in groups, just as they would as part of a work crew.

Students perform both a negative and positive seal check on the respirators they will be using while dressed out in both Level A and Level B protective clothing. A properly sealed face mask will help protect workers from exposures to hazardous chemicals when they begin work on an actual hazardous waste site.

Students often express amazement at the amount of information they learn in the 40-hour Hazardous Waste Worker class. For many, this class is the first experience they've had that focuses first on their own health and safety.

## WARNING

The material was prepared for use by experienced instructors in the training of persons who are or who anticipate being employed at a hazardous waste worksite. Authors of this material have prepared it for the training of this category of workers as of the date specified on the title page. Users are cautioned that the subject is constantly evolving. Therefore, the material may require additions, deletions, or modifications to incorporate the effects of that evolution occurring after the date of this material preparation.

## DISCLAIMER

The Occupational Safety and Health Administration (OSHA) rule to help assure worker health and safety at hazardous waste sites requires introductory, general training on basic hazard recognition, use of provided protective equipment, basic hazard control, decontamination procedures, and other relevant standard operating procedures, as well as training at each site. This program is intended to meet the requirements of the introductory, general training. It must be followed by on-site training, during which the specifics of the protective equipment, decontamination methods, and other procedures and information at the site are discussed and practiced. At that time, the elements of the site-specific standard operating procedures are given in detail.

Additional training is necessary to perform many activities. These activities include implementing the emergency response plan, identifying materials using monitoring instruments, selecting protective equipment, and performing advanced control containment or confinement. Additional site-specific training for emergency response must be provided so that you understand how to recognize and respond to alarms at the site and can carry out any role which may be assigned during a response.

For information about further training, consult the training instructor, your company safety and health plan, your company health and safety representative, or your union health and safety representative.

CPWR

# Chapter 1:
# Legal Rights & Responsibilities

The Occupational Safety and Health Administration (OSHA) is responsible for setting and enforcing regulations governing worker safety and health at hazardous waste sites. Other Federal and state agencies are responsible for protecting the community, environmental, and transportation system from hazardous materials. Your employer must provide a workplace free from recognized hazards that are causing or likely to cause death or serious physical harm to its employees. Your employer must provide the necessary hazard controls, training, and protective equipment to reduce exposure to hazardous substances. You are responsible for knowing and following the employer's safety rules.

**Chapter Objectives:**

After completing this module, you will be able to:

1. Identify which government agencies are responsible for aspects of safety, health, and environmental protection.
2. Find information you need in OSHA regulations.
3. Discuss your health and safety rights on the job.
4. Identify your health and safety responsibilities.

## Case Study


A worker at a hazardous waste cleanup site wanted to know more about the "SuperKleen" solvent they were using to take contamination off of walls. He asked a co-worker to get the Safety Data Sheet (SDS) for "SuperKleen." The co-worker told him, "You do not have to keep SDSs on hazardous waste sites."

**Do employers need to keep safety data sheets for chemicals used on a hazardous waste site?**

Yes. **The employer needs to have an SDS for "SuperKleen"** because the law says there must be SDSs on site for chemicals that are not hazardous waste. This requirement comes from the Hazard Communications Standard, also known as the "Right to Understand" law. In this chapter and later in Chapter 3, you will learn about what the laws say about hazardous waste cleanup work and chemical information that must be available to workers.

**The Occupational Safety and Health Act of 1970 (OSH Act) established the Occupational Health and Safety Administration (OSHA) within the Department of Labor.** Organized labor worked hard to support the creation of OSHA. OSHA's job is to write and enforce health and safety regulations to protect workers and by providing training, outreach, education and assistance. OSHA standards apply to all employers regardless of size.

**Your employer has the responsibility to:**

**Provide a safe and healthy workplace.**
The employer must provide a place of employment free from recognized hazards that are causing or are likely to cause death or serious physical harm to employees. This responsibility is commonly referred to as the "general duty clause" [Section 5 (a) (1)] of the OSH Act.

**Comply with OSHA standards.**
Employers must comply with OSHA regulations contained in either the General Industry Standards (29CFR1910) or the Construction Industry Standards (29CFR1926). If there is a conflict between two standards, the most protective standard must be used and enforced. Remember that all OSHA regulations are applicable on hazardous waste sites.

**You have the responsibility to:**

**Follow your employer's safety rules.**
Employees must wear provided personal protective equipment and follow the employer's safety rules. You cannot be cited or fined by OSHA, but your employer can discipline you for violating work place safety rules.

**Bring safety and health concerns to the attention of your union or management.**
Tell your job steward, supervisor, or business agent about health and safety concerns on the job. Section 11(c) of the OSH Act prohibits disciplining or discriminating against any worker for using their OSHA rights, including filing a complaint. Your union can also help you to use your rights.

**OSHA gives you the right to:**

**File a complaint against your employer or ask OSHA to inspect your workplace.**

**Be represented in the OSHA walk-around inspection.**
You or your representative, usually your union steward, can accompany the OSHA compliance officer in the walk-around inspection. OSHA regulations do not require the employer to pay the employee for time spent on the OSHA walk-around; however, some states with a state OSHA plan do require payment. Walk-around activities include all opening and closing conferences related to the conduct of the inspection.

**Talk/meet privately with an OSHA inspector.**

**Be represented in the closing conference after the inspection.**
You, or representative, have the right to attend the meeting with the OSHA inspector to discuss the results of the inspection and how to control any hazards identified.

**Be informed of imminent dangers.**
An OSHA compliance officer (inspector) must tell you if you are exposed to an imminent danger (one that could cause death or serious injury now or in the near future). The compliance officer will also ask the employer to stop the dangerous activity. If necessary, a judge can force the employer to stop the work.

**Be informed of health hazards and get copies of the results of tests done to find hazards in the workplace.**
You have the right to be notified if you are exposed to occupational hazards and to be notified of the results of occupational health studies conducted by the employer or by OSHA.

You or your union representative should submit a written request for all instrument readings or levels of contaminants found. A copy of the findings should also be requested from OSHA.

**Be told about OSHA citations.**
Notices of OSHA citations must be posted in the workplace near the site where the violation occurred and must remain posted for three days or until the hazard is corrected, whichever is longer.

**Appeal abatement dates (time limits for fixing hazards).**
OSHA will give the employer a date by which any hazards cited must be fixed. Employees or their union can appeal these dates if they believe that they allow too much time. Appeals must be filed within 15 days of the citation.

**Use your rights under the law without retaliation and discrimination.**
If you have been discriminated against for using your OSHA rights, you have the right to file a complaint with the OSHA area office within 30 days. This time limit is strictly enforced.

**Access your medical records.**
You have the right to see and to copy any medical records about you that the employer has. **Your employer is required by 1926.33 (and 1910.1020) to maintain your medical records for 30 years after you leave employment.** If you are employed for less than one year, the employer can maintain your records or give them to you when you leave the job.

## HAZWOPER —
## Hazardous Waste Operations and Emergency Response

The OSHA Hazardous Waste Operations and Emergency Response standard is commonly called **HAZWOPER**. In the construction standards it is 29CFR 1926.65 and in general industry it is **29CFR1910.120 (See page 21 of the chapter for this standard and page 84 for its Appendix B on levels of protection and protective gear)**. The intent of both standards is the same and their contents are similar.

**The HAZWOPER standard was designed to maintain the safety and health of workers at hazardous waste sites and during emergency response.--1926.65, Paragraph (a)**
The standard covers clean-up required by local, state, or federal government, voluntary clean-up of hazardous waste sites, and emergency response following the release of hazardous substances unless the employer can demonstrate that employee exposure to safety and health hazards is unlikely. A hazardous waste site can be a few buried barrels of chemicals or a decommissioned nuclear facility with millions of gallons of liquid hazardous waste, millions of cubic feet of solid hazardous waste, and contaminated ground water. The range of conditions possible at hazardous waste site makes obtaining site-specific information and providing site-specific plans, procedures, and controls necessary.



**Your employer must write and follow a safety and health program.--1926.65, Paragraph (b)**
The program must identify, evaluate, and control safety and health hazards and provide for emergency response at hazardous waste sites. The written safety and health program must be available to anyone involved with the hazardous waste operation and the site-specific safety and health plan, contained in the program, must be kept on site. The details about how to do the cleanup has to be worked out in advance. The safety and health program will be discussed in detail in Chapter 6.

**Site characterization must be done before cleanup begins on a hazardous waste site.--1926.65, Paragraph (c)**
Site characterization identifies safety and health hazards, determines the degree of the hazards, and determines the initial requirements for personal protective equipment. Workers who will work on the site must be informed of the results of the site characterization. (See Chapter 6, pages 3-9 for more information.)

**A site control program for protecting workers must be implemented before cleanup begins on a hazardous waste site.--1926.65, Paragraph (d)**

| The program must include | | | | | |
|---|---|---|---|---|---|
| Site maps | Work zones | Use of a “buddy system” | Site communications | Standard operating procedures | Location of the nearest medical assistance |

(See Chapter 6, pages 10-14 for more information.)

**Working on a hazardous waste site requires initial, on site, and refresher training.--1926.65, Paragraph (e)**

***Training for General Site Workers and Supervisors.--1926.65(e)(3)(i)***
This 40-hour training is just one part of the special training OSHA says you must have before you may work on a hazardous waste cleanup site. After you finish this general training, you need 3 more days of specific training on the site you are working on. This training may be needed even if you only move from one location to another on the same site. That is called site-specific training. Supervisors need 8 more hours of training.

***Training for Temporary Site Workers--1926.65(e)(3)(ii & iii)***
Workers who are on a site that has been fully characterized or who are on a site for a specific task and are unlikely to be exposed above the Permissible Exposure Limit require 24 hours of training plus 1 day of site specific training under the direct supervision of a trained, experienced supervisor.

***Training for workers--1926.65(p)(7) Treatment, Storage, and Disposal only***
Workers at a Treatment, Storage, and Disposal facility, as defined by 40CFR 264 and 265, require 24 hours of training plus site specific training as to their respective assignments.

In addition to the above requirements, all workers are required to attend 8 hours of refresher training annually.

**OSHA requires employers to provide medical surveillance (exams and tests) before, during, and at the end of a job on a hazardous waste site--1926.65, Paragraph (f)**

A medical surveillance program is a required part of the safety and health program. Medical surveillance can indicate that workers will be able to wear the required PPE while working in temperature extremes, that they do not have an illness from chemical exposure on prior jobs, and that they are not sick from being overexposed to chemicals on the current job.

**Medical surveillance must be provided by the employer for the following workers:**

1. All workers who are or may be exposed to hazardous substances or health hazards at or above the PEL or another published exposure level (if no PEL) for 30 days or more a year;
2. All workers who wear a respirator for 30 days or more a year or as required by 1910.134;
3. All workers who are injured, become ill, or show symptoms due to possible overexposure to hazardous substances from an emergency response or clean-up; and
4. Members of hazardous materials response (HAZMAT) teams.

Note that medical clearance must be obtained before a respirator is used, even if the respirator will be used for less than 30 days per year.

Employers must make medical examinations available to each employee who falls into one or more of the above categories. **Medical exams must be conducted:**

1. Before a new job assignment;
2. At a frequency determined by the doctor but not exceeding once every two years;
3. When a job ends, unless the last exam was less than 6 months before;
4. Following signs or symptoms indicating possible overexposure to hazardous substances or health hazard; or
5. Following injury or exposure above the PEL or other occupational exposure limit in an emergency situation.

**All medical examinations and procedures must be performed by or under the supervision of a licensed physician, preferably one knowledgeable in occupational medicine.** The exam must be provided without cost to the worker, without loss of pay, and at a reasonable time and place. A physician will decide on the content of the examination. You should explain to the physician the type of work you do, the potential health risks, and the type of protective equipment that you wear on the job. At a minimum medical exams must include a medical and work history. They should also include a complete physical, lung function test, hearing test, and an EKG for your heart.

**Your employer must give the physician:**

1. A copy of OSHA's HAZWOPER standard (29CFR1926.65);
2. Your job description;
3. Your current or anticipated exposure levels;
4. A description of personal protective equipment used or to be used;
5. Information from previous examinations that the physician may not have; and
6. Information required by the OSHA's Respiratory Protection standard (29CFR1910.134).

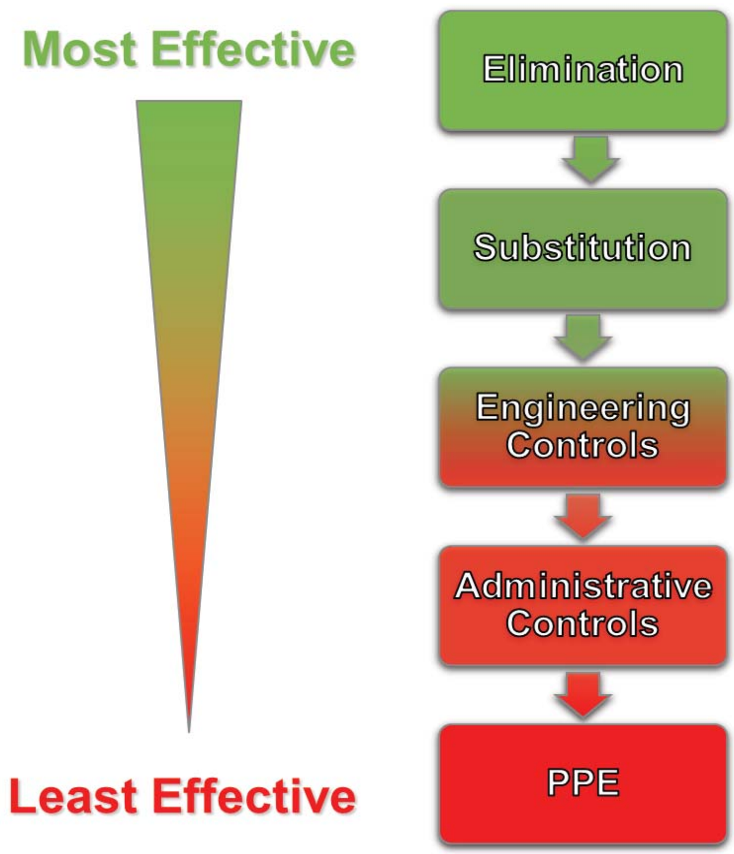
**Your employer must give you a copy of the doctor's written report, including:**

1. Medical conditions that would make hazardous waste work or respirator use particularly risky for you;
2. Recommended limitations on your assigned work;
3. Results of the exam and tests, if you request them; and
4. A statement that the doctor has told you about the exam results and any conditions that require further examination or treatment.

**The report your employer receives from the physician can only discuss findings related to your work.** Any medical conditions unrelated to your job must not be revealed to the employer. You have the right to a copy of the physician's full report.

**Your employer must keep medical and exposure records for as long as you are employed plus another 30 years.** If you work for your employer for less than a year, they do not have to keep your records provided that they give them to you when you leave.

**Controls must be used to protect employees from exposure to hazardous substances and safety and health hazards.--1926.65, Paragraph (g)**



**Moving or opening barrels, drums, and containers can result in injuries and requires special precautions.--1926.65, Paragraph (j)**

A 55-gallon metal drum full of gasoline weighs about 400 pounds while the same drum full of bromine will weight almost 1,500 pounds. It is important to know what is in a drum and how full it is before trying to move it. Dropping a drum can seriously injure a worker. Some chemicals can explode if they are dropped. Spilled chemicals can mix and start a fire or explosion. Employers must write a plan for how they will handle drums to prevent injuries.

**Decontamination procedures must be in place before entering areas where potential for exposure to hazardous substances exists.--1926.65, Paragraph (k)**

Every time you leave a contaminated work area you will go through decontamination to make sure you do not track chemicals out of the work area on your work clothes or on your skin. All equipment (even trucks) has to go through decontamination.

Photo courtesy U.S. DoD

**OSHA says that employers have to evaluate the danger to employees and the effectiveness of new cleanup technologies.--1926.65, Paragraph (o)**

Inventors and scientists are coming up with new ways to clean up hazardous waste all the time. Some methods make the cleanup easier, some reduce worker exposures, and some do both. For example, at some hazardous waste cleanup sites workers blast thousands of volts of electricity through waste, changing it into a solid. This process, called vitrification, traps the hazardous waste in the rock-like material.

Photo courtesy U.S. DOE

**The employer must write and implement an emergency response plan.--1926.65, Paragraph (q)**

Things can go wrong during a cleanup. There can be a fire or explosion; workers can be poisoned by gases or hit by a forklift, or large amounts of chemicals can spill.

Photo courtesy FEMA

## Hazard Communication Standard

The OSHA Hazard Communication Standard for Construction **(29CFR1926.59)** requires employers to set up a hazard communication (HazCom) program for the products they bring on site. This standard points you to the General Industry (non-construction) standard **29CFR1910.1200. The HazCom standard applies to all hazardous materials that are not hazardous wastes.** Materials covered by the HazCom program include: drum solvents, vehicle maintenance products, and chemicals used to treat wastes or chemicals for portable toilets. **A copy this standard can be found beginning on page 92 of this chapter.**

### Written Hazard Communication Program - 1910.1200 (e)

This program must:

1. Be available to workers and their representatives;
2. Include a complete and current list of the hazardous chemicals brought to each work area; and
3. Describe the methods used to inform workers about the hazards of non-routine tasks and unlabeled pipes.

## Labels and Other Forms of Warning - 1910.1200 (f)

Regulations for labels on incoming containers (not hazardous waste)

- Hazardous chemicals must be labeled with chemical identity, hazard warnings, and name and address of manufacturer.
- Employers must ensure that all containers of hazardous chemicals are labeled (except for portable containers used by a single employee during a single shift).

### Safety Data Sheets (SDS) - 1910.1200 (g)

Employers must keep Safety Data Sheets (SDSs) at the work site so that everyone can find information about the dangers of the chemicals they work with and how to protect themselves.

- Manufacturers and distributors must forward SDSs to the purchaser with the first shipment, and with the first shipment after an SDS is updated.
- Employers must get and keep SDSs for each hazardous chemical in their workplace.
- SDSs must be filled out completely and accurately.
- Electronic or paper copies of SDSs must be accessible to workers during all shifts.
- SDSs are not required for hazardous wastes found on site but the hazards and controls for wastes must be determined before cleanup work starts.

### Employee Information and Training - 1910.1200 (h)

Employers must train workers on the hazardous chemicals in their work areas at initial assignment and when new hazards are introduced.  Training must include the requirements of the OSHA HazCom Standard and how to **understand information on labels and SDSs.**  Workers must be trained on the hazards of the materials used in their areas and how to recognize exposure.  Workers must be told the location of the employer's written hazard communication program, SDSs, and hazardous chemical lists.

# Hazardous Materials Legislation

The Resource Conservation and Recovery Act (**RCRA**) of **1976** gave the EPA the authority to control hazardous waste from the "cradle to grave". This includes the generation, transportation, treatment, storage, and disposal (TSD) of hazardous waste. It also mandated that OSHA establish worker safety and health standards, including training.

The Comprehensive Environmental Response, Compensation, and Liability Act (**CERCLA**) of **1980**, also known as **Superfund**, authorized government money for cleanup of abandoned hazardous waste sites and compensation to injured victims. In **1986** the Superfund Amendment and Re-Authorization Act (**SARA**) continued this funding of efforts to determine which locations belonged on the National Priority List (**NPL**). SARA also mandated that OSHA establish worker safety and health standards for hazardous waste operations, and established requirements for worker and management training.

## Other Federal Agencies with Hazardous Materials Responsibilities

OSHA is the most important agency for protecting workers on Superfund sites. The following additional government agencies may be involved in hazardous waste operations –

### Environmental Protection Agency (EPA)

- Protects our air, land, and water from pollution.
- Regulates the cleanup of hazardous waste sites (Superfund).
- Requires the testing of chemicals before they are sold and the disposal of hazardous materials.

### Department of Transportation (DOT)

- Regulates the transportation of hazardous materials on land and air.
- Requires labels, placards, manifests, and shipping containers.

### United States Coast Guard (USCG)

- Regulates the transportation of hazardous material on navigable waters.
- Involved in cleaning up oil and chemical spills.

### Nuclear Regulatory Commission (NRC)

- Regulates community and worker exposure to radiation hazards.

### National Institute of Occupational Safety and Health (NIOSH)

- Approves respiratory protection equipment.
- Conducts research.
- Publishes workplace Recommended Exposure Limits (RELs).

### Department of Energy (DOE)

- Responsible for controlling worker and environmental hazards at nuclear weapons sites.

### Federal Emergency Management Agency (FEMA)

- Coordinates preparation for, response to, and recovery from disasters.

### United States Army Corps of Engineers (USACE)

- Civilian and uniformed personnel provide engineering services.
- Involved in disaster response and recovery, environmental restoration

# Summary: Legal Rights and Responsibilities

The agency in charge of health and safety at work is **OSHA--the Occupational Safety and Health Administration**. In some states, the U.S. government enforces regulations and in other states, the state government.

The OSH Act set up both employee and employer **rights and responsibilities**. A major employer responsibility is to provide a workplace free of recognized safety and health hazards likely to cause serious physical harm. A major worker responsibility is to follow proper employer safety rules and to wear personal protective equipment when required.

Two specific OSHA regulations important to hazardous waste workers are:

1. The **Hazardous Waste Operations and Emergency Response (HAZWOPER) Standard (29CFR1926.65 for construction or 29CFR1910.120 for general industry)**. It protects the safety and health of hazardous waste site workers, and includes:

- Safety Plan
    - *hazards on site*
    - *monitoring*
    - *haz waste cleanup plan/work practices*
    - *personal protective equipment*
    - *decontamination*
    - *medical surveillance*
    - *emergency procedures*
- Medical exams (medical surveillance)
- Decontamination – personal and equipment
- New cleanup methods (new technology)
- Moving barrels of waste (drum handling)
- Training for workers and supervisors
- What to do in an emergency (emergency response plan)

2. The **Hazard Communication Standard (29CFR1910.1200)** requires employers to inventory and label products that are hazardous. On a hazardous waste site, only cleanup and other products that are brought on site are covered. The employer must set up an effective, written program for communicating chemical hazards to workers which includes –

- Inventory of chemicals on site
- Labeling containers
- Getting and making available Safety Data Sheets (SDSs)
- Employee training
- Keeping records about the program.

## *Finding OSHA Regulations*

All Federal Regulations are published in the Code of Federal Regulations (CFR) and are available at http://www.ecfr.gov/. The 29th Title (or volume) of the CFR contains all the regulations about labor. Construction safety and health standards are contained in part 1926 of Title 29 and the construction HAZWOPER standard is in section 65 of part 1926. In legal shorthand this standard is referred to as 29CFR1926.65. Individual paragraphs are identified with lowercase letters and sub-paragraphs are given numbers. Sub-paragraphs are further divided using roman numerals and then capital letters.

General industry standards are found in part 1910 (the general industry HAZWOPER standard is at 29CFR1910.120). Many important standards, like **HAZCOM, Access To Employee Exposure and Medical Records, and Respiratory Protection are only printed in the general industry standards (1910) but are referred to in the construction standards and therefore apply to construction workplaces.**
The box below explains the system for referring to OSHA standards. **This will be useful when you need to find or refer to a specific section of a standard. For example, 29CFR1926.65(e)(3)(i) covers initial training for general site workers at hazardous waste sites.**

| 29CFR1926.65(e)(3)(i) | |
|---|---|
| 29 = | OSHA regulations are located in Title 29 |
| CFR = | Code of Federal Regulations is the title of the government publication containing OSHA and other standards |
| 1926 = | Part number 1926 covers construction |
| .65 = | Section number 65 covers hazardous waste operations and emergency response (HAZWOPER) |
| (e) = | Paragraph (e) describes a specific topic - training |
| (3) = | Sub-paragraph (3) provides details about the topic - initial training |
| (i) = | Sub-sub paragraph (i) provides more details about the sub-paragraph - initial training for general site workers |

# HAZWOPER

## OSHA Hazardous Waste Operations and Emergency Response Standard (HAZWOPER)

29CFR1926.65

### Table of Contents

**(a)**
**Scope, application, and definitions**

**(a)(1)**
“Scope.” This section covers the following operations, unless the employer can demonstrate that the operation does not involve employee exposure or the reasonable possibility for employee exposure to safety or health hazards:

**(a)(1)(i)**
Clean-up operations required by a governmental body, whether Federal, state, local or other involving hazardous substances that are conducted at uncontrolled hazardous waste sites (including, but not limited to, the EPA’s National Priority Site List (NPL), state priority site lists, sites recommended for the EPA NPL, and initial investigations of government identified sites which are conducted before the presence or absence of hazardous substances has been ascertained;

**(a)(1)(ii)**
Corrective actions involving clean-up operations at sites covered by the Resource Conservation and Recovery Act of 1976 (RCRA) as amended (42 U.S.C. 6901 et seq.);

**(a)(1)(iii)**
Voluntary clean-up operations at sites recognized by Federal, state, local or other governmental bodies as uncontrolled hazardous waste sites;

(a)(1)(iv)
Operations involving hazardous wastes that are conducted at treatment, storage, and disposal (TSD) facilities regulated by 40 CFR parts 264 and 265 pursuant to RCRA; or by agencies under agreement with U.S.E.P.A. to implement RCRA regulations; and

**(a)(1)(v)**
Emergency response operations for releases of, or substantial threats of releases of, hazardous substances without regard to the location of the hazard.

**(a)(2)**
Application.

**(a)(2)(i)**
All requirements of part 1910 and part 1926 of title 29 of the Code of Federal Regulations apply pursuant to their terms to hazardous waste and emergency response operations whether covered by this section or not. If there is a conflict or overlap, the provision more protective of employee safety and health shall apply without regard to 29 CFR 1926.20(e)(1).

**(a)(2)(ii)**
Hazardous substance clean-up operations within the scope of paragraphs (a)(1)(i) through (a)(1)(iii) of this section must comply with all paragraphs of this section except paragraphs (p) and (q).

**(a)(2)(iii)**
Operations within the scope of paragraph (a)(1)(iv) of this section must comply only with the requirements of paragraph (p) of this section.

***Notes and Exceptions:***

**(a)(2)(iii)(A)**
All provisions of paragraph (p) of this section cover any treatment, storage or disposal (TSD) operation regulated by 40 CFR parts 264 and 265 or by state law authorized under RCRA, and required to have a permit or interim status from EPA pursuant to 40 CFR 270.1 or from a state agency pursuant to RCRA.

**(a)(2)(iii)(B)**
Employers who are not required to have a permit or interim status because they are conditionally exempt small quantity generators under 40 CFR 261.5 or are generators who qualify under 40CFR 262.34 for exemptions from regulation under 40 CFR parts 264, 265 and 270 ("excepted employers") are not covered by paragraphs (p)(1) through (p)(7) of this section. Excepted employers who are required by the EPA or state agency to have their employees engage in emergency response or who direct their employees to engage in emergency response are covered by paragraph (p)(8) of this section, and cannot be exempted by (p)(8)(i) of this section. Excepted employers who are not required to have employees engage in emergency response, who direct their employees to evacuate in the case of such emergencies and who meet the requirements of paragraph (p)(8)(i) of this section are exempt from the balance of paragraph (p)(8) of this section.

**(a)(2)(iii)(C)**
If an area is used primarily for treatment, storage or disposal, any emergency response operations in that area shall comply with paragraph (p)(8) of this section. In other areas not used primarily for treatment, storage, or disposal, any emergency response operations shall comply with paragraph (q) of this section. Compliance with the requirements of paragraph (q) of this section shall be deemed to be in compliance with the requirements of paragraph (p)(8) of this section.

**(a)(2)(iv)**
Emergency response operations for releases of, or substantial threats of releases of, hazardous substances which are not covered by paragraphs (a)(1)(i) through (a)(1)(iv) of this section must only comply with the requirements of paragraph (q) of this section.

**(a)(3)**

**Definitions**

"Buddy system" means a system of organizing employees into work groups in such a manner that each employee of the work group is designated to be observed by at least one other employee in the work group. The purpose of the buddy system is to provide rapid assistance to employees in the event of an emergency.

"Clean-up operation" means an operation where hazardous substances are removed, contained, incinerated, neutralized, stabilized, cleared-up, or in any other manner processed or handled with the ultimate goal of making the site safer for people or the environment.

"Decontamination" means the removal of hazardous substances from employees and their equipment to the extent necessary to preclude the occurrence of foreseeable adverse health effects.

"Emergency response or responding to emergencies" means a response effort by employees from outside the immediate release area or by other designated responders (i.e., mutual-aid groups, local fire departments, etc.) to an occurrence which results, or is likely to result, in an uncontrolled release of a hazardous substance. Responses to incidental releases of hazardous substances where the substance can be absorbed, neutralized, or otherwise controlled at the time of release by employees in the immediate release area, or by maintenance personnel are not considered to be emergency responses within the scope of this standard. Responses to releases of hazardous substances where there is no potential safety or health hazard (i.e., fire, explosion, or chemical exposure) are not considered to be emergency responses.

"Facility" means (A) any building, structure, installation, equipment, pipe or pipeline (including any pipe into a sewer or publicly owned treatment works), well, pit, pond, lagoon, impoundment, ditch, storage container, motor vehicle, rolling stock, or aircraft, or (B) any site or area where a hazardous substance has been deposited, stored, disposed of, or placed, or otherwise come to be located; but does not include any consumer product in consumer use or any water-borne vessel.

"Hazardous materials response (HAZMAT) team" means an organized group of employees, designated by the employer, who are expected to perform work to handle and control actual or potential leaks or spills of hazardous substances requiring possible close approach to the substance. The team members perform responses to releases or potential releases of hazardous substances for the purpose of control or stabilization of the incident. A HAZMAT team is not a fire brigade nor is a typical fire brigade a HAZMAT team. A HAZMAT team, however, may be a separate component of a fire brigade or fire department.

"Hazardous substance" means any substance designated or listed under paragraphs (A) through (D) of this definition, exposure to which results or may result in adverse effects on the health or safety of employees:

(A) Any substance defined under section 101(14) of CERCLA;
(B) Any biological agent and other disease-causing agent which after release into the environment and upon exposure, ingestion, inhalation, or assimilation into any person, either directly from the environment or indirectly by ingestion through food chains, will or may reasonably be anticipated to cause death, disease, behavioral abnormalities, cancer, genetic mutation, physiological malfunctions (including malfunctions in reproduction) or physical deformations in such persons or their offspring;

(C) Any substance listed by the U.S. Department of Transportation as hazardous materials under 49 CFR 172.101 and appendices; and
(D) Hazardous waste as herein defined.

“Hazardous waste” means -

(A) A waste or combination of wastes as defined in 40 CFR 261.3, or
(B) Those substances defined as hazardous wastes in 49 CFR 171.8.

“Hazardous waste operation” means any operation conducted within the scope of this standard.

“Hazardous waste site” or “Site” means any facility or location within the scope of this standard at which hazardous waste operations take place.

“Health hazard” means a chemical or a pathogen where acute or chronic health effects may occur in exposed employees. It also includes stress due to temperature extremes. The term health hazard includes chemicals that are classified in accordance with the Hazard Communication Standard, § 1910.1200, as posing one of the following hazardous effects: acute toxicity (any route of exposure); skin corrosion or irritation; serious eye damage or eye irritation; respiratory or skin sensitization; germ cell mutagenicity; carcinogenicity; reproductive toxicity; specific target organ toxicity (single or repeated exposure); aspiration toxicity or simple asphyxiant. (See Appendix A to § 1910.1200—Health Hazard Criteria (Mandatory) for the criteria for determining whether a chemical is classified as a health hazard.)

“IDLH” or “Immediately dangerous to life or health” means 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.

“Oxygen deficiency” means that concentration of oxygen by volume below which atmosphere supplying respiratory protection must be provided. It exists in atmospheres where the percentage of oxygen by volume is less than 19.5 percent oxygen.

"Permissible exposure limit" means the exposure, inhalation or dermal permissible exposure limit specified either in 1926.55, elsewhere in subpart D, or in other pertinent sections of this part.

"Published exposure level" means the exposure limits published in "NIOSH Recommendations for Occupational Health Standards" dated 1986 incorporated by reference, or if none is specified, the exposure limits published in the standards specified by the American Conference of Governmental Industrial Hygienists in their publication "Threshold Limit Values and Biological Exposure Indices for 1987-88" dated 1987 incorporated by reference.

"Post emergency response" means that portion of an emergency response performed after the immediate threat of a release has been stabilized or eliminated and clean-up of the site has begun. If post emergency response is performed by an employer's own employees who were part of the initial emergency response, it is considered to be part of the initial response and not post emergency response. However, if a group of an employer's own employees, separate from the group providing initial response, performs the clean-up operation, then the separate group of employees would be considered to be performing post-emergency response and subject to paragraph (q)(11) of this section.

"Qualified person" means a person with specific training, knowledge and experience in the area for which the person has the responsibility and the authority to control.

"Site safety and health supervisor (or official)" means the individual located on a hazardous waste site who is responsible to the employer and has the authority and knowledge necessary to implement the site safety and health plan and verify compliance with applicable safety and health requirements.

"Small quantity generator" means a generator of hazardous wastes who in any calendar month generates no more than 1,000 kilograms (2,205 pounds) of hazardous waste in that month.

"Uncontrolled hazardous waste site," means an area identified as an uncontrolled hazardous waste site by a governmental body, whether Federal, state, local or other where an accumulation of hazardous substances creates a threat to the health and safety of individuals or the environment or both. Some sites are found on public lands such as those created by former municipal, county or state landfills where illegal or poorly managed waste disposal has taken place. Other sites are found on private property, often belonging to generators or former generators of hazardous substance wastes. Examples of such sites include, but are not limited to, surface impoundments, landfills, dumps, and tank or drum farms. Normal operations at TSD sites are not covered by this definition.

**(b)**
**Safety and health program.**

Note to (b): Safety and health programs developed and implemented to meet other Federal, state, or local regulations are considered acceptable in meeting this requirement if they cover or are modified to cover the topics required in this paragraph. An additional or separate safety and health program is not required by this paragraph.

**(b)(1)**
General.

**(b)(1)(i)**
Employers shall develop and implement a written safety and health program for their employees involved in hazardous waste operations. The program shall be designed to identify, evaluate, and control safety and health hazards, and provide for emergency response for hazardous waste operations.

**(b)(1)(ii)**
The written safety and health program shall incorporate the following:

**(b)(1)(ii)(A)**
An organizational structure;

**(b)(1)(ii)(B)**
A comprehensive work plan;

**(b)(1)(ii)(C)**
A site-specific safety and health plan which need not repeat the employer's standard operating procedures required in paragraph (b)(1)(ii)(F) of this section;

**(b)(1)(ii)(D)**
The safety and health training program;

**(b)(1)(ii)(E)**
The medical surveillance program;

**(b)(1)(ii)(F)**
The employer's standard operating procedures for safety and health; and

**(b)(1)(ii)(G)**
Any necessary interface between general program and site specific activities.

**(b)(1)(iii)**
Site excavation. Site excavations created during initial site preparation or during hazardous waste operations shall be shored or sloped as appropriate to prevent accidental collapse in accordance with subpart P of 29 CFR part 1926.

**(b)(1)(iv)**
Contractors and sub-contractors. An employer who retains contractor or sub-contractor services for work in hazardous waste operations shall inform those contractors, sub-contractors, or their representatives of the site emergency response procedures and any potential fire, explosion, health, safety or other hazards of the hazardous waste operation that have been identified by the employer, including those identified in the employer's information program.

**(b)(1)(v)**
Program availability. The written safety and health program shall be made available to any contractor or subcontractor or their representative who will be involved with the hazardous waste operation; to employees; to employee designated representatives; to OSHA personnel, and to personnel of other Federal, state, or local agencies with regulatory authority over the site.

**(b)(2)**
Organizational structure part of the site program -

**(b)(2)(i)**
The organizational structure part of the program shall establish the specific chain of command and specify the overall responsibilities of supervisors and employees. It shall include, at a minimum, the following elements:

**(b)(2)(i)(A)**
A general supervisor who has the responsibility and authority to direct all hazardous waste operations.

**(b)(2)(i)(B)**
A site safety and health supervisor who has the responsibility and authority to develop and implement the site safety and health plan and verify compliance.

**(b)(2)(i)(C)**
All other personnel needed for hazardous waste site operations and emergency response and their general functions and responsibilities.

**(b)(2)(i)(D)**
The lines of authority, responsibility, and communication.

**(b)(2)(ii)**
The organizational structure shall be reviewed and updated as necessary to reflect the current status of waste site operations.

**(b)(3)**
Comprehensive workplan part of the site program. The comprehensive workplan part of the program shall address the tasks and objectives of the site operations and the logistics and resources required to reach those tasks and objectives.

**(b)(3)(i)**
The comprehensive workplan shall address anticipated clean-up activities as well as normal operating procedures which need not repeat the employer's procedures available elsewhere.

**(b)(3)(ii)**
The comprehensive workplan shall define work tasks and objectives and identify the methods for accomplishing those tasks and objectives.

**(b)(3)(iii)**
The comprehensive workplan shall establish personnel requirements for implementing the plan.

**(b)(3)(iv)**
The comprehensive workplan shall provide for the implementation of the training required in paragraph (e) of this section.

**(b)(3)(v)**
The comprehensive workplan shall provide for the implementation of the required informational programs required in paragraph (i) of this section.

**(b)(3)(vi)**
The comprehensive workplan shall provide for the implementation of the medical surveillance program described in paragraph (f) of this section.

**(b)(4)**
Site-specific safety and health plan part of the program -

**(b)(4)(i)**
General. The site safety and health plan, which must be kept on site, shall address the safety and health hazards of each phase of site operation and include the requirements and procedures for employee protection.

**(b)(4)(ii)**
Elements. The site safety and health plan, as a minimum, shall address the following:

**(b)(4)(ii)(A)**
A safety and health risk or hazard analysis for each site task and operation found in the work plan.

**(b)(4)(ii)(B)**
Employee training assignments to assure compliance with paragraph (e) of this section.

**(b)(4)(ii)(C)**
Personal protective equipment to be used by employees for each of the site tasks and operations being conducted as required by the personal protective equipment program in paragraph (g)(5) of this section.

**(b)(4)(ii)(D)**
Medical surveillance requirements in accordance with the program in paragraph (f) of this section.

**(b)(4)(ii)(E)**
Frequency and types of air monitoring, personnel monitoring, and environmental sampling techniques and instrumentation to be used, including methods of maintenance and calibration of monitoring and sampling equipment to be used.

**(b)(4)(ii)(F)**
Site control measures in accordance with the site control program required in paragraph (d) of this section.

**(b)(4)(ii)(G)**
Decontamination procedures in accordance with paragraph (k) of this section.

**(b)(4)(ii)(H)**
An emergency response plan meeting the requirements of paragraph (l) of this section for safe and effective responses to emergencies, including the necessary PPE and other equipment.

**(b)(4)(ii)(I)**
Confined space entry procedures.

**(b)(4)(ii)(J)**
A spill containment program meeting the requirements of paragraph (j) of this section.

**(b)(4)(iii)**
Pre-entry briefing. The site specific safety and health plan shall provide for pre-entry briefings to be held prior to initiating any site activity, and at such other times as necessary to ensure that employees are apprised of the site safety and health plan and that this plan is being followed. The information and data obtained from site characterization and analysis work required in paragraph (c) of this section shall be used to prepare and update the site safety and health plan.

**(b)(4)(iv)**
Effectiveness of site safety and health plan. Inspections shall be conducted by the site safety and health supervisor or, in the absence of that individual, another individual who is knowledgeable in occupational safety and health, acting on behalf of the employer as necessary to determine the effectiveness of the site safety and health plan. Any deficiencies in the effectiveness of the site safety and health plan shall be corrected by the employer.

**(c)**
**Site characterization and analysis**

**(c)(1)**
General. Hazardous waste sites shall be evaluated in accordance with this paragraph to identify specific site hazards and to determine the appropriate safety and health control procedures needed to protect employees from the identified hazards.

**(c)(2)**
Preliminary evaluation. A preliminary evaluation of a site's characteristics shall be performed prior to site entry by a qualified person in order to aid in the selection of appropriate employee protection methods prior to site entry. Immediately after initial site entry, a more detailed evaluation of the site's specific characteristics shall be performed by a qualified person in order to further identify existing site hazards and to further aid in the selection of the appropriate engineering controls and personal protective equipment for the tasks to be performed.

**(c)(3)**
Hazard identification.  All suspected conditions that may pose inhalation or skin absorption hazards that are immediately dangerous to life or health (IDLH), or other conditions that may cause death or serious harm, shall be identified during the preliminary survey and evaluated during the detailed survey. Examples of such hazards include, but are not limited to, confined space entry, potentially explosive or flammable situations, visible vapor clouds, or areas where biological indicators such as dead animals or vegetation are located.

**(c)(4)**
Required information.  The following information to the extent available shall be obtained by the employer prior to allowing employees to enter a site:

**(c)(4)(i)**
Location and approximate size of the site.

**(c)(4)(ii)**
Description of the response activity and/or the job task to be performed.

**(c)(4)(iii)**
Duration of the planned employee activity.

**(c)(4)(iv)**
Site topography and accessibility by air and roads.

**(c)(4)(v)**
Safety and health hazards expected at the site.

**(c)(4)(vi)**
Pathways for hazardous substance dispersion.

**(c)(4)(vii)**
Present status and capabilities of emergency response teams that would provide assistance to hazardous waste clean-up site employees at the time of an emergency.

**(c)(4)(viii)**
Hazardous substances and health hazards involved or expected at the site, and their chemical and physical properties.

**(c)(5)**
Personal protective equipment. Personal protective equipment (PPE) shall be provided and used during initial site entry in accordance with the following requirements:

**(c)(5)(i)**
Based upon the results of the preliminary site evaluation, an ensemble of PPE shall be selected and used during initial site entry which will provide protection to a level of exposure below permissible exposure limits and published exposure levels for known or suspected hazardous substances and health hazards, and which will provide protection against other known and suspected hazards identified during the preliminary site evaluation. If there is no permissible exposure limit or published exposure level, the employer may use other published studies and information as a guide to appropriate personal protective equipment.

**(c)(5)(ii)**
If positive-pressure self-contained breathing apparatus is not used as part of the entry ensemble, and if respiratory protection is warranted by the potential hazards identified during the preliminary site evaluation, an escape self-contained breathing apparatus of at least five minute's duration shall be carried by employees during initial site entry.

**(c)(5)(iii)**
If the preliminary site evaluation does not produce sufficient information to identify the hazards or suspected hazards of the site, an ensemble providing protection equivalent to Level B PPE shall be provided as minimum protection, and direct reading instruments shall be used as appropriate for identifying IDLH conditions. (See appendix B for a description of Level B hazards and the recommendations for Level B protective equipment.)

**(c)(5)(iv)**
Once the hazards of the site have been identified, the appropriate PPE shall be selected and used in accordance with paragraph (g) of this section.

**(c)(6)**
Monitoring. The following monitoring shall be conducted during initial site entry when the site evaluation produces information that shows the potential for ionizing radiation or IDLH conditions, or when the site information is not sufficient reasonably to eliminate these possible conditions:

**(c)(6)(i)**
Monitoring with direct reading instruments for hazardous levels of ionizing radiation.

**(c)(6)(ii)**
Monitoring the air with appropriate direct reading test equipment (i.e., combustible gas meters, detector tubes) for IDLH and other conditions that may cause death or serious harm (combustible or explosive atmospheres, oxygen deficiency, toxic substances.

**(c)(6)(iii)**
Visually observing for signs of actual or potential IDLH or other dangerous conditions.

**(c)(6)(iv)**
An ongoing air monitoring program in accordance with paragraph (h) of this section shall be implemented after site characterization has determined the site is safe for the start-up of operations.

**(c)(7)**
Risk identification.

**(c)(7)(i)**
Once the presence and concentrations of specific hazardous substances and health hazards have been established, the risks associated with these substances shall be identified. Employees who will be working on the site shall be informed of any risks that have been identified. In situations covered by the Hazard Communication Standard, 29 CFR 1926.59, training required by that standard need not be duplicated.

**Note to (c)(7)** - Risks to consider include, but are not limited to:

**(c)(7)(i)(a)**
Exposures exceeding the permissible exposure limits and published exposure levels.

**(c)(7)(i)(b)**
IDLH concentrations.

**(c)(7)(i)(c)**
Potential skin absorption and irritation sources.

**(c)(7)(i)(d)**
Potential eye irritation sources.

**(c)(7)(i)(e)**
Explosion sensitivity and flammability ranges.

**(c)(7)(i)(f)**
Oxygen deficiency.

**(c)(8)**
Employee notification. Any information concerning the chemical, physical, and toxicologic properties of each substance known or expected to be present on site that is available to the employer and relevant to the duties an employee is expected to perform shall be made available to the affected employees prior to the commencement of their work activities. The employer may utilize information developed for the hazard communication standard for this purpose.

**(d)**
**Site control**

**(d)(1)**
General. Appropriate site control procedures shall be implemented to control employee exposure to hazardous substances before clean-up work begins.

**(d)(2)**
Site control program. A site control program for protecting employees which is part of the employer's site safety and health program required in paragraph (b) of this section shall be developed during the planning stages of a hazardous waste clean-up operation and modified as necessary as new information becomes available.

**(d)(3)**
Elements of the site control program. The site control program shall, as a minimum, include: A site map; site work zones; the use of a buddy system; site communications including alerting means for emergencies; the standard operating procedures or safe work practices; and, identification of the nearest medical assistance. Where these requirements are covered elsewhere they need not be repeated.

**(e)**
**Training**

**(e)(1)**
General.

**(e)(1)(i)**
All employees working on site (such as but not limited to equipment operators, general laborers and others) exposed to hazardous substances, health hazards, or safety hazards and their supervisors and management responsible for the site shall receive training meeting the requirements of this paragraph before they are permitted to engage in hazardous waste operations that could expose them to hazardous substances, safety, or health hazards, and they shall receive review training as specified in this paragraph.

**(e)(1)(ii)**
Employees shall not be permitted to participate in or supervise field activities until they have been trained to a level required by their job function and responsibility.

**(e)(2)**
Elements to be covered. The training shall thoroughly cover the following:

**(e)(2)(i)**
Names of personnel and alternates responsible for site safety and health;

**(e)(2)(ii)**
Safety, health and other hazards present on the site;

**(e)(2)(iii)**
Use of personal protective equipment;

**(e)(2)(iv)**
Work practices by which the employee can minimize risks from hazards;

**(e)(2)(v)**
Safe use of engineering controls and equipment on the site;

**(e)(2)(vi)**
Medical surveillance requirements, including recognition of symptoms and signs which might indicate overexposure to hazards; and

**(e)(2)(vii)**
The contents of paragraphs (G) through (J) of the site safety and health plan set forth in paragraph (b)(4)(ii) of this section.

**(e)(3)**
Initial training.

**(e)(3)(i)**
General site workers (such as equipment operators, general laborers and supervisory personnel) engaged in hazardous substance removal or other activities which expose or potentially expose workers to hazardous substances and health hazards shall receive a minimum of 40 hours of instruction off the site, and a minimum of three days actual field experience under the direct supervision of a trained, experienced supervisor.

**(e)(3)(ii)**
Workers on site only occasionally for a specific limited task (such as, but not limited to, ground water monitoring, land surveying, or geo-physical surveying) and who are unlikely to be exposed over permissible exposure limits and published exposure limits shall receive a minimum of 24 hours of instruction off the site, and the minimum of one day actual field experience under the direct supervision of a trained, experienced supervisor.

**(e)(3)(iii)**
Workers regularly on site who work in areas which have been monitored and fully characterized indicating that exposures are under permissible exposure limits and published exposure limits where respirators are not necessary, and the characterization indicates that there are no health hazards or the possibility of an emergency developing, shall receive a minimum of 24 hours of instruction off the site and the minimum of one day actual field experience under the direct supervision of a trained, experienced supervisor.

**(e)(3)(iv)**
Workers with 24 hours of training who are covered by paragraphs (e)(3)(ii) and (e)(3)(iii) of this section, and who become general site workers or who are required to wear respirators, shall have the additional 16 hours and two days of training necessary to total the training specified in paragraph (e)(3)(i).

**(e)(4)**
Management and supervisor training. On-site management and supervisors directly responsible for, or who supervise employees engaged in, hazardous waste operations shall receive 40 hours initial training, and three days of supervised field experience (the training may be reduced to 24 hours and one day if the only area of their responsibility is employees covered by paragraphs (e)(3)(ii) and (e)(3)(iii)) and at least eight additional hours of specialized training at the time of job assignment on such topics as, but not limited to, the employer's safety and health program and the associated employee training program, personal protective equipment program, spill containment program, and health hazard monitoring procedure and techniques.

**(e)(5)**
Qualifications for trainers. Trainers shall be qualified to instruct employees about the subject matter that is being presented in training. Such trainers shall have satisfactorily completed a training program for teaching the subjects they are expected to teach, or they shall have the academic credentials and instructional experience necessary for teaching the subjects. Instructors shall demonstrate competent instructional skills and knowledge of the applicable subject matter.

**(e)(6)**
Training certification. Employees and supervisors that have received and successfully completed the training and field experience specified in paragraphs (e)(1) through (e)(4) of this section shall be certified by their instructor or the head instructor and trained supervisor as having successfully completed the necessary training. A written certificate shall be given to each person so certified. Any person who has not been so certified or who does not meet the requirements of paragraph (e)(9) of this section shall be prohibited from engaging in hazardous waste operations.

**(e)(7)**
Emergency response.  Employees who are engaged in responding to hazardous emergency situations at hazardous waste clean-up sites that may expose them to hazardous substances shall be trained in how to respond to such expected emergencies.

**(e)(8)**
Refresher training.  Employees specified in paragraph (e)(1) of this section, and managers and supervisors specified in paragraph (e)(4) of this section, shall receive eight hours of refresher training annually on the items specified in paragraph (e)(2) and/or (e)(4) of this section, any critique of incidents that have occurred in the past year that can serve as training examples of related work, and other relevant topics.

**(e)(9)**
Equivalent training.  Employers who can show by documentation or certification that an employee's work experience and/or training has resulted in training equivalent to that training required in paragraphs (e)(1) through (e)(4) of this section shall not be required to provide the initial training requirements of those paragraphs to such employees and shall provide a copy of the certification or documentation to the employee upon request. However, certified employees or employees with equivalent training new to a  site shall receive appropriate, site specific training before site entry and have appropriate supervised field experience at the new site. Equivalent training includes any academic training or the training that existing employees might have already received from actual hazardous waste site work experience.

**(f)**
**Medical surveillance**

**(f)(1)**
General. Employers engaged in operations specified in paragraphs (a)(1)(i) through (a)(1)(iv) of this section and not covered by (a)(2)(iii) exceptions and employers of employees specified in paragraph (q)(9) shall institute a medical surveillance program in accordance with this paragraph.

**(f)(2)**
Employees covered. The medical surveillance program shall be instituted by the employer for the following employees:

**(f)(2)(i)**
All employees who are or may be exposed to hazardous substances or health hazards at or above the permissible exposure limits or, if there is no permissible exposure limit, above the published exposure levels for these substances, without regard to the use of respirators, for 30 days or more a year;

**(f)(2)(ii)**
All employees who wear a respirator for 30 days or more a year or as required by 1926.103;

**(f)(2)(iii)**
All employees who are injured, become ill or develop signs or symptoms due to possible overexposure involving hazardous substances or health hazards from an emergency response or hazardous waste operation; and

**(f)(2)(iv)**
Members of HAZMAT teams.

**(f)(3)**
Frequency of medical examinations and consultations. Medical examinations and consultations shall be made available by the employer to each employee covered under paragraph (f)(2) of this section on the following schedules:

**(f)(3)(i)**
For employees covered under paragraphs (f)(2)(i), (f)(2)(ii), and (f)(2)(iv):

**(f)(3)(i)(A)**
Prior to assignment;

**(f)(3)(i)(B)**
At least once every twelve months for each employee covered unless the attending physician believes a longer interval (not greater than biennially) is appropriate;

**(f)(3)(i)(C)**
At termination of employment or reassignment to an area where the employee would not be covered if the employee has not had an examination within the last six months;

**(f)(3)(i)(D)**
As soon as possible upon notification by an employee that the employee has developed signs or symptoms indicating possible overexposure to hazardous substances or health hazards, or that the employee has been injured or exposed above the permissible exposure limits or published exposure levels in an emergency situation;

**(f)(3)(i)(E)**
At more frequent times, if the examining physician determines that an increased frequency of examination is medically necessary.

**(f)(3)(ii)**
For employees covered under paragraph (f)(2)(iii) and for all employees including those of employers covered by paragraph (a)(1)(v) who may have been injured, received a health impairment, developed signs or symptoms which may have resulted from exposure to hazardous substances resulting from an emergency incident, or exposed during an emergency incident to hazardous substances at concentrations above the permissible exposure limits or the published exposure levels without the necessary personal protective equipment being used:

**(f)(3)(ii)(A)**
As soon as possible following the emergency incident or development of signs or symptoms;

**(f)(3)(ii)(B)**
At additional times, if the examining physician determines that follow-up examinations or consultations are medically necessary.

**(f)(4)**
Content of medical examinations and consultations.

**(f)(4)(i)**
Medical examinations required by paragraph (f)(3) of this section shall include a medical and work history (or updated history if one is in the employee's file) with special emphasis on symptoms related to the handling of hazardous substances and health hazards, and to fitness for duty including the ability to wear any required PPE under conditions (i.e., temperature extremes) that may be expected at the work site.

**(f)(4)(ii)**
The content of medical examinations or consultations made available to employees pursuant to paragraph (f) shall be determined by the attending physician. The guidelines in the Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities (See appendix D, Reference number 10) should be consulted.

**(f)(5)**
Examination by a physician and costs. All medical examinations and procedures shall be performed by or under the supervision of a licensed physician, preferably one knowledgeable in occupational medicine, and shall be provided without cost to the employee, without loss of pay, and at a reasonable time and place.

**(f)(6)**
Information provided to the physician. The employer shall provide one copy of this standard and its appendices to the attending physician, and in addition the following for each employee:

**(f)(6)(i)**
A description of the employee's duties as they relate to the employee's exposures.

**(f)(6)(ii)**
The employee's exposure levels or anticipated exposure levels.

**(f)(6)(iii)**
A description of any personal protective equipment used or to be used.

**(f)(6)(iv)**
Information from previous medical examinations of the employee which is not readily available to the examining physician.

**(f)(6)(v)**
Information required by 1926.103.

**(f)(7)**
Physician's written opinion.

**(f)(7)(i)**
The employer shall obtain and furnish the employee with a copy of a written opinion from the attending physician containing the following:

**(f)(7)(i)(A)**
The physician's opinion as to whether the employee has any detected medical conditions which would place the employee at increased risk of material impairment of the employee's health from work in hazardous waste operations or emergency response, or from respirator use.

**(f)(7)(i)(B)**
The physician's recommended limitations upon the employee's assigned work.

**(f)(7)(i)(C)**
The results of the medical examination and tests if requested by the employee.

**(f)(7)(i)(D)**
A statement that the employee has been informed by the physician of the results of the medical examination and any medical conditions which require further examination or treatment.

**(f)(7)(ii)**
The written opinion obtained by the employer shall not reveal specific findings or diagnoses unrelated to occupational exposures.

**(f)(8)**
Record keeping.

**(f)(8)(i)**
An accurate record of the medical surveillance required by paragraph (f) of this section shall be retained. This record shall be retained for the period specified and meet the criteria of 29 CFR 1926.33.

**(f)(8)(ii)**
The record required in paragraph (f)(8)(i) of this section shall include at least the following information:

**(f)(8)(ii)(A)**
The name and social security number of the employee;

**(f)(8)(ii)(B)**
Physician's written opinions, recommended limitations, and results of examinations and tests;

**(f)(8)(ii)(C)**
Any employee medical complaints related to exposure to hazardous substances;

**(f)(8)(ii)(D)**
A copy of the information provided to the examining physician by the employer, with the exception of the standard and its appendices.

**(g)**
**Engineering controls, work practices, and personal protective equipment for employee protection.**

Engineering controls, work practices, personal protective equipment, or a combination of these shall be implemented in accordance with this paragraph to protect employees from exposure to hazardous substances and safety and health hazards.

**(g)(1)**
Engineering controls, work practices and PPE for substances regulated either in 1926.55, elsewhere in subpart D, or in other pertinent sections of this part.

**(g)(1)(i)**
Engineering controls and work practices shall be instituted to reduce and maintain employee exposure to or below the permissible exposure limits for substances regulated either in 1926.55 or other pertinent sections of this part, except to the extent that such controls and practices are not feasible.

**Note to (g)(1)(i):** Engineering controls which may be feasible include the use of pressurized cabs or control booths on equipment, and/or the use of remotely operated material handling equipment. Work practices which may be feasible are removing all non-essential employees from potential exposure during opening of drums, wetting down dusty operations and locating employees upwind of possible hazards.

**(g)(1)(ii)**
Whenever engineering controls and work practices are not feasible or not required, any reasonable combination of engineering controls, work practices and PPE shall be used to reduce and maintain employee exposures to or below the permissible exposure limits or dose limits for substances regulated either in 1926.55 or other pertinent sections of this part.

**(g)(1)(iii)**
The employer shall not implement a schedule of employee rotation as a means of compliance with permissible exposure limits or dose limits except when there is no other feasible way of complying with the airborne or dermal dose limits for ionizing radiation.

**(g)(1)(iv)**
The provisions of subpart D shall be followed.

**(g)(2)**
Engineering controls, work practices, and PPE for substances not regulated either in 1926.55, elsewhere in subpart D, or in other pertinent sections of this part. An appropriate combination of engineering controls, work practices and personal protective equipment shall be used to reduce and maintain employee exposure to or below published exposure levels for hazardous substances and health hazards not regulated either in 1926.55, elsewhere in subpart D, or in other pertinent sections of this part. The employer may use the published literature and SDS as a guide in making the employer’s determination as to what level of protection the employer believes is appropriate for hazardous substances and health hazards for which there is no permissible exposure limit or published exposure limit.

**(g)(3)**
Personal protective equipment selection.

**(g)(3)(i)**
Personal protective equipment (PPE) shall be selected and used which will protect employees from the hazards and potential hazards they are likely to encounter as identified during the site characterization and analysis.

**(g)(3(ii)**
Personal protective equipment selection shall be based on an evaluation of the performance characteristics of the PPE relative to the requirements and limitations of the site, the task-specific conditions and duration, and the hazards and potential hazards identified at the site.

**(g)(3)(iii)**
Positive pressure self-contained breathing apparatus, or positive pressure air-line respirators equipped with an escape air supply, shall be used when chemical exposure levels present will create a substantial possibility of immediate death, immediate serious illness or injury, or impair the ability to escape.

**(g)(3)(iv)**
Totally-encapsulating chemical protective suits (protection equivalent to Level A protection as recommended in appendix B) shall be used in conditions where skin absorption of a hazardous substance may result in a substantial possibility of immediate death, immediate serious illness or injury, or impair the ability to escape.

**(g)(3)(v)**
The level of protection provided by PPE selection shall be increased when additional information on site conditions indicates that increased protection is necessary to reduce employee exposures below permissible exposure limits and published exposure levels for hazardous substances and health hazards. (See appendix B for guidance on selecting PPE ensembles.)

**Note to (g)(3):** The level of employee protection provided may be decreased when additional information or site conditions show that decreased protection will not result in hazardous exposures to employees.

**(g)(3)(vi)**
Personal protective equipment shall be selected and used to meet the requirements of subpart E of this part and additional requirements specified in this section.

**(g)(4)**
Totally-encapsulating chemical protective suits.

**(g)(4)(i)**
Totally-encapsulating suits shall protect employees from the particular hazards which are identified during site characterization and analysis.

**(g)(4)(ii)**
Totally-encapsulating suits shall be capable of maintaining positive air pressure. (See appendix A for a test method which may be used to evaluate this requirement.)

**(g)(4)(iii)**
Totally-encapsulating suits shall be capable of preventing inward test gas leakage of more than 0.5 percent. (See appendix A for a test method which may be used to evaluate this requirement.)

**(g)(5)**
Personal protective equipment (PPE) program. A written personal protective equipment program, which is part of the employer's safety and health program required in paragraph (b) of this section or required in paragraph (p)(1) of this section and which is also a part of the site-specific safety and health plan shall be established. The PPE program shall address the elements listed below. When elements, such as donning and doffing procedures, are provided by the manufacturer of a piece of equipment and are attached to the plan, they need not be rewritten into the plan as long as they adequately address the procedure or element.

**(g)(5)(i)**
PPE selection based upon site hazards,

**(g)(5)(ii)**
PPE use and limitations of the equipment,

**(g)(5)(iii)**
Work mission duration,

**(g)(5)(iv)**
PPE maintenance and storage,

**(g)(5)(v)**
PPE decontamination and disposal,

**(g)(5)(vi)**
PPE training and proper fitting,

**(g)(5)(vii)**
PPE donning and doffing procedures,

**(g)(5)(viii)**
PPE inspection procedures prior to, during, and after use,

**(g)(5)(ix)**
Evaluation of the effectiveness of the PPE program, and

**(g)(5)(x)**
Limitations during temperature extremes, heat stress, and other appropriate medical considerations.

**(h)**
**Monitoring**

**(h)(1)**
General.

**(h)(1)(i)**
Monitoring shall be performed in accordance with this paragraph where there may be a question of employee exposure to hazardous concentrations of hazardous substances in order to assure proper selection of engineering controls, work practices and personal protective equipment so that employees are not exposed to levels which exceed permissible exposure limits, or published exposure levels if there are no permissible exposure limits, for hazardous substances.

**(h)(1)(ii)**
Air monitoring shall be used to identify and quantify airborne levels of hazardous substances and safety and health hazards in order to determine the appropriate level of employee protection needed on site.

**(h)(2)**
Initial entry. Upon initial entry, representative air monitoring shall be conducted to identify any IDLH condition, exposure over permissible exposure limits or published exposure levels, exposure over a radioactive material's dose limits or other dangerous condition such as the presence of flammable atmospheres or oxygen-deficient environments.

**(h)(3)**
Periodic monitoring. Periodic monitoring shall be conducted when the possibility of an IDLH condition or flammable atmosphere has developed or when there is indication that exposures may have risen over permissible exposure limits or published exposure levels since prior monitoring. Situations where it shall be considered whether the possibility that exposures have risen are as follows:

**(h)(3)(i)**
When work begins on a different portion of the site.

**(h)(3)(ii)**
When contaminants other than those previously identified are being handled.

**(h)(3)(iii)**
When a different type of operation is initiated (e.g., drum opening as opposed to exploratory well drilling).

**(h)(3)(iv)**
When employees are handling leaking drums or containers or working in areas with obvious liquid contamination (e.g., a spill or lagoon).

**(h)(4)**
Monitoring of high-risk employees. After the actual clean-up phase of any hazardous waste operation commences; for example, when soil, surface water or containers are moved or disturbed; the employer shall monitor those employees likely to have the highest exposures to hazardous substances and health hazards likely to be present above permissible exposure limits or published exposure levels by using personal sampling frequently enough to characterize employee exposures. If the employees likely to have the highest exposure are over permissible exposure limits or published exposure limits, then monitoring shall continue to determine all employees likely to be above those limits. The employer may utilize a representative sampling approach by documenting that the employees and chemicals chosen for monitoring are based on the criteria stated above.

**Note to (h):** It is not required to monitor employees engaged in site characterization operations covered by paragraph (c) of this section.

**(i)**
**Informational programs.**

Employers shall develop and implement a program, which is part of the employer's safety and health program required in paragraph (b) of this section, to inform employees, contractors, and subcontractors (or their representative) actually engaged in hazardous waste operations of the nature, level and degree of exposure likely as a result of participation in such hazardous waste operations. Employees, contractors and subcontractors working outside of the operations part of a site are not covered by this standard.

**(j)**
**Handling drums and containers**

**(j)(1)**
General.

**(j)(1)(i)**
Hazardous substances and contaminated soils, liquids, and other residues shall be handled, transported, labeled, and disposed of in accordance with this paragraph.

**(j)(1)(ii)**
Drums and containers used during the clean-up shall meet the appropriate DOT, OSHA, and EPA regulations for the wastes that they contain.

**(j)(1)(iii)**
When practical, drums and containers shall be inspected and their integrity shall be assured prior to being moved. Drums or containers that cannot be inspected before being moved because of storage conditions (i.e., buried beneath the earth, stacked behind other drums, stacked several tiers high in a pile, etc.) shall be moved to an accessible location and inspected prior to further handling.

**(j)(1)(iv)**
Unlabeled drums and containers shall be considered to contain hazardous substances and handled accordingly until the contents are positively identified and labeled.

**(j)(1)(v)**
Site operations shall be organized to minimize the amount of drum or container movement.

**(j)(1)(vi)**
Prior to movement of drums or containers, all employees exposed to the transfer operation shall be warned of the potential hazards associated with the contents of the drums or containers.

**(j)(1)(vii)**
U.S. Department of Transportation specified salvage drums or containers and suitable quantities of proper absorbent shall be kept available and used in areas where spills, leaks, or ruptures may occur.

**(j)(1)(viii)**
Where major spills may occur, a spill containment program, which is part of the employer's safety and health program required in paragraph (b) of this section, shall be implemented to contain and isolate the entire volume of the hazardous substance being transferred.

**(j)(1)(ix)**
Drums and containers that cannot be moved without rupture, leakage, or spillage shall be emptied into a sound container using a device classified for the material being transferred.

**(j)(1)(x)**
A ground-penetrating system or other type of detection system or device shall be used to estimate the location and depth of buried drums or containers.

**(j)(1)(xi)**
Soil or covering material shall be removed with caution to prevent drum or container rupture.

**(j)(1)(xii)**
Fire extinguishing equipment meeting the requirements of subpart F of this part shall be on hand and ready for use to control incipient fires.

**(j)(2)**
Opening drums and containers. The following procedures shall be followed in areas where drums or containers are being opened:

**(j)(2)(i)**
Where an airline respirator system is used, connections to the source of air supply shall be protected from contamination and the entire system shall be protected from physical damage.

**(j)(2)(ii)**
Employees not actually involved in opening drums or containers shall be kept a safe distance from the drums or containers being opened.

**(j)(2)(iii)**
If employees must work near or adjacent to drums or containers being opened, a suitable shield that does not interfere with the work operation shall be placed between the employee and the drums or containers being opened to protect the employee in case of accidental explosion.

**(j)(2)(iv)**
Controls for drum or container opening equipment, monitoring equipment, and fire suppression equipment shall be located behind the explosion-resistant barrier.

**(j)(2)(v)**
When there is a reasonable possibility of flammable atmospheres being present, material handling equipment and hand tools shall be of the type to prevent sources of ignition.

(j)(2)(vi)
Drums and containers shall be opened in such a manner that excess interior pressure will be safely relieved. If pressure cannot be relieved from a remote location, appropriate shielding shall be placed between the employee and the drums or containers to reduce the risk of employee injury.

**(j)(2)(vii)**
Employees shall not stand upon or work from drums or containers.

**(j)(3)**
Material handling equipment. Material handling equipment used to transfer drums and containers shall be selected, positioned and operated to minimize sources of ignition related to the equipment from igniting vapors released from ruptured drums or containers.

**(j)(4)**
Radioactive wastes. Drums and containers containing radioactive wastes shall not be handled until such time as their hazard to employees is properly assessed.

**(j)(5)**
Shock sensitive wastes. As a minimum, the following special precautions shall be taken when drums and containers containing or suspected of containing shock-sensitive wastes are handled:

**(j)(5)(i)**
All non-essential employees shall be evacuated from the area of transfer.

**(j)(5)(ii)**
Material handling equipment shall be provided with explosive containment devices or protective shields to protect equipment operators from exploding containers.

**(j)(5)(iii)**
An employee alarm system capable of being perceived above surrounding light and noise conditions shall be used to signal the commencement and completion of explosive waste handling activities.

**(j)(5)(iv)**
Continuous communications (i.e., portable radios, hand signals, telephones, as appropriate) shall be maintained between the employee-in-charge of the immediate handling area and both the site safety and health supervisor and the command post until such time as the handling operation is completed. Communication equipment or methods that could cause shock sensitive materials to explode shall not be used.

**(j)(5)(v)**
Drums and containers under pressure, as evidenced by bulging or swelling, shall not be moved until such time as the cause for excess pressure is determined and appropriate containment procedures have been implemented to protect employees from explosive relief of the drum.

**(j)(5)(vi)**
Drums and containers containing packaged laboratory wastes shall be considered to contain shock-sensitive or explosive materials until they have been characterized.

**Caution:** Shipping of shock sensitive wastes may be prohibited under U.S. Department of Transportation regulations. Employers and their shippers should refer to 49 CFR 173.21 and 173.50.

**(j)(6)**
Laboratory waste packs. In addition to the requirements of paragraph (j)(5) of this section, the following precautions shall be taken, as a minimum, in handling laboratory waste packs (lab packs):

**(j)(6)(i)**
Lab packs shall be opened only when necessary and then only by an individual knowledgeable in the inspection, classification, and segregation of the containers within the pack according to the hazards of the wastes.

**(j)(6)(ii)**
If crystalline material is noted on any container, the contents shall be handled as a shock-sensitive waste until the contents are identified.

**(j)(7)**
Sampling of drum and container contents. Sampling of containers and drums shall be done in accordance with a sampling procedure which is part of the site safety and health plan developed for and available to employees and others at the specific worksite.

**(j)(8)**
Shipping and transport.

**(j)(8)(i)**
Drums and containers shall be identified and classified prior to packaging for shipment.

**(j)(8)(ii)**
Drum or container staging areas shall be kept to the minimum number necessary to identify and classify materials safely and prepare them for transport.

**(j)(8)(iii)**
Staging areas shall be provided with adequate access and egress routes.

**(j)(8)(iv)**
Bulking of hazardous wastes shall be permitted only after a thorough characterization of the materials has been completed.

**(j)(9)**
Tank and vault procedures.

**(j)(9)(i)**
Tanks and vaults containing hazardous substances shall be handled in a manner similar to that for drums and containers, taking into consideration the size of the tank or vault.

**(j)(9)(ii)**
Appropriate tank or vault entry procedures as described in the employer's safety and health plan shall be followed whenever employees must enter a tank or vault.

**(k)**
**Decontamination**

**(k)(1)**
General. Procedures for all phases of decontamination shall be developed and implemented in accordance with this paragraph.

**(k)(2)**
Decontamination procedures.

**(k)(2)(i)**
A decontamination procedure shall be developed, communicated to employees and implemented before any employees or equipment may enter areas on site where potential for exposure to hazardous substances exists.

**(k)(2)(ii)**
Standard operating procedures shall be developed to minimize employee contact with hazardous substances or with equipment that has contacted hazardous substances.

**(k)(2)(iii)**
All employees leaving a contaminated area shall be appropriately decontaminated; all contaminated clothing and equipment leaving a contaminated area shall be appropriately disposed of or decontaminated.

**(k)(2)(iv)**
Decontamination procedures shall be monitored by the site safety and health supervisor to determine their effectiveness. When such procedures are found to be ineffective, appropriate steps shall be taken to correct any deficiencies.

**(k)(3)**
Location. Decontamination shall be performed in geographical areas that will minimize the exposure of uncontaminated employees or equipment to contaminated employees or equipment.

**(k)(4)**
Equipment and solvents. All equipment and solvents used for decontamination shall be decontaminated or disposed of properly.

**(k)(5)**
Personal protective clothing and equipment.

**(k)(5)(i)**
Protective clothing and equipment shall be decontaminated, cleaned, laundered, maintained or replaced as needed to maintain their effectiveness.

**(k)(5)(ii)**
Employees whose non-impermeable clothing becomes wetted with hazardous substances shall immediately remove that clothing and proceed to shower. The clothing shall be disposed of or decontaminated before it is removed from the work zone.

**(k)(6)**
Unauthorized employees. Unauthorized employees shall not remove protective clothing or equipment from change rooms.

**(k)(7)**
Commercial laundries or cleaning establishments. Commercial laundries or cleaning establishments that decontaminate protective clothing or equipment shall be informed of the potentially harmful effects of exposures to hazardous substances.

**(k)(8)**
Showers and change rooms. Where the decontamination procedure indicates a need for regular showers and change rooms outside of a contaminated area, they shall be provided and meet the requirements of 29 CFR 1910.141. If temperature conditions prevent the effective use of water, then other effective means for cleansing shall be provided and used.

**(l)**
**Emergency response by employees at uncontrolled hazardous waste sites**

**(l)(1)**
Emergency response plan.

**(l)(1)(i)**
An emergency response plan shall be developed and implemented by all employers within the scope of paragraphs (a)(1)(i) through (ii) of this section to handle anticipated emergencies prior to the commencement of hazardous waste operations. The plan shall be in writing and available for inspection and copying by employees, their representatives, OSHA personnel and other governmental agencies with relevant responsibilities.

**(l)(1)(ii)**
Employers who will evacuate their employees from the danger area when an emergency occurs, and who do not permit any of their employees to assist in handling the emergency, are exempt from the requirements of this paragraph if they provide an emergency action plan complying with 1926.35 of this part.

**(l)(2)**
Elements of an emergency response plan. The employer shall develop an emergency response plan for emergencies which shall address, as a minimum, the following:

**(l)(2)(i)**
Pre-emergency planning.

**(l)(2)(ii)**
Personnel roles, lines of authority, and communication.

**(l)(2)(iii)**
Emergency recognition and prevention.

**(l)(2)(iv)**
Safe distances and places of refuge.

**(l)(2)(v)**
Site security and control.

**(l)(2)(vi)**
Evacuation routes and procedures.

**(l)(2)(vii)**
Decontamination procedures which are not covered by the site safety and health plan.

**(l)(2)(viii)**
Emergency medical treatment and first aid.

**(l)(2)(ix)**
Emergency alerting and response procedures.

**(l)(2)(x)**
Critique of response and follow-up.

**(l)(2)(xi)**
PPE and emergency equipment.

**(l)(3)**
Procedures for handling emergency incidents.

**(l)(3)(i)**
In addition to the elements for the emergency response plan required in paragraph (1)(2) of this section, the following elements shall be included for emergency response plans:

**(l)(3)(i)(A)**
Site topography, layout, and prevailing weather conditions.

**(l)(3)(i)(B)**
Procedures for reporting incidents to local, state, and federal governmental agencies.

**(l)(3)(ii)**
The emergency response plan shall be a separate section of the Site Safety and Health Plan.

**(l)(3)(iii)**
The emergency response plan shall be compatible and integrated with the disaster, fire and/or emergency response plans of local, state, and federal agencies.

**(l)(3)(iv)**
The emergency response plan shall be rehearsed regularly as part of the overall training program for site operations.

**(l)(3)(v)**
The site emergency response plan shall be reviewed periodically and, as necessary, be amended to keep it current with new or changing site conditions or information.

**(l)(3)(vi)**
An employee alarm system shall be installed in accordance with 29 CFR 1926.159 to notify employees of an emergency situation; to stop work activities if necessary; to lower background noise in order to speed communication; and to begin emergency procedures.

**(l)(3)(vii)**
Based upon the information available at time of the emergency, the employer shall evaluate the incident and the site response capabilities and proceed with the appropriate steps to implement the site emergency response plan.

**(m)**
**Illumination.**
Areas accessible to employees shall be lighted to not less than the minimum illumination intensities listed in the following Table D-65.1 while any work is in progress:

**TABLE D-65.1 - MINIMUM ILLUMINATION INTENSITIES IN FOOT-CANDLES**

| Foot-candles | Area of operations |
|---|---|
| 5 ...................... | General site areas. |
| 3 ...................... | Excavation and waste areas, access ways, active storage areas, loading platforms, refueling, and field maintenance areas. |
| 5 ...................... | Indoors: Warehouses, corridors, hallways, and exitways. |
| 5 ...................... | Tunnels, shafts, and general underground work areas. (Exception: Minimum of 10 foot-candles is required at tunnel and shaft heading during drilling mucking, and tunnel and shaft heading during drilling mucking, and cap lights shall be acceptable for use in the tunnel heading.) |
| 10 .................... | General shops (e.g., mechanical and electrical equipment rooms, active storerooms, barracks or living quarters, locker or dressing rooms, dining areas, and indoor toilets and workrooms.) |
| 30 .................... | First aid stations, infirmaries, and offices. |

**(n)**
**Sanitation at temporary workplaces**

**(n)(1)**
Potable water.

**(n)(1)(i)**
An adequate supply of potable water shall be provided on the site.

**(n)(1)(ii)**
Portable containers used to dispense drinking water shall be capable of being tightly closed, and equipped with a tap. Water shall not be dipped from containers.

**(n)(1)(iii)**
Any container used to distribute drinking water shall be clearly marked as to the nature of its contents and not used for any other purpose.

**(n)(1)(iv)**
Where single service cups (to be used but once) are supplied, both a sanitary container for the unused cups and a receptacle for disposing of the used cups shall be provided.

**(n)(2)**
Nonpotable water.

**(n)(2)(i)**
Outlets for nonpotable water, such as water for firefighting purposes, shall be identified to indicate clearly that the water is unsafe and is not to be used for drinking, washing, or cooking purposes.

**(n)(2)(ii)**
There shall be no cross-connection, open or potential, between a system furnishing potable water and a system furnishing nonpotable water.

**(n)(3)**
Toilet facilities.

**(n)(3)(i)**
Toilets shall be provided for employees according to the following Table D-65.2.

### TABLE D-65.2 - TOILET FACILITIES

| Number of employees | Minimum number of facilities |
|---|---|
| 20 or fewer.............................. | One. |
| More than 20, fewer than 200.. | One toilet seat and one urinal per 40 employees. |
| More than 200.......................... | One toilet seat and one urinal per 50 employees. |

**(n)(3)(ii)**
Under temporary field conditions, provisions shall be made to assure that at least one toilet facility is available.

**(n)(3)(iii)**
Hazardous waste sites not provided with a sanitary sewer shall be provided with the following toilet facilities unless prohibited by local codes:

**(n)(3)(iii)(A)**
Chemical toilets;

**(n)(3)(iii)(B)**
Recirculating toilets;

**(n)(3)(iii)(C)**
Combustion toilets; or

**(n)(3)(iii)(D)**
Flush toilets.

**(n)(3)(iv)**
The requirements of this paragraph for sanitation facilities shall not apply to mobile crews having transportation readily available to nearby toilet facilities.

**(n)(3)(v)**
Doors entering toilet facilities shall be provided with entrance locks controlled from inside the facility.

**(n)(4)**
Food handling. All food service facilities and operations for employees shall meet the applicable laws, ordinances, and regulations of the jurisdictions in which they are located.

**(n)(5)**
Temporary sleeping quarters. When temporary sleeping quarters are provided, they shall be heated, ventilated, and lighted.

**(n)(6)**
Washing facilities. The employer shall provide adequate washing facilities for employees engaged in operations where hazardous substances may be harmful to employees. Such facilities shall be in near proximity to the worksite; in areas where exposures are below permissible exposure limits and published exposure levels and which are under the controls of the employer; and shall be so equipped as to enable employees to remove hazardous substances from themselves.

**(n)(7)**
Showers and change rooms. When hazardous waste clean-up or removal operations commence on a site and the duration of the work will require six months or greater time to complete, the employer shall provide showers and change rooms for all employees exposed to hazardous substances and health hazards involved in hazardous waste clean-up or removal operations.

**(n)(7)(i)**
Showers shall be provided and shall meet the requirements of 29 CFR 1926.51(f)(4).

**(n)(7)(ii)**
Change rooms shall be provided and shall meet the requirements of 29 CFR 1926.51(i). Change rooms shall consist of two separate change areas separated by the shower area required in paragraph (n)(7)(i) of this section. One change area, with an exit leading off the worksite, shall provide employees with a clean area where they can remove, store, and put on street clothing. The second area, with an exit to the worksite, shall provide employees with an area where they can put on, remove and store work clothing and personal protective equipment.

(n)(7)(iii)
Showers and change rooms shall be located in areas where exposures are below the permissible exposure limits and published exposure levels. If this cannot be accomplished, then a ventilation system shall be provided that will supply air that is below the permissible exposure limits and published exposure levels.

**(n)(7)(iv)**
Employers shall assure that employees shower at the end of their work shift and when leaving the hazardous waste site.

**(o)**
**New technology programs**

**(o)(1)**
The employer shall develop and implement procedures for the introduction of effective new technologies and equipment developed for the improved protection of employees working with hazardous waste clean-up operations, and the same shall be implemented as part of the site safety and health program to assure that employee protection is being maintained.

**(o)(2)**
New technologies, equipment or control measures available to the industry, such as the use of foams, absorbents, adsorbents, neutralizers, or other means to suppress the level of air contaminates while excavating the site or for spill control, shall be evaluated by employers or their representatives. Such an evaluation shall be done to determine the effectiveness of the new methods, materials, or equipment before implementing their use on a large scale for enhancing employee protection. Information and data from manufacturers or suppliers may be used as part of the employer's evaluation effort. Such evaluations shall be made available to OSHA upon request.

**(p)**
**Certain operations conducted under the Resource Conservation and Recovery Act of 1976 (RCRA).**

Employers conducting operations at treatment, storage and disposal (TSD) facilities specified in paragraph (a)(1)(iv) of this section shall provide and implement the programs specified in this paragraph. See the Notes and Exceptions to paragraph (a)(2)(iii) of this section for employers not covered.

**(p)(1)**
Safety and health program. The employer shall develop and implement a written safety and health program for employees involved in hazardous waste operations that shall be available for inspection by employees, their representatives and OSHA personnel. The program shall be designed to identify, evaluate and control safety and health hazards in their facilities for the purpose of employee protection, to provide for emergency response meeting the requirements of paragraph (p)(8) of this section and to address as appropriate site analysis, engineering controls, maximum exposure limits, hazardous waste handling procedures and uses of new technologies.

**(p)(2)**
Hazard communication program. The employer shall implement a hazard communication program meeting the requirements of 29 CFR 1926.59 as part of the employer's safety and program.

**Note to 1926.65 -** The exemption for hazardous waste provided in 1926.59 is applicable to this section.

**(p)(3)**
Medical surveillance program. The employer shall develop and implement a medical surveillance program meeting the requirements of paragraph (f) of this section.

(p)(4)
Decontamination program. The employer shall develop and implement a decontamination procedure meeting the requirements of paragraph (k) of this section.

**(p)(5)**
New technology program. The employer shall develop and implement procedures meeting the requirements of paragraph (o) of this section for introducing new and innovative equipment into the workplace.

**(p)(6)**
Material handling program. Where employees will be handling drums or containers, the employer shall develop and implement procedures meeting the requirements of paragraphs (j)(1)(ii) through (viii) and (xi) of this section, as well as (j)(3) and (j)(8) of this section prior to starting such work.

**(p)(7)**
Training program -

**(p)(7)(i)**
New employees. The employer shall develop and implement a training program, which is part of the employer's safety and health program, for employees exposed to health hazards or hazardous substances at TSD operations to enable the employees to perform their assigned duties and functions in a safe and healthful manner so as not endanger themselves or other employees. The initial training shall be for 24 hours and refresher training shall be for eight hours annually. Employees who have received the initial training required by this paragraph shall be given a written certificate attesting that they have successfully completed the necessary training.

**(p)(7)(ii)**
Current employees. Employers who can show by an employee's previous work experience and/or training that the employee has had training equivalent to the initial training required by this paragraph, shall be considered as meeting the initial training requirements of this paragraph as to that employee. Equivalent training includes the training that existing employees might have already received from actual site work experience. Current employees shall receive eight hours of refresher training annually.

**(p)(7)(iii)**
Trainers. Trainers who teach initial training shall have satisfactorily completed a training course for teaching the subjects they are expected to teach or they shall have the academic credentials and instruction experience necessary to demonstrate a good command of the subject matter of the courses and competent instructional skills.

**(p)(8)**
Emergency response program -

**(p)(8)(i)**
Emergency response plan. An emergency response plan shall be developed and implemented by all employers. Such plans need not duplicate any of the subjects fully addressed in the employer's contingency planning required by permits, such as those issued by the U.S. Environmental Protection Agency, provided that the contingency plan is made part of the emergency response plan. The emergency response plan shall be a written portion of the employers safety and health program required in paragraph (p)(1) of this section. Employers who will evacuate their employees from the worksite location when an emergency occurs and who do not permit any of their employees to assist in handling the emergency are exempt from the requirements of paragraph (p)(8) if they provide an emergency action plan complying with 1926.35 of this part.

**(p)(8)(ii)**
Elements of an emergency response plan. The employer shall develop an emergency response plan for emergencies which shall address, as a minimum, the following areas to the extent that they are not addressed in any specific program required in this paragraph:

**(p)(8)(ii)(A)**
Pre-emergency planning and coordination with outside parties.

**(p)(8)(ii)(B)**
Personnel roles, lines of authority, and communication.

**(p)(8)(ii)(C)**
Emergency recognition and prevention.

**(p)(8)(ii)(D)**
Safe distances and places of refuge.

**(p)(8)(ii)(E)**
Site security and control.

**(p)(8)(ii)(F)**
Evacuation routes and procedures.

**(p)(8)(ii)(G)**
Decontamination procedures.

**(p)(8)(ii)(H)**
Emergency medical treatment and first aid.

**(p)(8)(ii)(I)**
Emergency alerting and response procedures.

**(p)(8)(ii)(J)**
Critique of response and follow-up.

**(p)(8)(ii)(K)**
PPE and emergency equipment.

**(p)(8)(iii)**
Training.

**(p)(8)(iii)(A)**
Training for emergency response employees shall be completed before they are called upon to perform in real emergencies. Such training shall include the elements of the emergency response plan, standard operating procedures the employer has established for the job, the personal protective equipment to be worn and procedures for handling emergency incidents.

**Exception Number 1:** An employer need not train all employees to the degree specified if the employer divides the work force in a manner such that a sufficient number of employees who have responsibility to control emergencies have the training specified, and all other employees, who may first respond to an emergency incident, have sufficient awareness training to recognize that an emergency response situation exists and that they are instructed in that case to summon the fully trained employees and not attempt control activities for which they are not trained.

**Exception Number 2:** An employer need not train all employees to the degree specified if arrangements have been made in advance for an outside fully-trained emergency response team to respond in a reasonable period and all employees, who may come to the incident first, have sufficient awareness training to recognize that an emergency response situation exists and they have been instructed to call the designated outside fully-trained emergency response team for assistance.

**(p)(8)(iii)(B)**
Employee members of TSD facility emergency response organizations shall be trained to a level of competence in the recognition of health and safety hazards to protect themselves and other employees. This would include training in the methods used to minimize the risk from safety and health hazards; in the safe use of control equipment; in the selection and use of appropriate personal protective equipment; in the safe operating procedures to be used at the incident scene; in the techniques of coordination with other employees to minimize risks; in the appropriate response to over exposure from health hazards or injury to themselves and other employees; and in the recognition of subsequent symptoms which may result from over exposures.

**(p)(8)(iii)(C)**
The employer shall certify that each covered employee has attended and successfully completed the training required in paragraph (p)(8)(iii) of this section, or shall certify the employee's competency at least yearly. The method used to demonstrate competency for certification of training shall be recorded and maintained by the employer.

**(p)(8)(iv)**
Procedures for handling emergency incidents.

**(p)(8)(iv)(A)**
In addition to the elements for the emergency response plan required in paragraph (p)(8)(ii) of this section, the following elements shall be included for emergency response plans to the extent that they do not repeat any information already contained in the emergency response plan:

**(p)(8)(iv)(A)(1)**
Site topography, layout, and prevailing weather conditions.

**(p)(8)(iv)(A)(2)**
Procedures for reporting incidents to local, state, and federal governmental agencies.

**(p)(8)(iv)(B)**
The emergency response plan shall be compatible and integrated with the disaster, fire and/or emergency response plans of local, state, and federal agencies.

**(p)(8)(iv)(C)**
The emergency response plan shall be rehearsed regularly as part of the overall training program for site operations.

**(p)(8)(iv)(D)**
The site emergency response plan shall be reviewed periodically and, as necessary, be amended to keep it current with new or changing site conditions or information.

**(p)(8)(iv)(E)**
An employee alarm system shall be installed in accordance with 29 CFR 1926.159 to notify employees of an emergency situation; to stop work activities if necessary; to lower background noise in order to speed communication; and to begin emergency procedures.

**(p)(8)(iv)(F)**
Based upon the information available at time of the emergency, the employer shall evaluate the incident and the site response capabilities and proceed with the appropriate steps to implement the site emergency response plan.

**(q)**
**Emergency response to hazardous substance releases**

This paragraph covers employers whose employees are engaged in emergency response no matter where it occurs except that it does not cover employees engaged in operations specified in paragraphs (a)(1)(i) through (a)(1)(iv) of this section. Those emergency response organizations who have developed and implemented programs equivalent to this paragraph for handling releases of hazardous substances pursuant to section 303 of the Superfund Amendments and Reauthorization Act of 1986 (Emergency Planning and Community Right-to-Know Act of 1986, 42 U.S.C. 11003) shall be deemed to have met the requirements of this paragraph.

**(q)(1)**
Emergency response plan. An emergency response plan shall be developed and implemented to handle anticipated emergencies prior to the commencement of emergency response operations. The plan shall be in writing and available for inspection and copying by employees, their representatives and OSHA personnel. Employers who will evacuate their employees from the danger area when an emergency occurs, and who do not permit any of their employees to assist in handling the emergency, are exempt from the requirements of this paragraph if they provide an emergency action plan in accordance with 1926.35 of this part.

**(q)(2)**
Elements of an emergency response plan. The employer shall develop an emergency response plan for emergencies which shall address, as a minimum, the following to the extent that they are not addressed elsewhere:

**(q)(2)(i)**
Pre-emergency planning and coordination with outside parties.

**(q)(2)(ii)**
Personnel roles, lines of authority, training, and communication.

**(q)(2)(iii)**
Emergency recognition and prevention.

**(q)(2)(iv)**
Safe distances and places of refuge.

**(q)(2)(v)**
Site security and control.

**(q)(2)(vi)**
Evacuation routes and procedures.

**(q)(2)(vii)**
Decontamination.

**(q)(2)(viii)**
Emergency medical treatment and first aid.

**(q)(2)(ix)**
Emergency alerting and response procedures.

**(q)(2)(x)**
Critique of response and follow-up.

**(q)(2)(xi)**
PPE and emergency equipment.

**(q)(2)(xii)**
Emergency response organizations may use the local emergency response plan or the state emergency response plan or both, as part of their emergency response plan to avoid duplication. Those items of the emergency response plan that are being properly addressed by the SARA Title III plans may be substituted into their emergency plan or otherwise kept together for the employer and employee's use.

**(q)(3)**
Procedures for handling emergency response.

**(q)(3)(i)**
The senior emergency response official responding to an emergency shall become the individual in charge of a site-specific Incident Command System (ICS). All emergency responders and their communications shall be coordinated and controlled through the individual in charge of the ICS assisted by the senior official present for each employer.

**Note to (q)(3)(i). -** The senior official at an emergency response is the most senior official on the site who has the responsibility for controlling the operations at the site. Initially it is the senior officer on the first-due piece of responding emergency apparatus to arrive on the incident scene. As more senior officers arrive (i.e., battalion chief, fire chief, state law enforcement official, site coordinator, etc.) the position is passed up the line of authority which has been previously established.

**(q)(3)(ii)**
The individual in charge of the ICS shall identify, to the extent possible, all hazardous substances or conditions present and shall address as appropriate site analysis, use of engineering controls, maximum exposure limits, hazardous substance handling procedures, and use of any new technologies.

**(q)(3)(iii)**
Based on the hazardous substances and/or conditions present, the individual in charge of the ICS shall implement appropriate emergency operations, and assure that the personal protective equipment worn is appropriate for the hazards to be encountered. However, personal protective equipment shall meet, at a minimum, the criteria contained in 29 CFR 1926.97 when worn while performing firefighting operations beyond the incipient stage for any incident.

**(q)(3)(iv)**
Employees engaged in emergency response and exposed to hazardous substances presenting an inhalation hazard or potential inhalation hazard shall wear positive pressure self-contained breathing apparatus while engaged in emergency response, until such time that the individual in charge of the ICS determines through the use of air monitoring that a decreased level of respiratory protection will not result in hazardous exposures to employees.

**(q)(3)(v)**
The individual in charge of the ICS shall limit the number of emergency response personnel at the emergency site, in those areas of potential or actual exposure to incident or site hazards, to those who are actively performing emergency operations. However, operations in hazardous areas shall be performed using the buddy system in groups of two or more.

**(q)(3)(vi)**
Back-up personnel shall stand by with equipment ready to provide assistance or rescue. Advance first aid support personnel, as a minimum, shall also stand by with medical equipment and transportation capability.

**(q)(3)(vii)**
The individual in charge of the ICS shall designate a safety official, who is knowledgeable in the operations being implemented at the emergency response site, with specific responsibility to identify and evaluate hazards and to provide direction with respect to the safety of operations for the emergency at hand.

**(q)(3)(viii)**
When activities are judged by the safety official to be an IDLH condition and/or to involve an imminent danger condition, the safety official shall have the authority to alter, suspend, or terminate those activities. The safety official shall immediately inform the individual in charge of the ICS of any actions needed to be taken to correct these hazards at the emergency scene.

**(q)(3)(ix)**
After emergency operations have terminated, the individual in charge of the ICS shall implement appropriate decontamination procedures.

**(q)(3)(x)**
When deemed necessary for meeting the tasks at hand, approved self-contained compressed air breathing apparatus may be used with approved cylinders from other approved self-contained compressed air breathing apparatus provided that such cylinders are of the same capacity and pressure rating. All compressed air cylinders used with self-contained breathing apparatus shall meet U.S. Department of Transportation and National Institute for Occupational Safety and Health criteria.

**(q)(4)**
Skilled support personnel. Personnel, not necessarily an employer's own employees, who are skilled in the operation of certain equipment, such as mechanized earth moving or digging equipment or crane and hoisting equipment, and who are needed temporarily to perform immediate emergency support work that cannot reasonably be performed in a timely fashion by an employer's own employees, and who will be or may be exposed to the hazards at an emergency response scene, are not required to meet the training required in this paragraph for the employer's regular employees. However, these personnel shall be given an initial briefing at the site prior to their participation in any emergency response. The initial briefing shall include instruction in the wearing of appropriate personal protective equipment, what chemical hazards are involved, and what duties are to be performed. All other appropriate safety and health precautions provided to the employer's own employees shall be used to assure the safety and health of these personnel.

**(q)(5)**
Specialist employees. Employees who, in the course of their regular job duties, work with and are trained in the hazards of specific hazardous substances, and who will be called upon to provide technical advice or assistance at a hazardous substance release incident to the individual in charge, shall receive training or demonstrate competency in the area of their specialization annually.

**(q)(6)**
Training. Training shall be based on the duties and function to be performed by each responder of an emergency response organization. The skill and knowledge levels required for all new responders, those hired after the effective date of this standard, shall be conveyed to them through training before they are permitted to take part in actual emergency operations on an incident. Employees who participate, or are expected to participate, in emergency response, shall be given training in accordance with the following paragraphs:

**(q)(6)(i)**
First responder awareness level. First responders at the awareness level are individuals who are likely to witness or discover a hazardous substance release and who have been trained to initiate an emergency response sequence by notifying the proper authorities of the release. They would take no further action beyond notifying the authorities of the release. First responders at the awareness level shall have sufficient training or have had sufficient experience to objectively demonstrate competency in the following areas:

**(q)(6)(i)(A)**
An understanding of what hazardous substances are, and the risks associated with them in an incident.

**(q)(6)(i)(B)**
An understanding of the potential outcomes associated with an emergency created when hazardous substances are present.

**(q)(6)(i)(C)**
The ability to recognize the presence of hazardous substances in an emergency.

**(q)(6)(i)(D)**
The ability to identify the hazardous substances, if possible.

**(q)(6)(i)(E)**
An understanding of the role of the first responder awareness individual in the employer’s emergency response plan including site security and control and the U.S. Department of Transportation’s Emergency Response Guidebook.

**(q)(6)(i)(F)**
The ability to realize the need for additional resources, and to make appropriate notifications to the communication center.

**(q)(6)(ii)**
First responder operations level. First responders at the operations level are individuals who respond to releases or potential releases of hazardous substances as part of the initial response to the site for the purpose of protecting nearby persons, property, or the environment from the effects of the release. They are trained to respond in a defensive fashion without actually trying to stop the release. Their function is to contain the release from a safe distance, keep it from spreading, and prevent exposures. First responders at the operational level shall have received at least eight hours of training or have had sufficient experience to objectively demonstrate competency in the following areas in addition to those listed for the awareness level and the employer shall so certify:

**(q)(6)(ii)(A)**
Knowledge of the basic hazard and risk assessment techniques.

**(q)(6)(ii)(B)**
Know how to select and use proper personal protective equipment provided to the first responder operational level.

(q)(6)(ii)(C)
An understanding of basic hazardous materials terms.

(q)(6)(ii)(D)
Know how to perform basic control, containment and/or confinement operations within the capabilities of the resources and personal protective equipment available with their unit.

**(q)(6)(ii)(E)**
Know how to implement basic decontamination procedures.

**(q)(6)(ii)(F)**
An understanding of the relevant standard operating procedures and termination procedures.

**(q)(6)(iii)**
Hazardous materials technician. Hazardous materials technicians are individuals who respond to releases or potential releases for the purpose of stopping the release. They assume a more aggressive role than a first responder at the operations level in that they will approach the point of release in order to plug, patch or otherwise stop the release of a hazardous substance. Hazardous materials technicians shall have received at least 24 hours of training equal to the first responder operations level and in addition have competency in the following areas and the employer shall so certify:

**(q)(6)(iii)(A)**
Know how to implement the employer's emergency response plan.

**(q)(6)(iii)(B)**
Know the classification, identification and verification of known and unknown materials by using field survey instruments and equipment.

**(q)(6)(iii)(C)**
Be able to function within an assigned role in the Incident Command System.

**(q)(6)(iii)(D)**
Know how to select and use proper specialized chemical personal protective equipment provided to the hazardous materials technician.

**(q)(6)(iii)(E)**
Understand hazard and risk assessment techniques.

**(q)(6)(iii)(F)**
Be able to perform advance control, containment, and/or confinement operations within the capabilities of the resources and personal protective equipment available with the unit.

**(q)(6)(iii)(G)**
Understand and implement decontamination procedures.

**(q)(6)(iii)(H)**
Understand termination procedures.

**(q)(6)(iii)(I)**
Understand basic chemical and toxicological terminology and behavior.

**(q)(6)(iv)**
Hazardous materials specialist. Hazardous materials specialists are individuals who respond with and provide support to hazardous materials technicians. Their duties parallel those of the hazardous materials technician, however, those duties require a more directed or specific knowledge of the various substances they may be called upon to contain. The hazardous materials specialist would also act as the site liaison with Federal, state, local and other government authorities in regards to site activities. Hazardous materials specialists shall have received at least 24 hours of training equal to the technician level and in addition have competency in the following areas and the employer shall so certify:

**(q)(6)(iv)(A)**
Know how to implement the local emergency response plan.

**(q)(6)(iv)(B)**
Understand classification, identification and verification of known and unknown materials by using advanced survey instruments and equipment.

**(q)(6)(iv)(C)**
Know of the state emergency response plan.

**(q)(6)(iv)(D)**
Be able to select and use proper specialized chemical personal protective equipment provided to the hazardous materials specialist.

**(q)(6)(iv)(E)**
Understand in-depth hazard and risk techniques.

**(q)(6)(iv)(F)**
Be able to perform specialized control, containment, and/or confinement operations within the capabilities of the resources and personal protective equipment available.

**(q)(6)(iv)(G)**
Be able to determine and implement decontamination procedures.

**(q)(6)(iv)(H)**
Have the ability to develop a site safety and control plan.

**(q)(6)(iv)(I)**
Understand chemical, radiological and toxicological terminology and behavior.

**(q)(6)(v)**
On scene incident commander. Incident commanders, who will assume control of the incident scene beyond the first responder awareness level, shall receive at least 24 hours of training equal to the first responder operations level and in addition have competency in the following areas and the employer shall so certify:

**(q)(6)(v)(A)**
Know and be able to implement the employer's incident command system.

**(q)(6)(v)(B)**
Know how to implement the employer's emergency response plan.
**(q)(6)(v)(C)**
Know and understand the hazards and risks associated with employees working in chemical protective clothing.

**(q)(6)(v)(D)**
Know how to implement the local emergency response plan.

**(q)(6)(v)(E)**
Know of the state emergency response plan and of the Federal Regional Response Team.

**(q)(6)(v)(F)**
Know and understand the importance of decontamination procedures.

**(q)(7)**
Trainers. Trainers who teach any of the above training subjects shall have satisfactorily completed a training course for teaching the subjects they are expected to teach, such as the courses offered by the U.S. National Fire Academy, or they shall have the training and/or academic credentials and instructional experience necessary to demonstrate competent instructional skills and a good command of the subject matter of the courses they are to teach.

**(q)(8)**
Refresher training.

**(q)(8)(i)**
Those employees who are trained in accordance with paragraph (q)(6) of this section shall receive annual refresher training of sufficient content and duration to maintain their competencies, or shall demonstrate competency in those areas at least yearly.

**(q)(8)(ii)**
A statement shall be made of the training or competency, and if a statement of competency is made, the employer shall keep a record of the methodology used to demonstrate competency.

**(q)(9)**
Medical surveillance and consultation.

**(q)(9)(i)**
Members of an organized and designated HAZMAT team and hazardous materials specialists shall receive a baseline physical examination and be provided with medical surveillance as required in paragraph (f) of this section.

**(q)(9)(ii)**
Any emergency response employees who exhibits signs or symptoms which may have resulted from exposure to hazardous substances during the course of an emergency incident, either immediately or subsequently, shall be provided with medical consultation as required in paragraph (f)(3)(ii) of this section.

**(q)(10)**
Chemical protective clothing. Chemical protective clothing and equipment to be used by organized and designated HAZMAT team members, or to be used by hazardous materials specialists, shall meet the requirements of paragraphs (g)(3) through (5) of this section.

**(q)(11)**
Post-emergency response operations. Upon completion of the emergency response, if it is determined that it is necessary to remove hazardous substances, health hazards, and materials contaminated with them (such as contaminated soil or other elements of the natural environment) from the site of the incident, the employer conducting the clean-up shall comply with one of the following:

**(q)(11)(i)**
Meet all of the requirements of paragraphs (b) through (o) of this section; or

**(q)(11)(ii)**
Where the clean-up is done on plant property using plant or workplace employees, such employees shall have completed the training requirements of the following: 29 CFR 1926.35, 1926.59, and 1926.103, and other appropriate safety and health training made necessary by the tasks that they are expected to be performed such as personal protective equipment and decontamination procedures. All equipment to be used in the performance of the clean-up work shall be in serviceable condition and shall have been inspected prior to use.

**[58 FR 35129, June 30, 1993; 61 FR 5507, Feb. 13, 1996]**

**OSHA Regulations (Standards-29 CFR)**
**General Description and Discussion of the Levels of Protection and Protective Gear- 1926.65 App B**

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| **Standard Number:** | **1926.65 App B** |
| **Standard Title:** | **General Description and Discussion of the Levels of Protection and Protective Gear** |
| **SubPart Number:** | **D** |
| **SubPart Title:** | **Occupational Health and Environmental Controls** |

This appendix sets forth information about personal protective equipment (PPE) protection levels which may be used to assist employers in complying with the PPE requirements of this section.

As required by the standard, PPE must be selected which will protect employees from the specific hazards which they are likely to encounter during their work on-site.

Selection of the appropriate PPE is a complex process which should take into consideration a variety of factors. Key factors involved in this process are identification of the hazards, or suspected hazards; their routes of potential hazard to employees (inhalation, skin absorption, ingestion, and eye or skin contact); and the performance of the PPE materials (and seams) in providing a barrier to these hazards. The amount of protection provided by PPE is material-hazard specific. That is, protective equipment materials will protect well against some hazardous substances and poorly, or not at all, against others. In many instances, protective equipment materials cannot be found which will provide continuous protection from the particular hazardous substance. In these cases the breakthrough time of the protective material should exceed the work durations.

Other factors matching the PPE to the employee's work requirements and task-specific conditions. The durability of PPE materials, such as tear strength and seam strength, should be considered in relation to the employee's tasks. The effects of PPE in relation to heat stress and task duration are a factor in selecting and using PPE.

In some cases layers of PPE may be necessary to provide sufficient protection, or to protect expensive PPE inner garments, suits or equipment.

The more that is known about the hazards at the site, the easier the job of PPE selection becomes. As more information about the hazards and conditions at the site becomes available, the sit supervisor can make decisions to up-grade or down-grade the level of PPE protection to match the tasks at hand.

The following are guidelines which an employer can use to begin the selection of the appropriate PPE. As noted above, the site information may suggest the use of combinations of PPE selected from the different protection levels (i.e., A, B, C, or D) as being more suitable to the hazards of the work. It should be cautioned that the listing below does not fully address the performance of the specific PPE material in relation to the specific hazards at the job site, and that PPE selection, evaluation and re-selection is an ongoing process until sufficient information about the hazards and PPE performance is obtained.

**Part A. Personal protective equipment is divided into four categories based on the degree of protection afforded. (See Part B of this appendix for further explanation of Levels A, B, C, and D hazards.)**

**I. Level A - To be selected when the greatest level of skin, respiratory, and eye protection is required.**

**The following constitute Level A equipment; it may be used as appropriate;**

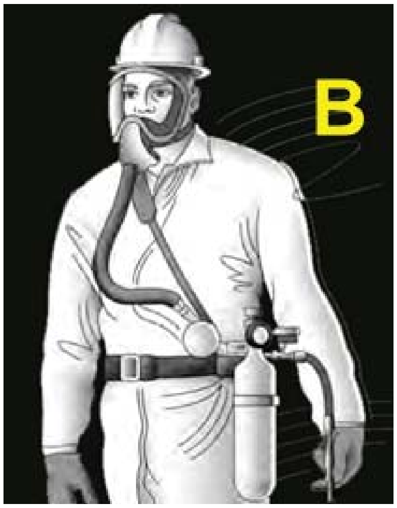
1. Positive pressure, full face-piece self-contained breathing apparatus (SCBA), or positive pressure supplied air respirator with escape SCBA, approved by the National Institute for Occupational Safety and Health (NIOSH).
2. Totally-encapsulating chemical-protective suit.
3. Coveralls.[1]
4. Long underwear.[1]
5. Gloves, outer, chemical-resistant.
6. Gloves, inner, chemical-resistant.
7. Boots, chemical-resistant, steel toe and shank.
8. Hard hat (under suit).[1]
9. Disposable protective suit, gloves and boots (depending on suit construction, may be worn over totally-encapsulating suit).

1 Optional, as applicable.

**II. Level B - The highest level of respiratory protection is necessary but a lesser level of skin protection is needed.**

**The following constitute Level B equipment; it may be used as appropriate.**

1. Positive pressure, full-facepiece self-contained breathing apparatus (SCBA), or positive pressure supplied air respirator with escape SCBA (NIOSH approved).
2. Hooded chemical-resistant clothing (overalls and long-sleeved jacket; coveralls; one or two-piece chemical-splash suit; disposable chemical-resistant overalls).
3. Coveralls.[2]
4. Gloves, outer, chemical-resistant.
5. Gloves, inner, chemical-resistant.
6. Boots, outer, chemical-resistant steel toe and shank
7. Boot-covers, outer, chemical-resistant (disposable).[2]
8. Hard hat.[2]
9. [Reserved]
10. Face shield.[2]




2 Optional, as applicable.

**III. Level C - The concentration(s) and type(s) of airborne substance(s) is known and the criteria for using air purifying respirators are met.**

**The following constitute Level C equipment; it may be used as appropriate.**

1. Full-face or half-mask, air purifying respirators (NIOSH approved).
2. Hooded chemical-resistant clothing (overalls; two-piece chemical-splash suit; disposable chemical-resistant overalls).
3. Coveralls.[3]
4. Gloves, outer, chemical-resistant.
5. Gloves, inner, chemical-resistant.
6. Boots (outer), chemical-resistant steel toe and shank[3]
7. Boot-covers, outer, chemical-resistant (disposable).[3]
8. Hard hat.[3]
9. Escape mask.[3]
10. Face shield.[3]

3 Optional, as applicable.

**IV. Level D - A work uniform affording minimal protection, used for nuisance contamination only.**

**The following constitute Level D equipment; it may be used as appropriate:**

1. Coveralls.
2. Gloves.[4]
3. Boots/shoes, chemical-resistant steel toe and shank.
4. Boots, outer, chemical-resistant (disposable.)[4]
5. Safety glasses of chemical splash goggles.[4]
6. Hard hat.[4]
7. Escape mask.[4]
8. Face shield.[4]

4 Optional, as applicable.

**Part B. The types of hazards for which levels A, B, C, and D protection are appropriate are described below:**

**I. Level A - Level A protection should be used when:**

1. The hazardous substance has been identified and requires the highest level of protection for skin, eyes, and the respiratory system based on either the measured (or potential for) high concentration of atmospheric vapors, gases, or particulates; or the site operations and work functions involve a high potential for splash, immersion, or exposure to unexpected vapors, gases, or particulates of materials that are harmful to skin or capable of being absorbed through the skin;
2. Substances with a high degree of hazard to the skin are known or suspected to be present, and skin contact is possible; or
3. Operations are being conducted in confined, poorly ventilated areas, and the absence of condition requiring Level A have not yet been determined.

**II. Level B - Level B protection should be used when:**

1. The type and atmospheric concentration of substances have been identified and require a high level of respiratory protection, but less skin protection;
2. The atmosphere contains less than 19.5 percent oxygen; or
3. The presence of incompletely identified vapors or gases is indicated by a direct-reading organic vapor detection instrument, but vapors and gases are not suspected of containing high levels of chemicals harmful to skin or capable of being absorbed through the skin.

   Note: This involves atmospheres with IDLH concentrations of specific substances that present severe inhalation hazards and that do not represent a severe skin hazard; or that do not meet the criteria for use of air-purifying respirators.

**III. Level C - Level C protection should be used when:**

1. The atmospheric contaminants, liquid splashes, or other direct contact will not adversely affect of be absorbed through any exposed skin;
2. The types of air contaminants have been identified, concentrations measured, and an air-purifying respirator is available that can remove the contaminants; and
3. All criteria for the use of air-purifying respirators are met.

**IV. Level D - Level D protection should be used when:**

1. The atmosphere contains no known hazard; and
2. Work functions preclude splashes, immersion, or the potential for unexpected inhalation of or contact with hazardous levels of any chemicals.

Note: As stated before, combinations of personal protective equipment other than those described for Levels A, B, C, and D protection may be more appropriate and may be used to provide the proper level of protection.

As an aid in selecting suitable chemical protective clothing, it should be noted that the National Fire Protection Association (NFPA) has developed standards on chemical protective clothing. The standards that have been adopted by include:

**NFPA 1991 -** Standard on Vapor-Protective Suits for Hazardous Chemical Emergencies (EPA Level A Protective Clothing)

**NFPA 1992 -** Standard on Liquid Splash-Protective Suits for Hazardous Chemical Emergencies (EPA Level B Protective Clothing)

**NFPA 1993 -** Standard on Liquid Splash-Protective Suits for None emergency, and Non-flammable Hazardous Chemical Situations (EPA Level B Protective Clothing).

These standards apply documentation and performance requirements to the manufacture of chemical protective suits. Chemical protective suits meeting these requirements are labeled as compliant with the appropriate standard. It is recommended that chemical protective suits that meet these standards be used.
**[58 FR 35144, June 30, 1993; 59 FR 43268, Aug. 22, 1994]**

# HAZCOM

**OSHA Hazard Communication Standard (HazCom) 29CFR1910.1200**
Note: This standard is included by reference in the Construction Standards at 29CFR 1926.59 and is therefore fully applicable to construction workplaces.

## Table of Contents



**(a) Purpose.**

**(a)(1)** The purpose of this section is to ensure that the hazards of all chemicals produced or imported are classified, and that information concerning the classified hazards is transmitted to employers and employees. The requirements of this section are intended to be consistent with the provisions of the United Nations Globally Harmonized System of Classification and Labeling of Chemicals (GHS), Revision 3. The transmittal of information is to be accomplished by means of comprehensive hazard communication programs, which are to include container labeling and other forms of warning, safety data sheets and employee training.

**(a)(2)** This occupational safety and health standard is intended to address comprehensively the issue of classifying the potential hazards of chemicals, and communicating information concerning hazards and appropriate protective measures to employees, and to preempt any legislative or regulatory enactments of a state, or political subdivision of a state, pertaining to this subject. Classifying the potential hazards of chemicals and communicating information concerning hazards and appropriate protective measures to employees, may include, for example, but is not limited to, provisions for: developing and maintaining a written hazard communication program for the workplace, including lists of hazardous chemicals present; labeling of containers of chemicals in the workplace, as well as of containers of chemicals being shipped to other workplaces; preparation and distribution of safety data sheets to employees and downstream employers; and development and implementation of employee training programs regarding hazards of chemicals and protective measures. Under section 18 of the Act, no state or political subdivision of a state may adopt or enforce any requirement relating to the issue addressed by this Federal standard, except pursuant to a Federally-approved state plan.

**(b) Scope and application.**

**(b)(1)** This section requires chemical manufacturers or importers to classify the hazards of chemicals which they produce or import, and all employers to provide information to their employees about the hazardous chemicals to which they are exposed, by means of a hazard communication program, labels and other forms of warning, safety data sheets, and information and training. In addition, this section requires distributors to transmit the required information to employers. (Employers who do not produce or import chemicals need only focus on those parts of this rule that deal with establishing a workplace program and communicating information to their workers.)

**(b)(2)** This section applies to any chemical which is known to be present in the workplace in such a manner that employees may be exposed under normal conditions of use or in a foreseeable emergency.

**(b)(3)** This section applies to laboratories only as follows:

**(i)** Employers shall ensure that labels on incoming containers of hazardous chemicals are not removed or defaced;

**(ii)** Employers shall maintain any safety data sheets that are received with incoming shipments of hazardous chemicals, and ensure that they are readily accessible during each workshift to laboratory employees when they are in their work areas;

**(iii)** Employers shall ensure that laboratory employees are provided information and training in accordance with paragraph (h) of this section, except for the location and availability of the written hazard communication program under paragraph (h)(2)(iii) of this section; and,

**(iv)** Laboratory employers that ship hazardous chemicals are considered to be either a chemical manufacturer or a distributor under this rule, and thus must ensure that any containers of hazardous chemicals leaving the laboratory are labeled in accordance with paragraph (f) of this section, and that a safety data sheet is provided to distributors and other employers in accordance with paragraphs (g)(6) and (g)(7) of this section.

**(b)(4)** In work operations where employees only handle chemicals in sealed containers which are not opened under normal conditions of use (such as are found in marine cargo handling, warehousing, or retail sales), this section applies to these operations only as follows:

**(i)** Employers shall ensure that labels on incoming containers of hazardous chemicals are not removed or defaced;

**(ii)** Employers shall maintain copies of any safety data sheets that are received with incoming shipments of the sealed containers of hazardous chemicals, shall obtain a safety data sheet as soon as possible for sealed containers of hazardous chemicals received without a safety data sheet if an employee requests the safety data sheet, and shall ensure that the safety data sheets are readily accessible during each work shift to employees when they are in their work area(s); and,

**(iii)** Employers shall ensure that employees are provided with information and training in accordance with paragraph (h) of this section (except for the location and availability of the written hazard communication program under paragraph (h)

(2)(iii) of this section), to the extent necessary to protect them in the event of a spill or leak of a hazardous chemical from a sealed container.

**(b)(5)** This section does not require labeling of the following chemicals:

**(i)** Any pesticide as such term is defined in the Federal Insecticide, Fungicide, and Rodenticide Act (7 U.S.C. 136 et seq.), when subject to the labeling requirements of that Act and labeling regulations issued under that Act by the Environmental Protection Agency;
**(ii)** Any chemical substance or mixture as such terms are defined in the Toxic Substances Control Act (15 U.S.C. 2601 et seq.), when subject to the labeling requirements of that Act and labeling regulations issued under that Act by the Environmental Protection Agency;

**(iii)** Any food, food additive, color additive, drug, cosmetic, or medical or veterinary device or product, including materials intended for use as ingredients in such products (e.g. flavors and fragrances), as such terms are defined in the Federal Food, Drug, and Cosmetic Act (21 U.S.C. 301 et seq.) or the Virus-Serum-Toxin Act of 1913 (21 U.S.C. 151 et seq.), and regulations issued under those Acts, when they are subject to the labeling requirements under those Acts by either the Food and Drug Administration or the Department of Agriculture;

**(iv)** Any distilled spirits (beverage alcohols), wine, or malt beverage intended for nonindustrial use, as such terms are defined in the Federal Alcohol Administration Act (27 U.S.C. 201 et seq.) and regulations issued under that Act, when subject to the labeling requirements of that Act and labeling regulations issued under that Act by the Bureau of Alcohol, Tobacco, Firearms and Explosives;

**(v)** Any consumer product or hazardous substance as those terms are defined in the Consumer Product Safety Act (15 U.S.C. 2051 et seq.) and Federal Hazardous Substances Act (15 U.S.C. 1261 et seq.) respectively, when subject to a consumer product safety standard or labeling requirement of those Acts, or regulations issued under those Acts by the Consumer Product Safety Commission; and,

**(vi)** Agricultural or vegetable seed treated with pesticides and labeled in accordance with the Federal Seed Act (7 U.S.C. 1551 et seq.) and the labeling regulations issued under that Act by the Department of Agriculture.

**(b)(6)** This section does not apply to:

**(i)** Any hazardous waste as such term is defined by the Solid Waste Disposal Act, as amended by the Resource Conservation and Recovery Act of 1976, as amended (42 U.S.C. 6901 et seq.), when subject to regulations issued under that Act by the Environmental Protection Agency;

**(ii)** Any hazardous substance as such term is defined by the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) (42 U.S.C. 9601 et seq.) when the hazardous substance is the focus of remedial or removal action being conducted under CERCLA in accordance with Environmental Protection Agency regulations.

**(iii)** Tobacco or tobacco products;

**(iv)** Wood or wood products, including lumber which will not be processed, where the chemical manufacturer or importer can establish that the only hazard they pose to employees is the potential for flammability or combustibility (wood or wood products which have been treated with a hazardous chemical covered by this standard, and wood which may be subsequently sawed or cut, generating dust, are not exempted);

**(v)** Articles (as that term is defined in paragraph (c) of this section);

**(vi)** Food or alcoholic beverages which are sold, used, or prepared in a retail establishment (such as a grocery store, restaurant, or drinking place), and foods intended for personal consumption by employees while in the workplace;

**(vii)** Any drug, as that term is defined in the Federal Food, Drug, and Cosmetic Act (21 U.S.C. 301 et seq.), when it is in solid, final form for direct administration to the patient (e.g., tablets or pills); drugs which are packaged by the chemical manufacturer for sale to consumers in a retail establishment (e.g., over-the-counter drugs); and drugs intended for personal consumption by employees while in the workplace (e.g., first aid supplies);

**(viii)** Cosmetics which are packaged for sale to consumers in a retail establishment, and cosmetics intended for personal consumption by employees while in the workplace;

**(ix)** Any consumer product or hazardous substance, as those terms are defined in the Consumer Product Safety Act (15 U.S.C. 2051 et seq.) and Federal Hazardous Substances Act (15 U.S.C. 1261 et seq.) respectively, where the employer can show that it is used in the workplace for the purpose intended by the chemical manufacturer or importer of the product, and the use results in a duration and frequency of exposure which is not greater than the range of exposures that could reasonably be experienced by consumers when used for the purpose intended;

**(x)** Nuisance particulates where the chemical manufacturer or importer can establish that they do not pose any physical or health hazard covered under this section;

**(xi)** Ionizing and nonionizing radiation; and,

**(xii)** Biological hazards.

**(c) Definitions.**

“Article” means a manufactured item other than a fluid or particle: (i) which is formed to a specific shape or design during manufacture; (ii) which has end use function(s) dependent in whole or in part upon its shape or design during end use; and (iii) which under normal conditions of use does not release more than very small quantities, e.g., minute or trace amounts of a hazardous chemical (as determined under paragraph (d) of this section), and does not pose a physical hazard or health risk to employees.

“Assistant Secretary” means the Assistant Secretary of Labor for Occupational Safety and Health, U.S. Department of Labor, or designee.

“Chemical” means any substance, or mixture of substances.

“Chemical manufacturer” means an employer with a workplace where chemical(s) are produced for use or distribution.

“Chemical name” means the scientific designation of a chemical in accordance with the nomenclature system developed by the International Union of Pure and Applied Chemistry (IUPAC) or the Chemical Abstracts Service (CAS) rules of nomenclature, or a name that will clearly identify the chemical for the purpose of conducting a hazard classification.

“Classification” means to identify the relevant data regarding the hazards of a chemical; review those data to ascertain the hazards associated with the chemical; and decide whether the chemical will be classified as hazardous according to the definition of hazardous chemical in this section. In addition, classification for health and physical hazards includes the determination of the degree of hazard, where appropriate, by comparing the data with the criteria for health and physical hazards.

“Commercial account” means an arrangement whereby a retail distributor sells hazardous chemicals to an employer, generally in large quantities over time and/or at costs that are below the regular retail price.

“Common name” means any designation or identification such as code name, code number, trade name, brand name or generic name used to identify a chemical other than by its chemical name.

“Container” means any bag, barrel, bottle, box, can, cylinder, drum, reaction vessel, storage tank, or the like that contains a hazardous chemical. For purposes of this section, pipes or piping systems, and engines, fuel tanks, or other operating systems in a vehicle, are not considered to be containers.

“Designated representative” means any individual or organization to whom an employee gives written authorization to exercise such employee’s rights under this section. A recognized or certified collective bargaining agent shall be treated automatically as a designated representative without regard to written employee authorization.

“Director” means the Director, National Institute for Occupational Safety and Health, U.S. Department of Health and Human Services, or designee.

“Distributor” means a business, other than a chemical manufacturer or importer, which supplies hazardous chemicals to other distributors or to employers.

“Employee” means a worker who may be exposed to hazardous chemicals under normal operating conditions or in foreseeable emergencies. Workers such as office workers or bank tellers who encounter hazardous chemicals only in non-routine, isolated instances are not covered.

“Employer” means a person engaged in a business where chemicals are either used, distributed, or are produced for use or distribution, including a contractor or subcontractor.

“Exposure or exposed” means that an employee is subjected in the course of employment to a chemical that is a physical or health hazard, and includes potential (e.g. accidental or possible) exposure. “Subjected” in terms of health hazards includes any route of entry (e.g. inhalation, ingestion, skin contact or absorption.)

“Foreseeable emergency” means any potential occurrence such as, but not limited to, equipment failure, rupture of containers, or failure of control equipment which could result in an uncontrolled release of a hazardous chemical into the workplace.

“Hazard category” means the division of criteria within each hazard class, e.g., oral acute toxicity and flammable liquids include four hazard categories. These categories compare hazard severity within a hazard class and should not be taken as a comparison of hazard categories more generally.

“Hazard class” means the nature of the physical or health hazards, e.g., flammable solid, carcinogen, oral acute toxicity.

“Hazard not otherwise classified (HNOC)” means an adverse physical or health effect identified through evaluation of scientific evidence during the classification process that does not meet the specified criteria for the physical and health hazard classes addressed in this section. This does not extend coverage to adverse physical and health effects for which there is a hazard class addressed in this section, but the effect either falls below the cut-off value/concentration limit of the hazard class or is under a GHS hazard category that has not been adopted by OSHA (e.g., acute toxicity Category 5).

“Hazard statement” means a statement assigned to a hazard class and category that describes the nature of the hazard(s) of a chemical, including, where appropriate, the degree of hazard.

“Hazardous chemical” means any chemical which is classified as a physical hazard or a health hazard, a simple asphyxiant, combustible dust, pyrophoric gas, or hazard not otherwise classified.

“Health hazard” means a chemical which is classified as posing one of the following hazardous effects: acute toxicity (any route of exposure); skin corrosion or irritation; serious eye damage or eye irritation; respiratory or skin sensitization; germ cell mutagenicity; carcinogenicity; reproductive toxicity; specific target organ toxicity (single or repeated exposure); or aspiration hazard. The criteria for determining whether a chemical is classified as a health hazard are detailed in Appendix A to §1910.1200 -- Health Hazard Criteria.

“Immediate use” means that the hazardous chemical will be under the control of and used only by the person who transfers it from a labeled container and only within the work shift in which it is transferred.

“Importer” means the first business with employees within the Customs Territory of the United States which receives hazardous chemicals produced in other countries for the purpose of supplying them to distributors or employers within the United States.

“Label” means an appropriate group of written, printed or graphic information elements concerning a hazardous chemical that is affixed to, printed on, or attached to the immediate container of a hazardous chemical, or to the outside packaging.

“Label elements” means the specified pictogram, hazard statement, signal word and precautionary statement for each hazard class and category.

“Mixture” means a combination or a solution composed of two or more substances in which they do not react.

“Physical hazard” means a chemical that is classified as posing one of the following hazardous effects: explosive; flammable (gases, aerosols, liquids, or solids); oxidizer (liquid, solid or gas); self-reactive; pyrophoric (liquid or solid); self-heating; organic peroxide; corrosive to metal; gas under pressure; or in contact with water emits flammable gas. See Appendix B to §1910.1200 -- Physical Hazard Criteria.

“Pictogram” means a composition that may include a symbol plus other graphic elements, such as a border, background pattern, or color, that is intended to convey specific information about the hazards of a chemical. Eight pictograms are designated under this standard for application to a hazard category.

“Precautionary statement” means a phrase that describes recommended measures that should be taken to minimize or prevent adverse effects resulting from exposure to a hazardous chemical, or improper storage or handling.
“Product identifier” means the name or number used for a hazardous chemical on a label or in the SDS. It provides a unique means by which the user can identify the chemical. The product identifier used shall permit cross-references to be made among the list of hazardous chemicals required in the written hazard communication program, the label and the SDS.

“Produce” means to manufacture, process, formulate, blend, extract, generate, emit, or repackage.

“Pyrophoric gas” means a chemical in a gaseous state that will ignite spontaneously in air at a temperature of 130 degrees F (54.4 degrees C) or below.

“Responsible party” means someone who can provide additional information on the hazardous chemical and appropriate emergency procedures, if necessary.

“Safety data sheet (SDS)” means written or printed material concerning a hazardous chemical that is prepared in accordance with paragraph (g) of this section.

“Signal word” means a word used to indicate the relative level of severity of hazard and alert the reader to a potential hazard on the label. The signal words used in this section are “danger” and “warning.” “Danger” is used for the more severe hazards, while “warning” is used for the less severe.

“Simple asphxyiant” means a substance or mixture that displaces oxygen in the ambient atmosphere, and can thus cause oxygen deprivation in those who are exposed, leading to unconsciousness and death.

“Specific chemical identity” means the chemical name, Chemical Abstracts Service (CAS) Registry Number, or any other information that reveals the precise chemical designation of the substance.

“Substance” means chemical elements and their compounds in the natural state or obtained by any production process, including any additive necessary to preserve the stability of the product and any impurities deriving from the process used, but excluding any solvent which may be separated without affecting the stability of the substance or changing its composition.

“Trade secret” means any confidential formula, pattern, process, device, information or compilation of information that is used in an employer’s business, and that gives the employer an opportunity to obtain an advantage over competitors who do not know or use it. Appendix E to §1910.1200—Definition of Trade Secret, sets out the criteria to be used in evaluating trade secrets.

“Use” means to package, handle, react, emit, extract, generate as a byproduct, or transfer.

“Work area” means a room or defined space in a workplace where hazardous chemicals are produced or used, and where employees are present.

“Workplace” means an establishment, job site, or project, at one geographical location containing one or more work areas.

**(d) Hazard classification.**

**(d)(1)** Chemical manufacturers and importers shall evaluate chemicals produced in their workplaces or imported by them to classify the chemicals in accordance with this section. For each chemical, the chemical manufacturer or importer shall determine the hazard classes, and where appropriate, the category of each class that apply to the chemical being classified. Employers are not required to classify chemicals unless they choose not to rely on the classification performed by the chemical manufacturer or importer for the chemical to satisfy this requirement.

**(d)(2)** Chemical manufacturers, importers or employers classifying chemicals shall identify and consider the full range of available scientific literature and other evidence concerning the potential hazards. There is no requirement to test the chemical to determine how to classify its hazards. Appendix A to §1910.1200 shall be consulted for classification of health hazards, and Appendix B to §1910.1200 shall be consulted for the classification of physical hazards.

**(d)(3) Mixtures.**

**(i)** Chemical manufacturers, importers, or employers evaluating chemicals shall follow the procedures described in Appendices A and B to §1910.1200 to classify the hazards of the chemicals, including determinations regarding when mixtures of the classified chemicals are covered by this section.

**(ii)** When classifying mixtures they produce or import, chemical manufacturers and importers of mixtures may rely on the information provided on the current safety data sheets of the individual ingredients, except where the chemical manufacturer or importer knows, or in the exercise of reasonable diligence should know, that the safety data sheet misstates or omits information required by this section.

**(e) Written hazard communication program.**

**(e)(1)** Employers shall develop, implement, and maintain at each workplace, a written hazard communication program which at least describes how the criteria specified in paragraphs (f), (g), and (h) of this section for labels and other forms of warning, safety data sheets, and employee information and training will be met, and which also includes the following:

**(i)** A list of the hazardous chemicals known to be present using a product identifier that is referenced on the appropriate safety data sheet (the list may be compiled for the workplace as a whole or for individual work areas); and,

**(ii)** The methods the employer will use to inform employees of the hazards of non-routine tasks (for example, the cleaning of reactor vessels), and the hazards associated with chemicals contained in unlabeled pipes in their work areas.

**(e)(2)** "Multi-employer workplaces." Employers who produce, use, or store hazardous chemicals at a workplace in such a way that the employees of other employer(s) may be exposed (for example, employees of a construction contractor working on-site) shall additionally ensure that the hazard communication programs developed and implemented under this paragraph (e) include the following:

**(i)** The methods the employer will use to provide the other employer(s) on-site access to safety data sheets for each hazardous chemical the other employer(s)' employees may be exposed to while working;

**(ii)** The methods the employer will use to inform the other employer(s) of any precautionary measures that need to be taken to protect employees during the workplace's normal operating conditions and in foreseeable emergencies; and,

**(iii)** The methods the employer will use to inform the other employer(s) of the labeling system used in the workplace.

**(e)(3)** The employer may rely on an existing hazard communication program to comply with these requirements, provided that it meets the criteria established in this paragraph (e).

**(e)(4)** The employer shall make the written hazard communication program available, upon request, to employees, their designated representatives, the Assistant Secretary and the Director, in accordance with the requirements of 29 CFR 1910.1020 (e).

**(e)(5)** Where employees must travel between workplaces during a workshift, i.e., their work is carried out at more than one geographical location, the written hazard communication program may be kept at the primary workplace facility.

**(f) Labels and other forms of warning.**

**(f)(1)** Labels on shipped containers. The chemical manufacturer, importer, or distributor shall ensure that each container of hazardous chemicals leaving the workplace is labeled, tagged or marked. Hazards not otherwise classified do not have to be addressed on the container. Where the chemical manufacturer or importer is required to label, tag or mark the following shall be provided:

**(i)** Product identifier;

**(ii)** Signal word;

**(iii)** Hazard statement(s);

**(iv)** Pictogram(s);

**(v)** Precautionary statement(s); and,

**(vi)** Name, address, and telephone number of the chemical manufacturer, importer, or other responsible party.

**(f)(2)** The chemical manufacturer, importer, or distributor shall ensure that the information provided under paragraphs (f)(1)(i) through (v) is in accordance with Appendix C, Allocation of Label Elements, for each hazard class and associated hazard category for the hazardous chemical, prominently displayed, and in English (other languages may also be included if appropriate).

**(f)(3)** The chemical manufacturer, importer, or distributor shall ensure that the information provided under paragraphs (f)(1)(ii) through (iv) is located together on the label, tag, or mark.

**(f)(4)** Solid materials

**(i)** For solid metal (such as a steel beam or a metal casting), solid wood, or plastic items that are not exempted as articles due to their downstream use, or shipments of whole grain, the required label may be transmitted to the customer at the time of the initial shipment, and need not be included with subsequent shipments to the same employer unless the information on the label changes;

**(ii)** The label may be transmitted with the initial shipment itself, or with the safety data sheet that is to be provided prior to or at the time of the first shipment; and,

**(iii)** This exception to requiring labels on every container of hazardous chemicals is only for the solid material itself, and does not apply to hazardous chemicals used in conjunction with, or known to be present with, the material and to which employees handling the items in transit may be exposed (for example, cutting fluids or pesticides in grains).

**(f)(5)** Chemical manufacturers, importers, or distributors shall ensure that each container of hazardous chemicals leaving the workplace is labeled, tagged, or marked in accordance with this section in a manner which does not conflict with the requirements of the Hazardous Materials Transportation Act (49 U.S.C. 1801 et seq.) and regulations issued under that Act by the Department of Transportation.

**(f)(6)** Workplace labeling. Except as provided in paragraphs (f)(7) and (f)(8) of this section, the employer shall ensure that each container of hazardous chemicals in the workplace is labeled, tagged or marked with either:

**(i)** The information specified under paragraphs (f)(1)(i) through (v) for labels on shipped containers; or,

**(ii)** Product identifier and words, pictures, symbols, or combination thereof, which provide at least general information regarding the hazards of the chemicals, and which, in conjunction with the other information immediately available to employees under the hazard communication program, will provide employees with the specific information regarding the physical and health hazards of the hazardous chemical.

**(f)(7)** The employer may use signs, placards, process sheets, batch tickets, operating procedures, or other such written materials in lieu of affixing labels to individual stationary process containers, as long as the alternative method identifies the containers to which it is applicable and conveys the information required by paragraph (f)(6) of this section to be on a label. The employer shall ensure the written materials are readily accessible to the employees in their work area throughout each work shift.

**(f)(8)** The employer is not required to label portable containers into which hazardous chemicals are transferred from labeled containers, and which are intended only for the immediate use of the employee who performs the transfer. For purposes of this section, drugs which are dispensed by a pharmacy to a health care provider for direct administration to a patient are exempted from labeling.

**(f)(9)** The employer shall not remove or deface existing labels on incoming containers of hazardous chemicals, unless the container is immediately marked with the required information.

**(f)(10)** The employer shall ensure that workplace labels or other forms of warning are legible, in English, and prominently displayed on the container, or readily available in the work area throughout each work shift. Employers having employees who speak other languages may add the information in their language to the material presented, as long as the information is presented in English as well.

**(f)(11)** Chemical manufacturers, importers, distributors, or employers who become newly aware of any significant information regarding the hazards of a chemical shall revise the labels for the chemical within six months of becoming aware of the new information, and shall ensure that labels on containers of hazardous chemicals shipped after that time contain the new information. If the chemical is not currently produced or imported, the chemical manufacturer, importer, distributor, or employer shall add the information to the label before the chemical is shipped or introduced into the workplace again.

**(g) Safety data sheets.**

**(g)(1)** Chemical manufacturers and importers shall obtain or develop a safety data sheet for each hazardous chemical they produce or import. Employers shall have a safety data sheet in the workplace for each hazardous chemical which they use.

**(g)(2)** The chemical manufacturer or importer preparing the safety data sheet shall ensure that it is in English (although the employer may maintain copies in other languages as well), and includes at least the following section numbers and headings, and associated information under each heading, in the order listed (See Appendix D to §1910.1200--Safety Data Sheets, for the specific content of each section of the safety data sheet):

**(i)** Section 1, Identification;

**(ii)** Section 2, Hazard(s) identification;

**(iii)** Section 3, Composition/information on ingredients;

**(iv)** Section 4, First-aid measures;

**(v)** Section 5, Fire-fighting measures;

**(vi)** Section 6, Accidental release measures;

**(vii)** Section 7, Handling and storage;

**(viii)** Section 8, Exposure controls/personal protection;

**(ix)** Section 9, Physical and chemical properties;

**(x)** Section 10, Stability and reactivity;

**(xi)** Section 11, Toxicological information.
Note 1 to paragraph (g)(2): To be consistent with the GHS, an SDS must also include the following headings in this order:

**(xii)** Section 12, Ecological information;

**(xiii)** Section 13, Disposal considerations;

**(xiv)** Section 14, Transport information; and

**(xv)** Section 15, Regulatory information.

Note 2 to paragraph (g)(2): OSHA will not be enforcing information requirements in sections 12 through 15, as these areas are not under its jurisdiction.

**(xvi)** Section 16, Other information, including date of preparation or last revision.

**(g)(3)** If no relevant information is found for any sub-heading within a section on the safety data sheet, the chemical manufacturer, importer or employer preparing the safety data sheet shall mark it to indicate that no applicable information was found.

**(g)(4)** Where complex mixtures have similar hazards and contents (i.e. the chemical ingredients are essentially the same, but the specific composition varies from mixture to mixture), the chemical manufacturer, importer or employer may prepare one safety data sheet to apply to all of these similar mixtures.

**(g)(5)** The chemical manufacturer, importer or employer preparing the safety data sheet shall ensure that the information provided accurately reflects the scientific evidence used in making the hazard classification. If the chemical manufacturer, importer or employer preparing the safety data sheet becomes newly aware of any significant information regarding the hazards of a chemical, or ways to protect against the hazards, this new information shall be added to the safety data sheet within three months. If the chemical is not currently being produced or imported the chemical manufacturer or importer shall add the information to the safety data sheet before the chemical is introduced into the workplace again.

**(g)(6)**

**(i)** Chemical manufacturers or importers shall ensure that distributors and employers are provided an appropriate safety data sheet with their initial shipment, and with the first shipment after a safety data sheet is updated;

**(ii)** The chemical manufacturer or importer shall either provide safety data sheets with the shipped containers or send them to the distributor or employer prior to or at the time of the shipment;

**(iii)** If the safety data sheet is not provided with a shipment that has been labeled as a hazardous chemical, the distributor or employer shall obtain one from the chemical manufacturer or importer as soon as possible; and,

**(iv)** The chemical manufacturer or importer shall also provide distributors or employers with a safety data sheet upon request.

**(g)(7)**

**(i)** Distributors shall ensure that safety data sheets, and updated information, are provided to other distributors and employers with their initial shipment and with the first shipment after a safety data sheet is updated;

**(ii)** The distributor shall either provide safety data sheets with the shipped containers, or send them to the other distributor or employer prior to or at the time of the shipment;

**(iii)** Retail distributors selling hazardous chemicals to employers having a commercial account shall provide a safety data sheet to such employers upon request, and shall post a sign or otherwise inform them that a safety data sheet is available;

**(iv)** Wholesale distributors selling hazardous chemicals to employers over-the-counter may also provide safety data sheets upon the request of the employer at the time of the over-the-counter purchase, and shall post a sign or otherwise inform such employers that a safety data sheet is available;

**(v)** If an employer without a commercial account purchases a hazardous chemical from a retail distributor not required to have safety data sheets on file (i.e., the retail distributor does not have commercial accounts and does not use the materials), the retail distributor shall provide the employer, upon request, with the name, address, and telephone number of the chemical manufacturer, importer, or distributor from which a safety data sheet can be obtained;

**(vi)** Wholesale distributors shall also provide safety data sheets to employers or other distributors upon request; and,

**(vii)** Chemical manufacturers, importers, and distributors need not provide safety data sheets to retail distributors that have informed them that the retail distributor does not sell the product to commercial accounts or open the sealed container to use it in their own workplaces.

**(g)(8)** The employer shall maintain in the workplace copies of the required safety data sheets for each hazardous chemical, and shall ensure that they are readily accessible during each work shift to employees when they are in their work area(s). (Electronic access and other alternatives to maintaining paper copies of the safety data sheets are permitted as long as no barriers to immediate employee access in each workplace are created by such options.)

**(g)(9)** Where employees must travel between workplaces during a workshift, i.e., their work is carried out at more than one geographical location, the safety data sheets may be kept at the primary workplace facility. In this situation, the employer shall ensure that employees can immediately obtain the required information in an emergency.

**(g)(10)** Safety data sheets may be kept in any form, including operating procedures, and may be designed to cover groups of hazardous chemicals in a work area where it may be more appropriate to address the hazards of a process rather than individual hazardous chemicals. However, the employer shall ensure that in all cases the required information is provided for each hazardous chemical, and is readily accessible during each work shift to employees when they are in their work area(s).

**(g)(11)** Safety data sheets shall also be made readily available, upon request, to designated representatives, the Assistant Secretary, and the Director, in accordance with the requirements of 29 CFR 1910.1020(e).

**(h) Employee information and training.**

**(h)(1)** Employers shall provide employees with effective information and training on hazardous chemicals in their work area at the time of their initial assignment, and whenever a new chemical hazard the employees have not previously been trained about is introduced into their work area. Information and training may be designed to cover categories of hazards (e.g., flammability, carcinogenicity) or specific chemicals. Chemical-specific information must always be available through labels and safety data sheets.

**(h)(2)** Information. Employees shall be informed of:

**(i)** The requirements of this section;

**(ii)** Any operations in their work area where hazardous chemicals are present; and,

**(iii)** The location and availability of the written hazard communication program, including the required list(s) of hazardous chemicals, and safety data sheets required by this section.

**(h)(3)** Training. Employee training shall include at least:

**(i)** Methods and observations that may be used to detect the presence or release of a hazardous chemical in the work area (such as monitoring conducted by the employer, continuous monitoring devices, visual appearance or odor of hazardous chemicals when being released, etc.);

**(ii)** The physical, health, simple asphyxiation, combustible dust, and pyrophoric gas hazards, as well as hazards not otherwise classified, of the chemicals in the work area;

**(iii)** The measures employees can take to protect themselves from these hazards, including specific procedures the employer has implemented to protect employees from exposure to hazardous chemicals, such as appropriate work practices, emergency procedures, and personal protective equipment to be used; and,

**(iv)** The details of the hazard communication program developed by the employer, including an explanation of the labels received on shipped containers and the workplace labeling system used by their employer; the safety data sheet, including the order of information and how employees can obtain and use the appropriate hazard information.

**(i) Trade secrets.**

**(i)(1)** The chemical manufacturer, importer, or employer may withhold the specific chemical identity, including the chemical name, other specific identification of a hazardous chemical, or the exact percentage (concentration) of the substance in a mixture, from the safety data sheet, provided that:

**(i)** The claim that the information withheld is a trade secret can be supported;

**(ii)** Information contained in the safety data sheet concerning the properties and effects of the hazardous chemical is disclosed;

**(iii)** The safety data sheet indicates that the specific chemical identity and/or percentage of composition is being withheld as a trade secret; and,

**(iv)** The specific chemical identity and percentage is made available to health professionals, employees, and designated representatives in accordance with the applicable provisions of this paragraph.

**(i)(2)** Where a treating physician or nurse determines that a medical emergency exists and the specific chemical identity and/or specific percentage of composition of a hazardous chemical is necessary for emergency or first-aid treatment, the chemical manufacturer, importer, or employer shall immediately disclose the specific chemical identity or percentage composition of a trade secret chemical to that treating physician or nurse, regardless of the existence of a written statement of need or a confidentiality agreement. The chemical manufacturer, importer, or employer may require a written statement of need and confidentiality agreement, in accordance with the provisions of paragraphs (i)(3) and (4) of this section, as soon as circumstances permit.

**(i)(3)** In non-emergency situations, a chemical manufacturer, importer, or employer shall, upon request, disclose a specific chemical identity or percentage composition, otherwise permitted to be withheld under paragraph (i)(1) of this section, to a health professional (i.e. physician, industrial hygienist, toxicologist, epidemiologist, or occupational health nurse) providing medical or other occupational health services to exposed employee(s), and to employees or designated representatives, if:

**(i)** The request is in writing;

**(ii)** The request describes with reasonable detail one or more of the following occupational health needs for the information:

(A) To assess the hazards of the chemicals to which employees will be exposed;

(B) To conduct or assess sampling of the workplace atmosphere to determine employee exposure levels;

(C) To conduct pre-assignment or periodic medical surveillance of exposed employees;

(D) To provide medical treatment to exposed employees;

(E) To select or assess appropriate personal protective equipment for exposed employees;

(F) To design or assess engineering controls or other protective measures for exposed employees; and,

(G) To conduct studies to determine the health effects of exposure.

**(iii)** The request explains in detail why the disclosure of the specific chemical identity or percentage composition is essential and that, in lieu thereof, the disclosure of the following information to the health professional, employee, or designated representative, would not satisfy the purposes described in paragraph (i)(3)(ii) of this section:

(A) The properties and effects of the chemical;

(B) Measures for controlling workers' exposure to the chemical;

(C) Methods of monitoring and analyzing worker exposure to the chemical; and,

(D) Methods of diagnosing and treating harmful exposures to the chemical;

**(iv)** The request includes a description of the procedures to be used to maintain the confidentiality of the disclosed information; and,

**(v)** The health professional, and the employer or contractor of the services of the health professional (i.e. downstream employer, labor organization, or individual employee), employee, or designated representative, agree in a written confidentiality agreement that the health professional, employee, or designated representative, will not use the trade secret information for any purpose other than the health need(s) asserted and agree not to release the information under any circumstances other than to OSHA, as provided in paragraph (i)(6) of this section, except as authorized by the terms of the agreement or by the chemical manufacturer, importer, or employer.

**(i)(4)** The confidentiality agreement authorized by paragraph (i)(3)(iv) of this section:

**(i)** May restrict the use of the information to the health purposes indicated in the written statement of need;

**(ii)** May provide for appropriate legal remedies in the event of a breach of the agreement, including stipulation of a reasonable pre-estimate of likely damages; and,

**(iii)** May not include requirements for the posting of a penalty bond.

**(i)(5)** Nothing in this standard is meant to preclude the parties from pursuing non-contractual remedies to the extent permitted by law.

**(i)(6)** If the health professional, employee, or designated representative receiving the trade secret information decides that there is a need to disclose it to OSHA, the chemical manufacturer, importer, or employer who provided the information shall be informed by the health professional, employee, or designated representative prior to, or at the same time as, such disclosure.

**(i)(7)** If the chemical manufacturer, importer, or employer denies a written request for disclosure of a specific chemical identity or percentage composition, the denial must:

**(i)** Be provided to the health professional, employee, or designated representative, within thirty days of the request;

**(ii)** Be in writing;

**(iii)** Include evidence to support the claim that the specific chemical identity or percent of composition is a trade secret;

**(iv)** State the specific reasons why the request is being denied; and,

**(v)** Explain in detail how alternative information may satisfy the specific medical or occupational health need without revealing the trade secret.

**(i)(8)** The health professional, employee, or designated representative whose request for information is denied under paragraph (i)(3) of this section may refer the request and the written denial of the request to OSHA for consideration.

**(i)(9)** When a health professional, employee, or designated representative refers the denial to OSHA under paragraph (i)(8) of this section, OSHA shall consider the evidence to determine if:

**(i)** The chemical manufacturer, importer, or employer has supported the claim that the specific chemical identity or percentage composition is a trade secret;

**(ii)** The health professional, employee, or designated representative has supported the claim that there is a medical or occupational health need for the information; and,

**(iii)** The health professional, employee or designated representative has demonstrated adequate means to protect the confidentiality.

**(i)(10)**

**(i)** If OSHA determines that the specific chemical identity or percentage composition requested under paragraph (i)(3) of this section is not a “bona fide” trade secret, or that it is a trade secret, but the requesting health professional, employee, or designated representative has a legitimate medical or occupational health need for the information, has executed a written confidentiality agreement, and has shown adequate means to protect the confidentiality of the information, the chemical manufacturer, importer, or employer will be subject to citation by OSHA.

**(ii)** If a chemical manufacturer, importer, or employer demonstrates to OSHA that the execution of a confidentiality agreement would not provide sufficient protection against the potential harm from the unauthorized disclosure of a trade secret, the Assistant Secretary may issue such orders or impose such additional limitations or conditions upon the disclosure of the requested chemical information as may be appropriate to assure that the occupational health services are provided without an undue risk of harm to the chemical manufacturer, importer, or employer.

**(i)(11)** If a citation for a failure to release trade secret information is contested by the chemical manufacturer, importer, or employer, the matter will be adjudicated before the Occupational Safety and Health Review Commission in accordance with the Act's enforcement scheme and the applicable Commission rules of procedure. In accordance with the Commission rules, when a chemical manufacturer, importer, or employer continues to withhold the information during the contest, the Administrative Law Judge may review the citation and supporting documentation "in camera" or issue appropriate orders to protect the confidentiality of such matters.

**(i)(12)** Notwithstanding the existence of a trade secret claim, a chemical manufacturer, importer, or employer shall, upon request, disclose to the Assistant Secretary any information which this section requires the chemical manufacturer, importer, or employer to make available. Where there is a trade secret claim, such claim shall be made no later than at the time the information is provided to the Assistant Secretary so that suitable determinations of trade secret status can be made and the necessary protections can be implemented.

**(i)(13)** Nothing in this paragraph shall be construed as requiring the disclosure under any circumstances of process information which is a trade secret.

**(j) Effective dates.**

**(j)(1)** Employers shall train employees regarding the new label elements and safety data sheets format by December 1, 2013.

**(j)(2)** Chemical manufacturers, importers, distributors, and employers shall be in compliance with all modified provisions of this section no later than June 1, 2015, except:

**(i)** After December 1, 2015, the distributor shall not ship containers labeled by the chemical manufacturer or importer unless the label has been modified to comply with paragraph (f)(1) of this section.

**(ii)** All employers shall, as necessary, update any alternative workplace labeling used under paragraph (f)(6), update the hazard communication program required by paragraph (h)(1), and provide any additional employee training in accordance with paragraph (h)(3) for newly identified physical or health hazards no later than June 1, 2016.

**(j)(3)** Chemical manufacturers, importers, distributors, and employers may comply with either §1910.1200 revised as of October 1, 2011, or the current version of this standard, or both during the transition period.


## Activity 1: Legal Rights

Use pages 1-1 through 1-20 to answer questions 1 through 4, the HAZWOPER standard beginning on page 1-21 to answer questions 5-17, and the HAZCOM standard beginning on page 1-92 to answer questions 18-19. Record exactly where in the standards or manual you found the answer.

**Example:** The employer must maintain a list of all hazardous chemicals brought into the workplace.

□ True

□ False

Section cited: ______________________________

Looking in OSHA Hazard Communication Standard 29CFR1910.1200 we find in section (e): "Written hazard communication program" at paragraph (e)(1)(i) that the written program must include "a list of the hazardous chemicals known to be present" in the workplace. But, in sub-section (b)(6)(i) we find that this standard does not apply to hazardous waste. Therefore, only the chemicals that are brought onto the site must have SDSs.

□ True

□ False

Section cited: ______________________________

***The statement is true and we cite 29CFR1910.1200(e)(1)(i) and (b)(6)(i)***

1. The government agency that is responsible for worker safety and health at hazardous waste sites is:

   □ a) OSHA (Occupational Safety and Health Administration)

   □ b) NIOSH (National Institute of Occupational Safety and Health)

   □ c) EPA (Environmental Protection Agency)

   □ d) NIEHS (National Institute of Environmental Health Sciences

   Section cited: ____________________________________________

2. If a worker is disciplined or fired for filing an OSHA complaint, she or he has no recourse under the OSH Act.

   □ True

   □ False

   Section cited: ____________________________________________

3. Which of the following is a right that workers have under the OSH Act: (Select all that apply)

□ a) file a safety complaint with OSHA

Section cited: ______________________________

□ b) request a workplace inspection

Section cited: ______________________________

□ c) talk to the OSHA inspector in private

Section cited: ______________________________

□ d) set the amount of fine for any employer violation

Section cited: ______________________________

4. The OSHA general duty clause requires employers to:

□ a) do all of the below

□ b) provide a safe and healthful workplace

Section cited: ______________________________

□ c) establish a joint labor-management safety and health committee

Section cited: ______________________________

□ d) have an industrial hygienist at each site

Section cited: ______________________________

5. The government agency that is responsible for protecting the air, land, and water from pollution is:

   □ a) OSHA (Occupational Safety and Health Administration)

   □ b) NIOSH (National Institute of Occupational Safety and Health)

   □ c) EPA (Environmental Protection Agency)

   □ d) NIEHS (National Institute of Environmental Health Sciences

   Section cited: ______________________________________

6. When working on a hazardous waste site, you must work with a buddy to ensure rapid assistance to employees in the event of an emergency.

   □ True

   □ False

   Section cited: ______________________________________

7. A “qualified person” and a “site safety and health officer/supervisor” are always the same person.

   □ True

   □ False

   Section cited: ______________________________________

8. Section (q) of the Hazardous Waste Standard deals with the qualifications for emergency response to hazardous substance releases.

   □ True

   □ False

   Section cited: ______________________________________________

9. In an emergency response to a hazardous substance release, those workers who respond in a defensive fashion without trying to stop the release must be trained at this level.

   □ a) first responder awareness level

   □ b) first responder operations level

   □ c) hazardous materials technician

   □ d) hazardous materials specialist

   □ e) on-scene incident commander

   Section cited: ______________________________________________

10. The difference between Level A and Level B protection is the:

- ☐ a) difference in respiratory protection
- ☐ b) difference in chemical protective clothing
- ☐ c) difference in number of layers of gloves worn
- ☐ d) difference in the type of boot covers worn

Section cited: ____________________________________________

11. All written safety and health programs must include:

- ☐ a) all of the below
- ☐ b) a medical surveillance program

Section cited: ____________________________________________

- ☐ c) a comprehensive work plan

Section cited: ____________________________________________

- ☐ d) a safety and health training plan

Section cited: ____________________________________________

12. On a hazardous waste site:

 □ a) all of the below are true

 □ b) decontamination must be performed in an area that minimizes exposure to contaminated employees and equipment

 Section cited: ______________________________________

 c) all employees leaving contaminated areas must decontaminated

 Section cited: ______________________________________

 □ d) all equipment and solvents used for decon must be decontaminated or disposed of properly

 Section cited: ______________________________________

13. The most important difference between Levels B, C, and D is:

 □ a) difference in respiratory protection

 □ b) difference in chemical protective clothing

 □ c) difference in layers of gloves worn

 □ d) difference in the type of boot covers worn

 Section cited: ______________________________________

14. On a hazardous waste site, the site-specific safety and health plan must include:

□ a) all of the below

□ b) the decontamination process

Section cited: ______________________________

□ c) the type of personal protective equipment used by employees on site

Section cited: ______________________________

□ d) the type and frequency of air monitoring

Section cited: ______________________________

15. Employers must provide hazardous waste workers with a medical examination:

□ a) all of the below are true

□ b) if the worker wants to start a family

Section cited: ______________________________

□ c) if the worker wants to get married

Section cited: ______________________________

□ d) prior to their assignment to a hazardous waste site

Section cited: ______________________________

16. An “uncontrolled hazardous waste site” is one that does not have a chain link fence around its perimeter.

 - ☐ True
 - ☐ False

 Section cited: ______________________________________________

17. On a hazardous waste job, each employer must develop and maintain a site-specific safety and health plan for their employees.

 - ☐ True
 - ☐ False

 Section cited: ______________________________________________

18. According to the Hazard Communication Standard:

□ a) all of the below are true

□ b) chemical manufacturers and importers must provide labels on containers and Safety Data Sheets (SDSs)

Section cited: ____________________________________________

□ c) employers must keep SDSs for every chemical used at their worksite

Section cited: ____________________________________________

□ d) employers must provide training for all their employees about the hazards of the chemicals they might be exposed to

Section cited: ____________________________________________

19. The Hazard Communication Standard states that labeling does not apply to hazardous waste.

□ True

□ False

Section cited: __________________________________________

Notes:

# Chapter 2:
# Hazard Recognition –
# Health Effects & Property of Chemicals

Chemical, physical, biological, and radiological hazards are found at hazardous waste sites. You need to know how to recognize hazards and the signs and symptoms of exposure in order to protect yourself, others, and the environment. This chapter covers health effects and hazardous properties of chemicals.

**Chapter Objectives:**

After completing this module, you will be able to:

1. Explain the types of symptoms and health effects caused by exposure to health hazards.
2. Explain information on the physical properties and characteristics of hazardous chemicals (i.e., vapor pressure/density, flashpoint, LEL/UEL, specific gravity).
3. Use measurements taken at work and occupational exposure limits to figure out if you have been overexposed to chemicals in the air.
4. Use health effects, chemical properties, and sampling and monitoring information to protect yourself (i.e., knowing what chemicals should not be mixed together).

## Case Study

A worker at a hazardous waste cleanup site was instructed to combine half-full drums. Sampling tests showed that two drums both contained non-flammable materials, so he poured the contents of one drum into the other. The liquid started to spatter, bubble, and produce a yellow cloud and then it caught on fire. **Why did this happen?**

When combined, the chemicals reacted and gave off vapors and so much heat that they caught on fire. Chemicals that are dangerous to mix together are called "incompatible." In this chapter, you will learn about properties of chemicals, including incompatibility, which can be used to recognize and prevent this kind of problem.

## Section I – Health Effects

**Toxicology is the study of poisons and their adverse health effects.**

What are some examples of poisons and their health effects (toxic response)?

- The nausea, dizziness and eye, throat, and airway irritation caused by inhaling smoke from your first cigarette.
- Slurred speech, dizziness, nausea, and vomiting caused by too much alcohol.
- Diseases and difficulty in breathing caused by years of working with concrete that contains crystalline silica.
- Others? ________________________________________________

  ________________________________________________

Exposures can be brief, occur over many years, or somewhere in between. Adverse health effects may be immediate, not evident for many years, or somewhere in between.

**Acute health effects appear immediately or shortly after (within 72 hours) exposure.**

Acute effects are usually caused by short-term (acute) exposures, generally less than 24 hours. Acute health effects may disappear soon after the exposure ends or the damage may be permanent.

| Exposure To: | Acute Responses: |
|---|---|
| carbon monoxide | headache, nausea, weakness, dizziness, unconsciousness and death |
| sulfuric acid | skin, eye, and throat burning |
| nitric acid | irritation of eyes, skin, and mucous membranes and pulmonary edema |
| phosgene (carbonyl chloride) | pulmonary edema 24 hours after exposure, death |

**Chronic health effects occur many months or years after exposure and are often the result of long-term, often low-level, exposure to a chemical.** With some chemicals, chronic health effects can result from short-term exposures.

You may not notice any effects from exposure to a chemical with chronic health effects for many years. You generally do not feel the damage as it is being done. For example, long-term exposure to asbestos can cause asbestosis, lung cancer, and other cancers, but it does not scratch your throat or give you any early warning that it is dangerous.

| Exposure To: | Chronic Health Effects: |
|---|---|
| asbestos | asbestosis, lung cancer, mesothelioma, and other cancers |
| benzene | leukemia, anemia, liver damage |
| formaldehyde | nasal and lung cancer, skin sensitization, asthma |
| fume from sulfuric and/or nitric acid | enamel erosion of front teeth |
| solvents | liver, kidney, skin damage, central nervous system effects |

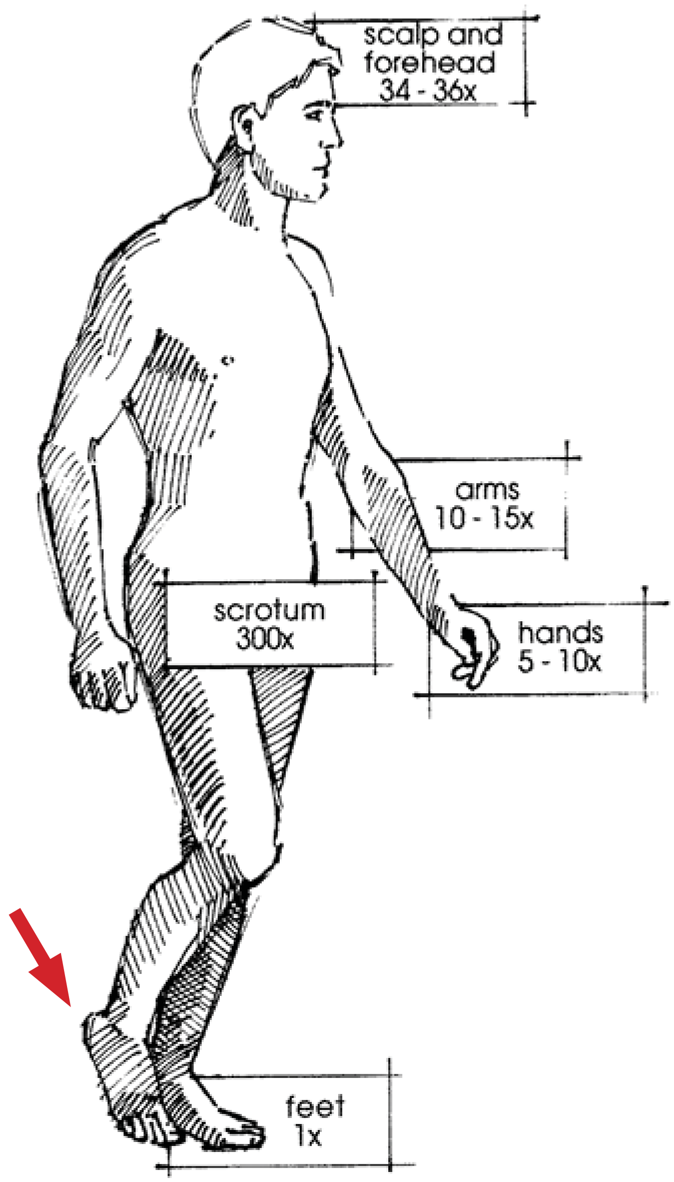
**Chemicals get into the body by four routes of entry: breathing (inhalation), absorption through the skin, swallowing (ingestion), and injection.**

Most chemicals can enter the body by more than one route of entry. The toxicity of a chemical may differ depending on how it entered your body and it may not be a hazard if it can't get into your body. Of the four routes of entry, the lungs generally offer the least resistance to a chemical entering your body. For example, ingesting large amounts of vitamin D can be acutely toxic but skin contact does not present a hazard because vitamin D is not absorbed through the skin. Inhaling metallic mercury (also known as elemental mercury or quicksilver) is generally more hazardous than ingesting it. This is because 80 percent of inhaled metallic mercury enters the blood through the lungs while less 0.01 percent of what is ingested enters the blood via the stomach and intestines.

**Inhalation, or breathing them in, is the most common way that chemicals get into your body.** The vapors, particles, and fibers you inhale end up in the lungs and, in some cases, cross into the blood stream along with oxygen. The smaller particles and fibers are the deeper into the lungs they are likely to travel. Fewer large particles and fibers get into the lungs because they are trapped by mucous in the nose and upper airways, moved up by the small hair-like cilia, and spit out or swallowed. Smoking damages the cilia, preventing them from moving the mucous containing trapped dust and chemicals out of the lungs.

**Absorption through the skin can also major route of exposure.** Many chemic example, solvents and liquid insecticides cross through intact skin into the bloodstr

**Different areas of the body absorb chemicals at different rates.** The rate absorption varies with skin thickness, water content, and fat content. Some chemicals will pass through your skin more quickly if your skin has been exposed to water for an extended period of time (for example, wearing sweaty gloves all day). The rate of absorption will also increase if the skin has been irritated, damaged, punctured, or been exposed to chemicals that break down fat in the skin. The relative rate of absorption is compared to a part of the body with a low rate of absorption. This graphic compare the chemical absorption rate of some par the body to the absorption rate of the **fee**




Chemicals may cause allergic or irritant dermatitis following skin contact (discussed later in this section).

**Chemicals can be ingested, or swallowed, when you eat, drink, or smoke.** Toxic particles are also ingested when you swallow the mucus that has trapped them. Do not eat, drink, smoke, or put on ChapStick© or other cosmetics in a contaminated area. Never bring food, cigarettes or cosmetics into contaminated areas.

**Chemicals, bacteria, and other materials can be injected under your skin by contaminated tools, sharp objects, or pressurized air, gas, or hydraulic fluid.**

**How does your body react when exposed to chemical or physical hazards?**

The resulting health effects include injuries and illnesses, temporary health effects and long-term diseases, minor symptoms to life-threatening conditions, and death. A few examples are provided below and specific types of health effects will be discussed in detail.

**Head (nervous system):** dizziness, headaches, stress nervousness, irritability, sleeplessness, tremors, speech changes

**Ears:** ringing, temporary deafness, hearing loss

**Teeth and Gums:** corrosion of enamel, blue/discolored gums

**Eyes:** redness, irritation, watering, grainy feeling, welder's flash

**Nose and Throat:** sneezing, coughing, sore throat, nasal cancer

**Chest and Lungs:** wheezing, congestion, shortness of breath with mild exercise, flu-like symptoms (metal fume fever)

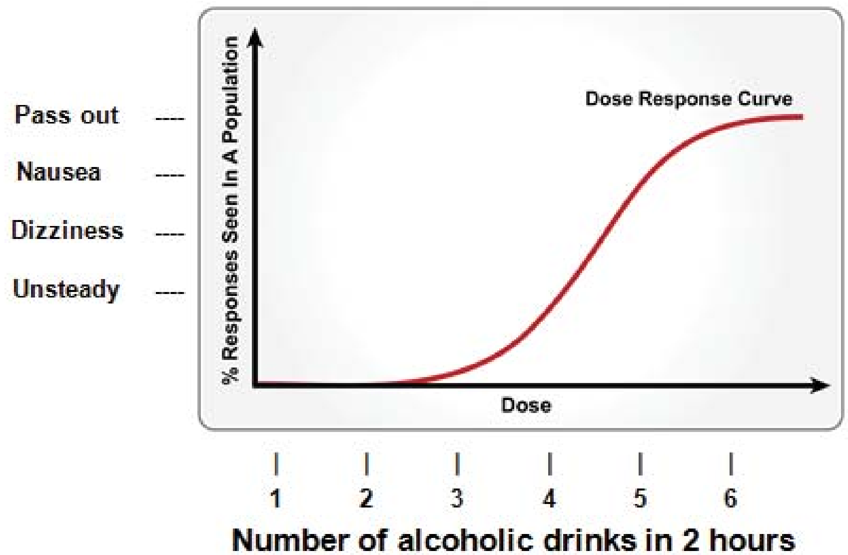
**Muscles, Tendons, and Joints:** soreness, inflammation, tendinitis

**Reproductive System:** miscarriage, irregularities in menstruation, damage to fetus or chromosomes, low sperm count, sterility

**Stomach and Intestines (gastrointestinal tract):** vomiting, diarrhea

**Skin:** redness, dryness, itching, ulcers, skin cancer

**The dose response curve shows how people respond to toxic chemicals. A higher dose means a greater response by the body.**




**Several factors influence each person's response to a certain dose, or amount, of a chemical.** This is true whether the chemical is the alcohol we drink, the medicine we take, or a solvent used at work.

Factors that affect an individual's response to a toxic chemical include:

- Body weight
- Occupation
- Physical and health condition
- Exposure to other chemicals (now or in the past)
- Gender
- Heredity
- Age
- Lifestyle (smoking, nutritional status)

**Your body processes chemicals in three ways:**

1. **Metabolize**, or break down, the chemical into a form that is more easily separated and removed from the body. Most chemicals are metabolized in the liver but other organs, including the lungs, kidneys, skin, stomach, and intestines can be involved in metabolizing chemicals too. Often the chemical is altered to be more water soluble (easier to excrete) and less toxic.
2. **Excrete** the chemical or the byproducts of its metabolism in urine, feces, sweat, exhaled air, or hair.
3. **Store** the chemical or byproducts of its metabolism in the bones, fat, or other tissues

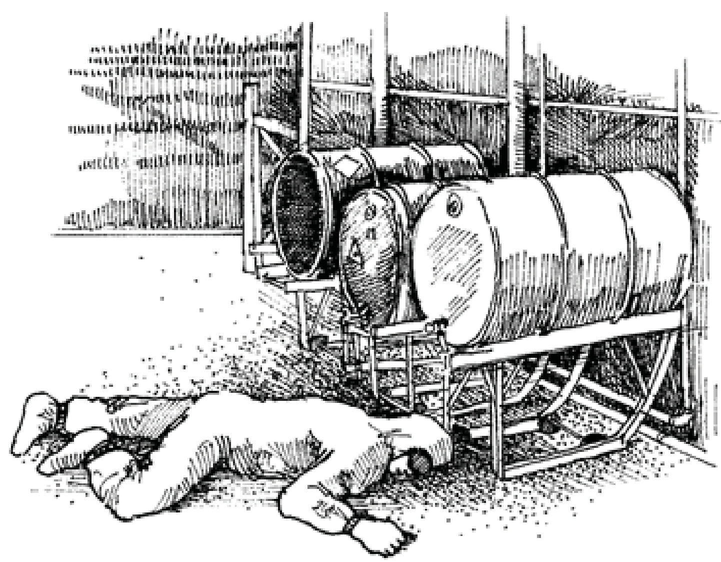
**Chemicals are often classified by how they harm us.** We're going to talk about the following classes of chemical hazards.

- Asphyxiants
- Irritants
- Sensitizers
- Systemic toxins
- Blood system
- Nervous system (neuro) toxins
- Liver (hepato) toxins
- Kidney (renal or nephron) toxins
- Reproductive toxins
- Carcinogens
- Teratogens
- Mutagens

**Asphyxiants are chemicals that interfere with getting oxygen to body tissues and can cause suffocation.** There are two kinds of asphyxiants: simple asphyxiants and chemical asphyxiants.

**Simple asphyxiants take the place of (displace) oxygen in the air so that there is less oxygen available to be brought into the body. There are many simple asphyxiants** that may be found on construction and hazardous waste sites. Carbon dioxide, ethane, helium, hydrogen, methane, neon, krypton, acetylene, nitrous oxide, argon, propane, and nitrogen are simple asphyxiants.

**An atmosphere with less than 19.5% oxygen by volume is considered oxygen deficient and immediately dangerous to life and health.** The health effects experienced depend on duration of the oxygen deficiency, work rate, breathing rate, temperature, health, and age. Adverse health effects, such as reduced reaction times, may begin at 19.0% oxygen but not be immediately noticeable or recognized. These percentages are for measurements taken at sea level; adjustments must be made for higher elevations.



**Chemical asphyxiants reduce your body's ability to provide oxygen to its tissues, even when there is plenty of oxygen in the air.** Chemical asphyxiants interfere with:

1. Oxygen getting into the blood
2. Oxygen being transported to body tissues
3. Oxygen being taken up by tissues
4. A combination of the three

Even at low levels or following brief exposures, chemical asphyxiants can cause collapse, unconsciousness, and death. Carbon monoxide, hydrogen cyanide, hydrogen sulfide, and methylene chloride are chemical asphyxiants.

**An irritant causes inflammation by direct contact with the skin, eyes, nose, mouth, or respiratory system.** Irritants can also be allergens.

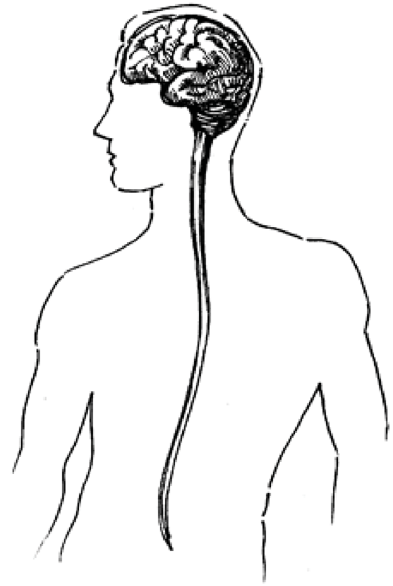
- **Respiratory tract irritants can cause injury to the nose, mouth, throat and lungs.** Inhaled irritants can harm any part of the respiratory tract but their water solubility determines where they will do the most damage. Materials that are more water-soluble (e.g., ammonia, formaldehyde, and sulfur dioxide) affect mainly the upper respiratory tract as they contact moist tissues in the nose and throat. Less water-soluble materials (e.g., nitrogen dioxide and phosgene) act deeper in the lungs (lower respiratory tract). Chlorine and ozone are examples of chemicals that often affect both the upper and lower respiratory tract.

  Respiratory tract irritation can be relatively minor, such as a tightening of the chest or bronchitis. But it may also be very serious, as in the case of pulmonary edema (fluid in the lungs), and cause death.

- **Skin irritants can cause redness, itching and drying of the skin, which is known as contact dermatitis.** Organic solvents and detergents are examples of skin irritants. Some acids, such as sulfuric acid, are irritants at low concentrations but can cause burns and destroy tissue at higher concentrations.

After repeated exposures to chemicals known as allergic sensitizers, some people become allergic and develop a reaction to even small exposures of those chemicals. **Allergic sensitizers generally affect the skin and respiratory tract and the reaction may get worse with each exposure.** The symptoms are often the similar to those caused by irritants but they can occur at locations other than where the chemical came in contact with the body. An example of such symptoms is asthma (inflammation and narrowing of the airways in the lungs) following skin contact with isocyanates. As with irritants, the response can be very serious, and may even cause death. Sensitizers include isocyanates, formaldehydes, phenol resins, epoxy resins, chromium, and nickel.

**Systemic toxins affect body systems that are removed from the body part of original contact.** This is different from local health effects, such as skin irritation or burns from contact with an acid, which occur at the point of contact with the chemical. An example of systemic toxicity is the central nervous system (brain) depression caused by exposure to alcohols. Like many chemicals, alcohols can also cause local health effects such as irritation at the site of contact (skin, eyes, and lungs).



Central Nervous System

**Blood system toxins damage blood cells or interfere with blood cell formation.** Examples include benzene, methylene chloride, arsine, phosphorus, and naphthalene.

**Nervous system (neuro) toxins damage the central nervous system (brain) or peripheral nervous system.** Symptoms include dullness, muscle tremor, restlessness, convulsions, loss of memory, epilepsy, and loss of muscle coordination. Examples include mercury, insecticides, hexachlorophene, and lead.

**Liver (hepato) toxins cause liver damage and produce symptoms including jaundice and liver enlargement.** Examples include alcohols, carbon tetrachloride, and nitrosamines.

**Kidney (renal or nephro) toxins damage the kidneys.** Examples include halogenated hydrocarbons, heavy metals, ethylene glycol.

**Reproductive toxins damage the reproductive cells (egg and sperm) or interfere with their formation.** Examples include DBCP, lead, cadmium, cellosolves, and vinyl chloride.

**Carcinogens cause cancer and must be listed on an SDS equal or greater than 0.1 percent** of the product. Cancer is the uncontrolled growth of malignant (harmful) cells at any site in the body. Cancer can take 20 to 30 years after the exposure to develop. Carcinogens include vinyl chloride, asbestos, methylene chloride, and toluene-2, 4-diisocyanate. Other chemicals must be listed on an SDS if the amount is 1.0 percent of the product.

**Teratogens cause birth defects in the developing fetus.** Examples include thalidomide, anesthetic gases, methyl ethyl ketone, xylene, methylene chloride, lead, methyl mercury, cigarette smoke, ionizing radiation. Many teratogens can affect the fetus even before the woman knows she is pregnant.

**Mutagens cause a change (mutation) in your genetic material.** Mutation of the reproductive cells may cause birth defects in future children. Mutation of other cells in the body may cause cancer. Examples of mutagens include ethylene oxide (a sterilizing chemical used in hospitals), benzene, hydrazine, and ionizing radiation. Many mutagens are also carcinogens.

**How do we describe how much of a chemical we might be exposed to?**

**Concentration is the amount of a substance** (the chemical we're concerned about) **in a given amount of another material** (when we're talking about workplace exposure, the other material is often air). Concentration is different from weight because 5 mg/m3 is not 5 milligrams of arsenic, it is 5 milligrams of arsenic in every cubic meter of air.

**Concentration of gases and vapors is often measured in parts per million (ppm) or parts per billion (ppb). Concentration of particulates is usually measured in weight per volume of air** (i.e., **mg/m3** [milligrams per cubic meter of air] **or ug/m3** [micrograms per cubic meter of air]).

**Parts per million (ppm) means the number of parts of one substance per million parts of another substance.** The concentration of gases and vapors in air is often measured in ppm or ppb. **1 ppm is equivalent to 1 inch in 16 miles or 1 drop in 14 gallons.**

**100% = 1,000,000 ppm**
**10% = 100,000 ppm**
**1% = 10,000 ppm**
**0.1% = 1,000 ppm**

**Parts per billion (ppb) is 1,000 times smaller than ppm so 1 ppb is 1 inch in 14,000 miles or 1 drop in 14,000 gallons.**

**mg/m3 means milligrams of substance in each cubic meter of air** (a cubic meter = 39 inches x 39 inches x 39 inches or about 1.25 cubic yards). These units are commonly used for concentrations of dusts, metal fumes, or other particles in the air. For example, one crushed aspirin in a cubic meter of air is 325 mg/m3.

**f/cc means the number of fibers in each cubic centimeter of air.** These units are used for substances such as asbestos and fiberglass. In the asbestos standard (29 CFR 1926.1101), OSHA defines a fiber as the "particulate form of asbestos, 5 micrometers or longer, with a length-to-diameter ratio of at least 3 to1."

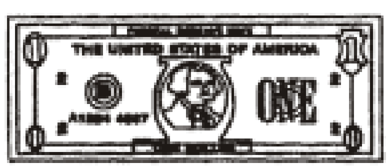
**mg/kg means milligrams of one substance per kilogram of another substance.** This unit is often used to indicate the amount of chemicals in milligrams per kilogram of body weight to produce a toxic response. It is also used to indicate the amount of a chemical in milligrams per kilogram of contaminated soil.

For many chemicals, the *NIOSH Pocket Guide* lists a conversion factor from ppm into mg/m3 for many chemicals.

**Micrograms (µg), milligrams (mg), grams (g), and kilograms (kg) are metric units of mass or weight.** A grain of sugar weighs approximately 1 milligram. A gram is one thousand (1,000) milligrams and approximately the mass of a dollar bill or a paper clip. A kilogram is one million (1,000,000) milligrams and about 2.2 U.S. pounds.

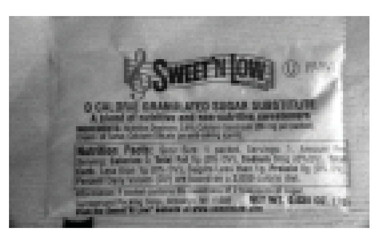
**2.2 pounds = 1 kg = 1,000 g = 1,000,000 mg = 1,000,000,000 µg**

**1 gram (g) = Weight of a dollar bill**




**or**

**Weight of 1 Packet of Sweet 'N Low**



**Micrometers (µm), millimeters (mm), centimeters (cm), and meters (m) are metric units of length.** There are approximately 2.5 centimeters in an inch.

**3.3 ft = 39.4 in = 1 m = 100 cm = 1,000 mm = 1,000,000 µm**

Cubic centimeter (cc or cm3) and cubic meter (m3) are common metric units of volume. **A cubic centimeter is the volume of a cube that is 1 centimeter long, 1 centimeter high, and 1 centimeter deep. A sugar cube is approximately one cubic centimeter.**

**A cubic meter is the volume of a cube that is 1 meter long, 1 meter high, and 1 meter deep. The volume of a blue public mailbox is approximately one cubic meter** and 1 million times larger than a cubic centimeter**.**

1 cubic meter (m3) =

**Exposure limits describe the maximum amount or concentration of chemical you can be exposed to.** The term occupational exposure limit (OEL) is a term that includes all workplace exposure limits. **Some OELs are legally enforceable and some are recommendations.**

**Permissible Exposure Limits (PELs) are enforceable exposure levels set by OSHA.** Employers must keep exposures below the PELs. NIOSH and non-governmental agencies (such as the American Conference of Governmental Industrial Hygienists) also establish limits, but these recommendations are not legally enforceable.

**Threshold Limit Values (TLVs) are recommended exposure limits set by the American Conference of Governmental Industrial Hygienists (ACGIH), a private, non-governmental organization. In general, TLVs are not legally enforceable.** Contractors on Department of Energy (DOE) sites are required to meet the 2005 TLVs when they are more protective (lower) than the OSHA PELs. TLVs are reviewed and updated annually and are usually more protective of human health than PELs.

**Recommended Exposure Levels (RELs) are set by NIOSH and are not legally enforceable.** RELs are usually more protective of human health than PELs.

Most PELs and TLVs are defined as average exposures over an 8-hour work shift. RELs are set for 10-hour days so they don't need to be adjusted when working 10-hour days. Some PELs, TLVs, and RELs have a "skin" notation, which means that the material is readily absorbed through the skin.

**Short-Term Exposure Limits (STELs) are a maximum average concentration to which a person may be exposed for a short period of time**, usually 15 minutes. It is legally enforceable if set by OSHA. NIOSH and ACGIH also have recommended STELs for some chemicals.

**The ceiling limit is an exposure level that must not be exceeded at any time. It is legally enforceable if set by OSHA.**

## *Your Exposure Limits: Important Points to Remember*

Most OSHA Permissible Exposure Limits (PELs) and ACGIH Threshold Limit Values (TLVs) are 8-hour averages.

- STELs are set for very few compounds
- STELs and Ceiling limits provide protection from the effects short-term exposure to high concentrations (acute effects)
- You can submit a written request to your employer for exposure monitoring results under the OSHA Standard on Access to Employee Exposure and Medical Records (29CFR1910.1020)

## *Exposure Limits – Time-Weighted Averages (TWA's)*

**Most PELs are 8-hour time-weighted averages (TWA) and are expressed as either mg/m3 or ppm.**

There are also shorter TWAs.  Short Term Exposure Limits (STELs) are TWAs that are averaged over a 15-minute period.

**How a Time-Weighted Average is Calculated**

You are exposed to acetone at 80 ppm for 6 hours and 60 ppm for 2 hours. What is your average exposure for the 8-hour shift?

$$\text{TWA} = \frac{(\text{concentration \#1 x time \#1}) + (\text{concentration \#2 x time \#2})}{(\text{time \#1 + time \#2})}$$

$$\text{TWA} = \frac{(\text{80 ppm x 6 hours}) + (\text{60 ppm x 2 hours})}{(\text{6 hours + 2 hours})}$$

$$\text{TWA} = \frac{(480 + 120)\text{ ppm}}{8}$$

$$\text{TWA} = 75\text{ ppm}$$

The OSHA Permissible Exposure Limit (PEL) for acetone is 1,000 ppm.  The PEL has not been exceeded.

**Time-Weighted Average Activity**

You are working with methyl alcohol (methanol). You know that the OSHA Permissible Exposure Limit (PEL) for methyl alcohol is 200 ppm and want to determine if you are being overexposed. Monitoring results show that you are exposed to 250 ppm for 4 hours and 25 ppm for 4 hours in one day. Determine your average exposure for the 8-hour shift?

$$\text{TWA} = \frac{(\text{concentration \#1 x time \#1}) + (\text{concentration \#2 x time \#2})}{(\text{time \#1 + time \#2})}$$

$$\text{TWA} = \frac{(\quad\quad \text{ppm x} \quad\quad \text{hours}) + (\quad\quad \text{ppm x} \quad\quad \text{hours})}{(\quad\quad \text{hours} + \quad\quad \text{hours})}$$

$$\text{TWA} = \underline{(\quad\quad + \quad\quad)\ \text{ppm}}$$

$$\text{TWA} = \quad\quad \text{ppm}$$

Does your exposure exceed the PEL?

**Exposure to all chemicals in a mixture must be considered, especially if the health effects of the chemicals are similar.** For example, if you work on a hazardous waste site cleaning up acetone, xylene, and toluene, it is important to consider your exposure to all three because they all affect the central nervous system.

This example shows how to combine exposures to chemicals that have similar effects. Air monitoring shows that acetone levels are at 500 ppm, xylene levels are at 50 ppm, and toluene levels are at 100 ppm.

$$\frac{\text{TWA acetone}}{\text{PEL acetone}} + \frac{\text{TWA xylene}}{\text{PEL xylene}} + \frac{\text{TWA toluene}}{\text{PEL toluene}} =$$

$$\frac{500\text{ ppm}}{1{,}000\text{ ppm}} + \frac{50\text{ ppm}}{100\text{ ppm}} + \frac{100\text{ ppm}}{200\text{ ppm}} =$$

$$\frac{1}{2} + \frac{1}{2} + \frac{1}{2} = \mathbf{1.5}$$

**In this example, the result was 1.5 meaning that additional controls to reduce exposures are needed.**

**Some exposures can be measured in blood, urine, or exhaled breath. This is called biological monitoring.**

Examples include:

| **Substance:** | **Measured In:** |
|---|---|
| Lead | Blood |
| Carbon monoxide | Breath or blood |
| n-hexane | Breath or urine |
| Parathion (pesticide) | Urine |
| Perchloroethylene | Blood, urine, breath |

### *Summary: Toxicology and Health Effects*

A high concentration (dose) of a toxic chemical for a short period (minutes) of time is called an **acute exposure**. Acute exposures can be very dangerous to your health now (acute effect). Exposure to a chemical over a long period of time (days, months, years) is called a **chronic exposure**. Some chronic exposures cause cancer, permanent nerve or brain damage, lung, liver, or kidney disease (chronic effect).

Some toxic chemicals only harm you at the point of contact with your body (skin, eyes, and lungs)--this is called a **local effect**. Other chemicals enter your body and harm tissues or organs in parts of the body that are not near the point of contact or entry. These are called **systemic effects**.

Chemicals can get into the body by **absorption** (soaking through the skin), **inhalation** (breathing in), **ingestion** (getting in your mouth when you eat or smoke), and **injection** (with a needle, splinter, tool, compressed air, etc.). These are called **routes of entry.** In addition, chemicals can harm us at the point of contact (skin, lungs, etc.).

When the dose, or amount of a toxic chemical the body is exposed to, increases, the body's response increases. This is called the **dose-response relationship** for the chemical. In other words, the dose-response relationship is the amount the harm or effect that a certain exposure causes increases as the dose increases. Each worker has a slightly different response to the same dose of a chemical.

Chemicals can be dangerous to both people and the environment. You should be able to identify these hazards and protect yourself.

**Solvents** often irritate the skin, eyes, nose, throat and lungs. When solvents get into the blood, the brain and nerves are often affected. Long-term exposure to some solvents can cause damage to the liver and kidneys.

**Acids** and **bases** (also known as caustics or alkalis) are corrosive chemicals that can damage the skin, eyes, and airways.

Chemicals exposures and radiation that damage the blueprint (DNA) of the cell are called **mutagens**. Substances (like asbestos) and radiation that cause cancer, usually many years after the exposure, are called **carcinogens**. Chemicals and radiation that cause birth defects are called **teratogens**. Chemicals that cause problems, such as infertility, low sperm count, changes in hormones, and menstrual problems, making it difficult or impossible for men and women to have children are called **reproductive toxins**.

When lead, mercury, or other **heavy metals** get into the body the brain and nerves are affected. Even at low levels, lead can cause anemia. Cadmium and uranium are poisons that can cause kidney damage and lung cancer.

## Section II – Properties of Chemicals

### *What will we clean up?*

ATSDR (Agency for Toxic Substances and Disease Registry) states that “this priority list is not a list of “most toxic” substances, but rather a prioritization of substances based on a combination of their frequency, toxicity, and potential for human exposure at NPL (National Priority List) sites.”

**ATSDR/EPA 2013 Substance Priority List**

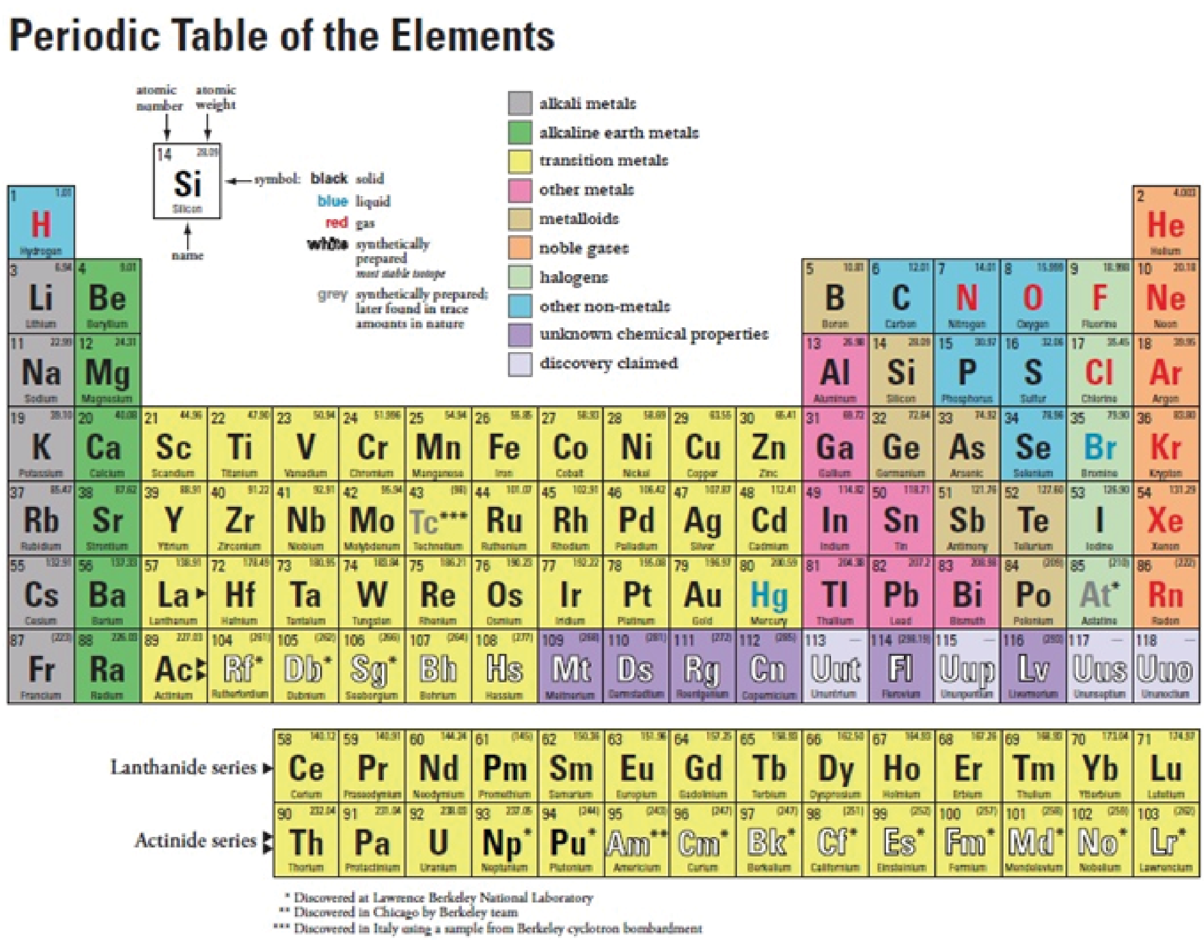
1. Arsenic
2. Lead
3. Mercury
4. Vinyl Chloride
5. Polychlorinated Biphenyls (PCBs)
6. Benzene
7. Cadmium
8. Benzo(A)Pyrene
9. Polycyclic Aromatic Hydrocarbons
10. Benzo(b)fluoranthene
11. Chloroform
12. Aroclor 1260
13. DDT, PP'
14. Aroclor 1254
15. Dibenzo(A, H)anthracene
16. Trichlorethylene
17. Chromium, hexavalent
18. Dieldrin
19. Phosphorus, white
20. Hexachlorobutadiene

Beryllium is also common on hazardous waste sites.

Source: ATSDR Web Site http://www.atsdr.cdc.gov/spl/

### *Chemical formulas*

**All chemicals are made up of atoms that can come together to form molecules.** There are approximately ninety-two types of atoms, or **elements**, that appear in nature. Each element has a chemical symbol. Carbon's symbol is C, oxygen's symbol is O, and silicon's symbol is Si but this pattern doesn't always hold true. Iron's symbol is Fe and potassium's symbol is K. **Chemical formulas indicate what atoms a molecule is made of**. Each formula lists the symbols of the atoms in the molecule and how many of those atoms are in each molecule. For example, carbon monoxide (CO) has one carbon atom and one oxygen atom; carbon dioxide (CO2) has one carbon atom and two oxygen atoms.



**Elements commonly found in hazardous chemicals or at hazardous sites**

| NON-METALS | | METALS | | INERT GASES | |
|---|---|---|---|---|---|
| ELEMENT | SYMBOL | ELEMENT | SYMBOL | ELEMENT | SYMBOL |
| Carbon | C | Sodium | Na | Helium | He |
| Oxygen | O | Potassium | K | Neon | Ne |
| Hydrogen | H | Aluminum | Al | Argon | Ar |
| Nitrogen | N | Iron | Fe | Radon | Rn* |
| Sulfur | S | Mercury | Hg | | |
| Phosphorous | P | Chromium | Cr | | |
| Chlorine | Cl | Nickel | Ni | | |
| Fluorine | F | Lead | Pb | | |
| | | Uranium | U* | | |
| | | Plutonium | Pu* | | |
| | | Silica | Si | | |

* radioactive elements

**Organic chemicals always contain a carbon atom, usually bonded to a hydrogen atom, but not all chemicals with a carbon atom are organic.** Do not confuse organic chemicals (many are poisonous) with organic vegetables (no pesticides). Many solvents are organic chemicals. Petroleum, coal, oils, vegetation and all animals are made of organic chemical compounds. Some organic compounds are listed below.

Benzene ($C_6H_6$)
Chloroform ($CHCl_3$)
Glucose ($C_6H_{12}O_6$)
Carbon tetrachloride ($CCl_4$)
Ethyl alcohol ($CH_3CH_2OH$)

**Inorganic chemicals generally do not contain carbon atoms.** Examples are provided below.

Hydrochloric acid (HCl)
Sulfuric Acid ($H_2SO_4$)
Water ($H_2O$)
Silica ($SiO_2$)
Ammonia ($NH_3$)
Sodium Chloride - table salt (NaCl)
Sodium Hydroxide (NaOH)

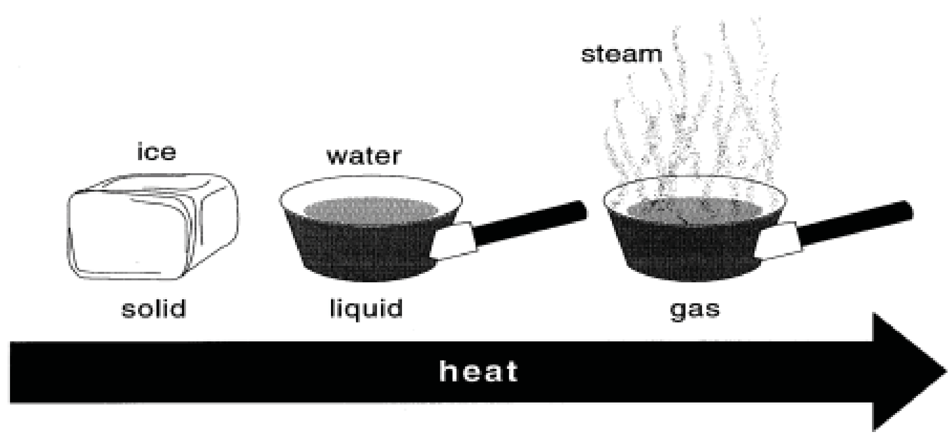
## *Chemical and Physical Properties: How Do Chemicals Act?*

How chemicals act depends upon their physical and chemical properties. Understanding how chemicals behave can help you anticipate the hazards.

The following properties of chemicals are explained below. The next chapter will discuss where to find this information for chemicals on your job site.

1. Freezing Point
2. Melting Point
3. Boiling Point
4. Corrosiveness
5. pH
6. Solubility in Water
7. Specific Gravity
8. Viscosity
9. Relative Gas Density (vapor density)
10. Vapor Pressure
11. Evaporation Rate
12. Flammability and Flash Point
13. Oxidizer
14. Explosive Limits
15. Incompatibility
16. Shock Sensitivity

**Chemicals can exist in three states: solid, liquid, or gas/vapor.** Solids have fixed volume and shape and are not compressible. Liquids are compressible, have a fixed volume, and change shape with the container. Gases are compressible and have an undefined shape and volume (they expand to fill the container).



We often use the terms gas and vapor interchangeably because they behave similarly, but they are actually slightly different. The difference is that **a vapor is a gas that is normally a liquid or solid at room temperature. When a liquid evaporates it produces vapors.** Some solids, such as iodine and carbon dioxide, are capable of **subliming (going directly from a solid to a gas)** at atmospheric pressure and room temperature; thus, such solids also have significant vapor pressures under these conditions.

**It is important to know what phase (solid, liquid, or gas) a chemical is in to understand the risk.** For example, a solid block of lead can't harm you unless you swallow it or grind it into small particles and inhale it. But if it is heated, the lead will turn into a liquid which can burn you. If heated more, the lead will turn into a fume that can be inhaled. The state of substance affects the type of hazards (burn or health effects from lead exposure) and the degree of the hazards (it is easier to be exposed to lead fume than a lead block).

## *Freezing Point*

**Definition:** Temperature at which a liquid becomes a solid

**Examples:** Water left in your freezer (less than 32°F) changes to a solid (ice)

## *Melting Point*

**Definition:** Temperature at which a solid becomes a liquid.

**Examples:** Ice (solid water) left at any temperature above 32°F changes to a liquid (water).

| | Melting Point |
|---|---|
| Tin | 449°F |
| Lead | 620°F |
| Copper | 1,985°F |
| Iron | 2,800°F |

### *Sublimation*

**Definition:** The process by which certain solids become gases (sublime) without ever being a liquid

**Example:** Dry ice ($CO_2$) changes from a solid to a gas at temperatures above -109°F

### *Boiling Point*

**Definition:** The temperature where a liquid rapidly changes into a vapor or gas. At this temperature, the vapor pressure of the liquid is equal to atmospheric pressure.

**Examples:**

| | |
|---|---|
| PCBs | 617-691°F |
| Water: | 212°F (100°C) |
| Acetone: | 133°F |
| Chlorine: | -29°F |

**Importance:** If you know the freezing, melting, sublimation, and boiling points, you can then figure out the form or state a compound will be in at the temperature you are working in.

### *Corrosive*

**Definition:** A compound that can damage skin, eyes, other tissues, metal, and other solids. For example, strong acids (low pH) and bases (high pH) are corrosive.

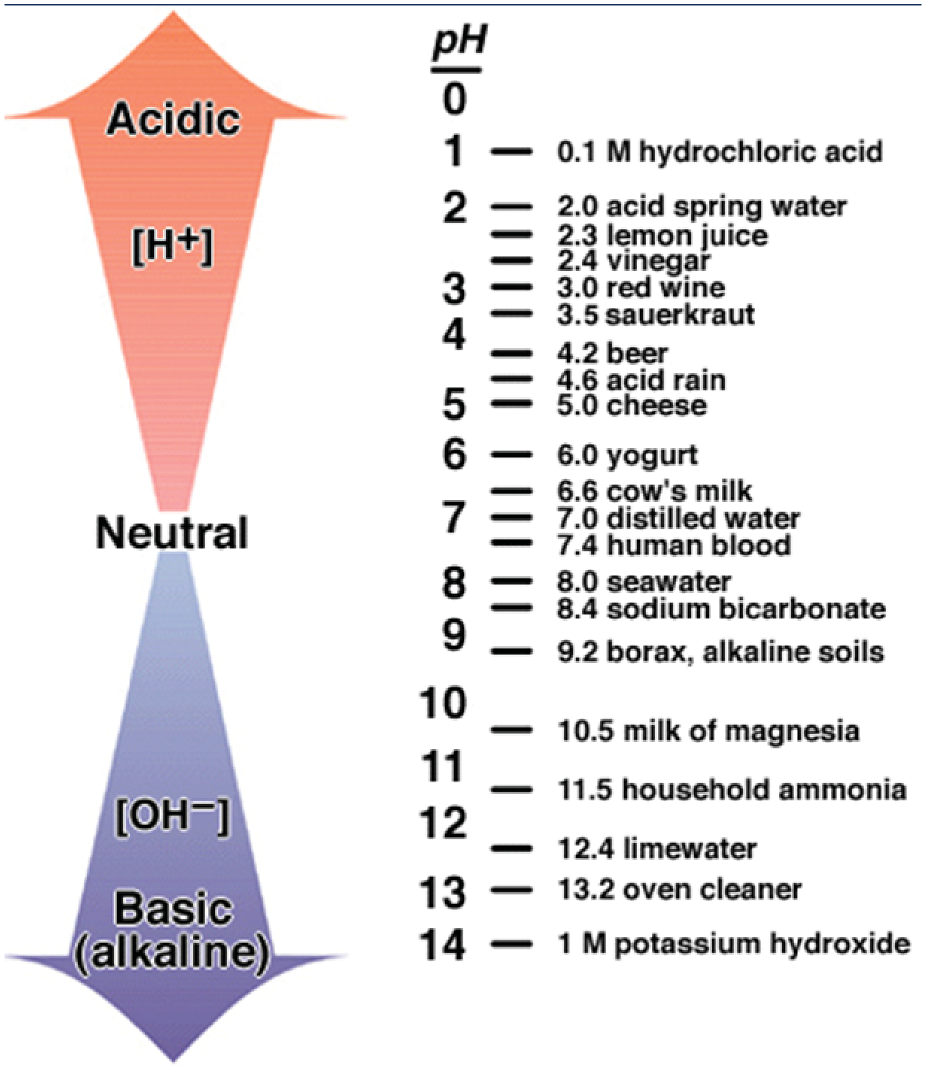
**Examples:**

| **Corrosive Acids** | **Corrosive Bases** |
|---|---|
| Sulfuric acid (oleum) | Sodium hydroxide |
| Nitric acid | Lime |
| Hydrochloric (muriatic) acid | Sodium hydroxide (also known as lye or caustic soda) |

**Importance:** Corrosives are health hazards and must be stored in glass or special plastics. **pH**

**Definition:** **pH is a measure of how strong an acid or base a substance is.** A pH of 1 is very acidic; a pH of 14 is very alkaline. A pH of 7 is neutral–neither acid nor base. **A change in pH of one unit** (for example, from 3 to 4) **represents a 10-fold change** in acidity or alkalinity.

**Importance:** Compounds with high and low pH values will cause burns, irritate eyes, nose and lungs. **Wastes with a pH of less than 2 or greater than 12 are legally defined as hazardous.**



## *How will a chemical act in the air or water?*

Knowing a material's chemical properties can help you to understand where it is most likely to go in the air and water. This information is important in determining where to do air monitoring and deciding how to protect the environment.

### *Solubility: Will it Dissolve in Water?*

**Definition:** Solubility is the ability of a substance to be dissolved in a solvent (often water). Solubility is usually expressed as a percentage, by weight or mass, that can be dissolved in a certain mass of solvent.

**Examples:** Methylene chloride has a solubility of 2% in water. This means that up to 2 grams of methylene chloride can be dissolved in 100 grams of water.

| Substance | Solubility in Water |
|---|---|
| Acetone | 100% or miscible |
| Methylene chloride | 2% |
| Toluene | 0.07% |
| PCBs | Insoluble |

**Importance:** Soluble compounds mix with water. **A substance is said to be immiscible if it is not at all soluble in water and miscible if it is fully soluble in water.** If a liquid that is immiscible (not soluble) spills into a waterway, most of it will either float to the top or sink to the bottom. A chemical's solubility helps determine how to clean up wastes.

## *Specific Gravity (Sp. Gr.): Will a Liquid Float on Water or Sink?*

**Definition:** Specific gravity is the density of a liquid compared to water (**water = 1**). If specific gravity is less than one, the chemical tends to float. If the specific gravity is greater than one, the chemical tends to sink. If the water is moving then the chemicals will mix.

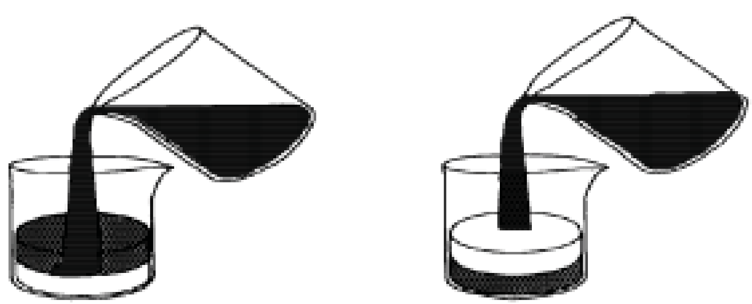
**Specific gravity (Sp. Gr.),** sometimes called relative density, is the ratio of the density (mass of a unit volume) of a substance to the density of a given reference material. Specific gravity usually means relative density with respect to water. Temperature and pressure must be specified for both the sample and the reference. Specific gravity is usually measured at 1 atm and a temperature of 68 °F.

**Examples:**

| | **Sp. Gr.** |
|---|---|
| Toluene | 0.87 |
| Methylene chloride | 1.33 |
| PCB | 1.39 |
| Light diesel oil | 0.86 |

**Importance:** By quantifying buoyancy, specific gravity helps you determine where a chemical spilled in water is likely to be found (floating on the surface or sunk down to the bottom) and to identify clean-up methods (like pillows or booms on the surface).

**Specific gravity of water is 1**



| | |
|---|---|
| Specific gravity less than 1 (floats) | Specific gravity greater than 1 (sinks) |

## *Viscosity: How thick is it?*

**Definition:** **Viscosity is the measure of a material's resistance to flow, which decreases as temperature increases and independent of pressure (except at very high pressure)**

**Importance:** This viscosity of a substance impacts how quickly it will spread if spilled.

## *Relative Gas Density (RGasD)*

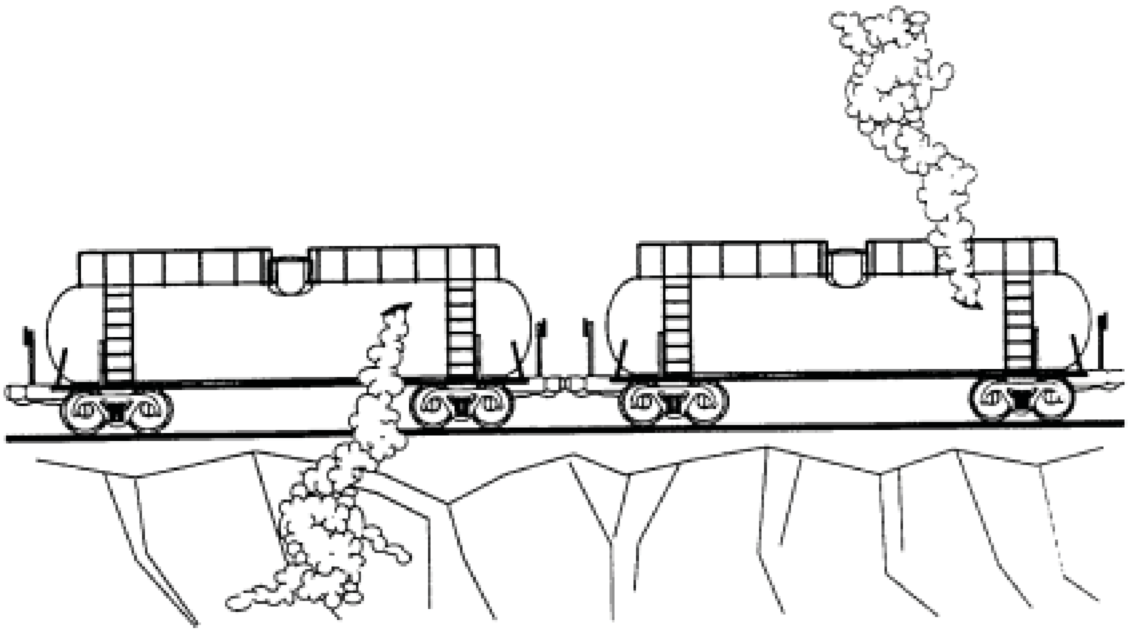
**Definition:** Relative gas density, also known as vapor density, is the weight of a vapor or gas compared to an equal volume of dry air at the same temperature and pressure. Relative gas density is unit-less. Air has a relative gas density (RGasD) of 1. If RGasD is greater than 1.0, the vapor or gas is heavier than air and tends to concentrate in low places. If less than 1.0, the vapor or gas tends to rise.

**Examples:**

| **Substance** | **RGasD** |
|---|---|
| Ammonia | 0.60 |
| Carbon monoxide | 0.97 |
| Air | 1.0 |
| Hydrogen sulfide | 1.19 |
| Methylene chloride | 2.90 |
| Gasoline | 3.79 |
| Trichloroethylene | 4.50 |

**Importance:** Tells you where to expect and monitor for released gases and vapors. Heavy gases and vapors will tend to collect in low-lying areas. Any air movement will mix gases and vapors so you can't assume that an area is safe based on relative gas density.

**RGasD of air is 1**



**RGasD greater than 1**
**(tends to sink)**

**RGasD less than 1**
**(tends to rise)**

**Hint: If you do not know the relative gas density of a chemical, look up its molecular weight (MW) in the NIOSH Pocket Guide. If the MW is more than 29 (the molecular weight of air) then the vapor or gas is heavier than air. If the MW is less than 29, the vapor or gas is lighter than air.**

## *Vapor Pressure (VP): How Fast Will a Liquid Release Vapors?*

**Definition:** **Vapor pressure (VP) is a measure of a liquid's ability to evaporate or give off vapor.** The higher the VP, the faster a liquid will become a vapor. Vapor pressure is measured in millimeters of mercury (mmHg). One atmosphere of pressure (1 atm) equals 760 mmHg. **Any chemical with a VP of 760 mmHg or more will be a gas at room temperature.**

Liquids release some vapor all of the time but chemicals with high vapor pressures release a large amount of vapor at room temperature. **Vapor pressure increases as temperature increases.** The boiling point is the temperature where the vapor pressure of the liquid is as high as atmospheric pressure, and a lot more vapor is released. A chemical with a high boiling point will have a low vapor pressure – it needs more heat to become a vapor. **The lower the boiling point, the higher the vapor pressure will be.**

**Examples:**

| | VP (mmHg) at 68°F | BP (°F) |
|---|---|---|
| Chlorine | 5,168 (6.8 atm) | -29 |
| Methylene Chloride | 350 | 104 |
| Acetone | 180 | 133 |
| Trichloroethylene | 58 | 189 |
| Water | 24 | 212 |
| o-Xylene | 7 | 292 |
| PCBs | .001 | 617 - 691 |

**Importance:** Chemicals with high vapor pressure are gases or enter the air quickly and can be more easily inhaled. Also, a sealed vessel containing a chemical with a high vapor pressure is more likely to become pressurized and explode as the temperature rises.

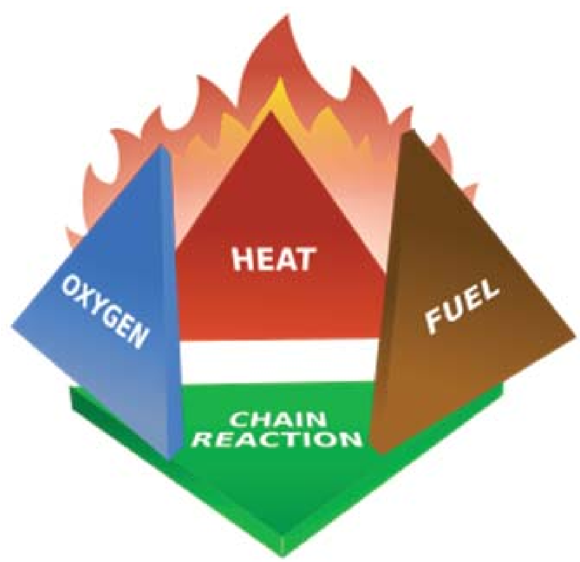
## *Evaporation Rate*

**Definition: Evaporation rate is the rate at which a material will vaporize compared to the rate of vaporization of a specific material.** Whenever a relative evaporation rate is given, the reference material must be stated and is usually ether or butyl acetate.

**Importance:** Evaporation rate determine how much of a liquid will vaporize and be present in the air. Evaporation rate increases as temperature, surface area (size), and air movement (wind) increase.

## ***Flammability***

**For a fire to burn, there must be a proper combination of four things: fuel, oxygen, heat (above the ignition temperature), and a chain reaction.** For example, even if you have enough fuel, enough oxygen, and an ignition source, there is no fire without a chain reaction producing enough heat to sustain the fire. Likewise, with enough fuel and an ignition source, but too little oxygen, there is no fire. These four items make up the fire tetrahedron.




**To put out a fire, you must remove one of the four elements shown in the fire tetrahedron.**

**What we were taught in science class about the fire triangle was not quite right.** Chain reaction was added because enough heat must be produced to sustain the fire (reaction). Think about holding the flame of a cigarette lighter beneath a 2 by 4 for a second. There is heat, oxygen and fuel, but no chain reaction. If the 2 by 4 was ground into sawdust, the reaction would go forward because the ratios were right.

## *Flash Point (Fl. P.): Can the vapors burn?*

**Definition:** The lowest temperature at which a liquid will give off enough vapor to form an ignitable mixture with air near the surface of the liquid if there is a source of ignition. Liquids do not burn, vapors burn.

**Examples:**

| | **Flash Point** | **Classification** |
|---|---|---|
| Gasoline | -45°F | Category 2 |
| Acetone | 0°F | Category 2 |
| Methyl ethyl ketone | 16°F | Category 2 |
| Toluene | 40°F | Category 2 |
| Turpentine | 95°F | Category 3 |
| Stoddard solvent | 102-110°F | Category 3 |
| Diesel | 126-205 °F | Category 3 |
| Cresol | 187°F | Category 4 |

**Why are some of these ranges?**

**Importance:** The flash point is used to classify the relative fire hazards of liquids. **OSHA (29CFR1910.106) defines a flammable liquid as any liquid having a flashpoint at or below 199.4 °F and divides them into four categories based on the following:**

Category 1 shall include liquids having flashpoints below 73.4 °F and having a boiling point at or below 95 °F.

Category 2 shall include liquids having flashpoints below 73.4 °F and having a boiling point above 95 °F

Category 3 shall include liquids having flashpoints at or above 73.4 °F and at or below 140 °F (60 °C). When a Category 3 liquid with a flashpoint at or above 100 °F is heated for use to within 30 °F of its flashpoint, it shall be handled in accordance with the requirements for a Category 3 liquid with a flashpoint below 100 °F.

Category 4 shall include liquids having flashpoints above 140 °F and at or below 199.4 °F. When a Category 4 flammable liquid is heated for use to within 30 °F of its flashpoint, it shall be handled in accordance with the requirements for a Category 3 liquid with a flashpoint at or above 100 °F.

When liquid with a flashpoint greater than 199.4 °F is heated for use to within 30 °F of its flashpoint, it shall be handled in accordance with the requirements for a Category 4 flammable liquid.

## *Oxidizer: Can it start a fire?*

**Definition:** Chemical that can start or promote burning of other materials.

**Examples:**

Perchloric acid
Ozone
Hydrogen peroxide
Household bleach
Peroxides
Chlorine

**Importance:** Oxidizers can react chemically with fuels and can start fires or explosions. Store oxidizers away from flammables and combustibles.

## *Flammable Vapor—Explosive Limits*

**Definitions:** **Explosive range (flammable)** is the concentration of a substance in air between the LEL and UEL. In this range, the substance will readily ignite.

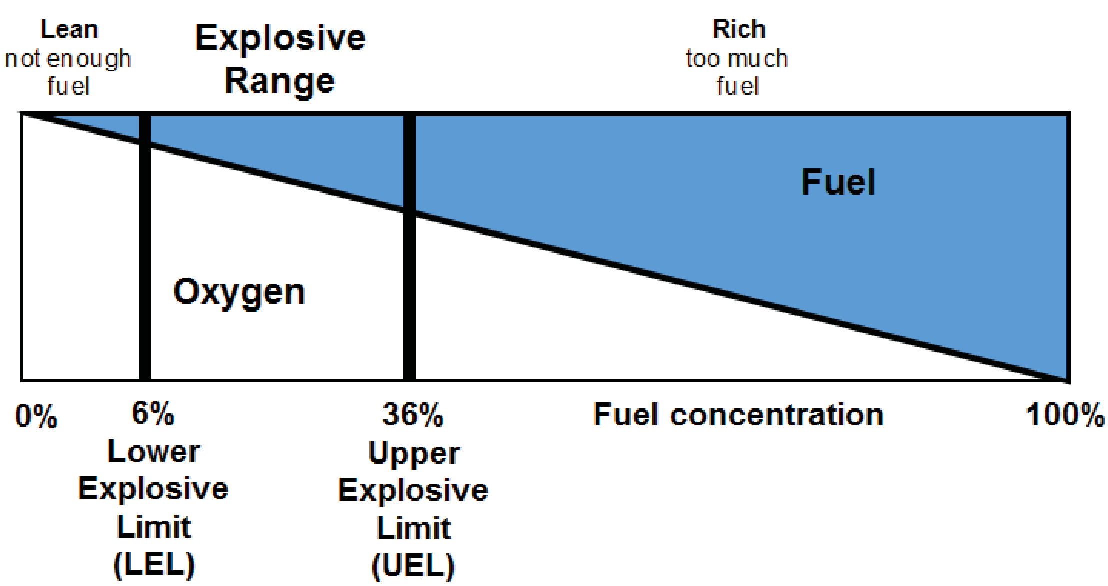
**Lower Explosive Limit (LEL)** is the lowest concentration (**% in air**) of a substance that will burn if ignited. Concentrations below the LEL **are "too lean" to ignite.**

**Upper Explosive Limit (UEL)** is the maximum concentration (% in air) of a substance that will burn if ignited. Concentrations above the UEL **are "too rich" to ignite.**

**Importance:** **Evacuate the area if the concentration of a flammable vapor or gas is greater than 10% of the LEL.** Do not enter or stay in an area that is above 10% of the LEL unless you are trained and properly equipped.

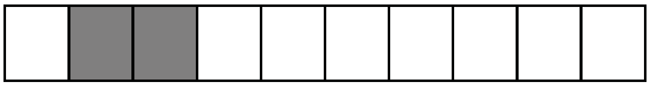
Concentrations above the UEL are not safe because the concentration can quickly drop into the explosive range when air is added or mixed.

The concentration of flammable gases and vapors can change rapidly, so constant air monitoring is essential. **Methyl alcohol's (also known as methanol) explosive range is between 6 and 36 percent and is illustrated below.**



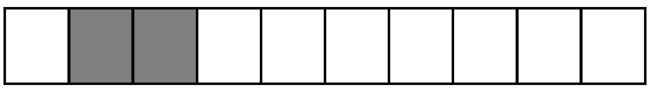
**Flammable ranges (shown below with shading) vary widely.**

**Ammonia (refrigerant)**

0%  100%%

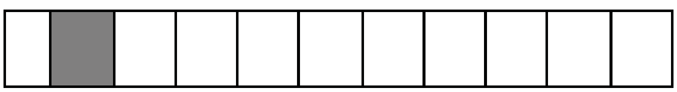
LEL 15% UEL 28%

**Acetone (solvent)**

0%  100%%

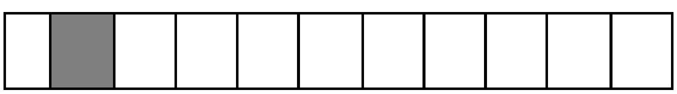
LEL 2.5% UEL 12.8%

**Benzene (solvent) also causes cancer at much lower levels**

0%  100%%

LEL 1.2% UEL 7.8%

**Gasoline (fuel)**

0%  100%%

LEL 1.4% UEL 7.6%

Ethylene Oxide (disinfectant) also causes cancer at much lower levels

0%  100%%

LEL 3% UEL 100%

**Would you enter a space containing 0.5% acetone? Why or why not?**

______________________________________________

______________________________________________

______________________________________________

*Combustible dust fires and explosions*

**Fire is a rapid chemical process that produces heat and light. An explosion is a rapid chemical process that produces heat and light and violent expansion of gases**

**Combustible dust is a finely divided combustible particulate solid that presents a flash fire hazard or explosion hazard when suspended in air or the process-specific oxidizing medium over a range of concentrations.**

**The ease of ignition and the severity of a combustible dust explosion is influenced by:**

1. particle size;
2. moisture content;
3. ambient humidity;
4. oxygen available for combustion;
5. the shape of dust particles; and
6. the concentration of dust in the air.

**Five conditions are necessary for a deflagration, explosion, or fire from combustible dust.**

1. Oxygen
2. Combustible dust
3. Dispersion/Ideal dust concentration
4. Confinement of the dust cloud
5. Ignition source

## *Incompatibilities and Reactivities: What will happen if these chemicals are mixed?*

**Incompatible chemicals react violently when they come in contact with each other and may result in:**

- fire;
- explosion; and/or
- toxic gas release.

Incompatible chemicals must be prevented from coming into contact with each other. Store containers of incompatible chemicals away from each other so that they won't come into contact if the containers leak or rupture.

When strong acids and bases (alkalis) are mixed, heat and spattering occur and can damage eyes and skin. Acids added to cyanides produces hydrogen cyanide gas, which can cause death.

**Water-reactive chemicals can create heat, spattering and toxic fumes upon contact with water.**

Examples of water reactive compounds are:

**Oxides, hydroxides, and hydrides, of:**

- Lithium
- Sodium
- Potassium

**Halogens**

- Fluorine
- Iodine
- Chlorine
- Bromine

**Strong acids**

- Sulfuric acid (oleum)
- Hydrochloric acid
- Hydrofluoric acid
- Nitric acid

**Strong bases**

- Sodium hydroxide (lye)
- Potassium hydroxide
- Calcium hydroxide (lime)

| Strong Oxidizers Such As: | React Violently With: |
|---|---|
| Chromic acid<br>Chromic anhydride<br>Sodium peroxide<br>Nitric acid<br>Dry bleaches<br>Disinfectants<br>Chlorates<br>Bromates<br>Nitrates<br>Peroxides | Acetaldehyde<br>Acetonitrile<br>Acrylonitrile<br>Benzene<br>Butyl alcohol<br>Carbon disulfide<br>Cresol<br>Cyanides<br>2,4-D<br>DDT |

**Do not store these chemicals near each other.**

A further listing of incompatible chemicals is found at the end of this chapter.

## *Polymerization*

**Definition:** **Polymerization is a reaction that causes molecules to link together to form chains and produces heat in the process. Heat and toxic chemicals are often produced during the reaction.**

**Importance:** **Knowing the reactive properties of chemicals you are working with can help you understand if they are dangerous to your skin and eyes or can start a fire.**

## *Hazardous Breakdown Products*

Some materials that do not burn may release hazardous materials in a fire or during welding.

**Examples:** Chlorinated hydrocarbons produce phosgene (mustard gas).
PCBs produce a soot containing the powerful carcinogens dibenzofurans and dibenzodioxins.

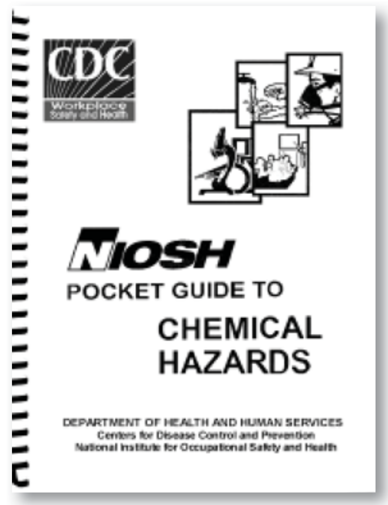
**Shock-sensitive chemicals can explode if dropped, shaken, or moved.**

**Examples:** **Ethyl ether can form peroxides, which are shock-sensitive and explosive.** Picric acid and perchloric acid become unstable over time and can explode if moved.

**Importance:** **Do not handle bulging drums or containers if crystals have formed around the lids.** Explosion containment devices and blast shields are needed to handle these chemicals. OSHA requirements for shock-sensitive chemicals are **in 1910.120(j)(5) and 1926.65(j)(5).**

**Where can I look up this information?**

The *NIOSH Pocket Guide to Chemical Hazards* is an important source of information on the hazards of 677 chemicals in use today. Safety data sheets contain information on specific products or chemicals and the DOT Emergency Response Guide provides information on groups of chemicals. These, and other information sources, will be discussed in Chapter 3.



## *Summary: Properties of Chemicals*

Chemical reactions can cause harm to people and the environment by:

1. releasing toxic gases;
2. producing out large amounts of heat; and/or
3. causing a fire or explosion.

The terms used to describe the chemical and physical properties of substances help you anticipate the hazards that may be present.

Knowing the upper and lower explosive limits helps you figure out if an atmosphere could explode. If the concentration of a flammable vapor or gas is greater than 10% of the LEL, then the area must be evacuated **immediately if you are neither trained nor equipped to work in an explosive atmosphere.**

The fire tetrahedron illustrates the four items necessary for a fire to burn:

1. fuel (can be solid, liquid, or a flammable vapor);
2. oxygen in the air ignition source;
3. heat (above the ignition temperature); and
4. a chain reaction.

It is very important for you to know which chemicals are incompatible for your own safety. **You can consult the NIOSH Pocket Guide to Chemical Hazards (discussed in Chapter 3)** to identify chemicals that react violently with water, oxidizers, degreasing solvents, bases (alkalis), and acids.

## *Partial List of Incompatible Chemicals*[1]

Substances in the right-hand column should be stored and handled so they will not come in contact with the substances in the corresponding row of the left-hand column.

| | |
|---|---|
| **Acetic acid** | Chromic acid, nitric acid, hydroxyl containing compounds, ethylene, perchloric acid, peroxides, and glycol permanganates |
| **Acetone** | Concentrated nitric and sulfuric acid mixtures |
| **Acetylene** | Chlorine, bromine, copper, silver, fluorine, and mercury |
| **Alkaline and alkaline earth metals** | Carbon dioxide, and carbon tetrachloride. Prohibit water, foam, and dry chemicals on fires involving these metals. |
| **Ammonia (anhydrous)** | Mercury, chlorine, calcium hypochlorite, iodine, bromide, and hydrogen fluoride |
| **Ammonium nitrate** | Acids, metal powders, flammable liquids, chlorine, nitrites, sulfur, and finely divided organics or combustibles |
| **Analine** | Nitric acid and hydrogen peroxide |

1 Based on Dangerous Chemicals Code, 1951, Edition, pp. 19-20, Bureau of Fire Prevention, City of Los Angeles, Fire Department, published by Parked and Company, Los Angeles, CA.

| | |
|---|---|
| **Bromine** | Ammonium salts, acetylene, butadiene, butane and other petroleum gases, sodium carbide, turpentine, benzene, and finely divided metals |
| **Calcium carbide** | Water (see also acetylene) |
| **Calcium oxide** | Water |
| **Chlorates** | Ammonium salts, acids, metal powders, sulfur, and finely divided organics or combustibles |
| **Chlorine** | Ammonia, acetylene, butadiene, butane and other petroleum gases, hydrogen, sodium carbide, turpentine, benzene, and finely divided metals |
| **Chlorine dioxide** | Ammonia, methane, phosphine, and hydrogen sulfur |
| **Chromic acid** | Acetic acid, naphthalene, camphor, glycerine, turpentine, alcohol, and other flammable liquids |
| **Copper** | Acetylene and hydrogen peroxide |
| **Fluorine** | Isolate from everything |
| **Hydrocarbons (benzene, butane, propane, gasoline, turpentine, etc.)** | Fluorine, chlorine, bromine, chromic, acid, sodium peroxide |
| **Hydrocyanic acid** | Nitric acid and alkalis |
| **Hydrofluoric acid, anhydrous. (Hydrogen fluoride)** | Ammonia (aqueous or anhydrous) |

| | |
|---|---|
| **Hydrogen peroxide** | Copper, chromium, iron, most metals or their salts, any flammable liquid, combustible materials, aniline, nitromethane, caustic soda, and other strong alkalis |
| **Hydrogen sulfide** | Fuming nitric acid and oxidizing gases |
| **Iodine** | Acetylene, ammonia (anhydrous or aqueous) |
| **Nitric acid (concentrated)** | Acetic acid, aniline, chromic acid, hydrocyanic acid, hydrogen sulfides, flammable liquids, flammable gases, and nitritable substances |
| **Nitroparaffins** | Inorganic bases |
| **Oxalic acid** | Silver and mercury |
| **Oxygen** | Oils, grease, and hydrogen, flammable liquids, solids or gases |
| **Oxygen (compressed or liquid)** | Oils, grease, hydrogen, flammable liquids, solids, or gases |
| **Perchloric acid** | Acetic anhydride, bismuth and its alloys, alcohol, paper, wood, grease and oils, any hydrating agents |
| **Peroxides** | Combustibles, magnesium, zinc, or aluminum powders |
| **Peroxides, organic** | Acids (organic or mineral) and avoid friction |
| **Phosphorus (white)** | Air, oxygen, nitric acid, nitrates, nitrites, chlorates, perchlorates |

| | |
|---|---|
| **Phosphorus oxychloride** | Water, alcohol |
| **Phosphorus pentoxide** | Water |
| **Picric acid** | Metals |
| **Potassium** | Carbon tetrachloride, carbon dioxide, water, lower aliphatic alcohols |
| **Potassium chlorate (see also chlorates)** | Sulfuric acid, other acids, sulfur, sulfites, hypophosphites, finely divided organics, or combustibles |
| **Potassium ferricyanide or** | Halogen with ammonia mercuricyanide |
| **Potassium percihlorate** | Sulfuric acid, other acids, finely divided (see also chlorates) organics or combustibles |
| **Potassium permanganate** | Glycerine, ethylene glycol, benzaldehyde, sulfide acid, alcohols, ether, flammable gases, and combustible materials |
| **Prussic acid** | Acetylene, oxalic acid, tartaric acid, fulminic acid, ammonium compounds, picric acid |
| **Silver** | Acetylene, oxalic acid, tartaric acid, ammonium compounds |
| **Sodium** | Carbon tetrachloride, carbon dioxide, water |
| **Sodium chlorate** | Combustible materials, sulfur, acids |
| **Sodium chlorite** | Combustible materials, sulfur, acids |
| **Sodium hypochlorite** | Water |

| | |
|---|---|
| **Sodium nitrate** | Ammonium nitrate and other ammonium salts |
| **Sodium oxide** | Water |
| **Sodium peroxide** | Any oxidizable substance (such as ethanol, methanol, glacial acetic acid, acetic anhydride, benzaldehyde, carbon disulfide, glycerine, ethylene glycol, ethyl acetate, methyl acetate, and furfural) |
| **Sulfur** | Chlorates, nitrates, other oxidizing material |
| **Sulfuric acid** | Sulfides, nitrates, nitrites, fluorides, bromides, iodides, fulminates, saltpeter, metallic powders, carbides, picrates, chlorates, perchlorates, permanganates, and other combustible materials. Potassium chlorate, potassium perchlorate, potassium permanganate (or such compounds with similar light metals, as sodium, lithium, etc.) |
| **Titanium** | Do not use water, carbon tetrachloride foam, or dry chemical on titanium fires |
| **Water** | Alkali metals and oxides, alkali metal hydrides, sulfuric acid, oleum, sulfur trioxide, phosphorus pentachloride, acetyl chloride, phosphorus pentoxide |
| **Zinc powder or dust** | Acids, sodium hydroxide, potassium hydroxide, moisture |
| **Zirconium** | Prohibit water, carbon tetrachloride foam, and dry chemical on zirconium fires |

Notes:

Notes:

CPWR

# Chapter 3: Information Sources

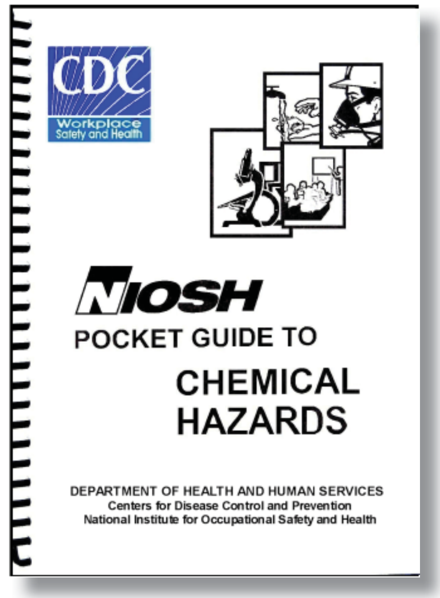
There are several different systems used to identify materials and their hazards. Identification information is included on labels fixed to small containers (drums, packages, boxes) and placards fixed to large containers (trailers, rail cars, tanks). Safety Data Sheets must be available for chemicals used on the job.

**Chapter Objectives:**

After completing this module, you will be able to:

1. Use the NIOSH Pocket Guide to find information on the properties, hazards, and controls for chemicals.
2. Use DOT symbols and NFPA labels to identify and rate the hazards of shipped and packaged materials.
3. Use a label and a Safety Data Sheet (SDS) to identify:
   - a product's manufacturer or importer;
   - what hazardous chemicals it contains;
   - the safety and health hazards of the product; and
   - what protective measures need to be taken when working with it

## Understanding the NIOSH Pocket Guide to Chemical Hazards




**The NIOSH Pocket Guide (NPG) is a quick source of information on properties, hazards, and controls for chemicals commonly found in the workplace.** NIOSH evaluates all known and available medical, biological, engineering, chemical, trade, and other information relevant to the hazard. The NIOSH Pocket Guide is 454 pages, including thirty pages of introduction and Appendices A-G, and contains information on 677 chemicals. **All substances in the NPG have a NIOSH REL or an OSHA PEL.**

Chemicals are listed alphabetically, two to a page, with seventeen categories of information for each chemical. Chemical names are cross-referenced to DOT ID numbers, CAS numbers, synonyms, and trade names in the indexes.

The NIOSH Pocket Guide is available on the NIOSH Web site (http://www.cdc.gov/niosh/npg/) in the following formats: website, PDF, CD, and print. While the website uses fewer abbreviations, the layout of the NPG is similar for all formats.

A reproduction of the format used in the NIOSH Pocket Guide with each titled, numbered cell is shown below and explained on the following pages.

<table>
<tr><td>Chemical Name<br>➡ #1</td><td>Formula<br>➡ #2</td><td>CAS#<br>➡ #3</td><td>RTECS#<br>➡ #4</td><td>IDLH<br>➡ #5</td></tr>
<tr><td>Conversion<br>➡ #6</td><td colspan="4">DOT<br>➡ #7</td></tr>
<tr><td colspan="5">Synonyms/Trade Names<br>➡ #8</td></tr>
<tr><td colspan="4">Exposure Limits<br>➡ #9</td><td rowspan="2">Measurement Methods<br>➡ #11</td></tr>
<tr><td colspan="4">Physical Description<br>➡ #10</td></tr>
<tr><td>Chemical and Physical Properties<br>➡ #12</td><td colspan="2">Personal Protection / Sanitation<br>➡ #13</td><td colspan="2">Respirator Recommendations<br>➡ #14</td></tr>
<tr><td colspan="5">Incompatibilities and Reactivities<br>➡ #15</td></tr>
<tr><td colspan="2">Exposure Routes, Symptoms, Target Organs<br>➡ #16</td><td colspan="3">First Aid<br>➡ #17</td></tr>
</table>

**Find the chemical toluene in the NIOSH Pocket Guide.** The chemical name can be found at the top of the page. **Toluene, will be used as an example in the explanations on the following pages.**

## *#1 Chemical Name*

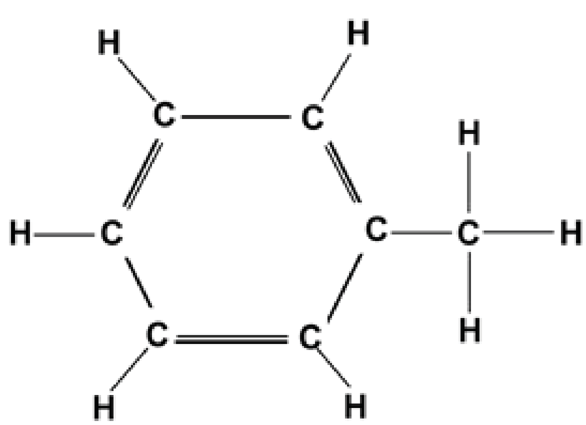
**Toluene**

**The NIOSH Pocket Guide contains 677 chemicals listed in alphabetical order. The chemical name used in the OSHA standards is listed in the blue shaded box in the upper left corner.** When researching chemicals, care must be taken to ensure that you're looking at the correct chemical. Several chemicals have names that sound similar or are spelled the same except for one or two letters or numbers and some are listed under alternative names (synonyms).

## *#2 Formula*

$C_6H_5CH_3$

**This section contains the chemical formula, which indicates the elements in a substance and their configuration.** A toluene molecule is made of 7 carbon atoms and 8 hydrogen atoms. The structural formula (below) is a better representation of how the atoms are arranged but is not included in the NPG.



## #3 CAS#

108-88-3

**Item #3 lists the Chemical Abstract Service (CAS) number, which is unique to the substance.** Sometimes SDSs or labels on containers will list the CAS number instead of the chemical name.

**A complete listing of the CAS numbers of substances in the NPG begins 374 after Appendix G.**

If you search the CAS number index for toluene, you will find 108-88-3 on page 375, third column, fourth from the bottom. You'll find page number 311 next to CAS number 108-88-3. If you to turn back to page 311, you'll find the entry for toluene with 108-88-3 in the CAS number section.

| CAS# | Page |
|---|---|
| 108-84-9 | 165 |
| 108-87-2 | 204 |
| 108-88-3 | 311 |
| 108-90-7 | 62 |
| 108-91-8 | 85 |
| 108-93-0 | 84 |

## #4 RTECS #

XS5250000

**The RTECS®, or NIOSH Registry of the Toxic Effects of Chemical Substances, is a collection of toxicity data from the scientific literature.** The print and PDF versions of the NPG do not have an index for RTECS# but **the web-based and CD-ROM versions have an index. The web-based and CD-ROM versions of the NPG allow you to view the RTECS data by clicking on the chemical's RTECS number.**

### *#5 IDLH*

**500 ppm**

This section lists the **immediately dangerous to life or health (IDLH)** concentration. This value **is the concentration above which exposure to a substance poses an immediate threat to life, causes irreversible adverse health effects, or impairs an individual's ability to escape.** Some of the factors taken into consideration when establishing IDLHs were severe eye or respiratory irritation, disorientation, and incoordination. IDLH values are based on effects that might occur following a 30-minute exposure but workers should make every effort to exit the area immediately. "**Ca**" appears in the IDLH field for substances that NIOSH classifies as carcinogens. "**10%LEL**" in the IDLH field indicates that the IDLH concentration was based on the potential for an explosion, not a toxicological hazard. "**N.D.**" indicates that an IDLH concentration has not been determine for the substance. A complete explanation of IDLH values and how they are set is found on page x in the front of the Guide.

### *#6 Conversion*

**1 ppm = 3.77 mg/m$^3$**

**The conversion field shows the relationship between concentration in units of parts per million (ppm) and milligrams per cubic meter(mg/m$^3$)** for chemicals with exposure limits given in ppm. If you know the concentration (or exposure limit) of a chemical in units of ppm then you can multiply it by the conversion factor to determine the concentration in mg/m$^3$. If you know the concentration of a chemical in units of mg/m$^3$ then you can divide it by the conversion factor to determine the concentration in ppm.

### *#7 DOT*

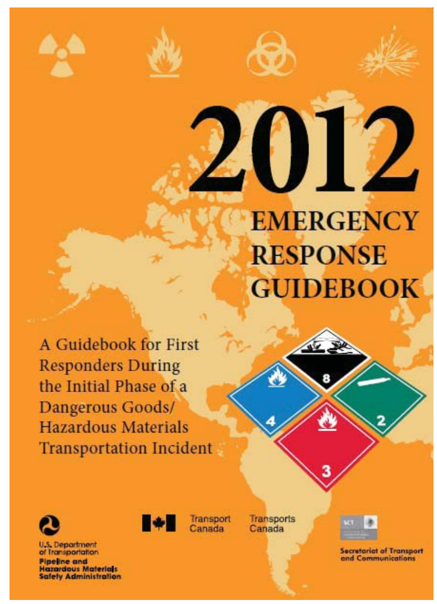
**1294 130**

**The DOT field contains the four digit DOT Identification (ID) number and the corresponding three digit Emergency Response Guide (ERG) number.**

The Department of Transportation (DOT) assigned an identifying number to each chemical, compound, or classification of materials transported on the nation's highways or rail-lines. Each ID number has a corresponding ERG number, which describes actions to stabilize an emergency situation. DOT labels and placards will be discussed in more detail later in this chapter.

| DOT ID # | Page |
|---|---|
| 1280 | 270 |
| 1282 | 272 |
| 1292 | 142 |
| 1294 | 311 |
| 1296 | 318 |
| 1297 | 319 |

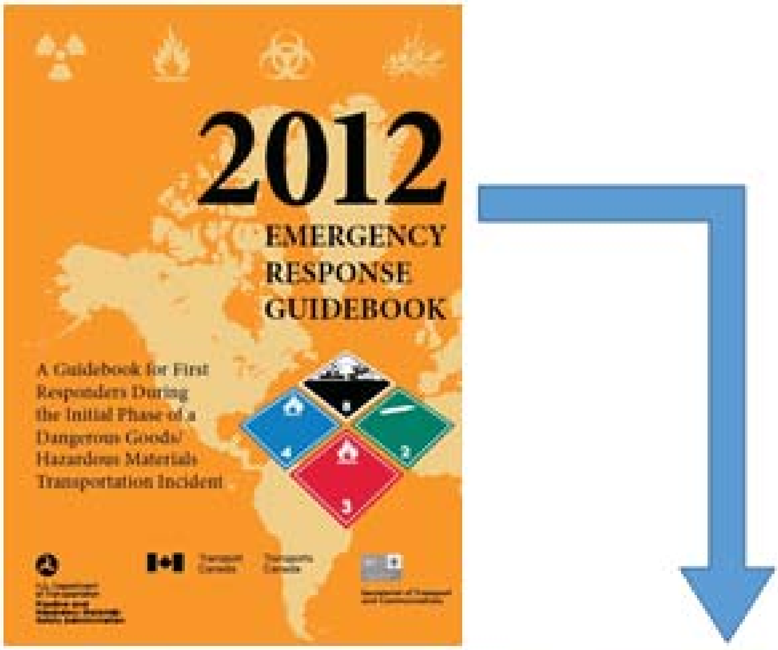
**The mustard-colored (DOT) Emergency Response Guide (ERG), pictured on this page, is used by emergency services responding to a spill or fire involving hazardous chemicals.** The NIOSH Pocket Guide contains a list of all DOT numbers used in this guide starting after Appendix G. Remember, these numbers and the information they refer to are not always specific to one chemical; the information may pertain to a group of similar chemicals.

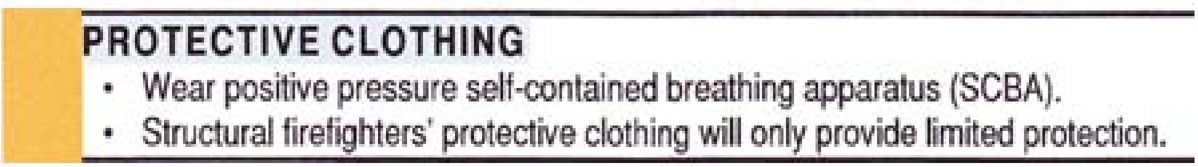



The National Library of Medicine worked with the DOT's Pipeline and Hazardous Materials Safety Administration (PHMSA) to develop free ERG applications for Apple and Android phones and tablets.

**Assume that a tanker began leaking on your job site.** Not having the shipping manifest close by, you could use the number on the diamond-shaped placard on the tanker to research the chemical in the NIOSH Pocket Guide and the DOT ERG. If you search the NPG DOT ID number index, you will see "311" next to 1294, on page 379, referring you to page 311 in the NIOSH Pocket Guide. **If you look in the yellow section of the DOT ERG, you'll find that 1294 is toluene.** Next to 1294, you will see the number "130". **If you knew that 1294 was toluene then you could also look it up in by the name in the blue section of the ERG. "130" refers you to Guide # 130 in the orange section of the DOT ERG.**

The Protective Clothing section of Guide 130 from the ERG has been reproduced below. The Protective Clothing section lists the precautions to be taken concerning the selection of protective clothing when responding to a spill.





**PROTECTIVE CLOTHING**

- Wear positive pressure self-contained breathing apparatus (SCBA).
- Structural firefighters' protective clothing will only provide limited protection.

As you can see, this section of **the 2012 ERG doesn't provide enough specific information for use during clean-up operations.** While it addresses the need for maximum respiratory protection during emergency operations, it gives no direction for selection of other protective clothing. Other sources of information, such as the NIOSH Pocket Guide and SDSs, should be used in selecting PPE and determining a proper course of action involving the clean-up of hazardous chemicals.

### *#8 Synonyms/Trade Names*

| |
|---|
| **methyl benzene, methyl benzol, phenyl methane, toluol** |

Often, products will arrive on the worksite with labels listing the ingredients using a synonym, rather than the proper names of the chemicals. The chemicals in the NIOSH Pocket Guide are organized by the names used in the OSHA standards but synonyms are provided. **There is an index of synonyms and trade names in the Name Index following Appendix G.**

If you receive a container listing the ingredient phenyl methane, you can research the chemical using the Pocket Guide. Phenyl methane is listed on page 414 in the NPG's synonyms index (right column, 10th from the bottom). Next to phenyl methane is page number 311. If you turn to page 311 and search through the synonyms, you will find phenyl methane listed under toluene.

### *#9 Exposure Limits*

**When available, exposure limits from NIOSH and OSHA are given for each chemical.** These limits are given in ppm, mg/m$^3$ or µg/m$^3$, or both, depending on their composition. Generally, gases and vapors are measured in ppm and particulates are measured by mass (weight), in milligrams or micrograms, per cubic meter of air.

**Toluene**
**NIOSH REL:**
TWA 100 ppm (375 mg/m$^3$)
ST 150 ppm (560 mg/m$^3$)
**OSHA PEL:**
TWA 200 ppm
C 300 ppm
500 ppm (10-minute maximum peak)

The notation "Ca" is given for substances that NIOSH considers potential occupational carcinogens.

**The OSHA Permissible Exposure Limits (PELs) are legally enforceable while the NIOSH Recommended Exposure Limits (RELs) are not legally enforceable .** When these exposure limits are preceded by "TWA" it means they are time-weighted average exposures over the course of a workday (OSHA uses an 8-hour workday and NIOSH uses a 10-hour workday ). The ACGIH Threshold Limit Values (TLVs) are not listed in the NPG but are another set of exposure limits that are not generally enforceable. Contractors on DOE sites are required to meet TLVs when they are more protective (lower) than the OSHA PELs.

**The section may also include exposure limits that are not full-shift time-weighted averages.** ST indicates a short-term exposure limit (STEL), which is a 15-minute time-weighted average (TWA), unless otherwise stated. The "C" designation refers to ceiling value, which is a concentration that workers should never be exposed to. OSHA's ceiling value (C) for toluene is 300 ppm. This means that workers should not be exposed to 300 ppm or higher concentrations of toluene.

These and other terms are explained beginning on page xi in the front of the NIOSH Pocket Guide.

**Example:**

> The OSHA Permissible Exposure Limit (PEL) is 200 ppm as an 8-hour TWA. This means that without some form of protection, workers may not be exposed to more than 200 ppm averaged over an 8-hour workday. PELs are legally enforceable.
>
> The NIOSH Recommended Exposure Limit (REL) for toluene is 100 ppm as a 10-hour time-weighted average (TWA). This means that NIOSH recommends that workers not be exposed to more than 100 ppm averaged over a 10-hour workday.

## Time-Weighted Average Activity

You are working 8-hour shifts using a product containing toluene and want to determine if your exposure exceeds the OSHA PEL for toluene. You know that the OSHA Permissible Exposure Limit (PEL) for toluene is 200 ppm averaged over an 8-hour day. Air monitoring results show that you were exposed to 10 ppm for the 4 hours before lunch and 100 ppm for 4 hours after lunch. What is your time-weighted average exposure to toluene for the 8-hour shift?

TWA = (concentration #1 x time #1) + (concentration #2 x time #2)
(time #1 + time #2)

TWA = (______ ppm x ______ hours) + (______ ppm x ______ hours)
( ______ hours + ______ hours)

TWA = (______ + ______) ppm

TWA = ______ ppm

Does your exposure exceed the OSHA PEL?

### *#10 Measurement Method*

**NIOSH** 1500, 1501, 3800, 4000
**OSHA** 111

This section indicates the NIOSH and/or OSHA methods used to measure exposure to the chemical. No explanation of these methods is given in the NIOSH Pocket Guide. For more information on these methods, visit https://www.osha.gov/dts/sltc/methods/ or http://www.cdc.gov/niosh/nmam

## #11 Physical Description

| |
|---|
| **Colorless liquid with a sweet, pungent, benzene-like odor** |

**The Physical Description gives a brief explanation of what the chemical looks and smells like.** While you should never use your nose to determine the presence of a chemical, this information is important if you smell something unexpected on your work site. It may also list the state (solid, liquid, or gas) in which the chemical is commonly shipped or found, such as a liquefied, compressed gas.

## # 12 Chemical and Physical Properties

The Chemical and Physical Properties section provides information on the specific properties of the chemical. Some items listed are: the molecular weight of the chemical (MW); the flash point (Fl.P); upper and lower explosive limits (UEL and LEL); the boiling point (BP) which is the temperature where a liquid turns to a vapor or gas; and the freezing point (FRZ) which is the temperature where a liquid chemical turns to a solid.

How chemicals act depends upon their physical and chemical properties. Understanding how chemicals behave can help you anticipate the hazards.

**MW:** 92.1
**BP:** 232°F
**Sol (74°F):** 0.07%
**Fl.P:** 40°F
**IP:** 8.82 eV
**Sp. Gr**: 0.87
**VP:** 21 mmHg
**FRZ:** -139°
**UEL:** 7.1%
**LEL:** 1.1%
Class 1B Flammable Liquid

**Example:**

> The Fl.P. of toluene is 40°F. At 40°F, toluene gives off enough vapors to burn if there is a source of ignition.

Chemical and physical properties are discussed in detail beginning on page 24 in chapter 2 of this manual.

The following abbreviations are used for the chemical and physical properties given for each substance. "NA" indicates that a property is not applicable, and a "?" indicates that it is unknown.

**MW** Molecular weight

**BP** Boiling point at 1 atmosphere, °F

**Sol** Solubility in water at 68 °F (unless a different temperature is noted), % by weight (i.e., g/100 ml)

**Fl.P** Flash point (i.e., the temperature at which the liquid phase gives off enough vapor to flash when exposed to an external ignition source), closed cup (unless annotated "(oc)" for open cup), °F

**IP** Ionization potential, eV (electron volts) [Ionization potentials are given as a guideline for the selection of photoionization detector lamps used in some direct-reading instruments.]

**VP** Vapor pressure at 68 °F (unless a different temperature is noted), mm Hg; "approx" indicates approximately

**MLT** Melting point for solids, °F

**FRZ** Freezing point for liquids and gases, °F

**UEL** Upper explosive (flammable) limit in air, % by volume (at room temperature unless otherwise noted)

**LEL** Lower explosive (flammable) limit in air, % by volume (at room temperature unless otherwise noted)

**MEC** Minimum explosive concentration, g/m$^3$ (when available)

**Sp.Gr** Specific gravity at 68 °F (unless a different temperature is noted) referenced to water at 39.2 °F (4 °C)

**RGasD** Relative density of gases referenced to air = 1 (indicates how many times a gas is heavier than air at the same temperature)

The flammability classification based on the OSHA criteria (29 CFR 1910.106) is provided for each chemical. A description of the classes can be found on page xiv of the NPG.

# *# 13 Personal Protection and Sanitation*

*The Personal Protection and Sanitation section gives guidelines to follow when working with the chemical. These recommendations should be followed if additional controls are needed after all feasible process, equipment, and task controls have been implemented.*

An explanation of the categories is provided on page xiv and the codes and their definitions are given in Table 2 on pages xviii and xix in the NPG.

For example, the recommendations when working with toluene are: Prevent skin contact; Prevent eye contact; Wash skin when contaminated; Remove wet clothing immediately due to flammability; No recommendation to change clothing after the work shift. The complete definitions for the recommendation codes for toluene are shown below.

| Category | Code | Definition |
|---|---|---|
| **Skin** | Prevent skin contact | Wear appropriate personal protective clothing to prevent skin contact. |
| **Eyes** | Prevent eye contact | Wear appropriate eye protection to prevent eye contact |
| **Wash skin** | When contam | The worker should immediately wash the skin when it becomes contaminated. |
| **Remove** | When wet (flamm) | Work clothing that becomes wet should be immediately removed due to its flammability hazard (i.e., for liquids with a flash point <100°F). |
| **Change** | N.R. | No recommendation is made specifying the need for the worker to change clothing after the workshift. |

## #14 Recommendations for Respiratory Protection

**NIOSH**
**500 ppm:** CcrOv*/PaprOv*/GmFOv/Sa*/ScbaF
**§:** ScbaF:Pd,Pp/SaF:Pd,Pp:AScba
**Escape:** GmFOv/ScbaE

**This section provides a condensed table of recommendations for selecting respirators for the conditions** (entry into unknown concentrations or IDLH conditions or escape) **and maximum use concentration** (500 ppm) **listed.** The first line indicates whether the respirator recommendations are based on the NIOSH or the OSHA exposure limit. The more protective exposure limit is used and “NIOSH/OSHA” is indicated if they are the same. An explanation of the Recommendations for Respirator Selection is found beginning on page xiv of the NIOSH Pocket Guide.

When using this section to choose a respirator, **care must be taken to understand the abbreviations and consider the IDLH values.**

Descriptions of the abbreviations and symbols used in the respiratory protection section are given to the right and a partial list of the codes and their description are given below. A complete listing of the codes for the categories of respirators, their Assigned Protection Factors (APFs), and their descriptions begins on page xx of the NIOSH Pocket Guide.

| Symbol | Definition |
|---|---|
| ¥ | At concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration |
| § | Emergency or planned entry into unknown concentrations or IDLH conditions |
| * | Substance reported to cause eye irritation or damage; may require eye protection |
| £ | Substance causes eye irritation or damage; eye protection needed |
| ¿ | Only nonoxidizable sorbents allowed (not charcoal) |
| † | End of service indicator (ESLI) required |
| APF | Assigned protection factor |

| Code | Description |
|---|---|
| CcrOv | Chemical cartridge respirator with organic vapor cartridge or canister |
| PaprOv | Powered, air-purifying respirator with organic vapor cartridge or canister |
| GmFOv | Air-purifying, full-facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor cartridge or canister |
| Sa | Supplied-air respirator |
| ScbaF | Any self-contained breathing apparatus with a full facepiece. |
| ScbaF:Pd,Pp | Any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode. |
| SaF:Pd,Pp:AScba | Any supplied-air respirator that has a full-facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in pressure-demand or other positive-pressure mode. |
| GmFOv | Any air-purifying, full-facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister. |
| ScbaE | Any appropriate escape-type, self-contained breathing apparatus. |

### *#15 Incompatibilities and Reactivities*

**Strong oxidizers**

Incompatibilities and Reactivities refer to specific conditions and types of chemicals to avoid when working with this substance. Toluene lists “Strong oxidizers” as an incompatible group of chemicals. Oxidizers provide a source of oxygen and with toluene, being a flammable chemical, additional oxygen in the atmosphere would create an extremely hazardous atmosphere due to the increased danger of fire or explosion.

### *#16 Exposure Routes, Symptoms, Target Organs*

**ER:** Inh, Abs, Ing, Con
**SY:** Irrit eyes, nose; lass, conf, euph, dizz, head; dilated pupils; lac; anxi, musc ftg, insom; pares; derm; liver, kidney damage
**TO:** Eyes, skin, resp sys, CNS, liver, kidneys

**Exposure Routes (ER) refers to how the chemical enters the body.** Toluene can enter the body through Inh (inhalation), Abs (absorbed through the skin), and Ing (ingestion or swallowing). Con indicates that contact with the skin or eyes may be hazardous (cause burns, irritation, etc.).

**Symptoms (SY) lists the possible effects of exposure to the chemical and whether NIOSH classifies it as a potential carcinogen.** A complete list of the abbreviations used in this section is found beginning on page xxvi but the terms are not explained. Many of the terms can be found in the U.S. National Library of Medicine's dictionary; http://www.nlm.nih.gov/medlineplus/mplusdictionary.html.

**Target Organs (TO) refers to the parts of the body affected by the chemical.** Toluene affects the eyes, skin, respiratory system, central nervous system, liver, and kidneys.

### *#17 First Aid*

**Eye:** Irr immed
**Skin:** Soap wash prompt
**Breath:** Resp support
**Swallow:** Medical attention immed

**The last section provides recommendations for first aid for workers who have been exposed to this chemical.**

Explanations for these and other terms used in the First Aid section begin on page xxviii of the NIOSH Pocket Guide.

If a person breathes large amounts of this toluene, move the exposed person to fresh air at once. If breathing has stopped, perform artificial respiration. Keep the affected person warm and at rest. Get medical attention immediately.

NIOSH

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To receive NIOSH documents or more information aboutoccupational safety and health topics, contact NIOSH at:

1-800-35-NIOSH (1-800-356-4674)
Fax: (513)533-8573
E-mail: pubstaff@cdc.gov

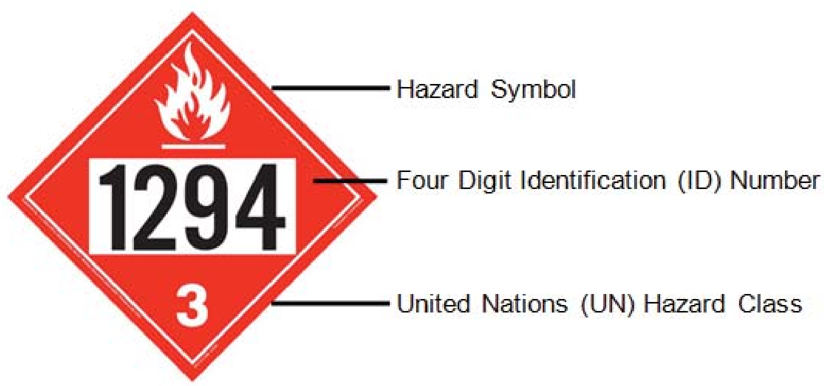
Or visit the NIOSH Web site at www.cdc.gov

**SAFER ▪ HEALTHIER ▪ PEOPLE**

## Department of Transportation (DOT) System Placards and Labels

**DOT labels and placards are diamond-shaped and use numbers, symbols and colors to warn about hazards.** These labels and placards must be posted on large portable tanks, tank trucks, and rail cars. The four-digit ID number that identifies the chemical is listed in the DOT *Emergency Response Guidebook*, the *NIOSH Pocket Guide*, and the *National Library's Wireless Information System for Emergency Responders (WISER)*.

**Some labels and placards identify specific chemicals, like this one for toluene (1294).**




**Others labels give the hazard symbol and UN hazard class number but name the hazard instead of the specific chemical.** The four digit ID number may be found on a nearby panel.

The one- or two-digit number at the bottom is the UN (United Nations) Hazard Class or Division. Substances (including mixtures and solutions) and articles subject to the UN numbers are assigned to one of nine classes according to the hazard or the most predominant of the hazards they present.

| # | **UN Hazard Class** |
|---|---|
| 1 | Explosives |
| 2 | Gases (compressed, liquefied, or dissolved under pressure) |
| 3 | Flammable liquids |
| 4 | Flammable solids or water reactive substances |
| 5 | Oxidizing substances and organic peroxides |
| 6 | Toxic/poisonous substances and infectious substances |
| 7 | Radioactive substances |
| 8 | Corrosive substances |
| 9 | Miscellaneous hazardous materials |

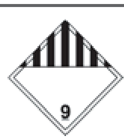
Some Hazard Classes are further divided into Divisions to provide more information about the hazard. For example, gases are divided into three Divisions: flammable (2.1), non-flammable, non-toxic (2.2), and toxic (2.3). The additional information may be conveyed with the name, the Division Number, or both.

| # | **UN Hazard Class and Division** |
|---|---|
| **2** | Gases |
| **2.1** | Flammable gases |
| **2.2** | Non-flammable, non-toxic gases |
| **2.3** | Toxic gases |

**The DOT specifies both colors and symbols to represent classes of hazards.**

| **Color** | **Hazard** |
|---|---|
| Orange | Explosive |
| Red | Flammable |
| Green | Non-flammable |
| Yellow | Oxidizer/organic peroxides |
| White | Poisonous |
| White/red vertical stripes | Flammable solid |
| White top with black bottom | Corrosive |
| Yellow top with white bottom | Radioactive |
| Blue | Dangerous when wet |
| White top with red bottom | Spontaneously combustible |

**The following are examples of symbols used to represent UN Hazard Classes and Divisions.** Note that some substances may fall into more than one Hazard Class or Division and some placards only indicate Class while others are more specific and indicate the Division Number.

| Hazard Class Number and Name | |
|---|---|
|  | 1 – Explosives |
|   | 2 – Gases |
|   | 3 – Flammable and combustible liquids |
|   | 4 - Flammable solids; Spontaneously combustible materials; and Dangerous when wet materials/Water-reactive substances |
|   | 5 – Oxidizers and organic peroxides<br>5.1 – Oxidizing substances |
|   | 6 – Toxic/poisonous substances and infectious substances |
|   | 7 – Radioactive materials |
|   | 8 – Corrosive |
|   | 9 – Miscellaneous hazardous materials |

**OSHA maintains a database of chemical information from several government agencies and organizations.** You can search for chemicals by name or CAS number or viewing an alphabetical list. The report for each chemical includes exposure limits, carcinogen classifications, and chemical and physical properties, and other information, from the NIOSH Pocket Guide. The reports also include emergency response information from the DOT Emergency Response Guidebook and from the EPA's Computer-Aided Management of Emergency Operations (CAMEO) software. https://www.osha.gov/chemicaldata/index.html

**Type "OSHA.gov" into your computer's web browser and hit "Enter"**

**Click on "A to Z Index" in the upper right corner**

**Click on "Chemical Database" under the letter "C"**

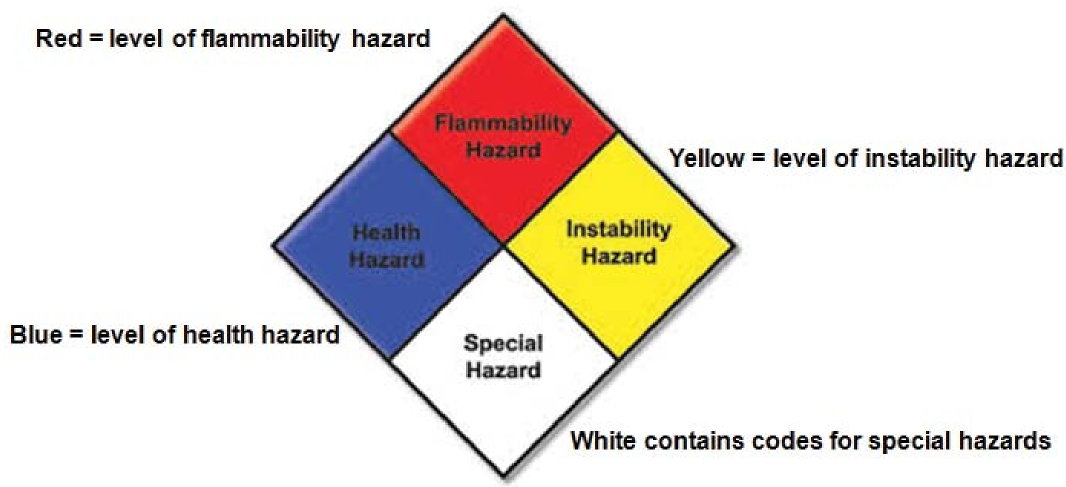
**Type a chemical name or CAS number in the "Search by" field on the left and click on the magnifying glass**

**Click on "Get Report" to the right of the chemical you are interested in**

The **NFPA (National Fire Protection Association) 704** (Standard System for the Identification of the Hazards of Materials for Emergency Response) is a standard maintained by the National Fire Protection Association. **The standard describes a system to help emergency personnel quickly and easily identify the short-term hazards posed by nearby hazardous materials during a fire, spill, or similar emergency.**

The 704M system may be used to label storage vessels, containers, buildings, and rooms at stationary facilities. Some facilities use this system throughout their departments and put the NFPA label on all hazardous materials. The facility's hazard communication training should inform the worker if this warning system is being used at the work site.

**The system uses numbers and symbols in four divisions of a color-coded diamond to convey the hazard information.** The number in the blue section indicates the level (severity) of health hazard, red indicates flammability, yellow instability (chemical reactivity), and white contains codes for special hazards.




**Health, flammability, and instability hazards are rated on a scale from 0 (minimal hazard) to 4 (severe hazard).** The NFPA diamond does not name individual chemicals and usually represents the maximum rating in each category for chemicals in the area. In areas with few chemicals, there may be a labeled NFPA diamond for each chemical.

| Color | Hazard | Risk (for all hazards) | | |
|---|---|---|---|---|
| red | flammability | 4 | _______ | Severe |
| blue | health risk | 3 | _______ | |
| yellow | instability (chemical reactivity) | 2 | _______ | |
| | | 1 | _______ | |
| | | 0 | _______ | Minimal |

The special hazard (white) section of the NFPA diamond may contain symbols that give more information about the chemical. **There are three special hazard symbols defined in the NFPA 704 standard.** Local fire jurisdictions may choose in include other symbols not defined by NFPA based on hazards in their area.

**OX**
- **Oxidizer.** May make combustion without an air supply possible and greatly increase the rate of combustion/fire.

**SA**
- **Simple asphyxiant.** Use is limited to nitrogen, helium, neon, argon, krypton, and xenon.

**~~W~~**
- **Reacts violently or explosively with water.**

**At a minimum, NFPA hazard diamonds should be posted at the following locations: 1) the two exterior walls of a facility, 2) access to a room or area, and 3) each principal means of access to an exterior storage area.** Since the NFPA hazard diamonds are intended to quickly provide hazard information to emergency responders, the placards should be visible where the responders are likely to enter. If there are numerous areas where the responders could enter, then there should be numerous placards.

**NFPA placards allow emergency responders to determine if they should enter and what, if any, specialty equipment should be used, procedures followed, or precautions taken during the first moments of an emergency response.**

**While not defined in the NFPA standard, infectious and radioactive materials may be indicated in the special hazard section of NFPA diamonds.**

One of the most common types of packaged biological waste is infectious waste from hospitals and other health care facilities. This type of waste should be in boxes, plastic containers, or red plastic bags marked on all sides with the infectious materials symbol shown below.

**Infectious Materials Symbol**

Examples of infectious materials include used needles and syringes, soiled bandages, test tubes, and disposable vials. Less frequently encountered biological hazards include biological research materials.

**Radiation Symbol**

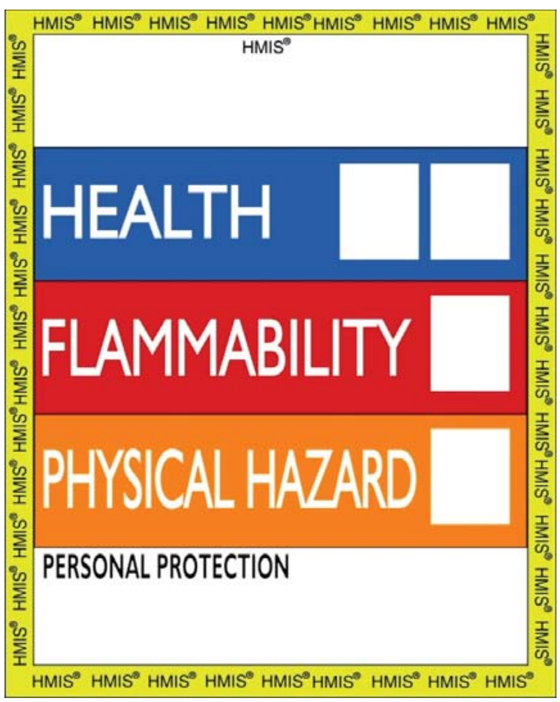
Radioactive sources are used in industry and medicine, and radioactive wastes result from energy and weapons production. Do not work with or around radiation hazards unless you have had the training to do so and have the proper PPE and equipment. Radiation hazards should be covered in the Standard Operating Procedures (SOPs) for your work site. **All forms of radiation should be considered very hazardous. Treat Them With Respect!**

**Hazard Materials Identification System (HMIS) is a proprietary labeling system for individual chemical containers.**

**HMIS uses colors, numbers, letters of the alphabet, and symbols of types to convey information to chemical users**

**Blue** = level of health hazard
**Red** = level of flammability hazard
**Orange** = level of physical hazard (similar to instability or reactivity)
**White** contains codes for PPE recommendations for normal use, not emergencies

**Health, flammability, and physical hazard are rated on a scale from 0 (minimal hazard) to 4 (severe hazard)**, just like the NFPA diamonds. The health section (blue) will include an * (asterisk) when a substance has chronic effects or may cause cancer.



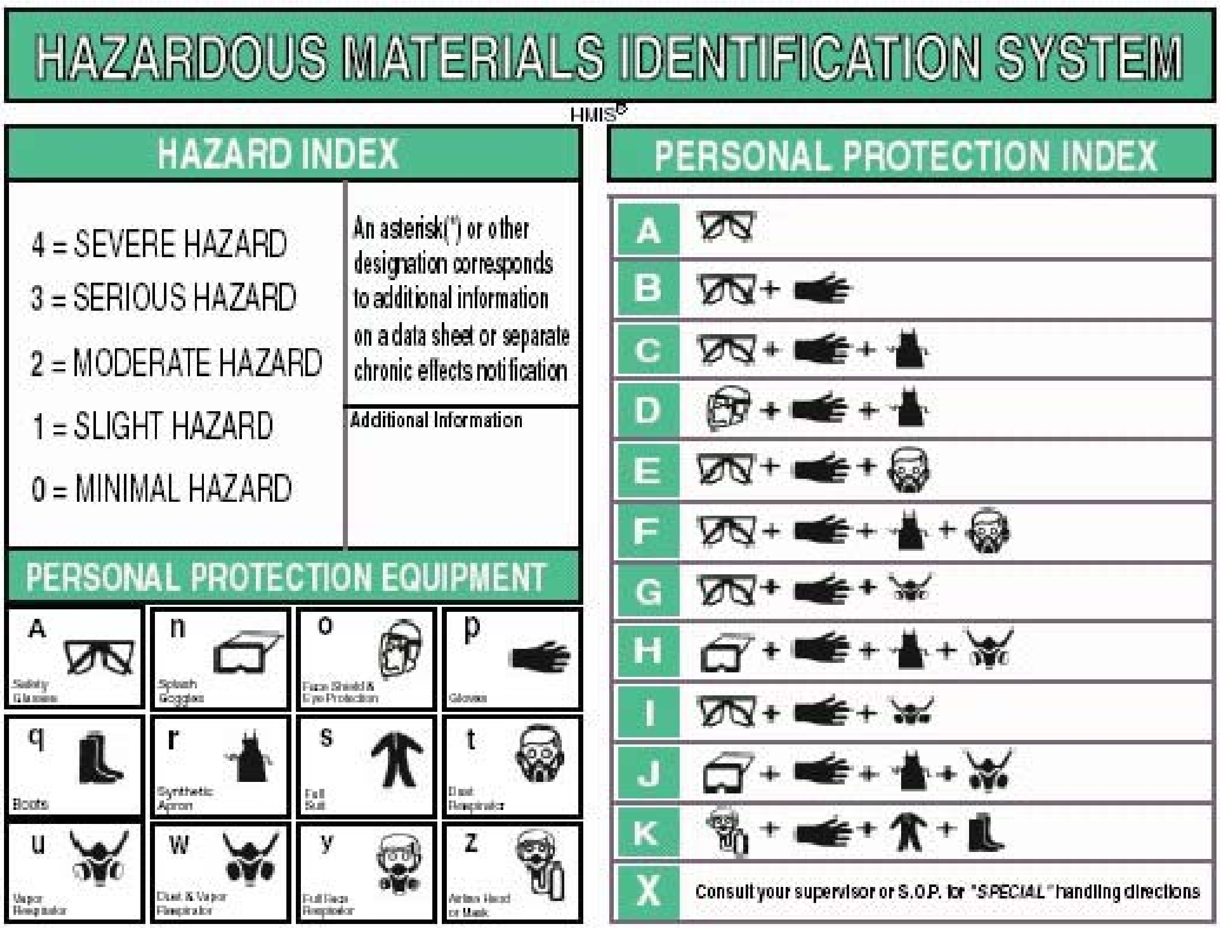

**Blue**

**Red**

**Orange**

**White**

**HMIS assigns a letter of the alphabet as a code for PPE combinations.** This chart shows combinations of PPE and HMIS's corresponding codes and symbols.




**HMIS labels are different from NFPA 704 diamonds in that they:**

1. Provide information on PPE
2. Indicate with an * when a substance has chronic effects or may cause cancer
3. Are typically on containers to communicate hazards to employees who work with the chemical

**WISER (Wireless Information System for Emergency Responders) is a system designed by the U.S. National Library of Medicine (NLM) to assist emergency responders in hazardous material incidents.** While it was intended for Hazmat First Responders, WISER is a considerable resource for construction workers and those making safety and health decisions.

**WISER provides a wide range of information on hazardous substances, including substance identification support, physical characteristics, human health information, and containment and suppression advice.**

**Hazardous substances include:**

- 400+ chemicals (5000+ aliases/synonyms)
- Radioisotopes
- Biologicals

**WISER is available online and as a stand-alone application for PCs and various mobile devices.** Visit http://wiser.nlm.nih.gov to use WISER when you have access to the internet or for information on downloading WISER for iOS (Apple), Android, and Windows devices for when you don't have access to the internet.

**WISER allows you to find information on a known substance by searching for:**

- Name
- UN/NA number
- CAS registry number
- STCC (standard transportation commodity codes)

**Results can be filtered by substance types or categories or a combination.**

1. Types of substances
   - Chemicals
   - Biologicals
   - Radiologicals
2. DOT Hazard Classifications
3. Weapons of mass destruction
4. Miscellaneous categories
5. Chemicals associated with meth labs
6. Chemical weapons precursors

**WISER is available online wiser.nlm.nih.gov**

Type wiser.nlm.nih.gov into your computer's web browser and hit "Enter"

Click on "WebWISER" near the top of the page

Select "Known Substances"

Select search by "Chemicals" and "Name" from the dropdown lists

Type "Sulfuric Acid" into the "Search Text" field and hit "Enter"

**WISER can help you to identify an unknown chemical.**

Using the options on the left side of the page, identify an unknown chemical by selecting criteria for any combination of the following:

- Select the chemical's physical properties
- Select symptoms of exposed victims
- Also narrow results using:
    - NFPA 704 placard
    - Substance categories
        - DOT classification
        - Meth Lab
        - Chemical weapons precursors
        - Weapons of mass destruction (blood, blister, choking, and nerve agents)

## Labels and Safety Data Sheets (SDS)

**The OSHA Hazard Communication Standard (29CFR1926.59 or 29CFR1910.1200) requires employers to have a hazard communication (HazCom) program, label chemical containers, and keep Safety Data Sheets (SDS) for each hazardous chemical used in their workplace.**

**Employees must be told the location of the employer's written hazard communication program, SDSs, and hazardous chemical lists.** If you don't know where SDSs are kept on your job, you should ask your supervisor first, your employer next and then the general contractor or the subcontractors.

In 2012, **OSHA revised its HazCom Standard to be consistent with the Globally Harmonized System of Classification and Labeling of Chemicals (GHS).** OSHA's use of the GHS helps to ensure a consistent way of classifying hazards and communicating the information to workers. **The new Hazard Communication standard gives workers the right to understand the chemical hazards associated with their jobs.**

**OSHA requires that labels contain these elements:**

1. **Product identifier** is the name, code, or batch number used to identify the hazardous chemical.
2. **Supplier identification** includes the name, address and telephone number of the chemical manufacturer, importer or other responsible party.
3. **Signal words** is used to indicate the relative level of severity of the hazard and alert the reader to a potential hazard on the label. "Danger" is used for the more severe hazards, while "warning" is used for the less severe.
4. **Hazard statement** describes the nature of the hazard(s) of a chemical, including, where appropriate, the degree of hazard and is based on the chemical's class and category.
5. **Precautionary statement** describes recommended measures that should be taken to minimize or prevent adverse effects resulting from exposure to the hazardous chemical or improper storage or handling.
6. **Hazard pictograms** - means a composition that may include a symbol plus other graphic elements, such as a border, background pattern, or color, that is intended to convey specific information about the hazards of a chemical.

**The label producer may provide any supplementary information that it determines helpful.** Such information may include hazards not otherwise classified, directions for use, PPE pictograms (as found on HMIS labels), expirations dates, and fill dates. This section must also identify the percentage of ingredient(s) of unknown acute toxicity when it is present in a concentration of ≥1% and the classification is not based on testing the mixture (product) as a whole.

**There are 9 pictograms that may be found on labels and SDS.**


**On the following page, the top row are physical hazards and the bottom row are health hazards, except for the final environmental pictogram.**

| Pictogram Name | Pictogram | Hazards/Types of Chemicals |
|---|---|---|
| Flame |  | Flammables<br>Self-Reactives<br>Pyrophorics<br>Self-Heating<br>Emits Flammable Gas<br>Organic Peroxides |
| Flame Over Circle |  | Oxidizers |
| Exploding Bomb |  | Explosives<br>Self-Reactives<br>Organic Peroxides |
| Corrosion |  | Skin Corrosion/Burns<br>Eye Damage<br>Corrosive to Metals |
| Gas Cylinder |  | Gases under pressure |
| Health Hazard |  | Carcinogen<br>Respiratory Sensitizer<br>Reproductive Toxicity<br>Target Organ Toxicity<br>Mutagenicity<br>Aspiration Toxicity |
| Exclamation |  | Irritant (skin and eye)<br>Skin (dermal) Sensitizer<br>Acute Toxicity (harmful)<br>Narcotic Effects<br>Respiratory Tract Irritation |
| Skull and Crossbones |  | Acute Toxicity (severe) |
| Environmental Pollutant |  | Aquatic Toxicity<br><br>Part of GHS, but not 1910.1200.<br>OSHA does not have jurisdiction over environmental matters |

**If you pour anything into a container it must be labeled unless you are going to use it within the work shift and control it.** Employers can go beyond the minimum standard and require labeling for all containers.

**Safety Data Sheets are an important information source on hazardous chemicals.** Manufacturers and distributors must forward SDSs to the purchaser with the first shipment, and with the first shipment after an SDS is updated. Whenever the employer receives a new or revised SDS that could impact your health, you must be informed within 30 days after receipt. Your employer must maintain SDSs for all hazardous chemicals used on the job. SDSs do not cover hazardous wastes. You can, however, find information on hazardous wastes in shipping papers, manifest forms, and waste profile sheets.

**Instead of Material Safety Data Sheets (MSDS), the 2012 OSHA HazCom standard requires Safety Data Sheets (SDS).** The major improvements with SDS are that the format and information found in them will be more complete and consistent. **Safety Data Sheets must contain the following 16 sections in the specified order.** Sections 1 through 8 contain general information about the chemical, identification, hazards, composition, safe handling practices, and emergency control measures (e.g., fire fighting). Sections 9 through 11 and 16 contain other technical and scientific information, such as physical and chemical properties, stability and reactivity information, toxicological information, exposure control information, and other information including the date of preparation or last revision. The SDS must also state that no applicable information was found when the preparer does not find relevant information for any required element. Sections 12 -15 are not mandatory. The SDS must contain headings for sections 12-15, to be consistent with the GHS, but OSHA will not enforce the content of these sections because they are within other agencies' jurisdictions.

1. Identification
2. Hazard(s) Identification
3. Composition, information on ingredients
4. First-aid measures
5. Fire-fighting measures
6. Accidental release measures
7. Handling and storage
8. Exposure controls, personal protection
9. Physical and chemical properties
10. Stability and Reactivity
11. Toxicological information
12. Ecological information
13. Disposal considerations
14. Transport information
15. Regulatory information
16. Other information

**Section 1: Identification** includes the product identifier, the name of the manufacturer or distributor along with the phone number and address and an emergency number. The name of the product in this section must be the same as the name on the label of the container. If other names, product numbers, or means of identification are used they should be listed. The section also lists the recommended use of the product as well as restrictions.

**1. Identification**

**Product identifier:** Sulfuric Acid

**Other means of identification**
**Product No.:** 9661, 3780, 9704, 9682, V648, V225, V186, V008, 6902, 2900, 2879, 2878, 2877, 2874, 6163, H996, H976, 5859, 2876, 5815, 5802, 9691, 9690, 9684, 9681, 9675, 9674, 9673, 9671, 5557, 5374, 21208, 21201

**Recommended use and restriction on use**
**Recommended use:** Not available.
**Restrictions on use:** Not known.

**Manufacturer/Importer/Supplier/Distributor information**

**Manufacturer**

| | |
|---|---|
| Company Name: | Avantor Performance Materials, Inc. |
| Address: | 3477 Corporate Parkway, Suite 200<br>Center Valley, PA 18034 |
| Telephone: | |
| | Customer Service: 855-282-6867 |
| Fax: | |
| Contact Person: | Environmental Health & Safety |
| e-mail: | info@avantormaterials.com |

**Emergency telephone number:**
24 Hour Emergency: 908-859-2151

Chemtrec: 800-424-9300

**Section 2: Hazard(s) identification** includes all the dangers about the chemical. The section must include the GHS label elements, hazard classifications, signal word, hazard statement, and precautionary statements. Hazard symbols may be provided as a graphical reproduction (pictograms) or the name of the symbol. Other hazards which do not result in classification (e.g., dust explosion hazard) or are not covered by the GHS would be listed in this section.

## 2. Hazard(s) identification

**Hazard classification**

**Physical hazards**

| | |
|---|---|
| Corrosive to metals | Category 1 |

**Health hazards**

| | |
|---|---|
| Skin corrosion/irritation | Category 1 |
| Serious eye damage/eye irritation | Category 1 |
| Carcinogenicity | Category 1A |
| Specific target organ toxicity - single exposure | Category 3 |

**Environmental hazards**

| | |
|---|---|
| Acute hazards to the aquatic environment | Category 3 |

_**Label elements**

**Hazard symbol:**

**Signal word:** Danger

**Hazard statement:**
May be corrosive to metals.
Causes severe skin burns and eye damage.
May cause respiratory irritation.
May cause cancer if inhaled.
Harmful to aquatic life.

**Precautionary statement**

**Prevention:** Obtain special instructions before use. Do not handle until all safety precautions have been read and understood. Keep only in original container. Wash thoroughly after handling. Do not breathe dust/fume/gas/mist/vapors/spray. Use only outdoors or in a well-ventilated area. Wear protective gloves/protective clothing/eye protection/face protection.

**Response:** IF exposed or concerned: Get medical advice/attention. Absorb spillage to prevent material damage. Immediately call a POISON CENTER or doctor/physician. IF SWALLOWED: Rinse mouth. Do NOT induce vomiting. IF ON SKIN (or hair): Remove/take off immediately all contaminated clothing. Rinse skin with water/shower. Wash contaminated clothing before reuse. IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing. IF INHALED: Remove victim to fresh air and keep at rest in a position comfortable for breathing.

**Storage:** Store locked up. Store in corrosive resistant container with a resistant inner liner. Store in a well-ventilated place. Keep container tightly closed.

**Disposal:** Dispose of contents/container to an appropriate treatment and disposal facility in accordance with applicable laws and regulations, and product characteristics at time of disposal.

**Other hazards which do not result in GHS classification:** None.

**Section 3: Composition/information on ingredients** lists the different chemicals in the product and any trade secret claims. Any hazardous chemical comprising 1% or more of the product (or 0.1% if the chemical is a carcinogen, reproductive toxin, or category 1 mutagen) must be listed in this section. Next to each hazardous ingredient, the SDS must list the Chemical Abstracts Service (CAS) number, synonyms, and content in percent. Trade secret claims must be identified on the SDS for any hazardous ingredients that are being withheld. These claims are usually indicated by the phrase “Proprietary Information,” or “Confidential.”

**3. Composition/information on ingredients**

**Substances**

| Chemical identity | Common name and synonyms | CAS number | Content in percent (%)* |
|---|---|---|---|
| SULFURIC ACID | | 7664-93-9 | 90 - 100% |

* All concentrations are percent by weight unless ingredient is a gas. Gas concentrations are in percent by volume.

**Section 4: First-aid measures** describes the important symptoms, immediate or delayed health effects, and required treatment. Descriptions of necessary first-aid measures must be subdivided according to the different routes of exposure, i.e., inhalation, skin and eye contact and ingestion.

**4. First-aid measures**

| | |
|---|---|
| **General information:** | Get medical advice/attention if you feel unwell. Show this safety data sheet to the doctor in attendance. |
| **Ingestion:** | Call a physician or poison control center immediately. Do NOT induce vomiting. If vomiting occurs, keep head low so that stomach content doesn't get into the lungs. |
| **Inhalation:** | Move to fresh air. Call a physician or poison control center immediately. Apply artificial respiration if victim is not breathing If breathing is difficult, give oxygen. |

**Section 5: Fire-fighting measures** lists the proper (and improper) ways to extinguish fires, the types of fire extinguisher that should be used, the specialized equipment, and chemical hazards from a fire involving the product. This information may be of limited value in situations when several chemicals are involved.

Under the federal Emergency Planning and Community Right-to-Know law, firefighters have the right to review workplace chemical inventories and SDSs and to inspect the workplace in order to plan for and prevent fires and explosions.

**5. Fire-fighting measures**

| | |
|---|---|
| **General fire hazards:** | In case of fire and/or explosion do not breathe fumes. |
| **Suitable (and unsuitable) extinguishing media** | |
| **Suitable extinguishing media:** | Foam, carbon dioxide or dry powder. |
| **Unsuitable extinguishing media:** | Do not use water as an extinguisher. |
| **Specific hazards arising from the chemical:** | Fire may produce irritating, corrosive and/or toxic gases. |
| **Special protective equipment and precautions for firefighters** | |
| **Special fire fighting procedures:** | Move containers from fire area if you can do so without risk. Fight fire from a protected location. Use water SPRAY only to cool containers! Do not put water on leaked material. Cool containers exposed to flames with water until well after the fire is out. |
| **Special protective equipment for fire-fighters:** | Firefighters must use standard protective equipment including flame retardant coat, helmet with face shield, gloves, rubber boots, and in enclosed spaces, SCBA. |

**Section 6: Accidental release measures** explains the emergency procedures, protective equipment and proper methods and materials for containment and cleanup.

**6. Accidental release measures**

| | |
|---|---|
| **Personal precautions, protective equipment and emergency procedures:** | Keep unauthorized personnel away. Keep upwind. Use personal protective equipment. See Section 8 of the MSDS for Personal Protective Equipment. Ventilate closed spaces before entering them. Do not touch damaged containers or spilled material unless wearing appropriate protective clothing. |
| **Methods and material for containment and cleaning up:** | Neutralize spill area and washings with soda ash or lime. Absorb spill with vermiculite or other inert material, then place in a container for chemical waste. Clean surface thoroughly to remove residual contamination. Dike far ahead of larger spill for later recovery and disposal. |
| **Notification Procedures:** | Dike for later disposal. Prevent entry into waterways, sewer, basements or confined areas. Stop the flow of material, if this is without risk. Inform authorities if large amounts are involved. |
| **Environmental precautions:** | Do not contaminate water sources or sewer. Prevent further leakage or spillage if safe to do so. Avoid discharge into drains, water courses or onto the ground. |

**Section 7: Handling and storage** describes precautions for safe handling and conditions for safe storage, including other chemicals that are not compatible with the product.

**7. Handling and storage**

| | |
|---|---|
| **Precautions for safe handling:** | Do not get in eyes, on skin, on clothing. Do not taste or swallow. Wash hands thoroughly after handling. Do not eat, drink or smoke when using the product. Use caution when adding this material to water. Add material slowly when mixing with water. Do not add water to the material; instead, add the material to the water. Do not handle until all safety precautions have been read and understood. Obtain special instructions before use. Use personal protective equipment as required. |
| **Conditions for safe storage, including any incompatibilities:** | Do not store in metal containers. Keep in a cool, well-ventilated place. Keep container tightly closed. Store in a dry place. |

**Section 8: Exposure controls/personal protection** lists occupational exposure limits, engineering controls, and personal protective equipment (PPE).

OSHAs Permissible Exposure Limits, ACGIH Threshold Limit Values, NIOSH Recommended Exposure Limits must be listed when available. You may see the notation “skin” after a PEL or TLV. This notation indicates that the chemical can be easily absorbed into the body through the skin.

The information on engineering controls is often limited and vague. Local exhaust ventilation, which captures contaminants at the source, is often the most effective and is often listed as a possible control but rarely recommended for typical use.

This section lists required PPE including respiratory protection and the recommended glove and clothing material. SDSs often indicate that gloves and chemical protective clothing must be “suitable” or “impervious” or “chemical resistant” instead of a recommending a specific material.

**8. Exposure controls/personal protection**

**Control parameters**

**Occupational exposure limits**

| Chemical identity | Type | Exposure Limit values | Source |
|---|---|---|---|
| SULFURIC ACID - Thoracic fraction. | TWA | 0.2 mg/m3 | US. ACGIH Threshold Limit Values (2011) |
| SULFURIC ACID | REL | 1 mg/m3 | US. NIOSH: Pocket Guide to Chemical Hazards (2010) |
| | PEL | 1 mg/m3 | US. OSHA Table Z-1 Limits for Air Contaminants (29 CFR 1910.1000) (02 2006) |
| | TWA | 1 mg/m3 | US. OSHA Table Z-1-A (29 CFR 1910.1000) (1989) |

**Appropriate engineering controls** No data available.

**Individual protection measures, such as personal protective equipment**

**General information:** Good general ventilation (typically 10 air changes per hour) should be used. Ventilation rates should be matched to conditions. If applicable, use process enclosures, local exhaust ventilation, or other engineering controls to maintain airborne levels below recommended exposure limits. If exposure limits have not been established, maintain airborne levels to an acceptable level. An eye wash and safety shower must be available in the immediate work area.

**Eye/face protection:** Wear safety glasses with side shields (or goggles) and a face shield.

**Skin protection**

**Hand protection:** Chemical resistant gloves

**Other:** Wear suitable protective clothing.

**Respiratory protection:** In case of inadequate ventilation use suitable respirator. Chemical respirator with acid gas cartridge.

**Hygiene measures:** Provide eyewash station and safety shower. Always observe good personal hygiene measures, such as washing after handling the material and before eating, drinking, and/or smoking. Routinely wash work clothing to remove contaminants. Discard contaminated footwear that cannot be cleaned.

**Section 9: Physical and chemical properties** lists the product's physical and chemical characteristics. A chemical's properties can help you identify it and determine the degree of the hazard it presents. Odor may help you identify a chemical; however, odor is generally a poor means of identifying a chemical and even worse method of determining the concentration of the substance in the air. Many substances can reach hazardous levels with no noticeable odor. Others cause olfactory fatigue and you become unable to smell the chemical.
The SDS must include the following properties or indicate that the information is not available.

- Appearance (physical state, color, etc.)
- Odor
- Odor threshold
- pH
- melting point/freezing point
- initial boiling point and boiling range
- flash point:
- evaporation rate
- flammability (solid, gas)
- upper/lower flammability or explosive limits
- vapor pressure
- vapor density
- relative density:
- solubility(ies)
- partition coefficient: n-octanol/water
- auto-ignition temperature
- decomposition temperature

## 9. Physical and chemical properties

**Appearance**

| | |
|---|---|
| **Physical state:** | Liquid |
| **Form:** | Liquid |
| **Color:** | Colorless |
| **Odor:** | Odorless |
| **Odor threshold:** | No data available. |
| **pH:** | 0.3 (1 N aqueous solution) |
| **Melting point/freezing point:** | 3 °C |
| **Initial boiling point and boiling range:** | 337 °C |
| **Flash Point:** | Not applicable |
| **Evaporation rate:** | No data available. |
| **Flammability (solid, gas):** | No data available. |
| **Upper/lower limit on flammability or explosive limits** | |
| **Flammability limit - upper (%):** | No data available. |
| **Flammability limit - lower (%):** | No data available. |
| **Explosive limit - upper (%):** | No data available. |
| **Explosive limit - lower (%):** | No data available. |
| **Vapor pressure:** | No data available. |
| **Vapor density:** | No data available. |
| **Relative density:** | 1.84 (20 °C) |
| **Solubility(ies)** | |
| **Solubility in water:** | Miscible with water. |
| **Solubility (other):** | No data available. |
| **Partition coefficient (n-octanol/water):** | No data available. |
| **Auto-ignition temperature:** | No data available. |
| **Decomposition temperature:** | No data available. |
| **Viscosity:** | No data available. |

**Section 10: Stability and reactivity** refers to the chemical's stability and the possibility of hazardous reactions. The section lists conditions to avoid (e.g., shock or vibration), incompatible chemicals that react dangerously with the substance, and decomposition products that might result from a reaction. Information on stability and reactivity is important for proper handling and storage of the product.

**10. Stability and reactivity**

| | |
|---|---|
| **Reactivity:** | Reacts violently with strong alkaline substances. |
| **Chemical stability:** | Material is stable under normal conditions. |
| **Possibility of hazardous reactions:** | Hazardous polymerization does not occur. Material reacts with water. |
| **Conditions to avoid:** | Moisture. Heat. Contact with incompatible materials. |
| **Incompatible materials:** | Water. Cyanides. Strong oxidizing agents. Strong reducing agents. Metals. Halogens. Organic compounds. Potassium. |
| **Hazardous decomposition products:** | Oxides of sulfur. |

**Section 11: Toxicological information** includes the ways the chemical can enter the body and the health effects it can cause. This section lists the routes of exposure, signs and symptoms of exposure, acute and chronic health effects, and quantitative measures of toxicity. This information is often inadequate or incomplete. A SDS must list a chemical as a carcinogen (cancer causing) if it is listed as such by the International Agency for Research on Cancer (IARC), the U.S. National Toxicology Program (NTP), or OSHA.

**11. Toxicological information**

**Information on likely routes of exposure**

| | |
|---|---|
| **Ingestion:** | May cause burns of the gastrointestinal tract if swallowed. |
| **Inhalation:** | May cause damage to mucous membranes in nose, throat, lungs and bronchial system. |
| **Skin contact:** | Causes severe skin burns. |
| **Eye contact:** | Causes serious eye damage. |

**Information on toxicological effects**

**Acute toxicity (list all possible routes of exposure)**

| | |
|---|---|
| **Oral** | |
| **Product:** | No data available. |
| **Dermal** | |
| **Product:** | No data available. |
| **Inhalation** | |
| **Product:** | No data available. |
| **Specified substance(s):** SULFURIC ACID | LC 50 (Guinea pig, 8 h): 0.03 mg/l<br>LC 50 (Rat, 1 h): 347 mg/l |
| **Repeated dose toxicity** | |
| **Product:** | No data available. |
| **Skin corrosion/irritation** | |
| **Product:** | Causes severe skin burns. |
| **Serious eye damage/eye irritation** | |
| **Product:** | Causes serious eye damage. |
| **Respiratory or skin sensitization** | |
| **Product:** | Not a skin sensitizer. |
| **Carcinogenicity** | |
| **Product:** | May cause cancer. |

**IARC Monographs on the Evaluation of Carcinogenic Risks to Humans:**

| | |
|---|---|
| SULFURIC ACID | Overall evaluation: 1. Carcinogenic to humans. |

**Section 12: Ecological information** refers to damage the chemical can cause to the environment. This section includes information on the chemical's ecotoxicity (aquatic and terrestrial), persistence and degradability, potential for bioaccumulation, and mobility in soil. OSHA does not enforce the content of this section because it is within other agencies' jurisdictions.

**12. Ecological information**

**Ecotoxicity:**

**Acute hazards to the aquatic environment:**

| | |
|---|---|
| **Fish** | |
| **Product:** | No data available. |
| **Specified substance(s):** | |
| SULFURIC ACID | LC 50 (Starry, european flounder (Platichthys flesus), 48 h): 100 - 330 mg/l Mortality<br>LC 50 (Western mosquitofish (Gambusia affinis), 96 h): 42 mg/l Mortality |
| **Aquatic invertebrates** | |
| **Product:** | No data available. |
| **Specified substance(s):** | |
| SULFURIC ACID | LC 50 (Common shrimp, sand shrimp (Crangon crangon), 48 h): 70 - 80 mg/l Mortality<br>LC 50 (Aesop shrimp (Pandalus montagui), 48 h): 42.5 mg/l Mortality |

**Chronic hazards to the aquatic environment:**

| | |
|---|---|
| **Fish** | |
| **Product:** | No data available. |
| **Aquatic invertebrates** | |
| **Product:** | No data available. |
| **Toxicity to Aquatic Plants** | |
| **Product:** | No data available. |

**Section 13: Disposal considerations** describes proper disposal and recycling practices and covers possible dangers when disposing of the chemical. OSHA does not enforce the content of this section because it is within other agencies' jurisdictions.

**13. Disposal considerations**

| | |
|---|---|
| **Disposal instructions:** | Discharge, treatment, or disposal may be subject to national, state, or local laws. |
| **Contaminated packaging:** | Since emptied containers retain product residue, follow label warnings even after container is emptied. |

**Section 14: Transport information** contains guidance on classification for shipping and transport (UN number, hazard classes, packing group, etc.) and provides precautions in connection with transporting the chemical. OSHA does not enforce the content of this section because it is within other agencies' jurisdictions.

| **14. Transport information** | |
|---|---|
| **DOT** | |
| UN number: | UN 1830 |
| UN proper shipping name: | Sulfuric acid |
| Transport hazard class(es) | |
| Class(es): | 8 |
| Label(s): | 8 |
| Packing group: | II |
| Marine Pollutant: | No |
| **IMDG** | |
| UN number: | UN 1830 |
| UN proper shipping name: | SULPHURIC ACID (with more than 51% acid) |
| Transport hazard class(es) | |
| Class(es): | 8 |
| Label(s): | 8 |
| EmS No.: | F-A, S-B |
| Packing group: | II |
| Marine Pollutant: | No |
| **IATA** | |
| UN number: | UN 1830 |
| Proper Shipping Name: | Sulphuric acid |
| Transport hazard class(es): | |
| Class(es): | 8 |
| Label(s): | 8 |
| Marine Pollutant: | No |
| Packing group: | II |

**Section 15: Regulatory information** identifies safety, health and environmental regulations (e.g., TSCA, CERCLA, SARA, CAA, Prop. 65) specific to the product in question. OSHA does not enforce the content of this section because it is within other agencies' jurisdictions.

**15. Regulatory information**

**US federal regulations**

**TSCA Section 12(b) Export Notification (40 CFR 707, Subpt. D)**

**US. OSHA Specifically Regulated Substances (29 CFR 1910.1001-1050)**

None present or none present in regulated quantities.

**CERCLA Hazardous Substance List (40 CFR 302.4):**

SULFURIC ACID Reportable quantity: 1000 lbs.

**Superfund amendments and reauthorization act of 1986 (SARA)**

**Hazard categories**

[X] Acute (Immediate) [X] Chronic (Delayed) [ ] Fire [ ] Reactive [ ] Pressure Generating

**SARA 302 Extremely hazardous substance**

| Chemical identity | RQ | Threshold Planning Quantity |
|---|---|---|
| SULFURIC ACID | 1000 lbs. | 1000 lbs. |

**SARA 304 Emergency release notification**

| Chemical identity | RQ |
|---|---|
| SULFURIC ACID | 1000 lbs. |

**SARA 311/312 Hazardous chemical**

| Chemical identity | Threshold Planning Quantity |
|---|---|
| SULFURIC ACID | 500lbs |

**SARA 313 (TRI reporting)**

| Chemical identity | Reporting threshold for other users | Reporting threshold for manufacturing and processing |
|---|---|---|
| SULFURIC ACID | 10000 lbs | 25000 lbs. |

**Clean Water Act Section 311 Hazardous Substances (40 CFR 117.3)**

SULFURIC ACID Reportable quantity: 1000 lbs.

**Clean Air Act (CAA) Section 112(r) Accidental Release Prevention (40 CFR 68.130):**

SULFURIC ACID Threshold quantity: 10000 lbs

**US state regulations**

**US. California Proposition 65**

SULFURIC ACID Carcinogenic.

**US. New Jersey Worker and Community Right-to-Know Act**

SULFURIC ACID Listed

**US. Massachusetts RTK - Substance List**
SULFURIC ACID Listed

**US. Pennsylvania RTK - Hazardous Substances**
SULFURIC ACID Listed

**US. Rhode Island RTK**
SULFURIC ACID Listed

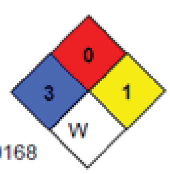
**Inventory Status:**

| | |
|---|---|
| Australia AICS: | On or in compliance with the inventory |
| Canada DSL Inventory List: | On or in compliance with the inventory |
| EU EINECS List: | On or in compliance with the inventory |
| EU ELINCS List: | Not in compliance with the inventory. |
| Japan (ENCS) List: | On or in compliance with the inventory |
| EU No Longer Polymers List: | Not in compliance with the inventory. |
| China Inv. Existing Chemical Substances: | On or in compliance with the inventory |
| Korea Existing Chemicals Inv. (KECI): | On or in compliance with the inventory |
| Canada NDSL Inventory: | Not in compliance with the inventory. |
| Philippines PICCS: | On or in compliance with the inventory |
| US TSCA Inventory: | On or in compliance with the inventory |
| New Zealand Inventory of Chemicals: | On or in compliance with the inventory |
| Switzerland Consolidated Inventory: | Not in compliance with the inventory. |
| Japan ISHL Listing: | Not in compliance with the inventory. |
| Japan Pharmacopoeia Listing: | Not in compliance with the inventory. |

**Section 16: Other information** includes the date the SDS was prepared or the last revision. Other useful information, such as NFPA ratings, may be included here.

**16.Other information, including date of preparation or last revision**

**NFPA Hazard ID**




Flammability
Health

SDS_US - SDSMIX000168 9/10

Reactivity
Special hazard.

Hazard rating: 0 - Minimal; 1 - Slight; 2 - Moderate; 3 - Serious; 4 - Severe
W: Water-reactive

| | |
|---|---|
| **Issue date:** | 06-11-2014 |
| **Revision date:** | No data available. |
| **Version #:** | 1.1 |
| **Further information:** | No data available. |
| **Disclaimer:** | THE INFORMATION PRESENTED IN THIS MATERIAL SAFETY DATA SHEET (MSDS/SDS) WAS PREPARED BY TECHNICAL PERSONNEL BASED ON DATA THAT THEY BELIEVE IN THEIR GOOD FAITH JUDGMENT IS ACCURATE. HOWEVER, THE INFORMATION PROVIDED HEREIN IS PROVIDED "AS IS," AND AVANTOR PERFORMANCE MATERIALS MAKES AND GIVES NO REPRESENTATIONS OR WARRANTIES WHATSOEVER, AND EXPRESSLY DISCLAIMS ALL WARRANTIES REGARDING SUCH INFORMATION AND THE PRODUCT TO WHICH IT RELATES, WHETHER EXPRESS, IMPLIED, OR STATUTORY, INCLUDING WITHOUT LIMITATION<(>,<)> WARRANTIES OF ACCURACY, COMPLETENESS, MERCHANTABILITY, NON-INFRINGEMENT, PERFORMANCE, SAFETY, SUITABILITY, STABILITY, AND FITNESS FOR A PARTICULAR PURPOSE, AND ANY WARRANTIES ARISING FROM COURSE OF DEALING, COURSE OF PERFORMANCE, OR USAGE OF TRADE. THIS MSDS/SDS IS INTENDED ONLY AS A GUIDE TO THE APPROPRIATE PRECAUTIONARY HANDLING OF THE MATERIAL BY A PROPERLY TRAINED PERSON USING THIS PRODUCT, AND IS NOT INTENDED TO BE COMPREHENSIVE AS TO THE MANNER AND CONDITIONS OF USE, HANDLING, STORAGE, OR DISPOSAL OF THE PRODUCT. INDIVIDUALS RECEIVING THIS MSDS/SDS MUST ALWAYS EXERCISE THEIR OWN INDEPENDENT JUDGMENT IN DETERMINING THE APPROPRIATENESS OF SUCH ISSUES. ACCORDINGLY, AVANTOR PERFORMANCE MATERIALS ASSUMES NO LIABILITY WHATSOEVER FOR THE USE OF OR RELIANCE UPON THIS INFORMATION. NO SUGGESTIONS FOR USE ARE INTENDED AS, AND NOTHING HEREIN SHALL BE CONSTRUED AS, A RECOMMENDATION TO INFRINGE ANY EXISTING PATENTS OR TO VIOLATE ANY FEDERAL, STATE, LOCAL, OR FOREIGN LAWS. AVANTOR PERFORMANCE MATERIALS REMINDS YOU THAT IT IS YOUR LEGAL DUTY TO MAKE ALL INFORMATION IN THIS MSDS/SDS AVAILABLE TO YOUR EMPLOYEES. |

### *Case Study*

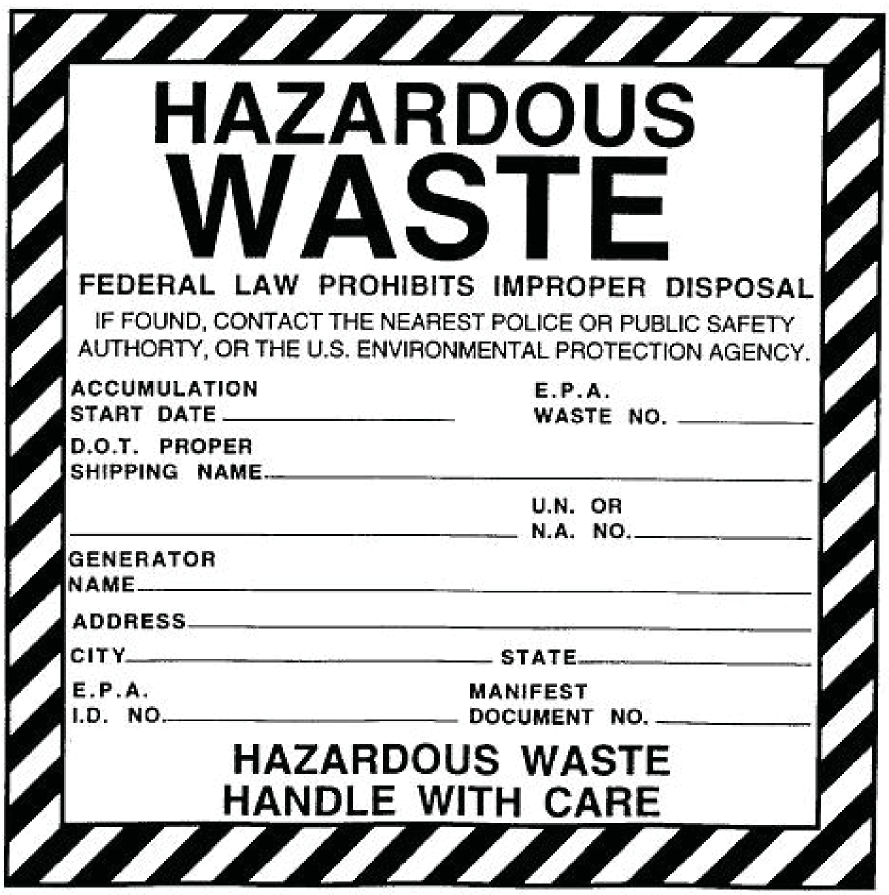
On a worksite in southwest Ohio, welders continually received chemical burns around their mouths, wrists, and ankles. A study of SDSs by company and union industrial hygienists did not identify the cause. The union hygienist requested more information on a new flux being used by the welders. It was soon determined that the flux, in combination with the coating on the steel, created boron gas. Ineffective local exhaust ventilation left most of the boron gas in the work area. When combined with water, or saliva and perspiration in this case, boron gas becomes boric acid, which led to welders' chemical burns.

## Other Forms of Hazardous Materials Documentation

**The EPA requires that hazardous wastes be labeled during transit.** An example of a hazardous waste label is shown below.

Information on the label must include:

- Generator's name and address.
- DOT proper shipping name.
- EPA identification number.
- Accumulation start date



**The DOT requires that truck drivers carry a bill of lading (shipping papers) containing the following information for all hazardous materials:**

- Shipper's name and address;
- Receiver's name and address;
- Description of hazardous material (identification number, proper shipping name, hazard class, and packing group);
- Emergency response information;
- DOT hazard classification information; and
- Quantity of material shipped to the location.

An example of shipping papers is provided on page 3-60.

**The EPA requires that hazardous waste be accompanied by a manifest to track it from the cradle-to-grave.** The manifest has a number of copies which are given to the generator, the transporter, and site characterization workers. Hazardous waste manifests must include:

- the identification number, name, and address of the generator;
- the identification number, name, and address of the permitted work site;
- the identification number and name of the hazardous waste hauler; and
- a description of the contents.

An example of a hazardous waste manifest form is provided on page 5-53.

**A waste profile sheet is provided by the laboratory that conducts the analysis of the hazardous waste.** The profile sheet describes the physical and chemical properties of the waste sample. Information from waste profile sheets is important for site characterization.

**Although the SDS, shipping papers, manifest forms, and waste profile sheets contain important information, they have a number of limitations.**

1. Information may be incomplete or inaccurate.
2. Information may not apply to the site or specific use.
3. Information may be too general.
4. SDS may not be current.

It is important that you read these documents before there is an emergency. It is a good practice to call the emergency number on the SDS to get clean-up response and emergency information before there is an emergency.

**This document provides clarification from the U.S. EPA on the custom imprinting of information on the manifest by registered printers. It identifies blocks of the manifest in which information may be custom imprinted (*e.g.*, at a customer's request).**

**Key**
- Information must not be custom imprinted in the block.
- Information may be custom imprinted in the block.
- A unique manifest tracking number must be pre-printed in this block.
- "On behalf of" may be pre-printed in this block.

Please print or type. (Form designed for use on elite (12-pitch) typewriter.)

Form Approved. OMB No. 2050-0039

**UNIFORM HAZARDOUS WASTE MANIFEST** | 1. Generator ID Number | 2. Page 1 of | 3. Emergency Response Phone | **4. Manifest Tracking Number**

GENERATOR

5. Generator's Name and Mailing Address — Generator's Site Address (if different than mailing address)

Generator's Phone:

6. Transporter 1 Company Name — U.S. EPA ID Number

7. Transporter 2 Company Name — U.S. EPA ID Number

8. Designated Facility Name and Site Address — U.S. EPA ID Number

Facility's Phone:

| 9a. HM | 9b. U.S. DOT Description (including Proper Shipping Name, Hazard Class, ID Number, and Packing Group (if any)) | 10. Containers No. | 10. Containers Type | 11. Total Quantity | 12. Unit Wt./Vol. | 13. Waste Codes |
|---|---|---|---|---|---|---|
| | 1. | | | | | |
| | 2. | | | | | |
| | 3. | | | | | |
| | 4. | | | | | |

14. Special Handling Instructions and Additional Information

15. **GENERATOR'S/OFFEROR'S CERTIFICATION:** I hereby declare that the contents of this consignment are fully and accurately described above by the proper shipping name, and are classified, packaged, marked and labeled/placarded, and are in all respects in proper condition for transport according to applicable international and national governmental regulations. If export shipment and I am the Primary Exporter, I certify that the contents of this consignment conform to the terms of the attached EPA Acknowledgment of Consent.
I certify that the waste minimization statement identified in 40 CFR 262.27(a) (if I am a large quantity generator) or (b) (if I am a small quantity generator) is true.

Generator's/Offeror's Printed/Typed Name — Signature — Month Day Year

INT'L

16. International Shipments ☐ Import to U.S. ☐ Export from U.S. Port of entry/exit:
Transporter signature (for exports only): Date leaving U.S.:

TRANSPORTER

17. Transporter Acknowledgment of Receipt of Materials
Transporter 1 Printed/Typed Name — Signature — Month Day Year
Transporter 2 Printed/Typed Name — Signature — Month Day Year

DESIGNATED FACILITY

18. Discrepancy
18a. Discrepancy Indication Space ☐ Quantity ☐ Type ☐ Residue ☐ Partial Rejection ☐ Full Rejection
Manifest Reference Number:
18b. Alternate Facility (or Generator) — U.S. EPA ID Number
Facility's Phone:
18c. Signature of Alternate Facility (or Generator) — Month Day Year

19. Hazardous Waste Report Management Method Codes (i.e., codes for hazardous waste treatment, disposal, and recycling systems)
1. 2. 3. 4.

20. Designated Facility Owner or Operator: Certification of receipt of hazardous materials covered by the manifest except as noted in Item 18a
Printed/Typed Name — Signature — Month Day Year

EPA Form 8700-22 (Rev. 3-05) Previous editions are obsolete.

DESIGNATED FACILITY TO DESTINATION STATE (IF REQUIRED)

**Unions, employers, trade groups, state governments, and other organizations may also provide sources of information.**

**New Jersey has prepared Hazardous Substance Fact Sheets for more than 1,600 pure substances.** These Fact Sheets are primarily prepared for workers and emergency responders who handle a specific substance.

**CPWR provides many publications and resources for workers. On cpwr.com you'll find:**

1. Monthly e-news (http://www.cpwr.com/publications/cpwr-updates )
2. Key Findings from Research (http://www.cpwr.com/publications/key-findings-from-research )
3. Hazard Alert cards (http://www.cpwr.com/publications/hazard-alert-cards )

**Free information from CPWR is also on:**

1. Work Safely with Silica (www.silica-safe.org) - This website is designed specifically for contractors and workers.
2. Construction Solutions is a database of practical control measures to reduce health hazards (www.CPWRConstructionSolutions.org) - organized by trade, task, hazard and controls.
3. CPWR's website for the campaign to prevent falls in construction also provides training and other resources (www.stopconstructionfalls.com)
4. CPWR maintains the Electronic Library of Construction Occupational Safety and Health (www.elcosh.org) - Types of information on eLCOSH include:
    - Videos
    - Images/photos
    - PowerPoints
    - Toolbox talks
    - Training guides
    - Handouts
    - Research reports
    - News articles
    - Recalls
    - Reference materials
    - Abstracts & summaries
    - eLCOSH Nano - a web-based construction nanomaterial inventory with 400+ products.

**Nanoparticles exist in nature and can be created and used for their unique properties.**

Materials engineered to be nano-scale are often referred to as engineered nanomaterials (ENMs) and can take on unique optical, magnetic, electrical, and other properties. These emergent properties have the potential for great impacts in electronics, medicine, and other fields but there is concern for potential health effect. (NIEHS)

**Nanoparticles must have at least one dimension that is less than 100 nanometers. Carbon nanotubes are 100,000 times smaller than a human hair. Little is known about the health effects of nanoparticles.**

1. Nanoparticles can enter the body through inhalation, ingestion, and dermal exposure.
2. They are small enough to pass from the blood to the brain.
3. The health effects of nanoparticles can be different than the health effects of larger particles of the same material.

**NIOSH, CPWR, and others are evaluating the potential for exposure to nanoparticles.**

## Summary: Labels, Signs, Placards, and SDS

Containers and trucks may have different kinds of labels that tell you about the chemicals inside. Containers must have hazard labels that are compliant with the Hazard Communication standard. Shipping containers must also have colored DOT labels (small). Trucks and railroad cars must have colored placards. The main colors specified by the DOT are:

| Color | Hazard |
|---|---|
| orange | explosive |
| red | flammable |
| white with black letters | poisonous |
| yellow | oxidizer (reactive) |
| blue | water reactive |
| green | non-flammable gas (high pressure) |
| black and white | corrosive or other |

Some localities use the NFPA diamond, which shows health (blue), fire (red), instability (yellow), and special (white) hazards.

Safety Data Sheets (SDS) may be on site for some wastes and must be on site for all products used to in cleanup. The SDS tells you what chemicals are in the product, chemical information, health and physical hazards, exposure limits, personal protective equipment, first aid, and spill precautions.

Every shipment of hazardous waste that leaves the cleanup site must have a form called a manifest that tells what the wastes are and where they come from.

Before you start work on a cleanup site, your employer should have received Waste Profile Sheets, information about waste, from a laboratory. These are a source of information about the chemical and physical properties of the waste.

Labels, SDSs, manifests, shipping papers, and waste profile sheets can be valuable sources of information for the contractor and the worker.

## Background Reading Material: Hazard Recognition

*NIOSH Pocket Guide to Chemical Hazards.* U.S. Department of HHS, PHS, CDC, NIOSH. http://www.cdc.gov/niosh/npg/

*Hawley's Condensed Chemical Dictionary.* Sax and Lewis. (1987). Van Nostrand Reinhold & Co., 115 Fifth Ave, N.Y. 10003 (11th ed.)

*Chemical Hazards of the Workplace* Fischman, M.L., Hughes, J.P., & Proctor, N.H. (1988).(2nd ed.). J.B. Lippincott Company, Philadelphia, PA.

*Hazardous Substance Fact Sheets.* New Jersey Department of Health. Trenton, NJ 08625. http://web.doh.state.nj.us/rtkhsfs/indexfs.aspx

*Occupational Health Guidelines for Individual Chemicals.* U.S. Department of Labor. Occupational Safety and Health Administration.

*Hazardous Waste Operations and Emergency Response*; Final Rule (29 CFR 1926.65) https://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=standards&p_id=10651

*Hazard Communication Final Rule* (29 CFR 1910.1200) https://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=standards&p_id=10099

*Occupational Safety and Health Guidance Manual for Hazardous Waste Sites*, 1985. (NIOSH #85-115)

*EPA's Standard Operating Safety Guides*, July, 1988.

*Emergency Response Guidebook 2012*, U.S. Department of Transportation. http://phmsa.dot.gov/hazmat/library/erg

# Shipping Paper

Please print or type (*Form designed for use on elite (12 - pitch) typewriter*) *Form Approved. OMB No. 2050 - 0039 Expires 9 - 30 - 91*

**UNIFORM HAZARDOUS WASTE MANIFEST**

GENERATOR

1 Generator's US EPA ID No. | Manifest Document No. | 2. Page 1 of | Information in the shaded areas is not required by Federal law

3. Generator's Name and Mailing Address

A. State Manifest Document Number

B. State Generator's ID

4. Generator's Phone ( )

5. Transporter 1 Company Name | 6. US EPA ID Number

C. State Transporter's ID

D. Transporter's Phone

7. Transporter 2 Company Name | 8. US EPA ID Number

E. State Transporter's ID

F. Transporter's Phone

9. Designated Facility Name and Site Address | 10. US EPA ID Number

G. State Facility's ID

H. Facility's Phone

| 11. US DOT Description *(Including Proper Shipping Name, Hazard Class, and ID Number)* | 12. Containers No. | Type | 13. Total Quantity | 14. Unit Wt/Vol | I. Waste No. |
|---|---|---|---|---|---|
| a. | | | | | |
| b. | | | | | |
| c. | | | | | |
| d. | | | | | |

J. Additional Descriptions for Materials Listed Above

K. Handling Codes for Wastes Listed Above

15. Special Handling Instructions and Additional Information

16. **GENERATOR'S CERTIFICATION:** I hereby declare that the contents of this consignment are fully and accurately described above by proper shipping name and are classified, packed, marked, and labeled, and are in all respects in proper condition for transport by highway according to applicable international and national government regulations.

If I am a large quantity generator, I certify that I have a program in place to reduce the volume and toxicity of waste generated to the degree I have determined to be economically practicable and that I have selected the practicable method of treatment, storage, or disposal currently available to me which minimizes the present and future threat to human health and the environment; **OR,** if I am a small quantity generator, I have made a good faith effort to minimize my waste generation and select the best waste management method that is available to me and that I can afford.

Printed/Typed Name | Signature | *Month Day Year*

TRANSPORTER

17. Transporter 1 Acknowledgement of Receipt of Materials

Printed/Typed Name | Signature | *Month Day Year*

18. Transporter 2 Acknowledgement of Receipt of Materials

Printed/Typed Name | Signature | *Month Day Year*

FACILITY

19. Discrepancy Indication Space

20. Facility Owner or Operator: Certification of receipt of hazardous materials covered by this manifest except as noted in item 19.

Printed/Typed Name | Signature | *Month Day Year*

**EPA Form 8700 - 22 (Rev. 9 - 88) Previous editions are obsolete.**

Notes:

Notes:

CPWR

# Chapter 4:
# Monitoring and Sampling

Monitoring, or sampling, is necessary to determine the identity or type of a substance and the amount of a substance. This information may be used to determine if workers can enter an area, what PPE they should wear, whether further cleanup is needed, and if wastes can be mixed. The concentration of hazardous substances can be measured in a short time with portable instruments or detector tubes or the substance may be collected and sent to laboratory for analysis.

**Chapter Objectives:**

After completing this module, you will be able to:

1. Describe situations where monitoring is needed.
2. Explain the advantage and disadvantage of monitoring methods.
3. Describe different types of sampling.
4. Identify issues with the way monitoring is being conducted at your job.

Union health & safety trainer calibrating a personal air sampling pump.

At a hazardous waste site, **what questions can we answer with monitoring and sampling?**

1. What is in that barrel?
2. How much lead is in this soil?
3. What chemicals are in the air where Jim is working?
4. How much is Jim exposed to?
5. After a chlorine gas leak, how far did the gas cloud spread?
6. Can you think of others?

Monitoring provides information about the presence of hazardous substances. **Monitoring and sampling are very important because they:**

1. Identify where the dangers are on the hazardous waste site.
2. Determine the extent and conditions of worker exposures.
3. Assist in the selection PPE (suit, gloves, respirator, etc.) and other controls.
4. Aid in planning work activities and methods (for example, using water sprayers).
5. Determine the special equipment and tools needed.
6. Determine whether employees need medical surveillance or exams.
7. Create a record of exposure.
8. Determine potential for community exposure.

**Monitoring must be performed whenever employees may be exposed to hazardous substances.** The monitoring results are one criteria in selecting PPE and other controls. Airborne exposures are very complex and can change a lot over the course of day or a project. An industrial hygienist, site health and safety professional, or other knowledgeable person must set up a monitoring plan indicating the frequency of monitoring. Monitoring must be conducted more frequently, or continuously, when conditions are more hazardous and more likely to change (for example, confined spaces, IDLH conditions, or flammable atmospheres). Monitoring includes all employees who may be exposed to hazardous concentrations of chemicals but should focus on those employees likely to have the highest exposure first. When worker overexposures have been identified, the monitoring program must be expanded to identify all overexposed workers.

**Exposures may change and monitoring must be repeated if:**

1. Work begins in a different area of the site;
2. Work activities or tasks change;
3. Materials being handled change;
4. Signs that exposures may have changed;
5. Excessive contamination in the work area; or
6. Weather conditions change.

**Monitoring can determine the presence or concentration of:**

1. Oxygen
2. Explosive gases or vapors
3. Toxic chemicals
4. Radiation
5. Noise
6. Heat stress
7. Biological hazards

**Sampling can be classified as personal, area, or bulk/surface.**

**Personal monitoring in the breathing zone determines a specific worker's exposure.**

**Personal monitoring is the most accurate measurement of exposure because the sampling device goes where you go and collects air from your breathing zone.** This is why personal sampling is used to compare actual worker exposures to occupational exposure limits (OELs) whenever possible. OELs may be legally enforceable or recommendations that are not legally enforceable. OSHA sets legally enforceable Permissible Exposure Limits (PELs) and requires personal monitoring while OELs set by NIOSH and ACGIH are not generally enforceable. The laboratory reports results as a concentration or TWA that can easily be compared to the OELs.

Breathing zone is about 1 foot from the mouth or nose

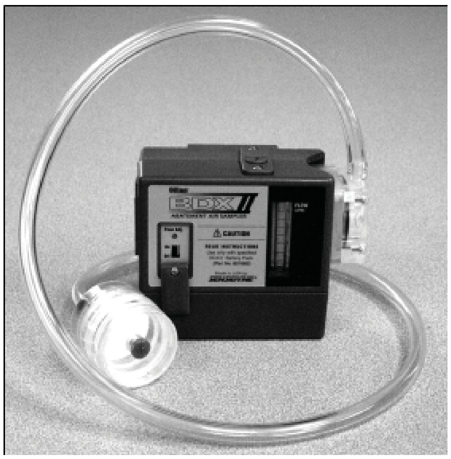
**Personal samples are usually collected by placing a battery-operated air pump on the person's belt and clipping a collection tube or filter cassette in their breathing zone** (near the collar). Air from the breathing zone is pulled into the collection device where the contaminants are trapped. The collection device, or the filter in it, is sent to a laboratory for analysis.


Union health & safety trainers learn from a certified industrial hygienist how to calibrate a personal sampling pump. Arrow points to calibrating device.

**NIOSH and OSHA methods require calibration of personal air sampling pumps before and after each use.** Calibration should be performed with same type of filter or sampling media that will used during monitoring. Primary calibration devices such as a bubble burette, a spirometer, electronic bubble meter, are the most accurate and preferred. Rotameters are a less expensive and less accurate calibration device and may be acceptable for field calibration in some cases.

**Passive dosimeters (diffusion monitor) are small badges that can be used for personal sampling too.** The badges are clipped to the collar and collect contaminants as air passes over them without using a pump. They can only be used once and must be sent to a lab for analysis

**Area monitoring is not used to determine a specific worker's exposure.** It's often used to measure background concentrations in air prior to the start of work, trigger alarms if concentrations get too high, assess the effectiveness of controls, and to protect the community.



Personal sampling pump with a cassette containing a particulate filter

**Bulk and surface sampling are used to determine how much of a hazardous substance is present:**

1. In water or liquids
2. In soil
3. In waste
4. On surfaces
5. In materials

**Bulk sampling of material identifies hazardous contents and is important for determining work plans, necessary controls, PPE, and proper disposal.**

**The presence of a hazardous substance can indicate the potential for exposure but should not be used to estimate worker exposure.**

**Wipe sampling shows which surfaces are contaminated.** A piece of cloth or other material is wiped across a known area (often 100 cm2) of the surface and then submitted to a laboratory for analysis. Wipe sampling for lead is common in homes believed to have older paint. DOE facilities use wipe sampling for beryllium and other metals.

**Personal, area, and bulk/surface sampling can be accomplished by sending a sample to a lab or using real-time monitoring.**

**There are many different monitoring methods and each approach may answer different questions and has different advantages and limitations.** Many methods are not as accurate or quick as we'd like them to be and no single instrument or method can detect all chemicals, but proper monitoring can provide information to help protect workers' health. Using the wrong method or instrument may expose workers to an unsafe work environment.

**There is often more than one sampling method for a hazardous substance.** Collecting lead-based paint chips and sending them to a laboratory is accurate but using an XRF instrument is much quicker and doesn't damage the surface.

**Sampling should be planned with the laboratory's input.** The laboratory must be qualified and accredited to perform the analysis you are requesting. The final limitation is that generally need to know what chemical or chemicals might be present before you sample so that you can select the right method.

**The time required to receive the results is a major weaknesses of personal sampling methods that require laboratory analysis. It may take 1-14 days to receive the results from a laboratory and that may be too long to wait for some decisions.** Also, these samples provide no information about ceiling exposures during the hours they were collected.

**Samples of groundwater and water from wells, ponds, and streams are usually sent to a lab to identify chemicals.**

**Soil samples are usually sent to a lab for analysis and can indicate the extent of the contamination (concentration), how deep it is, and the boundaries of the contaminated area.**

**A glass cylinder called a "thief" or a "coliwasa" is inserted into a waste drum or tank and used to collect a sample. Some basic tests may be performed on-site with colorimetric strips but the sample is often bottled and sent to a lab for analysis.** Compatibility testing is performed by a laboratory and can determine whether the hazardous materials can be safely mixed. The U.S. EPA, Army Corp of Engineers, and other groups have developed compatibility software programs.

**Real-time monitoring provides an immediate measurement of concentration.** The instrument, equipment, or method used depends upon the potential hazards present.

**Advantages of real-time monitoring include:**

1. Results are immediate (seconds to minutes)
2. Relatively inexpensive (starting at a few hundred dollars)
3. Relatively easy to operate with proper training
4. Used to ensure safe entry into confined space

**Disadvantages of real-time monitoring include:**

1. Concentration range limited - may not be able to detect high enough or low enough levels of toxic or flammable materials
2. Most monitors cannot identify an unknown contaminant or distinguish one from another;
3. Must be calibrated and maintained on a regular basis;
4. Background levels and other chemicals can give false readings (cross-sensitivity); and
5. Common instruments only have a few sensors.

**Real-time monitoring can be used to measure:**

- Oxygen
- Explosive gases or vapors
- Toxic chemicals
- Radiation
- Noise
- Others

When used for confined space entry, real-time measurements must be taken in the following order to ensure accuracy and safety: 1. oxygen (19.5%-23.5%), 2. flammable (less than 10% LEL), and 3. potential toxic substances (below IDLH or PEL, depending on the exact situation).

**Oxygen meters measure the percent oxygen in the air.**
Normal breathing air contains approximately 20.9% oxygen.  Air which contains less than 19.5% oxygen is oxygen-deficient.  The oxygen in confined spaces such as tanks, pits, silos, pipelines, vaults and sewers is often oxygen-deficient.  OSHA requires SAR (with escape) or SCBA respiratory protection in atmospheres with less than 19.5% oxygen.

An atmosphere is oxygen-enriched if it contains more than 23.5% oxygen.  Oxygen enrichment makes it easier for flammable and combustible substance to burn and increases the risk of fire or explosion.

**Keep in mind that:**

- Temperature, pressure and carbon dioxide can all affect readings;
- Instruments must be calibrated and checked regularly; and
- Users must be trained.

**Flammable and explosive chemicals are detected by combustible gas meters called Combustible Gas Indicators or CGI, and reported as a percent of the lower explosive limit (% LEL).** These instruments are useful for confined space entry. Above 10% of the LEL indicates there is an atmosphere with potential for fire/ explosion.

**Keep in mind that CGIs:**

- Should be field-calibrated (bump checked) by trained personnel before each shift;
- Require periodic factory calibrations;
- Do not respond the same to all gases and vapors;
- Need a minimal amount of oxygen to work properly;
- Users must be trained; and
- Must be allowed enough time for contaminants to reach the instrument through the length of tubing used.

**Combustible gas indicators are often manufactured to include other sensors to monitor such things as oxygen, carbon monoxide, and one or two toxic gases, such as hydrogen sulfide. These monitors are often called multi-gas detectors.**

**A colorimetric detector tube is a glass tube filled with a solid material that changes color when it reacts with certain chemicals.** A hand-operated or battery-powered pump is used to pull a specific volume of air through the tube and the contaminant reacts with the chemical in the tube producing a stain proportional in length to the concentration of the contaminant. Drager, MSA, Sensidyne, and others manufacture colorimetric detector tubes for dozens of contaminants or types of contaminants (alcohols, for example).

**The instructions are important and different for every type of colorimetric tube.**

**Pumps for colorimetric tubes are for single or multiple tubes and are manual or battery operated.**

**Colorimetric tubes are relatively easy to use, inexpensive, and quick.**

**There are limitations to the usefulness of colorimetric detector tubes**

- Cannot be used to reliably identify chemicals.
- Each tube is specific to a chemical or a small range of chemicals.
- Similar chemicals may produce a color change (interference).
- Pump must be checked for leaks and calibrated.
- Tubes have a limited shelf life (always check expiration date before use).
- User must read the correct scale on the tubes.
- User must follow specific pump-stroke requirements.
- Results can be off by as much as 25%
- Results may be affected by temperature and humidity.
- The results may not be clear.

**Numerous other real-time instrument are available for hazardous chemicals.** Use of these instruments, including photo-ionization detectors (PID), flame ionization detectors (FID), portable gas chromatographs, and other more specialized monitors, require special training.

**No single instrument can measure all forms of radiation accurately.** With different accessories, Geiger counters can be used to detect alpha particles, beta radiation, gamma and x-rays. Workers on sites with ionizing radiation may be required to wear badges (dosimeters) that measure dose over many days. On sites where radiation sources are present, a specific monitoring program should be in place which describes monitoring devices, the type of hazard, and control methods.

**Instruments to measure air velocity (speed) are useful for confined space entry.** Once you know the velocity you can use calculations or charts that come with blowers to determine air flow rate or how much air is being moved per hour. This is important when determining how long to ventilate a space before entry.

**Sound level meters (SLMs) are direct reading instruments that measure how loud the noise in decibels (dB).** Most instruments use the A scale (dBA) which mimics how the ear responds to noise.

**Keep in mind that SLMs:**

- Require calibration before and after each use
- Battery must be checked before each use
- Do not record data and the display must be viewed constantly during use
- Require training for proper use

**Personal noise dosimeters also measure sound level but they record data over a period of time.** These instruments are worn by the employee during the entire shift and used to determine a time-weighted average exposure.

**Heat stress monitors measure heat stress index, black globe temperature, air temperature and relative humidity.**

**The presence of biological hazards such as molds, bacteria, viruses, and certain parasites will affect PPE selection, as well as decontamination and disposal procedures.** Specialists must be brought in to investigate and evaluate biological hazards.

**If you are requested to wear a sampling device:**

1. Be sure the monitor is positioned properly within your breathing zone;
2. Notify your supervisor, safety or industrial hygiene personnel if any problems occur;
3. Use your rights provided by OSHA's Access to Employee Exposure and Medical Records Standard (1926.33) to request the results of tests in writing;
4. Compare the results with OSHA PELs, NIOSH RELs, and ACGIH TLVs;
5. Keep the results.  If you become ill the information may be helpful to your doctor; and
6. Ask for assistance if you do not know what the results mean.

**Site management and health and safety personnel are responsible for selecting appropriate monitoring equipment.** Manufacturers are often the best source of information about equipment uses, capabilities, and limitations. Some general considerations when selecting monitoring equipment follow:

- Instruments used in potentially flammable or explosive atmospheres must be intrinsically safe (incapable of creating sparks or heat that could ignite an explosive or flammable atmosphere).
- Most direct-reading instruments and sampling methods are designed to measure only one contaminant or group of contaminants and may experience interference from others.
- No instrument or monitoring method can measure all toxic substances.
- Make sure instruments are designed for the conditions (temperature, humidity, etc.) they will be used in.
- Users must be trained on monitoring procedures and allowed to practice regularly.

## *Case Study*

Construction workers lowered the sampling tube of a combustible gas meter into an underground vault and the readings came back normal (0% LEL). A worker climbed into the vault with the combustible gas meter and the alarm immediately sounded. **Why did this happen?**

Some combustible gas meters are not accurate when there is too little oxygen in the air and some may not work at all. Methane from an old dump had filled up the vault, pushed oxygen out, and prevented the meter from working properly. By opening the vault and climbing in, oxygen began to mix with the methane and the meter began working again. The workers should have tested for oxygen before combustible gases or used a meter that tests both at the same time.

## Summary:
## Air Monitoring

Air testing or monitoring tells you what levels of chemicals workers are exposed to. Your employer will use monitoring results to choose the right engineering controls and personal protective equipment.

Oxygen-deficient and oxygen enriched atmospheres, fire and explosion hazards, toxic chemicals, biological hazards, and radioactivity can all be monitored at the site.

Personal and area sampling is used to measure the amount of a toxic chemical in the air that a worker is exposed to. Usually, these samples must be sent to a laboratory for analysis.

Real-time instruments give you an immediate measurement of contaminants in the air. Direct-reading instruments may be used for personal or area monitoring. They can measure flammable gases and vapors, oxygen, and toxic gases and vapors.

The air in a confined space must be tested with direct-reading instruments in this order: oxygen (19.5%-23.5%), flammable (less than 10% LEL), and then potential toxic substances (below IDLH or PEL, depending on the exact situation) before you enter and periodically while workers are inside. If the oxygen level is low or high, or if the meter is not properly calibrated, combustible gas levels (% LEL) will not be accurate. If the oxygen level is less than 19.5% or the combustible gas indicator reads above 10% of the LEL, leave the area immediately and alert your supervisor.

OSHA requires employers to do everything they can to keep exposure to air contaminants below the Permissible Exposure Limits (PELs). Personal sampling is required to ensure exposures are below PELs and provides the most accurate information on a worker’s exposure. Personal sampling is usually accomplished by having the worker wear a small pump that is collecting an air sample in the breathing zone. A full-shift time-weighted average (TWA) is calculated from the results and compared to occupational exposure limits (PELs, RELs, or TLVs). It may take a day to a couple of weeks to get the results back from the lab and they provide no information about periods of high (peak) exposures during the shift.

# Background Reading Material: Monitoring

*Hazardous Waste Operations and Emergency Response Standard Final Rule*,
March 6, 1990 (29CFR1926.65) (h) Monitoring

*Occupational Safety and Health Guidance Manual for Waste Site Activities*
October 1985. (NIOSH # 85-115)
Chapter 7 Air Monitoring, p. 1-7

*EPA's Standard Operating Safety Guides*, July 1988
Part 8 Air Surveillance p. 1-8 and Annex 5 and 6
Appendix I Characteristics of HNU Photoionizer and Organic Vapor Analyzer, p. 1-4

Appendix II Rationale for Relating Total Atmospheric Vapor/Gas Concentrations to the Selection of the Level of Protection

*NIOSH Pocket Guide to Chemical Hazards*, (2005).
Column 8 Measurement method
Table 1 (p. xix) Codes for measurement methods

*NIOSH Manual of Analytical Methods (NMAM)*
http://www.cdc.gov/niosh/docs/2003-154/

*AIHA Laboratory Accreditation Programs, LLC*
http://www.aihaaccreditedlabs.org

*EPA Test Method Collections*
http://www.epa.gov/fem/methcollectns.htm

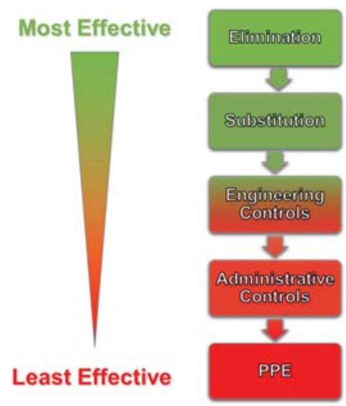
*NIST National Voluntary Laboratory Accreditation Program (NVLAP)*
http://www.nist.gov/nvlap/

*OSHA Safety and Health Topics: Sampling and Analytical Methods*
www.osha.gov/dts/sltc/methods/index.html

Notes:

# Chapter 5:
# Personal Protective Equipment (PPE)

Eliminating hazards or using engineering and administrative controls may not always be feasible on hazardous waste sites. **Personal Protective Equipment (PPE) is required by OSHA and the EPA for all contractors working on Superfund sites when other controls cannot provide adequate protection.** PPE shields or isolates the wearer from the chemical, physical, radiological, and biological hazards at hazardous waste sites. Careful selection and use of PPE can protect the respiratory system, skin, eyes, ears, hands, feet, and head.




**Chapter Objectives:**

After completing this module, you will be able to:

1. Identify if the proper PPE has been selected for the hazard.
2. Properly Don and Doff your PPE.
3. Inspect, clean and store your PPE.
4. Describe the four ensemble levels that may be used when doing hazardous waste work.
5. Explain the difference between a qualitative and a quantitative fit test.

## Case Study

Two workers were removing paint from a small process room. Methylene chloride was applied to the walls using brushes and rags. The workers wore coveralls, vinyl gloves, and full-face respirators with organic vapor cartridges. After an hour in the room, the workers felt eye and throat irritation but continued to work. After two hours, one of the workers was dizzy and both workers left the area. What happened?

The high levels of methylene chloride in the room used up the charcoal in the organic vapor cartridges. After 45 minutes, the workers had begun to breathe in large amounts of the chemical, but ignored the warning signs of exposure until they became too sick to keep working. The employer did not implement an adequate respiratory protection program; a change out schedule was not used to make sure that the cartridge life was not exceeded. The employer did not provide appropriate gloves and clothing to prevent the absorption of methylene chloride and skin absorption added to the inhalation exposure. The workers were not trained to recognize the signs of exposure to the chemicals that they were using.

## Section I – Personal Protective Equipment (PPE) Program

**A written personal protective equipment (PPE) program is required by OSHA [1926.65(g)(5)]** as part of the employer's safety and health program and site-specific safety and health plan [1926.65(b)(1)]. Selected PPE must be capable of protecting employees from known and potential hazards. The PPE program must address:

1. selection, based upon site-specific hazards;
2. use and limitations;
3. work task duration;
4. maintenance and storage;
5. decontamination and disposal;
6. training and proper fitting;
7. putting on and taking off equipment;
8. inspection procedures;
9. evaluation of the effectiveness of the PPE program; and
10. limitations during temperature extremes, heat stress, and other appropriate medical considerations.

The preliminary site evaluation should provide enough information to select the appropriate PPE. **When information on hazards is inadequate, OSHA mandates a high level of skin and respirator protection (called Level B; see page 33), along with the use of special equipment to monitor the air [(1926.65(c)(5)(i) and (iii)].**

OSHA addresses PPE in 29CFR1926 Subpart E and 29CFR1910 Subpart I.

| Standard Title | Construction Standard | General Industry Standard |
|---|---|---|
| General requirements | 1926.95 | 1910.132 |
| Foot protection | 1926.96 | 1910.136 |
| Head protection | 1926.100 | 1910.135 |
| Hearing protection | 1926.101 | 1910.95 |
| Eye and face protection | 1926.102 | 1910.133 |
| Respiratory Protection | 1926.103 | 1910.134 |
| Safety belts, lifelines and lanyards | 1926.104 | |
| Hand Protection | | 1910.138 |

## *Respiratory Protection*

**Respiratory protection is required at hazardous work sites when engineering or administrative controls cannot provide adequate protection.** This section outlines the types of respiratory protection and their use and limitations.

Respirators can provide protection from chemical and particulate (dusts, fumes, mists, fibers) exposures (including some radioactive and biological materials) and oxygen deficient atmospheres. The respiratory protection standards for general industry (29CFR1910.134) and construction (29CFR1926.103) are identical. **OSHA's respiratory protection standards require employers to develop a site-specific written respiratory protection program if workers are required to wear respirators.** When voluntary use of respirators is permitted employers are required to have a written program sufficient to control the potential hazards associated with the use of the respirator **[1910.134(c) or 1926.103(c)].** If voluntary use is permitted, employers must provide users with the information contained in Appendix D of the respiratory protection standard.

**The respiratory protection program must be written, have a designated administrator, and address:**

1) **Hazard evaluation**
   a) Potential exposures

2) **Respirator selection and use**
   a) Type of respirator needed for each job
   b) Type of filter or cartridge needed
   c) User seal checks
   d) Supplying Grade D air

3) **Medical evaluation**
   a) Before use and then as needed

4) **Fit testing (tight-fitting respirators)**
   a) Type of fit testing
   b) Before use and at least annually

5) **Training**
   a) Before use, as needed, and at least annually

6) **Storage, maintenance, repair, and care**

7) **Program evaluation**
   a) Identify the program administrator
   b) How the program will be evaluated

8) **Recordkeeping**

**Employers must provide medical evaluations to determine employees' ability to use a respirator before fit testing and use. Medical clearance to use a respirator is determined by a physician or other licensed health care professional (PLHCP).** The PLHCP uses a questionnaire and, if necessary, a follow-up medical examination, to determine if you are at risk for adverse health effects from the added stress of a respirator. If you answer "yes" to specific questions on the questionnaire, you must then get tests or a physical exam. The medical clearance is repeated if you have health problems, change the type of respirator you use, or the workplace changes. The PLHCP must be told what your job involves. Your employer keeps a copy of the medical clearance report with your other workplace records. The report must be limited to your ability to wear a respirator.

Medical conditions that could keep you from wearing a respirator include:

- lung disease
- claustrophobia (fear of small spaces)
- severe high blood pressure
- heart disease
- punctured eardrum

**Selecting the correct respirator for the hazard is the responsibility of the program administrator or other qualified personnel.** Choosing the wrong respirator may be life-threatening. All respirators must be approved by the National Institute for Occupational Safety and Health (NIOSH). Procedures for selecting respirators must be part of your employer's written program. To select the correct respirator a qualified person must first test the air and know:

- The percentage of oxygen in the air
- The hazardous substances workers may be exposed to
- The concentration of the substances in the air
- Permissible Exposure Limits (PELs) for the substances
- The likelihood of Immediately dangerous to life or health (IDLH) conditions
- If the contaminants are hazardous to skin and eyes

**Air monitoring and direct reading instruments are used to identify the substances in the air and determine their concentrations.**

**The concentration of the each hazardous substance must be compared to its PEL or another more protective occupational exposure limit.**

**Immediately dangerous to life or health (IDLH) means an atmosphere that poses an immediate threat to life, would cause irreversible adverse health effects, or would impair an individual's ability to escape. IDLH values are based on effects that might occur following a 30-minute exposure but workers should make every effort to exit the area immediately.**

**An atmosphere with less than 19.5% oxygen by volume is considered oxygen deficient and immediately dangerous to life and health.** The health effects experienced depend on duration of the oxygen deficiency, work rate, breathing rate, temperature, health, and age. Adverse health effects, such as reduced reaction times, may begin at 19.0% oxygen but not be immediately noticeable or recognized. These percentages are for measurements taken at sea level; adjustments must be made for higher elevations.

**An assigned protection factor (APF) indicates the level of respiratory protection that a respirator can be expected to provide to employees when used as part of an effective respiratory protection program.** OSHA, NIOSH, and ANSI have published assigned protection factors for each type of respirator. We will be referring to the OSHA APFs throughout this manual but some organizations and government installations use other APFs. A lower APF means the respirator does not provide as much protection. For example, a full facepiece air-purifying respirator has an OSHA APF of 50 and an SCBA in positive pressure mode has an APF of 10,000. The full facepiece air-purifying respirator will let more contaminant into your facepiece and provide less protection than the SCBA will.

## OSHA Assigned Protection Factors[1]

| **Type of respirator [2, 3]** | Quarter mask | Half mask | Full facepiece | Helmet / hood | Loose-fitting facepiece |
|---|---|---|---|---|---|
| Air-Purifying Respirator | 5 | [4]10 | 50 | | |
| Powered Air-Purifying Respirator (PAPR) | | 50 | 1,000 | [5]25/1,000 | 25 |
| Supplied-Air Respirator (SAR) or Airline Respirator | | | | | |
| • Demand mode | | 10 | 50 | | |
| • Continuous flow mode | | 50 | 1,000 | [5]25/1,000 | 25 |
| • Pressure-demand or other positive-pressure mode | | 50 | [6]1,000 | | |
| Self-Contained Breathing Apparatus (SCBA) | | | | | |
| • Demand mode | | 10 | 50 | 50 | |
| • Pressure-demand or other positive-pressure mode (e.g., open/ closed circuit) | | | 10,000 | 10,000 | |

1 These APFs do not apply to respirators used solely for escape. For escape respirators used in association with specific substances covered by 29 CFR 1910 subpart Z, employers must refer to the appropriate substance-specific standards in that subpart. Escape respirators for other immediately dangerous to life or health atmospheres are specified by 29 CFR 1910.134 (d)(2)(ii).

2 Employers may select respirators assigned for use in higher workplace concentrations of a hazardous substance for use at lower concentrations of that substance, or when required respirator use is independent of concentration.

3 The assigned protection factors in Table 1 are only effective when the employer implements a continuing, effective respirator program as required by this section (29 CFR 1910.134), including training, fit testing, maintenance, and use requirements.

4 This APF category includes filtering facepieces and half masks with elastomeric facepieces.

5 The employer must have evidence provided by the respirator manufacturer that testing of these respirators demonstrates performance at a level of protection of 1,000 or greater to receive an APF of 1,000. This level of performance can best be demonstrated by performing a Workplace Protection Factor or Simulated Workplace Protection Factor study or equivalent testing. Absent such testing, all other PAPRs and SARs with helmets/hoods are to be treated as loose-fitting facepiece respirators, and receive an APF of 25.

6 A SAR in the positive pressure/pressure demand mode with an escape bottle has an assigned protection factor of up to 10,000 when used in the escape mode.

**Maximum use concentration (MUC) is a respirator's APF multiplied by the OSHA PEL (or another exposure limit) for a chemical.** The MUC is for a specific chemical and type of respirator and does not take into account the filter or cartridge. Air-purifying respirators cannot be used at IDLH concentrations even when the MUC is greater than the IDLH concentration. In this situation, you must use a respirator, such as a SCBA, specifically listed for IDLH conditions.

**Use the following formula to calculate maximum use concentration:**

**MUC = Respirator's APF X OSHA PEL**

**Here is an example:**

You were given a half-face air-purifying respirator for work on a site with napthalene. The OSHA PEL for napthalene is 10 ppm. What is the maximum use concentration (MUC) in this scenario?

MUC = APF of 10 X 10 ppm

**MUC = 100 ppm** naphthalene with a half-face air-purifying respirator

If naphthalene concentrations may exceed 100 ppm then your employer must provide you with respirator with a higher APF.

***An MUC is the maximum amount of a hazardous substance a worker can be exposed to wearing a particular respirator.***

If you know the concentration at your worksite, you can also use a respirator's assigned protection factor to figure out the maximum concentration of a chemical you're likely to be exposed to while wearing that respirator.  You need to make sure that the concentration inside your respirator is below the OSHA PEL for the chemical. Use the following formula to do this.

$$\frac{\text{concentration of chemical in the work area}}{\text{Respirator's APF}} = \text{Concentration of chemical in the respirator}$$

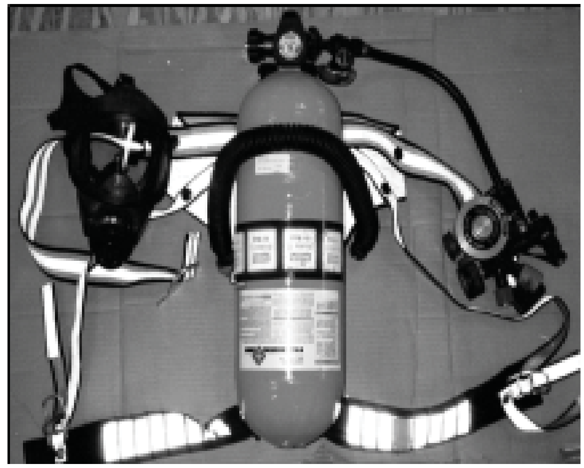
**Here is an example:**

The OSHA PEL for o-xylene is 100 ppm.  You are working in an atmosphere where the concentration of o-xylene is 800 ppm.  Which of the two respirators below would you rather have to protect you against the chemical?

| A half-face air-purifying respirator with an assigned protection factor of 10? | A full facepiece air-purifying respirator with an assigned protection factor of 50? |
|---|---|
| $\frac{\text{800 ppm}}{\text{APF of 10}}$ = 80 ppm maximum concentration inside your respirator | $\frac{\text{800 ppm}}{\text{APF of 50}}$ = 16 ppm maximum concentration inside your respirator |
| **Less Protective** | **More Protective** |

A properly fitted full facepiece air-purifying respirator protects your eyes and provides five times more protection than a half-face air-purifying respirator.

There are two main types of respirators, each with several subtypes:



SCBA: full-face, positive-pressure, pressure demand 30 minute unit.

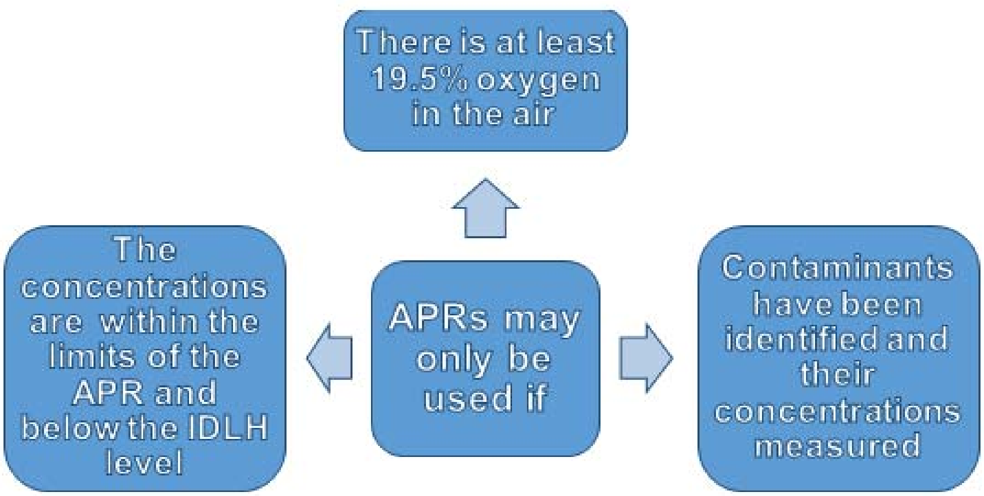
1. **Air-purifying respirators** (APRs) remove contaminants from the air before it is inhaled.
2. **Atmosphere-supplying respirators** (also known as air-supplying respirators) supply clean breathing air from a source independent of the work area.

   **Supplied-air respirators (SARs) or airline respirators** supply air through an airline from a tank or compressor to the wearer.

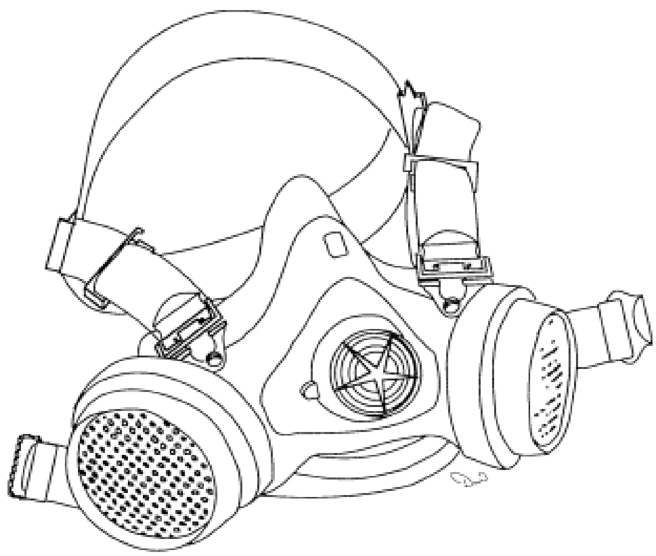
   **Self-contained breathing apparatus (SCBA)** supplies the air from a tank on the wearer's back.

## *Air-Purifying Respirators*

**Air-purifying respirators (APRs) can provide protection from particulates (dusts) and some toxic chemicals. They work by filtering air before it is inhaled.** APRs include half mask filtering facepieces, half mask elastomerics, full facepiece elastomerics, and powered-air purifying respirators (PAPRs). Elastomeric means a polymer plastic that stretches. Most APRs consist of a facepiece with one or two filtering cartridges through which the air enters, an exhalation (out) valve near the chin, and two straps. The most widely used on hazardous waste sites are full facepiece elastomeric APRs. Respirators and masks that are not approved by NIOSH should **never** be used for respiratory protection on a hazardous waste site or other jobs.




**Half-mask respirators and disposable filtering facepiece respirators have an APF of 10** so they only provide one-fifth the respiratory protection of full facepiece APRs. Unlike full facepiece respirators, **half-mask APRs do not provide eye protection.** Half mask filtering facepieces consist of a filtering medium that makes up the entire facepiece and, in some cases, an exhalation valve. Filtering facepiece respirators do not provide protection from gases or vapors but are permitted for particles as long as they provide sufficient protection for the concentration present. Remember, APRs must not be used when the oxygen content is less than 19.5%

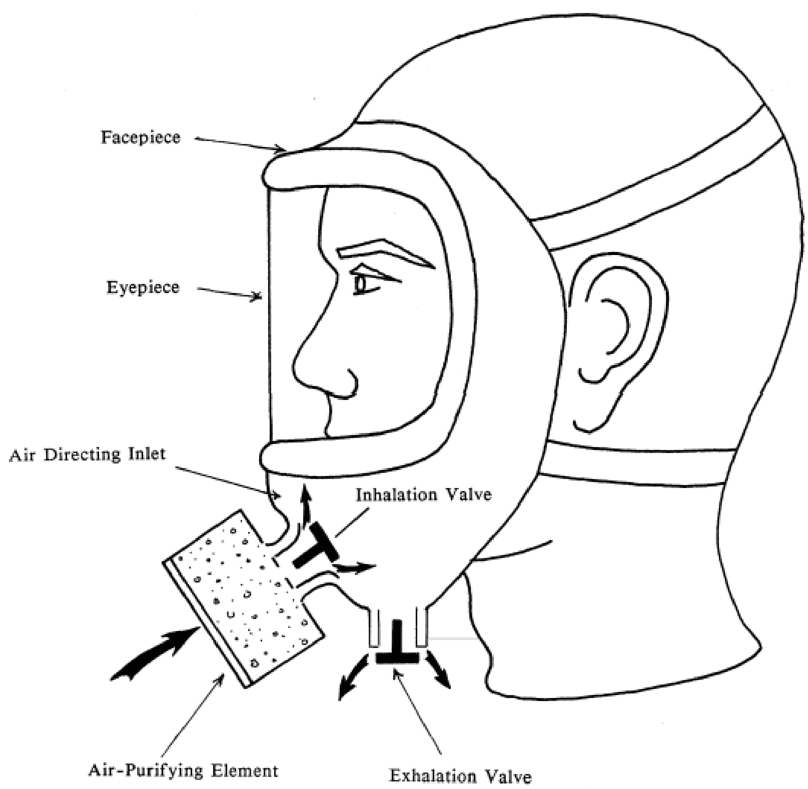


**Half-Mask Air-Purifying Respirator.**

**Filtering Facepiece Air-Purifying Respirator**

**Full facepiece APRs have an APF of 50 and provide eye protection. They protect against dusts and some toxic chemicals by filtering air before it is inhaled.** Air enters through the cartridge(s), which is selected to remove dusts, particles, chemicals, or some combination of these, and exits through a valve. Note the proper placement of the straps or headbands.

Workers who wear glasses will need a special kit to prevent the temples (side pieces) of the glasses from letting air leak in around the sides of the mask.




**Typical Full Facepiece Air-Purifying Respirator**

**Another type of APR is the powered air-purifying respirator (PAPR), which uses a blower to force air through the filters or cartridges and into the mask.** PAPRs consist of a hood or helmet, facepiece, filter or cartridge, power source, and a blower. APF for PAPRs are 50 with a half mask, 1,000 with a full facepiece, 25 with a helmet, hood, or loose-fitting facepiece. PAPRs with a helmet or hood can be given an APF of 1,000 with evidence from the manufacturer. PAPRs can only be used in environments where there is enough oxygen. If an employee has medical condition that prevents the use of a negative pressure respirator then the employer must provide a PAPR [1910.134(e)(6)(ii)].

**Two types of air purifiers (cleaners) are used with APRs.**

1. Filters or air purifying elements remove dusts, particles, mists, and fumes (tiny metal particles) from air
2. Chemical cartridges use a filter, sorbent, or catalyst, or a combination of these to remove vapors and gases from air

**Procedures for selecting filters and cartridges must be part of your employer's written program.** Filters and cartridges are chosen based on the contaminants, the concentration of the contaminants, and, to a lesser extent, the size of the particles. For example, welding often produces both fumes and gases and may require a combination cartridge with both a filter and a chemical cartridge. In some instances, cartridges to protect you from a chemical are not available or have short service life and it is not possible or practical to use an APR.

**Filters, canisters, and cartridges are labeled and, as a secondary means of identification, color-coded.**

**Color Assigned to Canister, Cartridge, or Filter** (ANSI Z88.7-2010)

| Contaminants | Color Assigned |
|---|---|
| Acid gases | White |
| **Organic vapors** | **Brown/Black**[7] |
| Ammonia gas | Green |
| Ammonia & methylamine gas | Green |
| Carbon monoxide gas | Blue |
| **Acid gases & organic vapors** | **Yellow** |
| Acid gases, ammonia, and organic vapors | Brown |
| Organic vapors, chlorine, chlorine dioxide, hydrogen chloride, hydrogen fluoride, sulfur dioxide, formaldehyde, hydrogen sulfide (escape only), ammonia, methylamine | Pale Brown (Tan) |
| Acid gases, ammonia, carbon monoxide, and organic vapors | Red |
| Other vapors and gases or combinations not listed above | Olive |
| **Any Particulates – High Efficiency (HE), for PAPRs only** | **Purple/Magenta** |
| **Any Particulates – P100** | **Purple/Magenta**[8] |
| **Any Particulates – P95, P99, R95, R99, R100** | **Orange**[9] |
| **Any Particulates free of oil – N95, N99, or N100** | **Teal**[10] |

7 Organic vapor cartridges may be brown following changes to ANSI Z88.7 in 2010.
8 Particulate filters housed within a container, and which do not have replaceable filter media, shall be color-coded as above. Particulate filters not housed within a container and which have a NIOSH filter class designation (N95, P95, etc.) on the filter do not need to be color-coded.
9 An orange stripe or indicator shall be used to identify P class particulate filters, except P100, in combination with any vapor or gas canister or cartridge if the filter is housed within a container and the NIOSH filter class designation is not visible on the filter.
10 A teal stripe indicator shall be used to identity N class particulate filters in combination with any vapor or gas canister or cartridge if the filter is housed within a container and the NIOSH filter class designation is not visible on the filter.

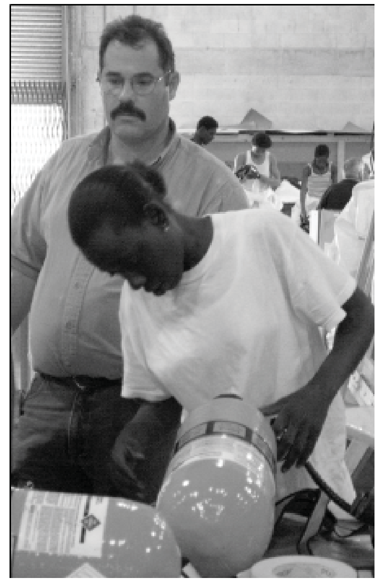
NIOSH has nine filter classes for non-powered respirators and they are based on three levels of filter efficiency and three levels of resistance to degradation from oil mist.

| | Resistance to Oil | | |
|---|---|---|---|
| **Minimum Efficiency** | **N (not oil resistant)** | **R (oil resistant)** | **P (oil proof)** |
| 95% | N95 | R95 | P95 |
| 99% | N99 | R99 | P99 |
| 99.97% | P100 | R100 | R100 |

**How do you know when your cartridge or filter needs to be changed?**

Your employer's written program must include a **change schedule for cartridges for gases and vapors [1910.134(d)(3)(iii)(B)(2)]**, unless the cartridge has an **end-of-service-life indicator (ESLI)**, which is a dot that changes color when the cartridge is no longer effective. **The frequency with which cartridges need to be changed depends on the chemicals, their concentrations and boiling points, the temperature and humidity of the air, and your rate of work or breathing.** Some cartridges will only last for minutes while others may be effective for many hours. It is considered a best practice to replace gas and vapor cartridges at the beginning of each shift and some substance-specific OSHA standards (e.g. benzene and formaldehyde) require this even if the end of the cartridge's service life has not been reached. Odor, taste, and irritation cannot be used in place of a change schedule or ESLI but **you must leave the work area and change your cartridges if you detect a taste or smell** in your respirator. You cannot rely on smell, taste, or irritation because they may not occur until you've already been exposed. If your sense of smell is weakened, you may be working with a useless cartridge and not even know it. When a particulate filter becomes "loaded" it becomes difficult to breathe through and must be changed. Cartridges and filters must also be changed when recommended by the manufacturer or when they become damaged or wet.

### *Atmosphere-Supplying Respirators*



**Atmosphere-supplying respirators (also known as air-supplying respirators) include self-contained breathing apparatus (SCBA) and supplied-air respirators (SARs).[11]**

**Self-contained breathing apparatus (SCBA) supply clean breathing air from a tank carried on the wearer's back.** Full facepiece SCBAs operated in a positive pressure or pressure demand mode offer the best respiratory protection because the pressure in the facepiece prevents you from breathing contaminated air, even if you have a leak. The usefulness of SCBAs is limited by the amount of air that can be carried in the tank on the wearer's back.

There are several different brands of SCBAs on the market. **You must be fit tested and trained to use the specific make and model of SCBA your employer gives you.** Each SCBA will have different checkout procedures and manufacturer's instructions. **Do not attempt to use an SCBA without proper training.**

**Supplied-air respirators (SARs), also known as airline respirators, supply breathing air from a tank or compressor through an airline to the wearer's mask.** For the greatest protection, airline respirators should be used with a full facepiece and operated in a positive pressure/pressure demand mode.

Airline hoses must **never exceed 300 feet** from the air source to the wearer. Supplied-air respirator hoses are a problem when there is any moving equipment. The hose can get cut, run over, or tangled up in equipment. Often hoses are covered with plastic or duct tape to keep chemicals off of them.

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11 In this manual, when we write "SCBA" we always mean a positive-pressure/pressure-demand full-facepiece (modern style) minimum 30-minute SCBA approved by NIOSH. When we write SAR we always mean a positive-pressure/pressure-demand full-facepiece (modern style) SAR with an escape bottle approved by NIOSH.

An escape bottle should always be used with airline SARs in case the hose is cut or damaged. Never go farther into a contaminated area than you can escape from in **five minutes**. Escape bottles, when properly filled, are rated to provide air for 5, 10, or 15 minutes of **normal breathing**.

Compressors used to supply breathing air must meet special requirements. These compressors must be equipped with in-line, air-purifying sorbent beds and filters that are maintained and replaced or refurbished per manufacturer's instructions. The compressor's exhaust must not contaminate the air it supplies. To avoid contamination of the supplied air, locate compressor air intakes in a contaminant-free area. **Compressed breathing air must meet or exceed the following criteria for Grade D breathing** as described in ANSI/CGA G-7.1-1989:

- **Oxygen content of 19.5 - 23.5%;**
- **Hydrocarbon (condensed) content of 5 mg/m3 or less;**
- **CO content of 10 ppm or less;**
- **CO2 content of 1,000 ppm or less; and**
- **Lack of noticeable odor.**

Procedures for protecting hoses and ensuring clean air must be part of your employer's written program.

Sometimes workers need to go into areas that are immediately dangerous to life or health (IDLH). SCBA and SARs with escape bottle are the most protective forms of respiratory protection and the only types allowed in IDLH conditions. **Whenever SCBAs or SARs are used in these areas, there must be a trained worker outside who is in constant contact with the workers inside.** Provisions must be made for rescue.

**After receiving medical clearance**

**Prior to use**

**Following changes in respirator make, model, or size**

**Following changes in physical characteristics affecting fit**

**Annually**

| **Positive pressure SCBAs or SARs with an escape bottle must be used when:** |
|---|
| • Oxygen content of the air is less than 19.5%;<br>• Contaminants and/or its concentration are unknown;<br>• Concentration of the contaminant is IDLH or above the concentration safely handled by a less protective respirator; and<br>• There is an emergency including any of the above conditions. |

**Respirators must fit properly, be worn correctly, cleaned, stored, and maintained to provide the level of respiratory protection indicated by the assigned protection factor.**

A tight-fitting respirator will protect you only if it seals against your face. Faces come in different sizes; so do respirators. The purpose of fit testing is to find the manufacturer/size combination that offers you the best protection. OSHA's respiratory protection standard requires that **users of tight-fitting respirators be fit-tested:**

Weight loss or gain, scars, dentures, dental work, or facial injury can change the way the respirator seals to your face and require another fit test.

Facial hair prevents the respirator from sealing to your face and **wearing or fit testing a tight-fitting respirator is not allowed when facial hair may interfere with the face-to-facepiece seal.**

Section 1910.134(g)(1)(i) of the OSHA General Industry Standards states:

"The employer shall not permit respirators with tight-fitting face-pieces to be worn by employees who have (A) facial hair that comes between the sealing surfaces of the face-piece and the face . . . or (B) any condition that interferes with the face-to-face-piece seal."

OSHA says there cannot be any facial hair between the skin and the facepiece when you use a respirator that relies upon a good face-to-face-piece seal. This includes any tight-fitting (as opposed to helmet or loose-fitting hood) positive pressure respirators.

Even a heavy stubble can prevent a good face-to-face-piece seal. Studies clearly show that facial hair will reduce the protection provided by respirators, particularly negative-pressure respirators. Twelve out of 14 studies reviewed showed that leakage increased 20 to 1,000 times when respirator wearers had facial hair (Stobbe, 1988). Rules about facial hair must be part of your employer's written program.

**Workers must be fit tested with the same make, model, style, and size of respirator that will be used. Fit testing can be either qualitative (subjective) or quantitative (objective measurement with a computer), depending on the respirator.** Procedures for annual fit tests and routine seal checks must be part of your employer's written program.

**Qualitative** and **Quantitative** fit testing are used to find the size and model of respirator you should wear and demonstrate that your face-to-facepiece seal is adequate. These tests must be repeated at least annually to ensure a proper fit and your employer must keep a record of the tests.

## Qualitative (Taste/Smell) Testing

Purpose: Determine whether the seal between the respirator's facepiece and the wearer's face is adequate.

Method: While wearing a respirator you are exposed to a test substance which is an irritant (smoke), has a strong odor (banana oil), or has a sweet or bitter taste (saccharine or Bitrex). If you smell, taste, or detect the substance then your respirator does not fit well and will not protect you.

Requirements: These qualitative methods are OSHA-approved and can be used to fit test tight-fitting respirators as required by 1910.134. These tests can only be used for APRs with an APF of 10 or less and tight-fitting atmosphere-supplying respirators and PAPRs.

Disadvantages: Qualitative fit testing depends on your senses; passing or failing is subjective and determined by the respirator user. Having a poor sense of smell or taste or not following the method may cause you to believe you are protected when you aren't.

Some of the test substances can irritate the eyes or cause coughing. NIOSH recommends against fit testing with irritant smoke because of the associated health risks.

Fit testing is often done in an "ideal" environment that does not reflect real working conditions. Test conditions will not show how a respirator will fit in extreme temperatures or during hard physical work.

### Quantitative (Computer) Testing

Purpose: Measures the effectiveness of a respirator in keeping contaminants from entering the facepiece during a fit test. Quantitative fit tests provide a fit factor to indicate whether the seal between the respirator's facepiece and the wearer's face is adequate. Fit factor means a quantitative estimate of the fit of a particular respirator to a specific individual, and typically estimates the ratio of the concentration of a substance in room air to its concentration inside the respirator when worn.

Method: A probe is added to the respirator facepiece or between the filter and the facepiece. Then an instrument is used to measure particles or air pressure inside and outside the mask. The most common method measures the number of particles in the room and in the respirator mask, compares the two numbers, and calculates a fit factor. The test is repeated while you complete 8 activities (speaking, moving your head, deep breathing, running in place, etc.) that may affect fit. These activities are performed for one minute each except for grimacing (smiling or frowning) which is done for 15 seconds. Grimacing breaks the face to facepiece seal and checks to see if the respirator reseals to the face afterward. The test provides an average fit factor for the 7 one-minute activities.

Requirements: Quantitative fit testing is required by OSHA for all negative pressure respirators with an APF greater than 10 and is a good practice for all respirators. The quantitative fit test must indicate a fit factor of at least 100 for half mask respirators and at least 500 for full facepiece respirators or else the respirator cannot be used.

Disadvantages: The equipment is more expensive to purchase than the equipment required for qualitative fit testing.

## *Respirator User Seal Checks*

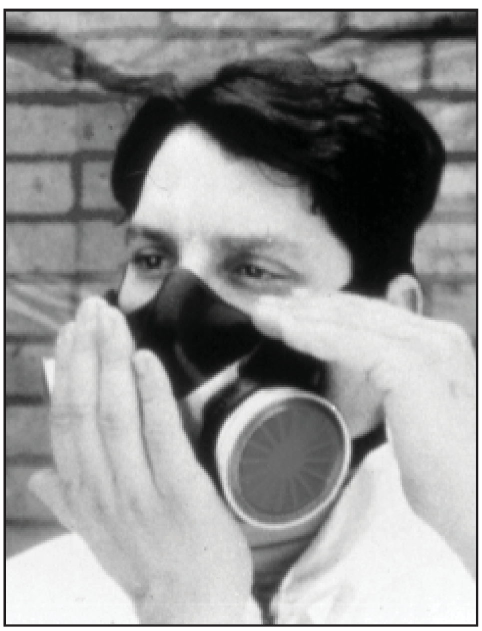
**Both positive-pressure and negative-pressure user seal checks must be done each time you put on a respirator.** These quick checks ensure that the respirator is properly seated on and sealed to your face but do not replace initial or annual fit-testing.

### Positive-Pressure (Exhale) User Seal Check

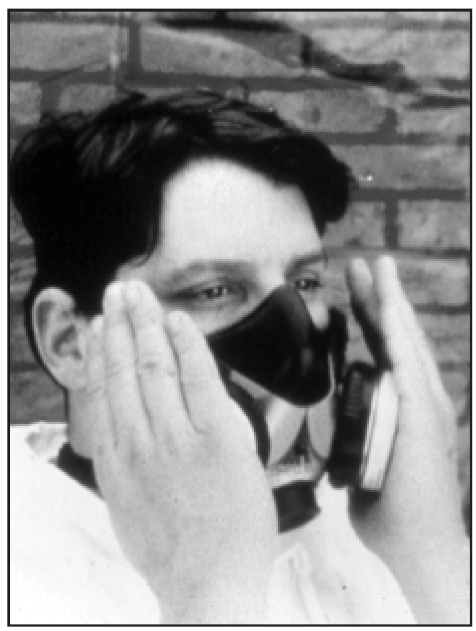
Method: Cover the exhalation (out) valve with your hand and blow out gently. The facepiece should expand but not break the seal. Adjust the respirator to eliminate leaks if necessary, and repeat the process. For a positive pressure respirator, after the air supply is attached, simply hold your breath. You should not hear any air leaking from the mask.

### Negative-Pressure (Inhale) User Seal Check

Method: For an APR, place your hands or latex gloves over cartridges and inhale. For an SCBA or SAR, disconnect the hose at the regulator, cover the end of the hose and inhale. Hold your breath for 10 seconds and check to see that no outside air leaks into the face-piece. Adjust the respirator to eliminate leaks if necessary, and repeat the process.



**Positive Pressure Check**



**Negative Pressure Check**

Positive-pressure and negative-pressure user seal checks can be done quickly and easily in the field.

**Respirators should be inspected before and after each use and, if not used, at least monthly.** Most construction workers are responsible for doing this themselves. Even if someone else is assigned to inspect your respirator, it is a good idea to check for yourself. Procedures for inspecting, maintaining, and storing respirators must be part of your employer's written program. Your employer's policy may include more frequent inspections.

**Inspection for all respirators should include:**

1. Check the condition of the face-piece and all of its parts
2. Check the headbands to make sure that they can be tightened to provide a good fit

**Inspection for SCBAs and SARs should include:**

1. Check the hoses and the points where the hose attaches to the face-piece and to the air tank
2. Check the head and tank harnesses for cracks, tears, or other defects
3. Check the regulator according to the manufacturer's directions
4. Check the air tanks or compressor for damage
5. Report defects or unusual conditions immediately

**Employers must provide each user with a respirator that is clean, sanitary and in good working order. Employers must ensure that respirators are cleaned and disinfected using the procedures in 1910.134 Appendix B-2 or equivalent procedures recommended by the respirator manufacturer.**

**It is a good practice to clean and disinfect respirators after every use. OSHA states that respirators must be cleaned and disinfected:**

- as often as necessary to maintain sanitary conditions when used by one person;
- before being worn by different individuals when issued to more than one employee; and
- after each use for respirators used for emergencies, fit testing, or training.

**Cleaning and disinfecting for all respirators should include:**

1. Inspect each piece
2. Wash/disinfect the respirator components following the manufacturer's instructions
3. Hand-drying with a clean, lint-free cloth or air-drying
4. Reinspect the pieces as they are put back together
5. Store away from dust, sunlight, heat, extreme cold, high humidity, and chemicals

**Cleaning and disinfecting for SCBAs and SARs should include:**

1. Remove the air tank or hoses
2. Inspect each piece
3. Wash/disinfect the face-piece, hose, and harness following the manufacturer's instructions with disinfectant soap and water
4. Hand-drying with a clean, lint-free cloth or air -drying
5. Do not submerge SCBAs in water
6. Follow the manufacturer's specialized instructions

**If you find something wrong with your respirator, do not try to fix it yourself. Find out who is authorized to do repairs in your site-specific respiratory protection program.**

## *Summary: Respirator Protection*

Respirators prevent toxic materials from entering your body through your lungs. When respirators are required, your employer must have a **written respiratory protection program**. You must complete a respirator medical evaluation (questionnaire) and/or exam and **receive medical clearance** from a physician or other licensed health care professional before your fit test.

**Selecting the right respirator and filter or cartridge can be a matter of life or death.** Special considerations in use of respirators include facial hair, eyeglasses, communication, and use in IDLH atmospheres (such as low oxygen or chlorine leaks).

A respirator that filters the air is an **air-purifying respirator** or **APR**. These may be filtering facepiece respirators or elastomeric (rubber) respirators with cartridges or filters. Elastomeric respirators have a facepiece, straps, an exhalation (out) valve, and one or two filters or cartridges where the air enters. Filters remove dusts and particulates, cartridges remove vapors and gases, and some hazards require filters and cartridges to be used together. Your employer must have a change schedule unless the cartridge has an end of service life indicator (ESLI). An APR can only be used if there is enough oxygen in the air.

Situations where you must **not** use an air-purifying respirator (APR) include:

- not enough oxygen (less than 19.5%);
- the chemicals or concentrations of chemicals are not known
- levels of hazardous substances in the air are above the maximum use concentration for the respirator and chemical;
- atmosphere is immediately dangerous to life and health (IDLH); and
- skin hazards where you must wear a fully encapsulating suit.

**Atmosphere-supplying respirators include self-contained breathing apparatus (SCBA) and supplied-air respirators (SARs).**

**SCBA** are the type of respirator firefighters use most often. They can be used in areas with low oxygen, high levels of chemicals, very toxic chemicals, or fires. SCBA have a facepiece, a 30-60 minute tank of air, a pressure gauge, a low-pressure alarm, a regulator, and a safety or bypass valve for use during regulator failure.

**SARs, also known as airline respirators,** have a long hose that supplies air. The long hose must be protected from chemicals and cuts. **If SARs are used in IDLH** situations or for unknown concentrations, a small bottle of air for escape must also be worn.

A tight-fitting respirator is only as good as its fit. You need a fit test before you wear a tight-fitting respirator and at least once a year after that. The two kinds of fit tests are **qualitative** (yes or no) or **quantitative** (computer and instrument provide a number to indicate how good the fit is). Before each use, you must also do positive- and negative-pressure user seal checks.

Respirators do not work well or reliably unless they are properly **cleaned, inspected, and stored**. Respirators must be inspected before and after each use or monthly if not used routinely.

**Important abbreviations related to respiratory protection include:**

| | |
|---|---|
| **APR** | air-purifying respirator |
| **APF** | assigned protection factor |
| **FF** | fit factor |
| **IDLH** | immediately dangerous to life or health |
| **MUC** | maximum use concentration |
| **PAPR** | powered air-purifying respirator |
| **PLHCP** | physician or other licensed health care professional |
| **SAR** | supplied-air respirator |
| **SCBA** | self-contained breathing apparatus |

## Section II – Chemical Protective Clothing (CPC)

After other controls have been used to the extent feasible, PPE provides an important barrier between chemicals or other hazards and your body. Although it cannot eliminate exposures, PPE can reduce exposures when properly selected and worn.

**Chemical protective clothing (CPC) is a type of PPE and protects employees from chemical and physical hazards.** CPC is an important part of a hazardous waste site worker's protective equipment.

Chemical protective clothing includes suits, foot covers, boots, gloves, and hoods that are made of special materials. These materials are chemical-resistant, which means they act as a barrier to keep chemicals from coming in contact with your skin. It is critical to select CPC that is designed to protect against the specific chemicals on your site. Otherwise, you might not be protected, even when you think you are.

**CPC, and other PPE, must be selected based on potential exposures** and explained in the safety and health plan. For example, totally-encapsulating suits may be required for moving leaking drums, whereas non-encapsulating suits may be okay for operating a remote (robot) drum handler. The level of protection provided must be reevaluated as additional site information is gained.

**Suits, respirators, gloves, and chemical protective steel-toed boots are always worn together in an ensemble, or combination. PPE ensembles are selected based on the respiratory and skin risks of the job. OSHA describes PPE ensembles as Level A, Level B, Level C, and Level D, in Appendix B of the HAZWOPER standard (29CFR1926.65).**

| PPE Ensemble Level | Respiratory Risk | Skin Risk |
|---|---|---|
| **A** | High | High |
| **B** | High | Moderate |
| **C** | Moderate | Moderate |
| **D** | Low / None | Low / None |

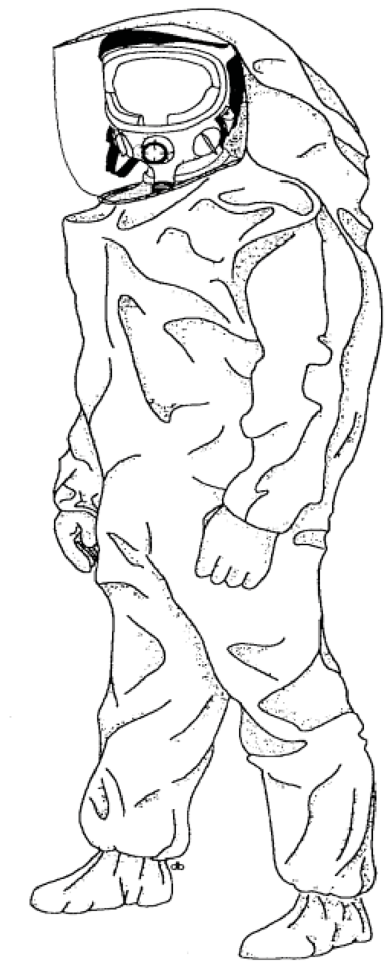
**Chemical protective suits are of two general types, totally-encapsulating or nonencapsulating.**

1. Totally-encapsulating chemical-protective (TECP) suit: Provides head-to-toe coverage to protect the wearer from chemicals. These “moon suits” have special seams and zippers to prevent chemicals from leaking into the suit. They are gas/vapor-tight and have exhalation valves. TECPs are used when the highest levels of skin and respiratory protection are needed. These suits have a face shield that is part of the hood.
2. Non-encapsulating chemical-protective (NECP) suit: Provides good protection from chemicals and may or may not have face shields. These suits are not totally-encapsulating, are not vapor tight, and do not have exhalation valves. They provide less skin protection than vapor tight suits. These suits are used when less skin protection is needed. The hood can either be part of the suit or detached.

Disposable suits, which provide limited protection from chemicals, can be used alone or in conjunction with these chemical-protective suits.

**Level A provides the highest level of skin, respiratory, and eye protection that can be worn by a hazardous waste site worker.**

**The following constitute Level A equipment and may be used as appropriate:**



1. NIOSH-approved positive pressure, full face-piece self-contained breathing apparatus (SCBA), or positive pressure supplied air respirator (SAR) with escape SCBA.
2. Totally-encapsulating chemical-protective (TECP) suit.
3. Built-in outer chemical-resistant gloves and separate inner chemical-resistant gloves.
4. Chemical-resistant boots with steel toe and shank.
5. Disposable protective suit, gloves, and boots (worn outside the Level A suit to protect the expensive suit).*
6. Coveralls.*
7. Hard hat (under suit).*
8. Long underwear (to absorb sweat).*

*** Optional depending on conditions**

**Note:** With SAR, the suit must be properly equipped with a pass-through air-line connection, called an air-line egress.

**Level A should be worn when:**

1. The identified substances require the **highest level of protection for the skin, eyes, and respiratory system;**
2. There is potential for splash, hand or foot, immersion, or other **skin contact** with substances that may harm or be absorbed through the skin; or
3. Working in confined, poorly ventilated areas, and the chemicals present or their concentrations are **unknown**.

**Level B provides the highest level of respiratory protection, but a lesser degree of skin and eye protection than Level A. Level B is the minimum acceptable level for initial entry.**

**The following constitute Level B equipment and may be used as appropriate:**

1. NIOSH-approved positive pressure, full face-piece self-contained breathing apparatus (SCBA), or positive pressure supplied air respirator (SAR) with escape SCBA.
2. Non-encapsulating chemical-protective (NECP) suit. Hooded chemical-resistant clothing (overalls and long-sleeved jacket; coveralls; one or two-piece chemical-splash suit; disposable chemical-resistant overalls) - **not vapor-tight.**
3. Inner and outer chemical-resistant gloves.
4. Chemical-resistant boots (outer) with steel toe and shank.
5. Boot covers: outer, chemical-resistant (disposable).
6. Disposable protective suit or coveralls and gloves (worn outside the Level B suit to protect the expensive suit and gloves).*
7. Hard hat.*
8. Face shield. *
9. Long underwear (to absorb sweat).*

A Level B suit that covers the SCBA would reduce equipment contamination

*** Optional depending on conditions**

**Level B should be worn when:**

1. The type and concentration of substances in the air have been identified and require a high level of respiratory protection, but less skin protection.
2. The atmosphere contains less than 19.5 percent oxygen; or
3. Incompletely identified vapors or gases are present but not suspected of containing high levels of chemicals harmful to skin or capable of being absorbed through the skin.

**Note:** This involves atmospheres with IDLH concentrations of specific substances that present severe inhalation hazards and that do not represent a severe skin hazard; or that do not meet the criteria for use of air-purifying respirators.

**Level C provides less respiratory protection than Levels A and B and less skin protection than A.** It may or may not provide the same skin protection as Level B, depending on the type of suit worn.

**The following constitute Level C equipment and may be used as appropriate:**

1. NIOSH-approved air-purifying respirator (APR), full-face or half-mask.
2. Hooded chemical-resistant clothing (overalls; two-piece chemical-splash suit; disposable chemical-resistant overalls).
3. Inner and outer chemical-resistant gloves.
4. Coveralls.*
5. Chemical-resistant boots (outer) with steel toe and shank.*
6. Boot covers: outer, chemical-resistant (disposable).*
7. Hard hat.*
8. Escape mask.*
9. Face shield.*

*** Optional depending on conditions**

**Level C should be worn when:**

1. The types and concentrations of airborne substances are known and there is at least 19.5% oxygen in the air;
2. A sufficient APR is available and all criteria for use have been met; and
3. Direct contact with the hazardous substance will not harm the skin or be absorbed through the skin.

**Level D provides no respiratory protection and little or no skin protection.** It is for people who work outside of the hazardous waste area. Level D protection is typically worn by workers involved with support activities such as equipment supply, maintenance, or off-site vehicle operation. Level D is similar to "typical work clothes" except for chemical-resistant boots with steel shank.

**The following constitute Level D equipment and may be used as appropriate:**

1. Coveralls (work clothing).
2. Chemical-resistant boots or shoes with steel toe and shank.
3. Hard hat.*
4. Gloves.*
5. Outer, chemical-resistant boots (disposable).*
6. Safety glasses or chemical splash goggles.*
7. Face shield.*
8. Escape mask.*

*** Optional depending on conditions**

**Level D should be worn when:**

1. The atmosphere contains no known hazards; and
2. The work will not involve getting chemicals on the skin or inhaling hazardous levels of any chemicals.

**Remember, CPC ensembles must be selected based on the level of respiratory and skin protection required.** Combinations of personal protective equipment other than those described for Levels A, B, C, and D protection may be more appropriate and may be used to provide the proper level of protection.

| CPC Ensemble Level | Respirators | Skin Protection | Protection From |
|---|---|---|---|
| **A** | SCBA or SAR | TECP suit, chemical-resistant gloves & boots | High respiratory and skin hazards and unknowns |
| **B** | SCBA or SAR | NECP suit, chemical-resistant gloves & boots | High or unknown respiratory and moderate skin hazards |
| **C** | APR or PAPR | NECP suit, chemical-resistant gloves | Moderate respiratory and skin hazards |
| **D** | None | Optional gloves | No respiratory hazards and minimal skin hazard |

## CPC Selection Guidelines

**Chemical resistance:** Different materials are resistant to different chemicals. Even water can breakdown some materials. CPC must provide protection against the chemicals likely to be at the site. This is true for whole-body as well as hand and foot protection.

**Durability:** In addition to exposure to chemicals, CPC will be subject to stretching, contact with rough surfaces and sharp objects. CPC must be durable enough to be used without being torn, punctured, or abraded.

**Resistance to temperature extremes:** Heat and cold can often damage CPC. Clothing which will be worn in cold temperatures could crack or become ineffective against chemicals. Likewise, heat may destroy the chemical resistance of clothing or even melt it. Always check the manufacturer's information about temperature damage.

**Ability to be cleaned:** Clothing must either be decontaminated or disposed of after each use.

**Cost:** CPC is expensive, but buying less expensive, inferior products which do not adequately protect employees can be more expensive in the long run due to increased medical costs and lost work time.

**Flexibility:** Materials need to be flexible enough for the wearer to move and work safely. Overly rigid suits can result in unnecessary accidents from slips, trips, and falls. Gloves which are too rigid can make gripping difficult and lead to other hazards.

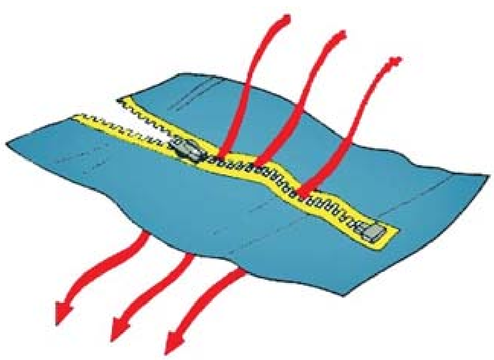
**Heat stress and thermal comfort:** CPC's contribution to workers' heat stress must be considered, monitored, controlled, and balanced against the need to provide protection from chemicals.

**Size:** CPC should be available in a variety of sizes to accommodate different sized workers. Suits that are too small will tear easily and provide no protection. Suits that are too large will make walking and working difficult. Safety boots that are too big will result in a tripping hazard and reduced comfort. Gloves that don't fit well make using equipment difficult and dangerous.

**Chemical protective clothing's ability to protect us depends on:**

- Contact time
- Concentration
- Presence of chemical mixtures
- Temperature
- Size of the contaminant molecules and pore size of the CPC material
- Physical state (solid, liquid, gas) of the chemical contaminants

**Penetration** is the movement of a chemical through openings in CPC. Zippers, stitched seams, abrasions, punctures, tears, or other openings in the CPC material can contribute to penetration.



**Degradation** is the physical deterioration of the protective material and reduces chemical resistance. High temperature, sunlight, inappropriate storage environments, and chemical exposure can contribute to degradation.. Signs of degradation are not always visible and include discoloration, blistering, brittleness, softening, cracking, swelling, and shrinking.

**Permeation** is the movement of a chemical through a protective material on a molecular level (invisible). Breakthrough time is the amount of time required for a chemical to permeate, or pass through, a material.

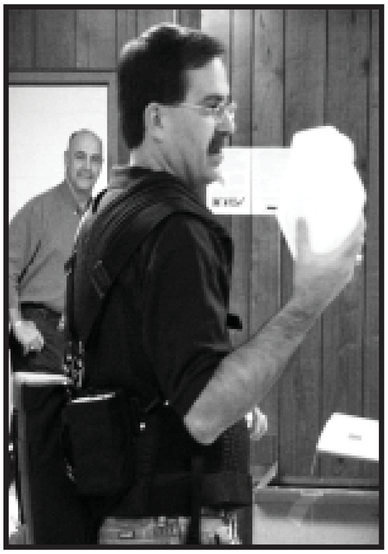
Materials used to make most PPE and suits do not “breathe”, causing rapid heat and moisture build-up inside the PPE. **Wearing PPE makes it difficult for the body to cool itself and adds to heat stress. This leads to discomfort and possibly heat-related illnesses including:**

- Heat exhaustion
- Heat cramps
- Heat rash
- Heat stroke

**The safety and health plan should address preventing heat-related illnesses with procedures for:**

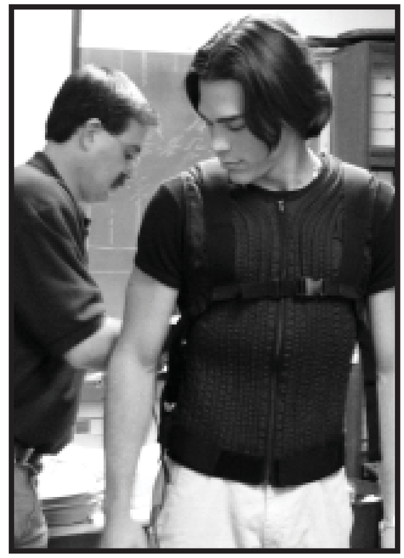
- Monitoring forecasts and weather conditions
- Acclimatizing workers to working in a hot work environment
- Implementing a work-rest schedule
- Providing water and shade and ensuring they are used
- Identifying and responding to heat-related illnesses

**Wearing cool suits and vests while wearing protective clothing keeps workers cool.**



Instructor with Cool Suit vest and a frozen H2O bottle

A closer view of the vest, bottle carrier (r), pump priming bulb (m), and battery pack (l)



Front view of the Cool Suit vest & sternum strap

It is important to **inspect** CPC for evidence of chemical or physical damage. Instructions for inspection, maintenance, and storage should be in the site safety and health plan.

**CPC should always be inspected when it is:**

1. Received from the distributor
2. Issued to workers
3. Put into storage
4. Taken out of storage
5. Used in training
6. Used for work or an emergency response
7. Received following maintenance or repair

**An inspection checklist should be developed for each item. CPC inspection checklists should consider:**

1. Weakness in zipper or valve seals
2. Cuts, holes, tears, swelling, and abrasions in seams of fabric
3. Signs of contamination such as discolorations or visible stickiness
4. Signs of malfunctioning exhaust valves
5. Improper storage

**Note:** CPC may be contaminated even though it does not appear discolored.

Proper **maintenance** and **storage** can prevent problems with CPC and prolong the life of the equipment. SOPs should describe storage before the CPC is issued to the wearer and also post-use storage. Check manufacturer's data, as most CPC has a shelf life.

**Chemical-protective clothing has limitations:**

1. Fully encapsulating suits **make communication very difficult.** It is important to establish other ways to communicate. Learn the alarm and hand signals used on your site. Two-way radios, portable radios, or radios with a microphone and speaker combination attached to the full-face respirator are recommended. Remember, all radios must be intrinsically safe when working in a potentially explosive atmosphere.
2. Most suits **restrict movement and increase clumsiness**, especially when climbing, working in tight areas, or using hand tools.
3. PPE, especially TECPs, **increases heat stress and the risk of heat-related illnesses.** Heat stroke is a serious threat. Watch for signs of dizziness, nausea, and lack of perspiration, especially at temperatures over 70°F.
4. Disposable **boot covers may be slippery.** Use caution to prevent slips and falls.
5. Suit-to-boots and suit-to-glove **joints on Level B and Level C suits should be taped.** Fold the end of the tape back under to make a tab for easy removal (See image to the right). Use special care when removing tape as adhesive tape can damage the suit material.

6. **Goggles and eye/face protection may become clouded** due to moisture from breathing. When wearing Level A, you may want to keep a cloth inside the suit to wipe fog off the inside of the face shield.
7. **Kneeling can contaminate and tear the suit.**
8. **Seams are weak points,** especially in disposable suits. Be careful not to strain and split them. If this occurs, report the incident and follow the appropriate SOP.
9. **Use caution when suits are worn in potential fire areas. Most suits offer no fire protection** and may increase the possibility of injury because they melt. If fire occurs, get out of the area. Special fire retardant suits may be worn over your CPC, but this makes movement more difficult and greatly increases heat stress.

### *Other Protective Clothing and Equipment*

The situation and potential exposures determine the PPE needed. For example, chemical-resistant gloves, face shield/goggles, and aprons can be used with Level D when there are no respiratory hazard present but some skin hazards exist.

A number of operations at hazardous waste sites result in a substantial noise exposure and require the use of hearing protection. When required, a hearing conservation program must be implemented **(29CFR1926.52 and 29CFR1910.95)**. The employer must provide a selection of hearing protection for you to choose from **(29CFR1926.101 and 29CFR1910.95)**.

### *Summary: Chemical Protective Clothing*

**Personal protective equipment (PPE)** includes respirators, chemical-resistant suits, steel-toed boots, gloves, hard hats, and hearing protection. PPE is required by OSHA regulations and protects workers from:

- chemical contact with skin and eyes
- noise
- respiratory hazards
- sharp objects underfoot
- falling objects

Chemical protective clothing and other PPE expose wearers to **heat stress** because heat, moisture, and air do not move through them well, or at all. Heat stress can lead to symptoms including severe fatigue, nausea, chills, dizziness, confusion and heat-related illnesses including heat exhaustion, fainting, heat cramps, heat rash, and heat stroke. Anyone experiencing these symptoms or suspected of having these conditions should receive **immediate medical attention.**

Suits are made of many different kinds of **materials**, including butyl, neoprene, and polyethylene. No one material can stop all chemicals. All chemicals will eventually soak through the material (permeate), move through the seams (penetrate), or damage the material (degrade).

Suits, respirators, several pairs of gloves, and chemical protective steel-toed boots are always worn together in an **ensemble**. The PPE ensemble used must be selected based on the respiratory and skin hazards present or anticipated.

**Level A** is for gases, mists, or vapors that may burn the skin or spills of chemicals that can soak through the skin. It provides the most protection and includes:

- an SCBA (or supplied-air respirator with escape unit).
- a **gas-tight,** totally-encapsulating chemical-protective suit with gloves and foot coverings built in.

**Level B** is for high levels of gases or small spills of chemicals that can soak through the skin. It includes:

- an SCBA (or supplied-air with escape unit).
- a full-body chemical-protective suit that is not gas-tight
- gloves and boots

**Level C** is for known, low levels of gases, dusts, or spills of chemicals that cannot soak through the skin. It includes:

- an air-purifying respirator (APR).
- hooded, chemical-resistant clothing.
- gloves and boots.

PPE must be properly **cared for, maintained, inspected, and stored.** Wearers should know the uses and limitations of PPE. Written programs about selection, care, and use of PPE should be included in or referenced in the safety and health plan.

## Background Reading Material and Resources: Personal Protective Equipment

*Occupational Safety and Heath Guidance Manual for Waste Sites*
1989. (NIOSH # 85-115)
Chapter 8 — Personal Protective Equipment, p. 1-24
Appendix D — Decontamination of Levels A, B, C

EPA's *Standard Operating Safety Guides,* July 1988.
Part 5 — Site Entry—Levels of Protection, p. 1-14
Part 7 — Decontamination, p. 9-11 and Annexes

*Hazardous Waste Operations and Emergency Response Standard*
*Federal Register, Final Rule.* March 6, 1989. (29CFR1926.65)
Personal Protective Equipment
Personal Protective Equipment Program
Engineering Controls, Work Practices and Personal Protective Equipment for Employee Protection

*Ergonomic Criteria for the Selection of Chemical Protective Clothing,* J.O. Stull, Washington D.C., Workplace Health Fund, 1991

Notes:

Notes:

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# Chapter 6: Work Practices and Site Control

Workers' exposures to hazards at a waste site are controlled using engineering and administrative controls and personal protective equipment (PPE), in that order. Engineering controls are the most effective way to reduce workers' exposure. Personal protective equipment does not control the source of exposure, but it does reduce the amount of substance reaching the body.

Safe work practices are vitally important to protect the workers' safety and health. Standard operating procedures (SOPs) are written instructions for safe work practices. Safe work practices can minimize exposure for workers, the environment, and nearby communities. Each site's SOP contains written instructions for safe work practices.

**Chapter Objectives:**

After completing this module, you will be able to:

1. Recognize what information is needed about the work site before cleanup work begins.
2. Obtain information from a site-specific health and safety plan.
3. Explain terms used when talking about hazard controls. For example "site map," "buddy system," "communication systems," "work zones," and "site control."
4. Recognize when unsafe methods are being used.
5. Explain the five approaches to controlling hazards.

## Case Study

Workers were assigned to cut apart an empty 500-gallon tank. A mixture of benzene, xylene, and toluene had been drained out of the tank and there was no liquid inside. Everything was going fine when they were cutting on the outside of the tank, but once they cut through the metal there was a giant roar and flames shot out of the top of the tank. Luckily, it was a flash fire that went out quickly and no one was hurt. **Why did this happen?**

Some of the chemical vapors were left in the tank and caught fire. In this chapter you will learn about how to do the work safely to prevent this kind of problem.

**There is no single description of a hazardous waste site.** The contaminants, size of the site, duration of cleanup, and other aspects of hazardous wastes sites vary widely. For example, a hazardous waste site could be a military base contaminated with heavy metals, an abandoned industrial facility contaminated with chlorinated solvents, a chemical spill on a highway, or a chemical plant following an explosion.

**Site characterization and analysis identifies the safety and health hazards on a hazardous waste site so that they can be controlled.** Site characterization must be done before cleanup begins on a hazardous waste site and conditions must be monitored after site characterization to detect changes. --29CFR1926.65(c)

**Experts must determine:**

1. What chemicals or hazardous wastes are at the site
2. How much of each hazardous substance is on site
3. Chemical and physical properties of the hazardous substances
4. Safety and health hazards on the site
5. Appropriate controls, including PPE, to protect employees from the hazards

**Hazardous waste site characterization and analysis requirements can be divided into seven parts.**

## *Part 1: Required Information*

**Before workers can enter a site, the following information must be obtained:**

1. Location and approximate size of the site
2. Description of the tasks to be performed
3. Time required to do the tasks
4. Site layout and accessibility by air and roads
5. Safety and health hazards expected at the site
6. Pathways for movement of released hazardous substances
7. Capabilities of emergency response teams
8. Expected hazardous substances and their chemical and physical properties

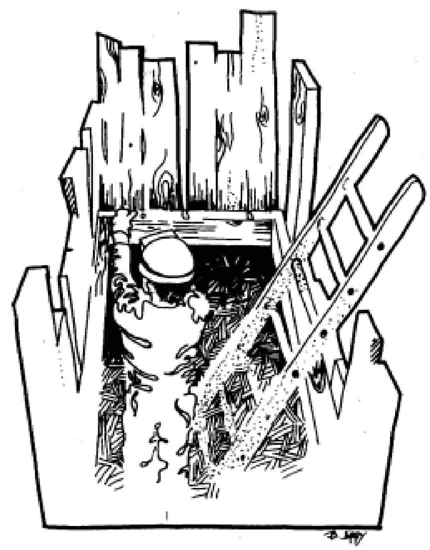
## Potential Hazards

| Chemical | Biological |
|---|---|
| • Acids<br>• Bases (caustics)<br>• Solvents<br>• Chemical hazards may be in the form of gases or vapors, liquids, solids, dusts, and fumes | • Bacteria - *Salmonella*<br>• Parasites - ticks, chiggers, mites<br>• Plants - poison ivy, poison oak<br>• Animals - snakes, rodents, wild dogs<br>• Viruses - AIDS, hepatitis<br>• Animal waste - hanta virus, psittacosis, histoplasmosis |
| **Physical** | **Physiological or Psychological** |
| • Radiation<br>• Noise<br>• Vibration<br>• Electricity<br>• Temperatures - heat and cold<br>• Slips, trips, falls<br>• Punctures - needle sticks<br>• Trenches and excavations<br>• Confined spaces<br>• Utilities (above and below ground)<br>• Site run-off | • Claustrophobia (fear of closed or narrow spaces)<br>• Acrophobia (fear of heights)<br>• Monotonous jobs<br>• Disorientation in PPE<br>• Anxiety (fear of hazardous waste)<br>• Fatigue<br>• Dehydration |

## *Part 2: Personal Protective Equipment (respirator, suits, gloves, etc.)*

**Personal protective equipment must be provided for workers engaged in initial site entry.** If this initial survey cannot establish airborne concentrations, all employees must use a high level of protective gear called Level B or higher (see Chapter 5). **Once further information on the hazards is available, the protective equipment will be reevaluated by the health and safety specialist and adjusted to be more or less protective.**

## *Part 3: Preliminary Evaluation--History and Background*



**The preliminary site evaluation determines the level of protection to be worn by the entry team.** Information is obtained prior to the initial entry through observations and monitoring from the perimeter, interviews, and review of records, Safety Data Sheets (SDSs), and other documents regarding materials at the site.

After the preliminary evaluation, the entry and back-up teams evaluate the site's specific characteristics to identify existing hazards and help select the appropriate engineering controls and personal protective equipment for the tasks to be performed. **Until contaminant concentrations are known, Level B is the minimum level of PPE required for entry and back-up teams.**

## *Part 4:  Hazard Identification--A List of Dangers*

**Hazard identification documents all conditions that may cause death or serious harm, including those that may pose inhalation or skin absorption hazards that are immediately dangerous to life or health (IDLH).** Hazards include but are not limited to confined spaces (including trenches and low spots), potentially explosive or flammable situations, and other construction hazards (falls, electrocution, noise, etc.).

Some of the dangers on a hazardous waste site are the same as on a regular construction job, and some of them are different.  Even the simplest task can become hazardous while wearing a respirator and other PPE.

## *Part 5: Monitoring--Air Tests and Chemical Samples*

**Monitoring must be conducted during the initial entry when the site evaluation shows the potential for IDLH conditions or ionizing radiation or if the evaluation provides insufficient information to eliminate the possibility of these conditions.** Hazardous levels of ionizing radiation are measured with direct-reading instruments. Direct-reading instruments are also used to identify IDLH conditions such as flammable or explosive atmospheres, oxygen deficiency, and toxic substances.

**In addition to the monitoring required for initial entry, periodic monitoring is required when there is a possibility that exposures may exceed the Permissible Exposure Limits.** Additional monitoring may be required when work begins in a different area, when work involves new contaminants, when different task are performed, or when working with obvious contamination.

## *Part 6: Risk Identification--How Great Are the Dangers?*

**Once hazards (specific hazardous materials or conditions) are identified, the risks associated with these hazards must be determined.** Employees must be informed of any risks, including:

- Exposures exceeding OSHA PELs or other occupational exposure limits recommended by NIOSH or ACGIH;
- IDLH concentrations;
- Potential sources of skin and eye irritation or absorption;
- Explosion and flammability risks; and
- Oxygen deficiency or enrichment.

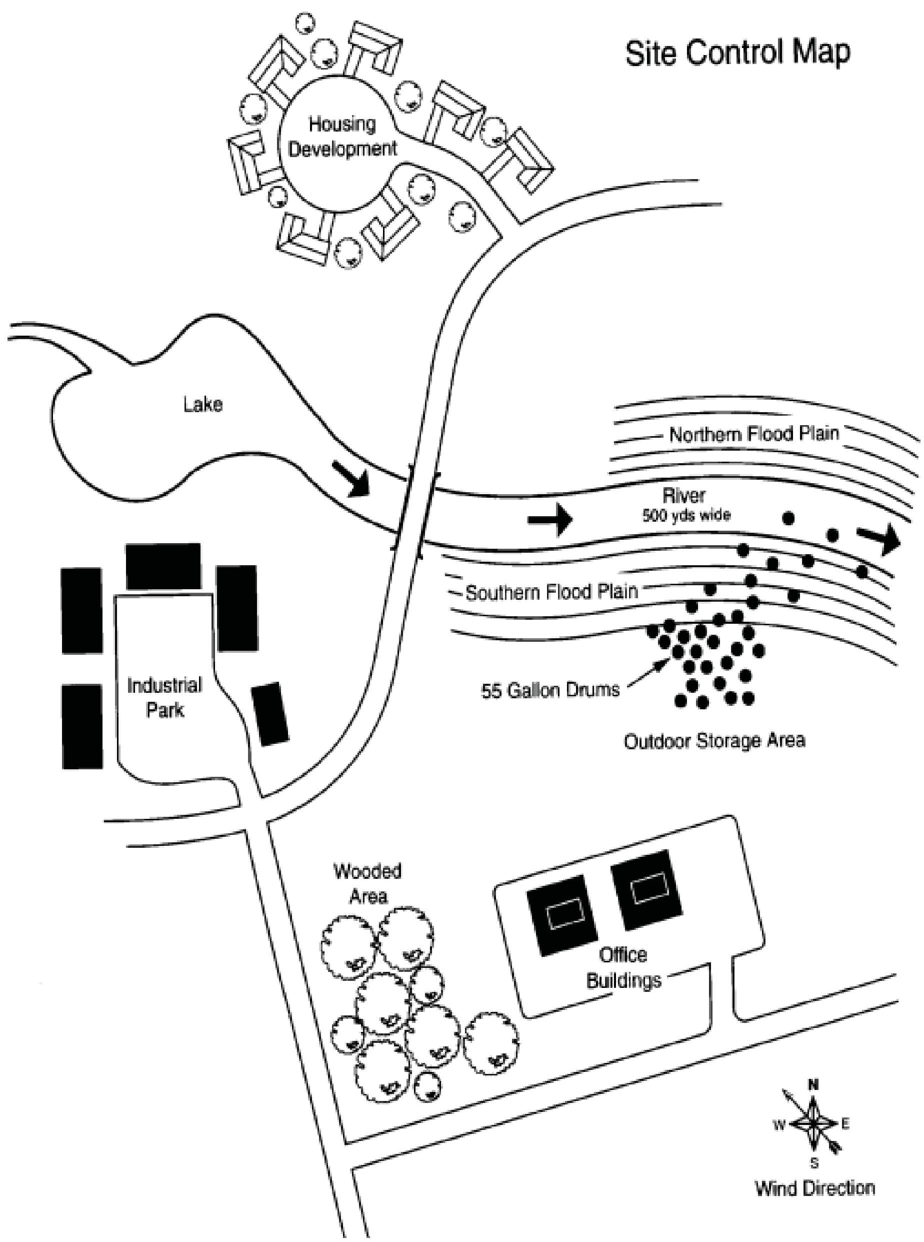
## *Part 7: Worker Notification*

**Before work begins, each site worker must be told about the substances known or expected to be present on the site.** The employer must make information including chemical and physical properties and health effects available to workers so that they understand the hazards of doing their job.

**A site control program for protecting employees must be implemented before cleanup begins on a hazardous waste site.--1926.65, Paragraph (d)**

| The program must include: | | | | | |
|---|---|---|---|---|---|
| Site maps | Work zones | Use of a "buddy system" | Site communications | Standard operating procedures | Location of the nearest medical assistance |

**A site map should show the lay of the land, prevailing wind direction, drainage, and the location of buildings, containers, impoundments, pits, ponds, and tanks. Site maps are helpful for planning PPE use, assigning personnel to work zones, and identifying evacuation routes.** A site map should be modified during work to reflect changes in activities. Computer software or clear overlays can be used to help prevent information from cluttering the map.



**Most hazardous waste sites have three work zones: Hot, Warm, and Cold.**

**The hazards, potential for exposure, and level of personal protective equipment needed is different for each zone. These zones are used to control the spread of hazardous substances, restrict the number of people in high-risk areas, and to ensure that the people in each area have appropriate training and PPE.** You may hear each zone called several different names.

**The Hot Zone, or Exclusion Zone, is the contaminated area and presents a high potential for exposure to hazards.** Personnel working in this area wear the highest level of PPE required on the site. Workers must be decontaminated every time they leave the Hot Zone.

Activities performed in the Hot Zone include:

- Site characterization (e.g., mapping, photographing, sampling);
- Installation of wells for ground water monitoring or treatment; and
- Clean-up work such as drum movement and staging.

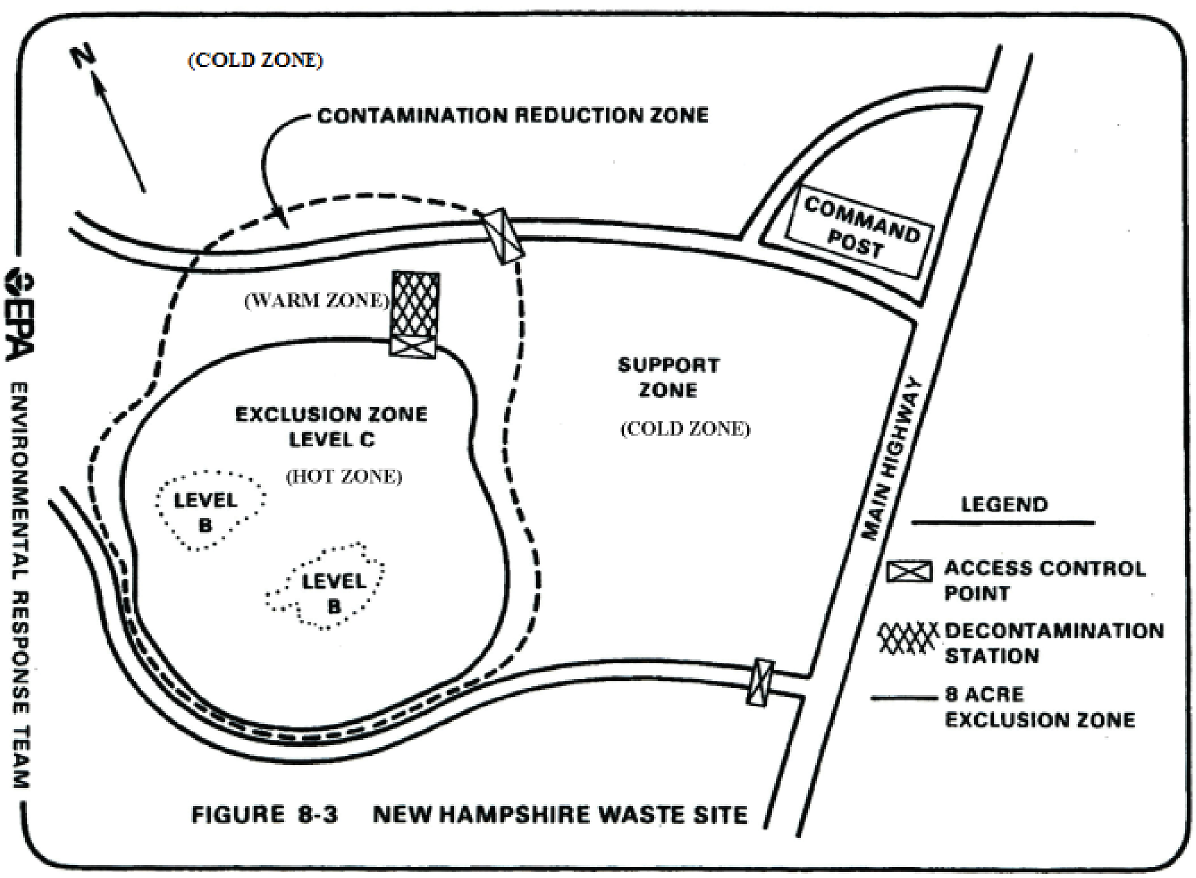
**The boundary between the Hot Zone and Warm Zone is called the hot line.** It must be clearly marked by lines or hazard tape or enclosed with physical barriers such as chains, fences, or ropes.

**The Warm Zone is between the Hot and Cold Zones and where decontamination activities take place.** The site safety officer, personnel decontamination station operator, and emergency response personnel are usually stationed in the Warm Zone. Equipment, supplies and workers' rest areas are also located here. The Warm Zone, or Contamination Reduction Zone, contains the Decontamination Line or Contamination Reduction Corridor. The decontamination line is made up of a series of stations, arranged in order of decreasing contamination, that reduce contamination. Personal protective equipment and clothing are removed and decontamination procedures take place in the warm zone to prevent the transfer of hazardous substances to cleaner areas. There are often two Decontamination Lines; one for workers and, if necessary, one for heavy equipment, tools, and machinery. Decontamination will be discussed in detail in Chapter 7.

**The Contamination Control Line is the boundary between the Cold and the Warm Zone.** Everything located outside of the Contamination Control Line is in the Cold Zone.

**The Cold Zone, or Support Zone, is free of contamination and personnel should have no exposure.** The command post supervisor, project team leader, and support field team members are usually stationed in the Cold Zone. The location of the Cold Zone is chosen for accessibility (emergency vehicles), resources (power lines, water, shelter), visibility (line of sight to the Hot Zone), wind direction (upwind of the Hot Zone), and distance (as far from the highest hazard as practical).

**A Typical Arrangement of the Three Work Zones**



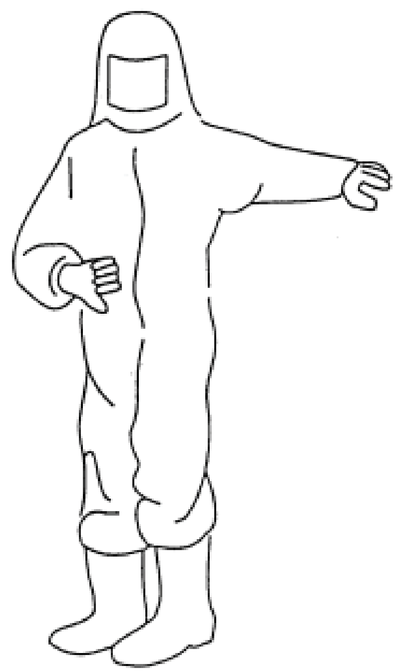

**Hazardous waste workers must always use the buddy system and work in teams of two or more.** The "buddy system" requires teams of workers to watch out for each other's safety and health.

A buddy provides assistance, observes his or her partner for signs of chemical exposure or heat stress, periodically checks the partner(s)' PPE, and notifies the command post supervisor if help is needed.

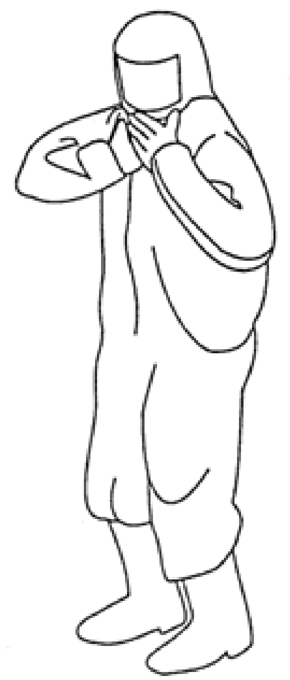
**Buddies should maintain line-of-sight contact and communication with each other and the command post supervisor.** Workers must make sure that hand signals are understood before entering the Hot Zone.

**Communication systems need to be established prior to the start of work** so that team members can alert each other to emergencies, pass along safety information (i.e., time available in air cylinder), initiate changes in work tasks, and maintain site control. **The system must address communication with individuals on the site and at other locations (for example, with emergency responders).** Internal communication systems include 2-way radios, walkie-talkies, audio and visual alarms, hand-signals, and cell phones. External communication systems include telephone, computer or email, 2-way radios, audio and visual alarms, including sirens, horns, flags or pennants, and strobe or other flashing lights. Any communication device that is electric or electronic must be intrinsically safe. Flares and smoke should only be used in the Cold Zone. **Site-specific training on communication and warning systems is required. Some common hand signals are shown on the following page.**

In trouble and need help getting out of suit!



Task cannot be completed with remaining air.



Out of air!

**This is an example of a basic communication plan**

Channel 2 has been designated as the radio frequency for personnel in the Hot Zone. All other on-site communications will be on channel 3.

Personnel in the Hot Zone should remain in constant radio communication or within sight of the Project Team Leader. Any failure or radio communication requires an evaluation of whether personnel should leave the Hot Zone.

A horn blast is the emergency signal to indicate that all personnel should leave the Hot Zone. In addition, a loud speaker is available if required.

The following hand signals will be used in case of failure of radio communications:

Hand gripping throat = Out of air, cannot breathe
Grip partner's wrist or hands around the waist = Leave area immediately
Hands on top of head = Need assistance
Thumbs up = OK, I'm All right

Telephone communication to the Command Post should be established as soon as possible. The phone number is 555-555-5555.

**Nearby medical facilities must be identified before cleanup begins on a hazardous waste site.** The facility should be made aware of the cleanup activities and procedures for requesting medical assistance. All employees must be informed of the location the medical facility and how to notify them in the event of an emergency or when treatment is needed. The location of the nearest prepared medical facility and notification procedures must be included in the site control plan.

## Safety and Health Program

**OSHA** [29CFR1926.65(b)] **requires a safety and health program. The program must be written and identify, evaluate, and control safety and health hazards and provide for emergency response** at hazardous waste sites. The written safety and health program and the site-specific safety and health plan, contained in the program, must be kept on site and available to anyone involved with the hazardous waste operation.

**The safety and health program must describe:**

1. An organizational structure for the operation;
2. A comprehensive workplan;
3. A site-specific safety and health plan;
4. The safety and health training program;
5. The medical surveillance program;
6. The standard operating procedures for safety and health; and
7. Any connection between the general program and site-specific activities.

**The organizational structure section of the program must describe lines of authority** (who reports to whom), **responsibilities of supervisors and employees, and communication between all personnel involved in the cleanup operation.** This information must be in writing and covered during the site-specific training. The lines or authority or organizational chart must identify a general supervisor who has overall responsibility and authority for clean-up activities. This section must also identify the safety and health supervisor who develops the site safety and health plan and makes sure it is followed. The components of the organizational structure section should be reviewed and updated as necessary to ensure that they are accurate and effective. Site-specific training is needed whenever there is a change in work location or process.

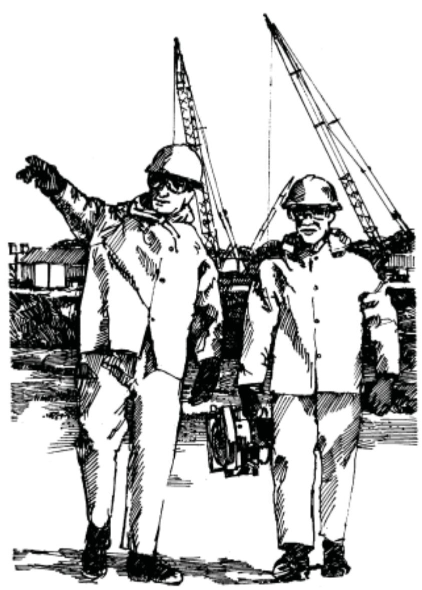
**The comprehensive workplan must include activities, logistics, and use of resources.** The comprehensive work plan should be reviewed during the site-specific training. The work plan must include specific details about:

- The tasks to be done;
- How they will be done;
- Who will do them;
- What equipment and resources will be needed;
- What training will be needed; and
- What medical tests will be needed.

**How are hazardous wastes cleaned up?**

Just as there is no single description of a hazardous waste site, there isn't one universal cleanup method. In the early days of hazardous waste cleanup, rusty barrels of chemicals were put into new drums and buried again in pits lined with plastic sheets. Tons of contaminated dirt were also dumped over the drums in these "safer" landfills. In 1984 EPA made it illegal to put hazardous waste in common landfills (the land ban). Since that time, scientists have been coming up with new ways to treat hazardous waste and to clean up water or soil. **Treatment methods include:**

**Free-product recovery** - Pump pools of waste out of the ground. The waste has to be treated with one of the methods below or the chemical may be purified and reused.



**Filtration** - Filter out solid hazardous waste from water with sand beds or other filters. The waste has to be treated with one of the methods below.

**Incineration** - Burn the hazardous waste in a high-temperature incinerator.

**Solidification** - Mix waste with cement and ashes to turn it into a solid block that can be buried in a regular landfill.

**Chemical decontamination** - Wash buildings or pipes or treat waste with chemicals to remove, transform, or neutralize the contaminant. The resulting solution may need to be treated with one of the above methods before disposal.

**Mechanical decontamination** - Scrape, blast, or grind buildings to remove chemicals. Sometimes special peel-off coatings are used. The dust and debris has to be treated with one of the above methods.

**Dismantling** - Cut machines or building components apart with saws, cutters, grinders, torches, explosives, or water jets. Dust must be treated with one of the above methods.

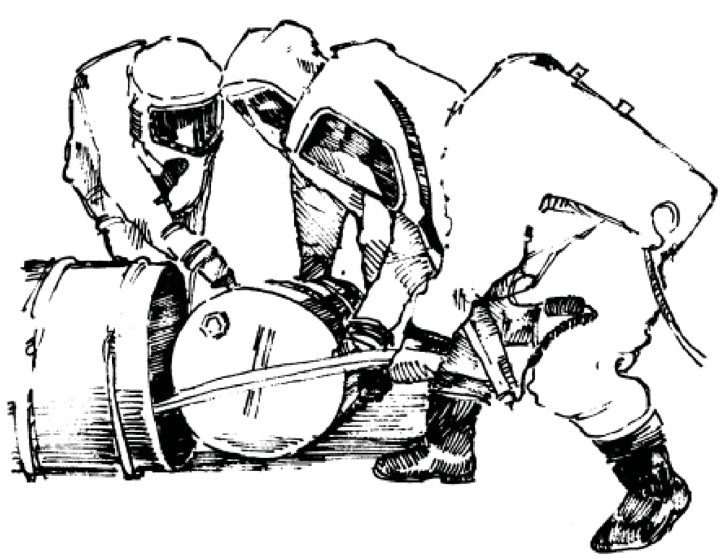
**These treatment methods can cause serious health and safety problems without the proper precautions and controls.**

**The site-specific safety and health plan addresses the hazards during each phase of the work and the procedures and controls required to protect workers.** To the extent possible, the plan should be detailed enough to avoid language that is generic or requires interpretation. The site-specific safety and health plan should be used as a planning guide before site work begins and a reference tool throughout the site work. When new information is obtained during site inspections, the plan should be updated. Each of the following topics must be covered:

- Safety and health hazard analysis for each task or operation
- Employee training
- Personal protective equipment
- Medical surveillance
- Air monitoring
- Site control
- Decontamination
- Emergency response
- Confined-space entry
- Spill-containment

Under the OSHA standard [29CFR1926.65(e)], t**raining must be provided for all hazardous waste workers who are exposed to hazardous substances, health hazards, or safety hazards.** Supervisors and management responsible for the site must also receive training. All hazards at a site and methods which will be used to control them must be described in writing. The safety and health program must address on-site training. Training should include the following as required based on the job description:

- Names of personnel and alternates;
- Safety and health hazards present;
- Use of personal protective equipment;
- Safe work practices;
- Engineering controls and equipment;
- Medical surveillance, including recognition of symptoms which may indicate overexposure;
- Decontamination;
- Emergency response;
- Confined-space entry; and
- Spill-containment program.



**General site workers must have a minimum of 40 hours of instruction and a minimum of three days of site-specific training** under the direct supervision of a trained, experienced supervisor. Supervisors are required to complete the 40-hour general program, three site-specific training days, and an additional 8 hours of training designed for managers. Treatment, storage and disposal (TSD) facility workers and workers on site for a specialized operation must have a minimum of 24 hours of instruction and a minimum of one day of site-specific training.

**Eight hours of refresher training is required every year for all site workers and supervisors.** Workers who will assist with emergency response (ER) activities must receive site-specific ER training.

**The medical surveillance program must provide for monitoring of workers' health before, during employment, and at the end of employment** (if the last exam was more than 6 months before the job ends). **The medical surveillance program must be provided by the employer for the following employees:**

- All employees who are or may be exposed to hazardous substances or health hazards at or above the PEL or another published exposure level (if no PEL) for 30 days or more a year;
- All employees who wear a respirator for 30 days or more a year or as required by 1910.134;
- All employees who are injured, become ill, or show symptoms due to overexposure to hazardous substances from an emergency response or clean-up; and
- Members of hazardous materials response teams.

**NOTE:** Medical clearance must be obtained before using a respirator.

**Medical exams must be conducted:**

- Before a new job assignment;
- At least once every year unless a physician determines that a longer period, up to two years, is appropriate;
- More than once each year if the doctor decides it is necessary;
- When a job ends; and
- If an employee has symptoms which may have been caused by exposure to hazardous substances or if the employee has been injured or exposed above the PEL or other occupational exposure limit in an emergency situation.

All **medical examinations and procedures must be performed by or under the supervision of a licensed physician**, preferably one knowledgeable in occupational medicine. The exam is provided without cost to the employee, without loss of pay, and at a reasonable time and place. A physician will decide on the content of the examination.

**Your employer must give the physician:**

- A copy of OSHA's HAZWOPER standard (29CFR1926.65);
- Your job description and exposures;
- Your current or anticipated exposure levels;
- A description of personal protective equipment used or to be used;
- Information from previous examinations that the physician may not have; and
- Information required by the respirator standard (29CFR1910.134).

**Your employer must give you a copy of the physician's written opinion, including:**

- Medical conditions that would make hazardous waste work or respirator use particularly risky to you;
- Recommended limitations on your assigned work;
- Results of the exam and tests, if you request them; and
- A statement that the doctor has told you about the exam results and any conditions which require further examination or treatment.

**The report your employer gets from the physician can discuss only findings related to your work.** Any medical conditions unrelated to your job must not be revealed to the employer. You have the right to request and be given a copy of the physician's full report. **Your employer must keep medical and exposure records for as long as you are employed plus another 30 years.** If you work for your employer for less than a year, he does not have to keep your records provided that he gives them to you when you leave.

**Standard operating procedures (SOPs) ensure that site characterization and cleanup are conducted according to a plan.** SOPs provide guidelines for routine operations and for emergency response, must be written, and must be site-specific. Your site may have SOPs for the use of specialized air monitoring equipment, discovering underground cables, and communicating with neighborhood groups or organizations. Examples of tasks, tools, and hazards that may require SOPs are discussed in this chapter.

## Hazard Control

**The safety and health program must include a standard operating procedure (SOP) for introducing effective new technologies and equipment for improved worker protection.** Some new methods make the cleanup easier or more effective, some reduce worker exposures, and some do both.

New technologies must be evaluated before they are used on a large scale. Data from the manufacturer or supplier may be included in the evaluation. The process and all data must be available to OSHA.

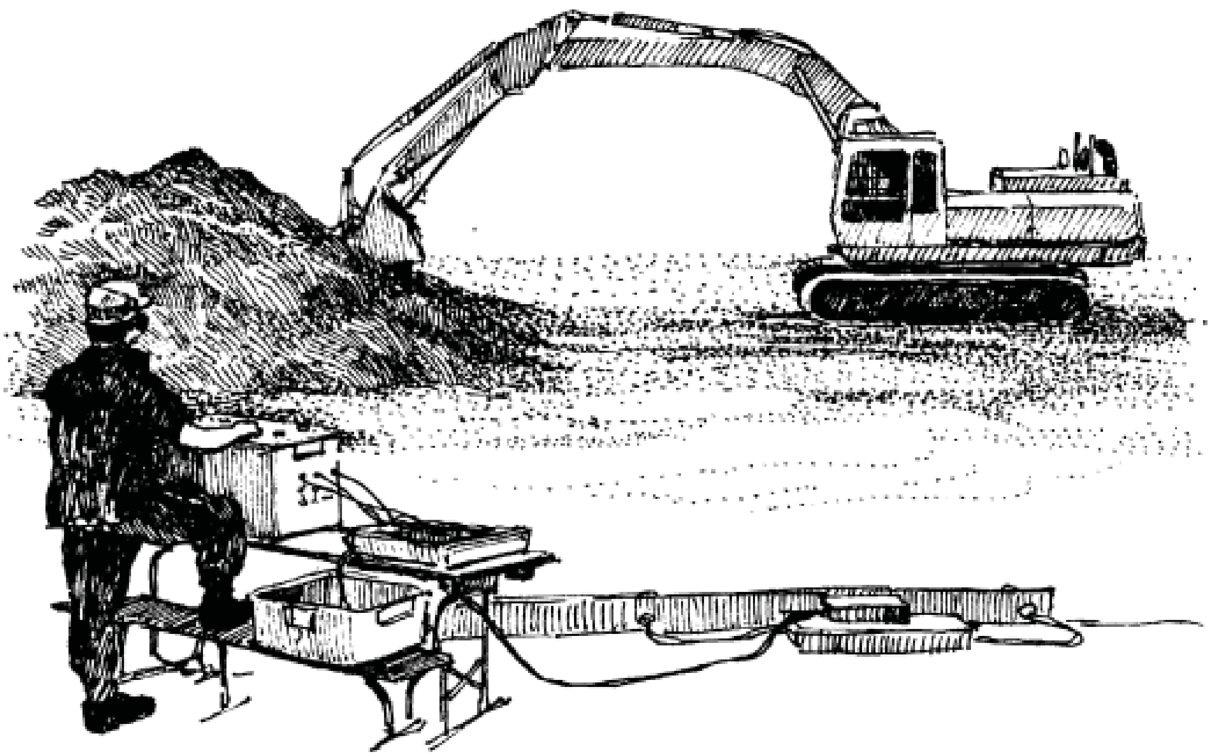
**From most effective to least effective, the five approaches to hazard control are:**

1. **Elimination** removes the hazard from the workplace
2. **Substitution** replaces hazard with a less hazardous alternative
3. **Engineering controls** prevent hazard from reaching the worker
4. **Administrative controls** use work practices, training, procedures, and scheduling to reduce exposure
5. **Personal protective equipment (PPE)** is worn by workers to prevent the hazard from reaching the worker

**Personal protective equipment (PPE) is the last line of defense and only used when other controls cannot provide adequate protection.**

Eliminating hazards or substituting less hazardous alternative are effective controls but are often difficult, especially on hazardous waste sites.
Engineered controls such as remotely operated drum punchers, ventilation of confined spaces, and sealed cabs on earth moving equipment control the hazard to prevent exposure. **Engineering controls are usually the most reliable way to control hazards that can not be eliminated.**

**Engineering Controls:** This operator is reducing exposure using a backhoe that can be operated from a distance.



**Administrative controls use policies and work practices to reduce worker exposure to hazards and must be written before the work begins.** They may include a scheduling system to limit time in a workspace or access to the space. Examples of administrative controls include industrial hygiene monitoring programs, medical surveillance programs, confined-space entry permits, lock-out procedures, training, work practices, and limiting exposure time. Administrative controls can be less reliable than elimination or engineering controls because they require workers to know and follow procedures.


**Personal protective equipment (PPE) is the last resort and must be used to reduce worker exposures when the hazard cannot be eliminated or controlled with engineering or administrative controls.** Examples of personal protective equipment include respirators, gloves, steel-toed boots, chemical-protective suits, and face shields. PPE is discussed in more detail in Chapter 5.

## Standard Operation Procedures (SOPs)

**There are many hazardous conditions, substances, and tasks that may be present on hazardous waste sites and require specific controls.**

**SOPs detail safe work practices for the activities on a particular hazardous waste site and should be covered in site-specific training.** The following pages contain examples of tasks, tools, and hazards that may require SOPs:

- Fire prevention
- Hot-work permit
- Electrocution
- Power tool use
- Soil excavation
- Equipment and vehicle operation
- Maintenance activity
- Ladder and scaffolding use
- Loading and unloading procedures
- Drum handling, storage, and sampling procedures
- Spill control
- Illumination/Sanitation
- Heat and cold stress
- Radiation
- Noise
- Slips, Trips, Falls
- Confined-space entry
- Lock-out

## *Fire Prevention*

Fire and explosions are serious hazards on hazardous waste sites. Flammable materials, incompatible and unstable chemicals, and other fuel sources are present and equipment, hot work, and other ignition sources can trigger a fire or explosion.

Constant attention must be given by everyone onsite to preventing fires and explosions.

**To help prevent fires, you should:**

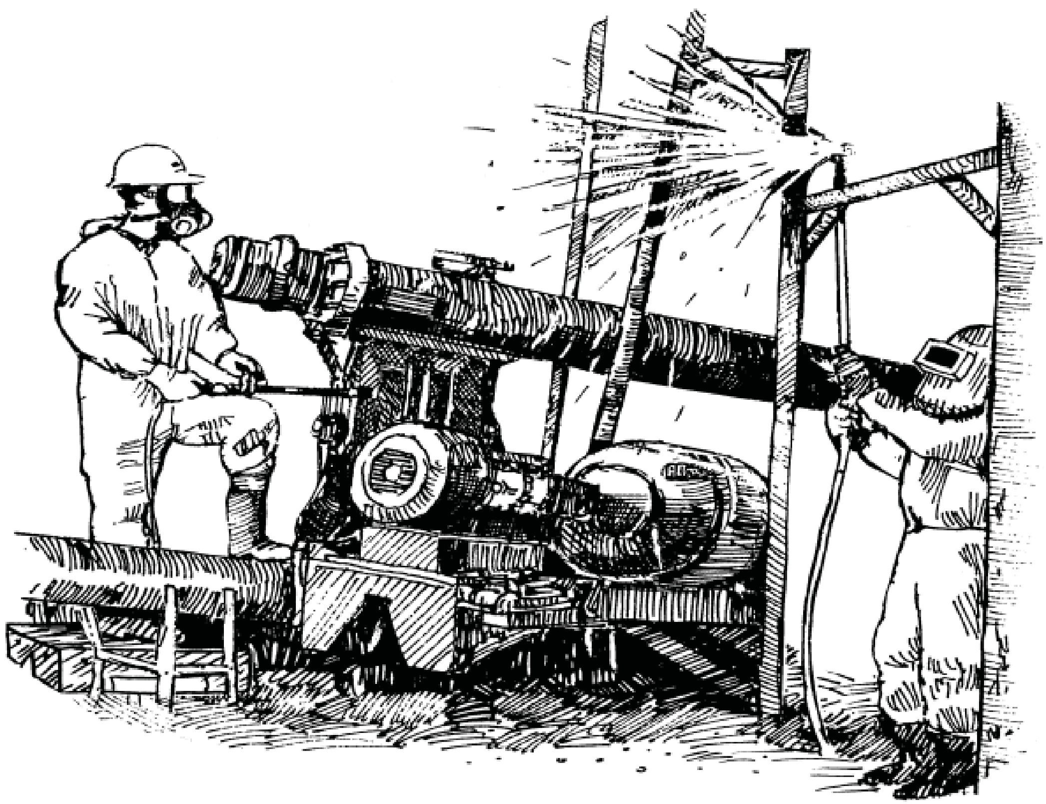
1. Use non-sparking tools and intrinsically safety equipment
2. Participate in training, drills, and practice
3. Follow other safety rules to reduce the possibility of fire.
4. Store and handle compressed gases and explosive/flammable chemicals properly
5. Conduct frequent fire safety inspections
6. Train employees in hazard recognition

To prevent and control fires your employer should:

1. Maintain supplies of fire-extinguishing media (foam, water, powder)
2. Locate fire-fighting equipment in strategic areas
3. Train fire brigade crews and allow them adequate practice time
4. Conduct fire drills and site evacuations
5. Conduct frequent fire safety inspections
6. Inspect and maintain fire-suppression equipment
7. Post evacuation routes
8. Train employees in hazard recognition
9. Store and handle compressed gases and explosive/flammable chemicals properly
10. Provide non-sparking tools and intrinsically safe radios, electronic and electrical equipment, and power tools

## *Hot-Work Permit*

Cutting, welding, and grinding are common activities at hazardous waste sites and require hot-work permits.  Before welding begins, remove any extra air cylinders or other cylinders from the area to prevent fires and explosions.  Welding on equipment or vessels that may contain traces of heavy metals or chlorinated solvents must be done with adequate ventilation and personal protective equipment.  OSHA's Subpart J--Welding and Cutting provides minimum safety requirements for all cutting and welding activities.  Hot-work SOPs should include a permit system



**The fire-watch buddy system during cutting**

### *Electrocution*

Electrocution is one of the most common causes of death among construction workers.

Electrical shock and electrocution are often the result of:

1. Contact with energized equipment and live lines, especially overhead lines
2. Use of electrical equipment in wet areas
3. Failure of equipment

Electrical hazards can be controlled by:

1. Lock-out/tag-out;
2. Ground-fault circuit interrupter (GFCI) equipment; and
3. Double-insulated tools and grounded tools kept in good repair.

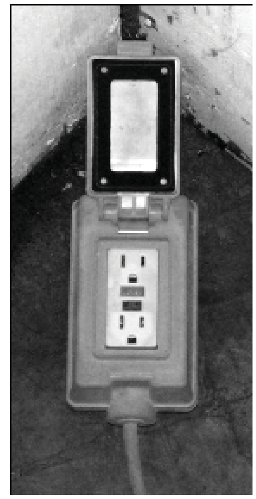
## *Power Tool Use*


Improperly used or maintained power tools can cause electrical shocks, fires, and explosions. On hazardous waste sites, power tools can spread contamination too.

The following general guidelines should be incorporated into site-specific SOP's for power tool use.

1. Use ground-fault circuit interrupter (GFCI) protection when working with power tools
2. Use non-sparking hand tools near flammable and combustible material
3. Use specially-designed explosion-proof power tools (called intrinsically safe) near flammable material
4. Keep guards and other safety devices in place and operational at all times
5. All electric power tools must be UL approved double insulated or grounded
6. All tools must be inspected before use
7. Decontaminate tools after each use, and return them to proper storage

When GFCIs are not used, a construction site must have an Assured Equipment Grounding Conductor Program for cords and receptacles that are not part of the building. This program must:



1. Be written
2. Name a competent person to run the program
3. Include inspections of all cords, plugs, and receptacles before each day's use
4. Include continuity tests and polarity test every 3 months and after repairs
5. Maintain records of tests and keep them on site

## *Soil Excavation*

At a minimum, soil excavation SOPs must comply with all OSHA requirements listed in 1926 Subpart P--Excavations.

**These include:**

1. Excavations 5 feet or more deep (in stable soil) must be shored or sloped.
2. Excavations 4 feet or more in depth must have a stairway, ramp, ladder or other safe ways to exit to prevent more than 25 feet in lateral travel for employees.
3. Locations of utility lines must be determined before excavation begins.
4. Air monitoring must be conducted if oxygen deficient or hazardous atmospheres exist or could exist in an excavation that is more than 4 feet deep.

**The soil excavation SOP needs to address these questions.**

1. What is the contaminant?  What are the physical properties of the soil?
2. How much has to be removed?
3. What equipment is needed for excavating and loading soil?
4. Will personal monitoring be necessary?
5. What is needed to prevent a collapse or cave in?
6. What PPE is required?

**The SOPs should contain these or similar directions.**

1. Use shoring and sloping as required by OSHA;
2. Excavate clean areas first, then dirty areas to avoid spread of contamination on machinery.
3. Set up soil loading and stockpile area with:
   a. Bermed, plastic-lined area to hold soil;
   b. A method to cover the pile in case of rain or wind; and
   c. Catwalks and platforms from which to work when lining and tarping trucks.
4. Take soil samples when excavation reaches required depth to determine if the excavation is clean.
5. Decontaminate all equipment that was used for removal and will be used for restoration.

## *Equipment and Vehicle Operation*

Even though a worker may not operate equipment or vehicles, the presence of heavy equipment and vehicles can endanger everyone on a hazardous waste site.

Keep the following in mind:

1. All equipment in the Hot Zone must stay there until it is thoroughly decontaminated.
2. Equipment and vehicle operators who wear protective clothing and respirators may not be able to hear or see as well as they normally do and their reactions may be slower.
3. Never work or stand underneath loads handled by lifting or digging equipment.
4. If you are working in an excavation, pay close attention to any nearby vehicles or equipment.
5. Workers near or around vehicles must be given highly visible vests or clothing. This is especially true on hazardous waste sites where an operator's vision and hearing may be impaired.
6. Always check vehicles entering and exiting the site for leaks and spills. Direct vehicles to decontamination if needed.

## *Maintenance Activity*

Equipment maintenance is an ongoing process at any hazardous waste site. Equipment should be removed from the Hot Zone, decontaminated and taken to the Cold Zone for maintenance and repairs unless:

1. Repairs are minor; or
2. Equipment cannot be moved or cannot be moved without causing additional damage.

If repairs must be done in the Hot Zone, then the mechanics must be qualified for entry and must wear the required PPE.

Equipment in the Cold Zone should be repaired away from site activity, traffic and flammable and combustible materials, especially if welding, cutting, or heating is needed.  Equipment, blades, end-loader buckets, dump bodies, and similar equipment must be either fully lowered or blocked when being repaired, as described in OSHA's **Subpart O** (motor vehicles, mechanized equipment) **1926.600(a)(3)(i)**.  All controls must be in a neutral position, with the motor stopped and brakes set, unless the work requires otherwise.

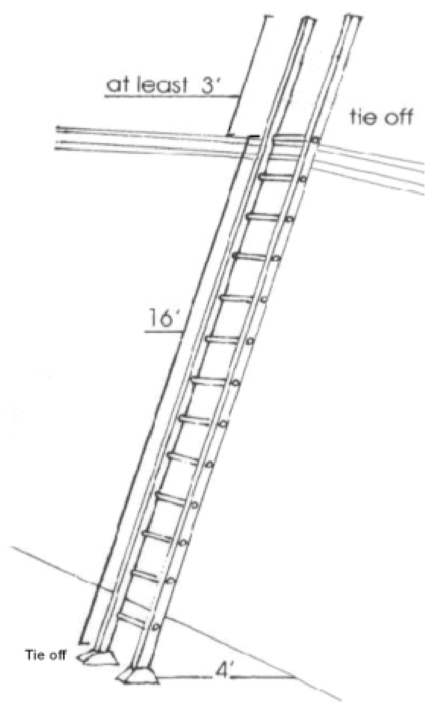
## *Ladder and Scaffolding Use*

Ladders must not be moved, shifted or extended while occupied.  At a minimum ladders must comply with the requirements of OSHA's 1926 Subpart X Stairways and Ladders.

**You must take extra care when using ladders while wearing PPE.**  Restricted motion and visibility make these regulations especially important.

1926.1053 Ladders

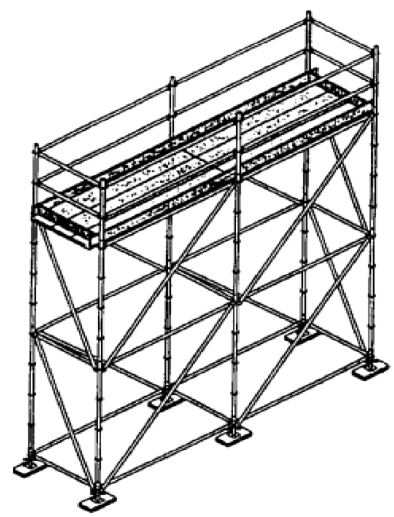
1. Ladders must have non-conductive side rails if used around energized electrical equipment.
2. You must hold the ladder with at least one hand when going up or down the ladder.
3. You must not carry any object or load that could obstruct or hamper a climb, or cause loss of balance.
4. Portable ladders must be capable of supporting at least 4 times the intended load.
5. The horizontal distance between the bottom of the ladder and the wall should be ¼ the length of the ladder.
6. Ladder must extend 36 inches above a landing platform.



**Everyone who works on a scaffold must be trained to be able to recognize and control the hazards of working on scaffolds (1926.454).** Anyone who erects, dismantles, moves, repairs, or inspects scaffolds must be trained on the procedures for those tasks.

At a minimum, the use of scaffolds must be in compliance with OSHA's Subpart L (1926.450-454). Working on, erecting or dismantling scaffolds in a hazardous atmosphere or while wearing PPE requires extra caution.

The following are a few of the basic scaffold safety requirements which must be met:



1. Scaffolds must be able to support their own weight plus at least four (4) times the maximum intended load.
2. Personal falls arrest systems or guardrails are required on scaffolds when workers are exposed to falls above 10 feet.
3. Supported scaffolds with a base to height ratio above 4:1 must be restrained by guying, tying, bracing, etc. Supported scaffolds must be plumbed and braced.
4. Supported scaffolds must rest on base plates and either mud sills or other firm foundations.
5. Scaffold platforms must be fully planked or decked. Planks and decking must meet minimum loading and other requirements.

**The five most serious scaffold hazards are:**

1. Falls
2. Unsafe access
3. Struck by falling objects
4. Electrocution when scaffold components become energized or contact live lines
5. Scaffold collapse

### *Loading and Unloading Procedures*

To reduce the risk of musculoskeletal injures during lifting, loading and other manual materials handling:

1. Use carts, dollies, hoists, and pulleys whenever possible.  Repetitive lifting of even light loads can cause damage to the spine.
2. Get help when lifting heavy and awkwardly shaped loads.
3. Lift by squatting and keeping the object as close to your body as possible, if the load is compact enough to fit between your knees.
4. Store materials at waist height to avoid excessive bending and reaching.
5. Keep the distance of the lift between knee and shoulder height.  Lifting above the shoulders places extra stress on the spine and back muscles as well as the neck, shoulders and arms.
6. Avoid uneven, one-sided lifting.  Never twist and lift at the same time.
7. Do not try to catch falling objects.
8. Push instead of pulling – it is less stressful to your back, arms, and shoulders and gives you the advantage of using your own weight.
9. Get adequate rest and take breaks.

## *Drum Handling, Storage, and Sampling Procedures*

Unidentified drums can be very dangerous and should be inspected, sampled, and handled by experts. If you discover a drum, report it immediately to your supervisor. Assume that a drum or container is hazardous until tested. Do not rely on outdated or questionable drum markings or labels alone to identify hazards.

Special instruments or probes should be used to detect buried drums. Drums which may contain radioactive wastes must not be handled until specially trained personnel can assess the hazards.

**Only workers trained to do so should move drums.** They should use remote handling equipment whenever possible. Fire-extinguishing equipment must be on hand and ready to use. They will move the contents of deteriorated drums to clean drums when they cannot fix the drums. The clean container must meet DOT, OSHA, and EPA requirements.

OSHA lists minimum special handling precautions which must be taken if a container is known or suspected of holding shock sensitive wastes [29CFR1926.65(j)(5)]. You should **assume that a container of packaged laboratory wastes contains shock sensitive or explosive material until the contents have been characterized.**

**OSHA also lists special requirements for handling drums with mixed wastes from laboratories, which are called lab packs** [(1926.65(j) (6)].

**These requirements include:**

- Lab packs are only opened when necessary
- Only persons with the knowledge to inspect, classify, and segregate the contents of a lab pack may open it
- Unless the contents are otherwise identified, handle as shock-sensitive waste (especially if you see crystals on any container)

Even if your job does not involve drum handling, you may work near large numbers of drums containing known or unknown chemicals. **Use the chart below, to figure out what type of material is supposed to be in a drum.**

| Type of Drum | Construction | Contents |
|---|---|---|
| Closed-top* | Metal (unlined) | Non-corrosive products in liquid form |
| Closed-top | Plastic or composite (plastic inside metal or lined cardboard) | Corrosive liquids (acids or bases) |
| Open-top | Metal (unlined) | Non-corrosive solids or sludges |
| Open-top** | Plastic (lined) | Corrosive solids or sludges |
| Special | Stainless steel, nickel, and Monel ™ | Extremely hazardous materials |
| Overpack--Large Outside Drum with a Leaking Drum Inside | Metal or plastic | Any leaking drums listed above |
| Closed-Top Drums with Fittings | Fittings for pressurizing with inert gas | Reactive, flammable, or explosive liquids |
| Open-top | Plastic or metal | Lab packs of a variety of potentially dangerous and incompatible materials |

* Closed-top drums are sealed and have small openings (bungs) in the top.
** Open-top drums have removable lids and may or may not have bungs.

**Staging means placing drums with similar contents alongside each other.** This is one step toward remedial action. When staging drums, place them no more than 2 wide with an aisle between. This allows access to all drums without standing on, or leaning over, drums.

Activities in staging areas may include:

- Opening drums and sampling the contents;
- Holding materials until test results come back;
- Bulking or mixing compatible materials; and
- Loading and shipping.

The number of staging areas should be kept to a minimum. There must be adequate access and exit routes must be maintained at all times.

**Drum sampling requires specific precautions and is usually carried out by trained engineers or technicians.** The drum sampling procedures must be included in the safety and health plan.

**If any of the following conditions are present, the drum should not be sampled until special precautions are taken:**

- A bulging top warns of pressure build up within the drum
- Damaged or dented drum could also mean a buildup of pressure
- Vapor or mist coming from the top of the drum, usually near the bung hole
- Obvious leak

**These sampling safe work practices should be included in the drum sampling SOP:**

1. Drum tops should be covered with plastic sheeting to avoid worker contact
2. Never stand on drums, use ladders and platforms to reach stacked drums
3. Do not lean over drums to reach the one being sampled
4. Dispose of or decontaminate sampling equipment according to the sampling plan

## *Spill Control*

Your site must have a spill control plan that describes actions to take if either a minor or major spill occurs. Depending on the chemical, the spill control plan may include:

**1) Containment includes:**

- **Plugging —** The leaking drum is plugged to prevent or limit further release. Common plugging materials include wood, soap, rags, and commercial products. Plug materials must be compatible with the chemical that is leaking.
- **Patching —** A patch is applied over the leaking area. Patching materials include rubber, patching mud, and tape. Patching materials must be compatible with the chemical that is leaking.
- **Over packing —** Placing a leaking drum into a compatible larger drum to contain the contents.

**2) Confinement keeps the spill in a defined area and includes:**

- **Diking —** Dikes may be built around the perimeter of the leak with sand, earth, straw, sorbent, or other materials. The diking material must be compatible with the spilled material. Plastic sheeting can be used as an additional barrier.
- **Blocking —** Drains, ditches, or storm sewers should be covered and blocked to prevent run-off of spilled materials. This blocking can be done with a sorbent pad, a piece of plastic, or a rubber pad. If flammable or toxic materials enter these systems, the potential for damage to property or people is increased.
- **Absorption —** Run-off can be absorbed with dirt, sand, soda ash, saw dust, wood chips, peat moss, vermiculite, foam, or other materials. The sorbent must be compatible with the spill. For example, wood chips and an acid can start a fire.
- **Collection —** Run-off can also be collected in containers such as drums or buckets.

**Drums should be stored with compatible chemical groups to prevent hazardous reactions and errors in shipping.**

If drums are stored on pallets:

- Store only compatible substances on the same or adjacent pallets.
- Use only intact pallets without broken or damaged boards;
- Set drums squarely on pallets and band drums together if possible;
- Place drums with labels and numbers facing outward; and
- They may be placed no more than 2 high and 2 wide with an aisle in between (in contrast with staging from the previous page where they cannot be stacked).

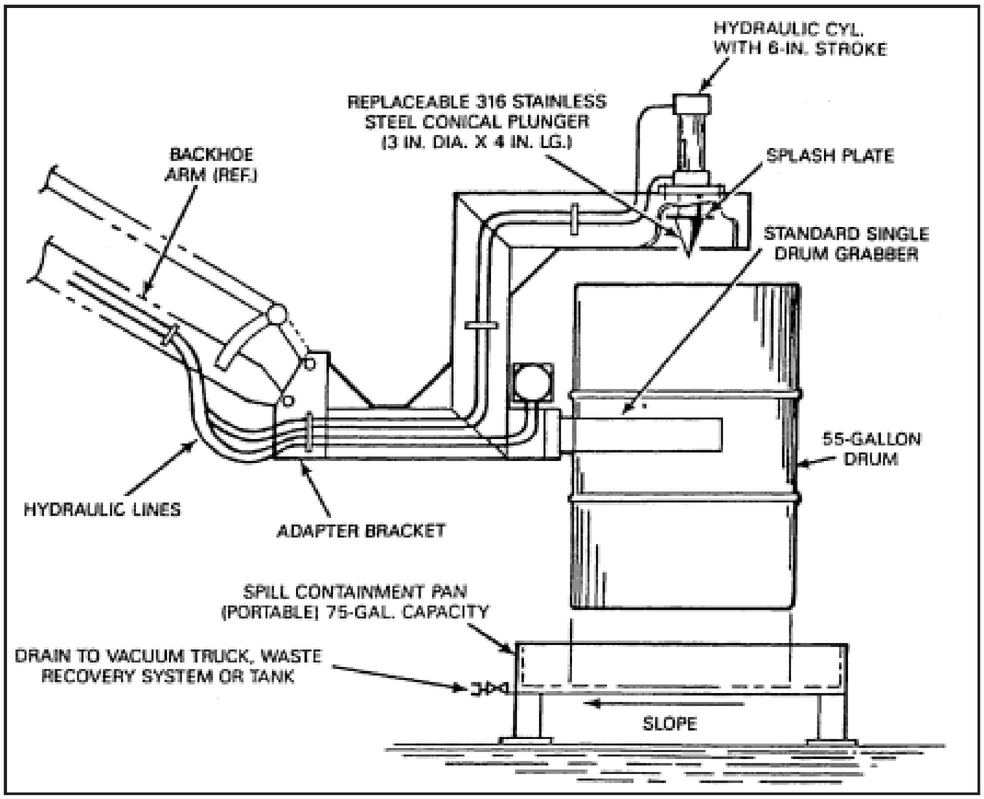
Drum inspections should be conducted daily, or according to the site SOP, to look for:

- Leaking
- Swelling or bulging
- Rust or other signs of deterioration
- Exterior corrosion or crystallization
- Damage

Report these or other identified conditions to the supervisor.

**Opening drums puts workers at serious risk and should be done with a remote drum punch or other remotely operated equipment if possible.** OSHA 29CFR1926.65(j)(2) requires certain procedures where drums or containers are being opened. Anyone who opens drums must use non-sparking and intrinsically-safe tools and grounding may be necessary. Never stand on drums or containers.

**Backhoe-mounted drum puncture device.**



**Ponds and lagoons store large volumes of waste materials and may also be used for treating waste materials.** The hazards around ponds and lagoons may include:

1. Drowning
2. Corrosive and toxic gases, vapors, and liquids
3. Unstable walking surfaces

The precautions that should be used around ponds and lagoons include:

1. Safety equipment such as life jackets, safety belts, or life lines when working close to unguarded areas;
2. Chemical protective equipment to prevent skin contact and inhalation of chemicals;
3. Limit access and keep barricades secure; and
4. Train workers.

### *Illumination/Sanitation*

Adequate lighting must be provided so that the work activities can be performed in a safe manner. OSHA sets out minimum illumination requirements in the HAZWOPER standard, **1926.65(m)**. The site safety officer should ensure that illumination meets the requirements of the standard.

Employers must ensure adequate sanitation at temporary workplaces, including hazardous waste sites. 1926.65(n)

An adequate supply of drinking (potable) water must be provided at the site and kept clean and free of contamination. If water unfit for drinking (non-potable) is available at the site for firefighting or other purposes, the water lines and hose connections must be clearly marked to indicate that it not safe for drinking, washing, or cooking.

HAZWOPER **1926.65(n)(3)** requires a minimum number of toilet facilities based on the number of workers. Hazardous waste sites that do not have sewers must be provided with chemical, recirculating, combustion, or flush toilets, unless these are prohibited by local codes.

Employers must provide enough nearby washing and showering facilities to ensure that workers can remove hazardous materials from themselves.

Showers and change rooms for all workers exposed to hazardous substances and health hazards must meet the following requirements.

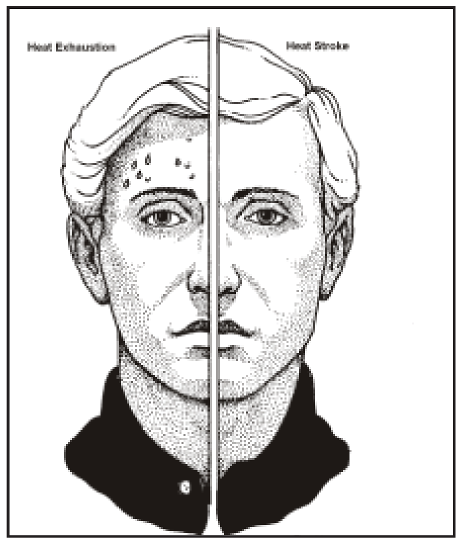
- Showers must be provided in accordance with **29CFR1926.51(f)(4).**
- Change rooms must have two separate areas, one for removal and storage of clean clothes and one for the removal and storage of work clothing. Change rooms must meet the requirements of **29CFR1926.51(i).**
- Showers and change rooms must be located in areas where exposures are below the PEL. If this is not possible, then a ventilation and supplied-air system must be provided to reduce exposures to the required levels.
- Employers must ensure that all workers shower at the end of the work shift and when leaving the site.
- Showers are not required for jobs lasting less than 6 months. If the job lasts longer than 6 months, showers and change rooms must be provided in accordance with **29CFR1926.65(n)(7).**

## *Heat and Cold Stress*

High temperatures put extra physical stress on the body and over time, this heat stress can cause illness, particularly if you are not accustomed to it. Wearing chemical protective clothing and equipment greatly increases the risk of heat illness even if outside temperatures are moderate.

**Heat stress is a serious problem on hazardous waste sites and requires careful monitoring and training for all at risk workers.** These factors can increase your risk of heat-related illness:

1. Lack of physical fitness and heat acclimation (adjustment)
2. Temperature and humidity
3. Wearing heavy and impermeable clothing
4. Age
5. Lack of fluid intake
6. Alcohol and drug use
7. Sunburn, diarrhea, infection




To help prevent heat-related illnesses:

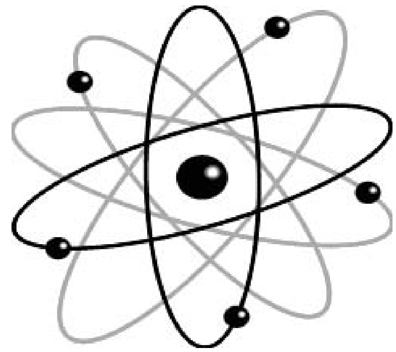
1. Work in the shade
2. Wear light permeable clothing
3. Drink more fluids than your thirst tells you to (especially water);
4. Avoid alcohol;
5. Take additional breaks until you've worked in the heat for two week ; and
6. Take regular cool-off breaks, in an air-conditioned space if possible, but at least out of direct sunlight.

| Heat-Related Illnesses | |
|---|---|
| **Heat Cramps** | |
| Symptoms: | painful muscle spasms |
| Cause: | profuse sweating and drinking large amounts of water |
| Treatment: | provide water and electrolytes (sodium, potassium) like diluted Gatorade™ |
| **Heat Exhaustion** | |
| Symptoms: | Weakness, fatigue, dizziness, pale, cool, moist skin, heavy sweating, headache, nausea |
| Cause: | Dehydration from profuse sweating and insufficient intake of water and salts |
| Treatment: | Replace water and electrolytes lost in sweat, provide rest in a cool place. Do not send the worker back into a hot environment that day |
| **Heat Stroke** | |
| Symptoms: | Very dry, hot skin with red mottled or bluish appearance; confusion; convulsions; unconsciousness; rapidly rising temperature |
| Cause: | Body becomes overheated because the worker does not sweat; can be fatal |
| Treatment: | **Call for medical help immediately.** Move person to cool place. Remove protective equipment. Use wet towels to reduce the victim's temperature. Fan rapidly to cool while waiting for help<br><br>**Heat stroke is a life-threatening emergency. Medical attention is required.** |

**Prolonged exposure to cold environments can cause hypothermia and frostbite** (freezing of tissues, usually on the extremities such as the hands, toes, nose, cheeks, and ears). Parts of the body with frostbite appear red and tingling, then turn pale and numb. Frostbitten tissue should be gently warmed slowly by a trained medical person. The victim should be given hot liquids to drink and not allowed to smoke because it interferes with blood flow. Hypothermia is when the body is losing heat faster than it can make it and the body temperature falls below 95 degrees. Mild hypothermia begins with shivering, progresses to stumbling, lack of coordination, and difficulty speaking, and in severe cases can result in loss of consciousness and death.

Cold, wet conditions can increase your risk of muscle strain and other musculoskeletal injuries. Using vibrating tools in cold weather can lead to hand-arm vibration syndrome, which causes the blood vessels in your fingertips to collapse. This causes your fingertips to go white and numb.

*Radiation*



**The three types of radiation, alpha, beta, and gamma, are capable of causing serious health effects including reproductive and developmental problems, cancer, and death.** The degree of damage depends upon the dose and type of radiation.

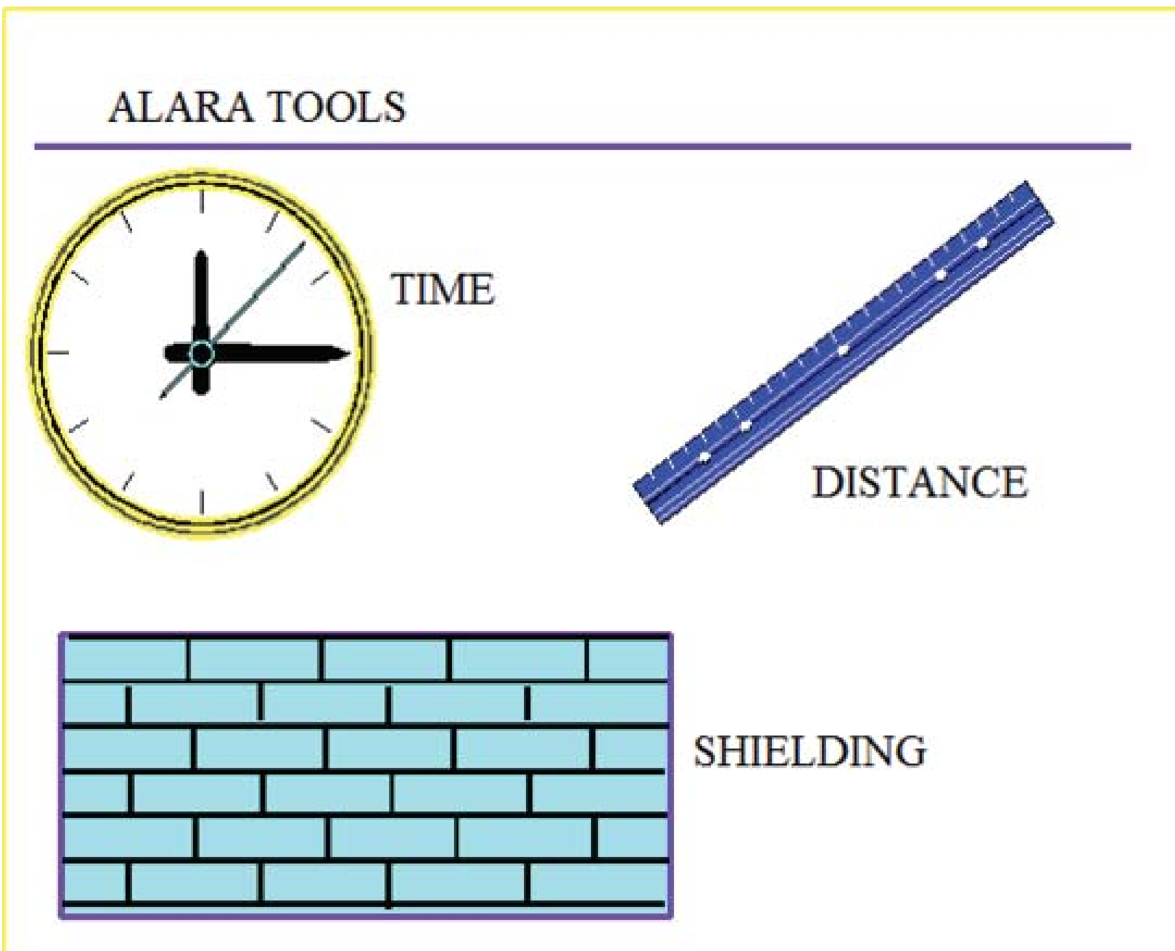
> **Alpha radiation particles are relatively large and do not travel far** (about 3 inches in air). They can be stopped by material as thin as a sheet of paper or your outermost layer of skin. **If taken into the body (swallowed or breathed in), alpha particles are an extreme health hazard.** Respiratory protection is required. Sources include radon, uranium, polonium and plutonium.
>
> **Beta radiation particles are small and travel farther than alpha particles (a few feet in air).** Beta particles will travel through clothes and skin but are somewhat stopped by plastic. They are most dangerous if swallowed or breathed in. Sources include radioactive phosphorus and radioactive carbon.
>
> **Gamma radiation can pass deep into the body,** damage inner organs, and cause burns, cancer, and death. It takes a thick lead or concrete shield to stop gamma rays. Sources include radioactive cobalt and cesium.

**Areas controlled for radiological purposes will be designated with a magenta (or black) standard three-bladed radiological warning symbol on a yellow background.**

Entrance points to radiation areas must have signs (or equivalent postings) indicating the presence of radiation or radioactive materials and stating the entry requirements, such as “Personnel Dosimeters, Radiation Work Permit RWP, and Respirator Required.” Remember, conditions can change quickly so do not assume the sign is the same as the one you saw before.

**This is not a RADWORKER course!  If you see this symbol on your worksite, leave the area unless you have been specially trained to deal with the hazards of radiation**

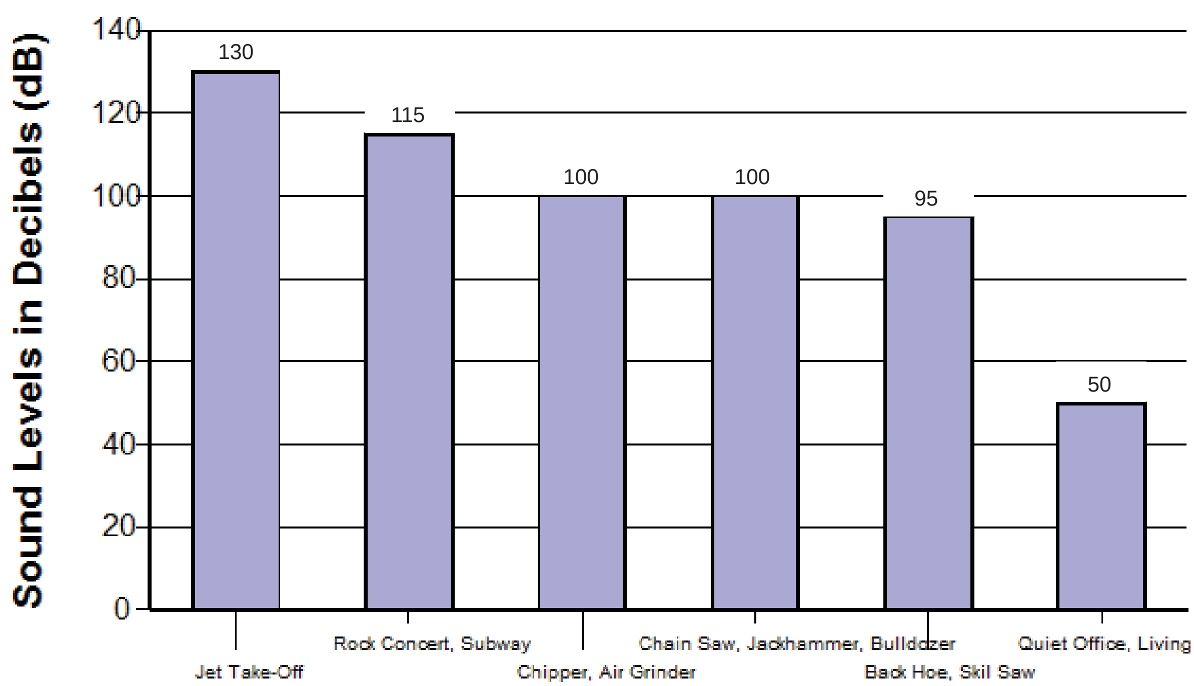
**Exposure to radiation must be kept ALARA (as low as reasonably achievable).** Site-specifics will teach you how to use time, distance, and shielding to protect yourself from radiation.  In general, you should minimize your exposure time, stay as far away from the radiation source as possible, and use protective barriers or shield to keep radiation from reaching you.



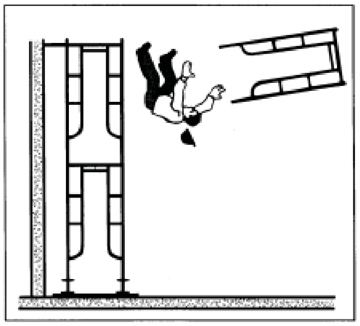
## *Noise*

Imagine if you could not hear your child speak to you or hear the phone ring. **Repeated exposure to excessive noise can cause permanent hearing loss.** High-volume sound is also linked to high blood pressure, stress, insomnia, anxiety, and headaches. **While the OSHA PEL is 8 hours at 90 decibels (dB), noise levels above 85 decibels are considered dangerous by most organizations.** Building trades workers are at high risk for hearing damage from workplace noise. **Data have shown that 73 percent of construction workers are exposed to noise levels above the NIOSH REL (data collected between 1999 and 2009) and 58 percent of construction workers on DOE sites have noise-induced hearing loss (data collected between 1996 and 2010).**

The decibel scale is logarithmic, like the Richter scale for earthquakes, not linear. NIOSH uses a doubling rate of 3 dB meaning that every increase of 3 dB doubles the noise level so 88 dB is twice as powerful and damaging as 85 dB. A 115 dB sound is more than 300 times as powerful as a 90 dB sound.



*Slips, Trips, Falls*



**Falls are a leading cause of death and injury among construction workers.** In 2010, falls lead to 267 deaths and about 18,000 nonfatal injuries among construction workers. This means that in 2010, 33% of construction worker deaths and 24% of construction worker injuries were due to falls.

OSHA's scaffolding safety standard, Subpart L of 1926, mandates training for scaffold erectors and users. **Fall protection is required when working 6 feet above a lower level (10 feet for workers on scaffolding).**

Slips and trips are caused mainly by poor housekeeping. Slippery surfaces, poor lighting, and weather conditions also contribute to slip/trip hazards. Slips and trips may sound minor but they cause enormous back and other musculoskeletal injuries. A clean worksite helps to prevent injuries and increases productivity.

**Being struck by a vehicle, construction equipment or material is another leading cause of injuries for construction workers.** Personal protective equipment can limit your vision and hearing and create a sense of isolation. To prevent struck-by injuries:

- Pay close attention to all activities around you
- Watch out for others
- Use and listen for vehicle back-up alarms
- Watch for improperly stacked drums
- Do not use damaged pallets
- Wear high visibility clothing

## *Confined-Space Entry*

**Every year approximately one hundred (100) workers in the United States die in confined spaces and several thousand are injured.** About one-third of confined space fatalities are would-be rescuers. In many confined space fatalities, employers did not have a written confined space program or a confined space permit system.

SAR-supplied entrant with 7' tripod, attendant, supervisor, and mechanical ventilation.

According to OSHA, **confined spaces have three defining properties:**

1. Limited or restricted ways to get in and out of the space;
2. Not intended for continuous human occupancy; and
3. Large enough to fit a person.

**Confined spaces found at hazardous waste sites include:**

1. Ditches, culverts, and ravines
2. Incinerators and scrubbers
3. Tank trucks and rail cars
4. Vaults and silos
5. Sewer system with manhole entrance

**Permit-required confined spaces (PRCS) are confined spaces with at least one additional hazard.**

1. Hazardous atmosphere (or the potential for one)
2. Material that could engulf a person. The material could be stored in the space (for example, grain) or enter the space through pipes (such as water or chemicals)
3. A shape (tapers, slopes or converges) that could trap or asphyxiate someone
4. Any other recognized serious safety or health hazard

Confined spaces do not always look dangerous. It may even be hard to recognize that a particular space is a confined space. For example, settling tanks and excavations are confined spaces even though they are open on top.

The potential hazards of confined spaces can become life-threatening conditions very quickly. Lack of ventilation can allow toxic gases and vapors to accumulate. Materials stored in the space or brought in through pipes can instantaneously engulf entrants. Energy sources which are not locked out can be turned on by people outside the space. **All potential hazards must be evaluated and controlled before work inside the space begins.**

**A large portion confined space deaths are due to atmospheric hazards** (toxic gases or vapors, asphyxiants, flammable or explosive atmospheres). The trouble is that you can't see atmospheric (air) hazards. You can't see when there is too little (less than 19.5% oxygen) or too much oxygen (greater than 23.5%) in the air. Nor can you see toxic or flammable gases or vapors that accumulate in confined spaces (except for very rare cases).

**What causes oxygen deficiency?**

1. Other gases in the confined space can displace the oxygen in the air
2. Activities such as welding and burning can “use up” oxygen in the confined space
3. Chemical reactions such as rusting or the drying of certain paints and cements can also “use up” the oxygen

Toxic, flammable, or explosive gases or vapors may be present in a confined space or introduced by work activities. **The acute (immediate) hazards that could impair your ability to leave a space are the greatest concern.** These hazards include central nervous system effects from solvents and chemical residues, asphyxiation from carbon monoxide or hydrogen sulfide, and fire or explosion of gasoline or solvents.

**Monitor the inside of a confined space before entering the space and while inside.** Collect the initial air sample through a sampling probe inserted into the space.

**Ventilation can be used to bring air into the space and eliminate hazards from oxygen deficiency and gases and vapors that are toxic, flammable, and explosive.**

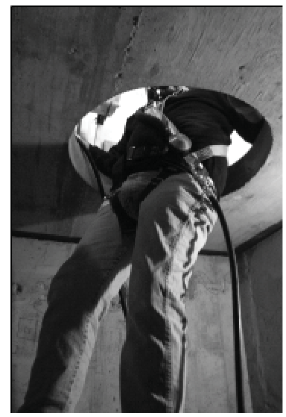
**Note:** Using welding or medical oxygen to “ventilate” a space can cause oxygen levels to become dangerously high (greater than 23.5%).

**Remember:**

- Always monitor to find the oxygen and chemical content of air in a confined space.
- Do not operate heaters or motors in confined spaces without special precautions limit carbon monoxide and other contaminants in exhaust.
- Rust, drying paint, cement, or caulking can increase the chances of oxygen deficiency.
- Welding or burning inside confined spaces present major hazards and require special precautions as well as special hot work permits.

**All confined space SOP's should be in compliance with OSHA's confined spaces standard (29CFR1910.146 for General Industry and 29CFR1926 Subpart AA for Construction) and permits must include the required elements.** This should be the case even if the space is not a permit-required confined space.

**Confined space permits must include:**



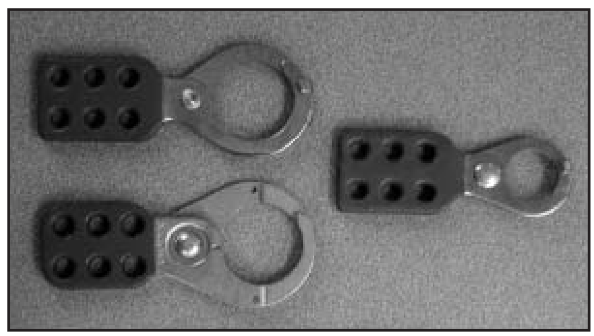
1. A description of the space that will be entered
2. Why the space needs to be entered (description of the work to be done)
3. The date, length of time the permit is good for
4. Names and/or identification of the authorized entrants
5. Names of the attendants who will remain outside the space
6. Name of the entry supervisor - A space for the initials /signature of the supervisor who originally authorized entry
7. The hazards of the space
8. How the hazards in the space will be eliminated or controlled (for example, with ventilation or lock-out of hazardous energy sources)
9. The conditions that must exist for entry to begin
10. Air monitoring results and the names/initials of the people who did the monitoring.
11. When air monitoring was done
12. Who to call for emergencies and rescue and how to contact them
13. How entrants and attendants will communicate with each other
14. All the equipment that has to be provided to comply with the standard. This includes alarms and monitoring, personal protective, communication, and rescue equipment
15. Any other information which is needed to ensure worker safety during confined space entry
16. Other permits, such as hot work permits, which are needed for the work to be done

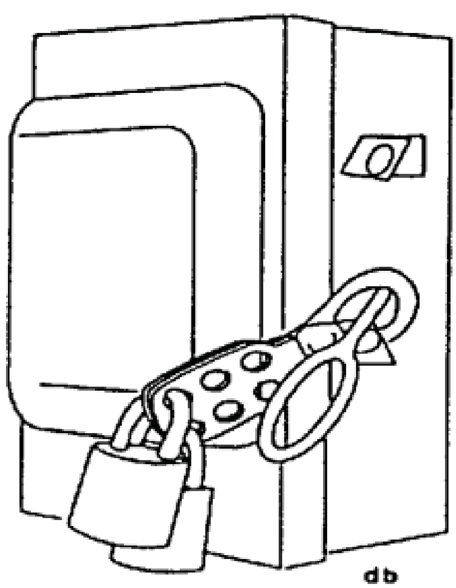
## *Lock-Out*

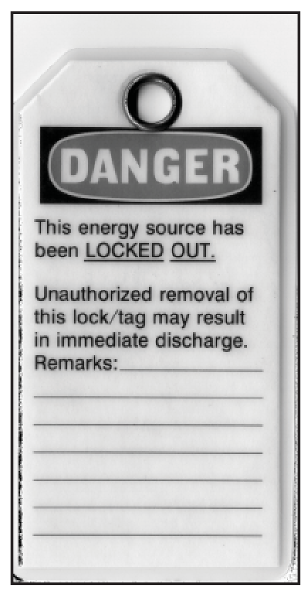
Electrical power, mechanical equipment, pipes and valves must be locked-out to prevent operation and the release of energy during repair or cleaning.  It is not enough to just turn off an electrical switch or close a valve.  You must lock-out energy sources to prevent someone who is unaware of the work being done from turning the power on.  When locking out steam or fluid transfer pipes, release the pressure before unbolting and separating pipes.

- Know the site lock-out procedure before any operation is attempted.
- Never assume a machine, circuit, or pipe is locked out just because it should be.
- When in doubt, lock it out!

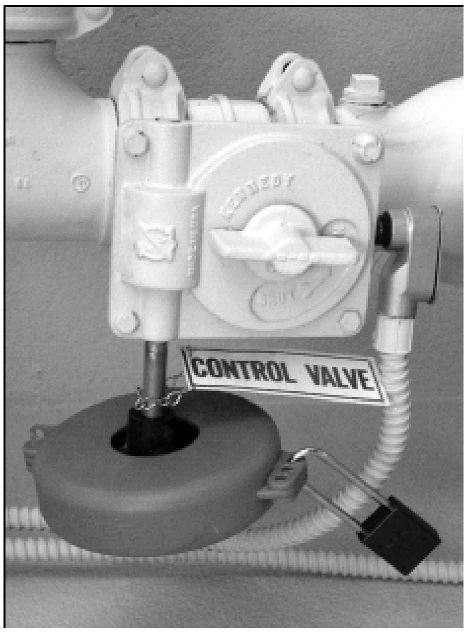
**Lock-out tags should be placed on all locked-out equipment.**





**A variety of lock-out device are available, depending on the power source and equipment.**





## Summary:
## Work Practices and Site Control

Before you ever come on site, experts have done a lot of work to determine what chemicals and dangers are present, how to do the cleanup work, and how to protect you--this is called **site characterization.**

**There are five approaches to hazard control at hazardous waste sites:**

1. **Elimination** removes the hazard from the workplace
2. **Substitution** replaces the hazard with a less hazardous alternative
3. **Engineering controls**, such as ventilation, prevent the hazard from reaching the worker
4. **Administrative controls** use work practices, training, and scheduling to reduce exposure
5. **Personal protective equipment (PPE)** worn by workers to prevent the hazard from reaching the worker

Elimination and substitution are difficult to implement on hazardous waste site but most cleanup jobs will use the other three methods. PPE should always be the last resort.

**The safety and health plan is a written document that includes site-specific information designed to identify, evaluate, and control exposures to hazards.** The plan must include: organizational structure on the site; a comprehensive work plan; a site-specific safety and health plan; standard operating procedures (SOPs); safety and health training; a medical surveillance and exam program; and any information necessary to link the overall company plan to the site-specific plan.

**Hazard control procedures must be written and put in place before workers enter the site.** These procedures must include a site map, work zones, buddy system, site communication (routine and emergency, hand signals, alarms, etc.), standard operating procedures, and identifying the nearest appropriate medical facility.

Special work methods are needed to protect worker safety and health. Carefully planned, detailed written work instructions called Standard Operating Procedures (SOPs) tell you how to do the work safely. SOPs lay out work practices that are needed to protect worker safety and health. At each hazardous waste site, workers must be trained on the SOPs that relate to their work.

Sampling or moving drums is one of the most dangerous jobs you can do. Extra precautions must be taken before moving or sampling any drums that are damaged, leaking, unstable, or have any crystals around the edge. Keep absorbents and overpack drums handy any time you move a drum in case there is a spill or leak.

**General site workers must receive at least 40 hours of off-site training before entering the site and three days of on-site training before beginning work.** TSD and specialized workers must receive 24 hours of training with one day of site-specific training. Supervisors receive an additional 8 hours of off-site training. All employees attend an additional 8-hour refresher training course each year.

**Every site is divided into three areas: a hot zone** (chemical cleanup), **warm zone** (buffer & decon), **and cold zone** (support & rescue) **to ensure proper PPE, minimize exposure, and keep chemicals from spreading outside of the work area.** The zones are set up depending on monitoring results and the layout of the site.

## Background Reading Material: Work Practices and Site Control

NIOSH Workplace Safety and Health Topics – Hierarchy of Controls
http://www.cdc.gov/niosh/topics/hierarchy/

NIOSH Workplace Safety and Health Topics – Prevention Through Design
http://www.cdc.gov/niosh/topics/ptd/

*Hazardous Waste Operations and Emergency Response Standard, Federal Register, Final Rule* - March 6, 1989, 29CFR1926.65 Drums and Containers.

*Occupational Safety and Health Guidance Manual for Hazardous Waste Sites,* (NIOSH # 85-115) 1984, Chapter 11, Handling Drums and Other Containers, p. 1-12.

*EPA's Standard Operating Safety Guides*, July 1988, Part 2, Standard Operating Safety Procedures.

Notes:

Notes:

# Chapter 7: Decontamination

Decontamination (decon) is the process of removing contaminants from personnel and equipment to protect yourself, your fellow workers, and your family and community. It may also include neutralizing contaminants by chemical means. Proper disposal is an important part of decontamination.

**Chapter Objectives:**

After completing this module, you will be able to:

1. Demonstrate proper decontamination of your personal protective equipment, yourself, your tools and equipment to protect yourself, your family, and your community.
2. Explain the layout of a decontamination line.

## Case Study

Two workers finished a day of pumping out a tank full of xylene. They rinsed off their reusable suits with water and hung them up to dry. When they came back the next day the suit material felt soft and sticky. The suits had to be thrown away. **Why did this happen?**

**They did not decontaminate properly.** The workers were wearing the right suits, but they did not clean them off with soap and water. Poor decontamination can damage suits or equipment and expose you or your family. In this chapter, you will learn about how to decontaminate equipment properly to prevent this kind of problem.

**Decontamination (decon) is necessary to prevent worker exposure and the spread of hazardous substances beyond the work site.** Each hazardous waste site involves different workers, equipment, chemicals, and risks.

**Decontamination procedures are described in the employer's site safety and health plan.** The site-specific decontamination and safety and health plans should state when, where, and how decontamination will occur.

**The decontamination plan must contain the following information:**

1. A description of the **location** and **layout** of decontamination stations
2. A list of the decontamination **equipment and supplies** needed (for example, water, scrubbing-brushes)
3. **PPE** to be worn by decontamination workers
4. Specific **decontamination procedures** for substances that may be encountered on the site
5. Methods for **preventing contamination** of clean areas
6. Procedures for **minimizing worker contact** with contaminants during removal of PPE
7. Safe **disposal methods** for clothing and equipment which are not completely decontaminated
8. A plan for the **evaluation and revisions of the plan** whenever the type of PPE changes, the site conditions change, or the site hazards are reassessed based on new information

**Proper decontamination procedures must:**

1. Be communicated to workers and implemented before workers or equipment enter the with hazardous substance
2. Protect workers and the environment from hazardous substances or contaminated equipment
3. Prevent continued permeation of the hazardous substance into PPE, other equipment, and tools and degradation that could result
4. Prevent the mixing of incompatible substances
5. Prevent the uncontrolled transfer of contaminants to the home and community and to workers in clean areas
6. Be monitored by the safety and health supervisor and revised as necessary

**It is important to reduce the need for decontamination by minimizing contamination and contact with hazardous substances.** SOPs should establish practices that minimize exposure and maximize worker protection.

For example, these PPE practices can minimize worker exposure:

1. Inspect PPE before each use to ensure it is in good condition
2. Close zippers, buttons, and snaps fully
3. Tuck inner gloves under the suit's sleeves and outer gloves over suit's sleeves
4. Wear a third pair of tough outer gloves over the sleeves
5. Tuck boots under the legs of outer clothing
6. Wear hoods over the respirator harness
7. Tape and tab all joints (if tape adhesive is compatible with suit materials) to help prevent contaminants from getting inside gloves, boots, and jackets

**Proper work practices can help reduce the amount of contamination and the need for decontamination.** Examples of good work practices include:

1. Follow SOPs that minimize contact with hazardous substances
2. Do not kneel or walk through puddles or areas of obvious contamination
3. Properly dispose of decontamination equipment and solvents
4. Use remotely controlled equipment, such as drum grapplers, to sample, handle, and open drums
5. Cover monitoring and sampling instruments with plastic bags
6. Wear disposable outer garments and use disposable equipment whenever possible

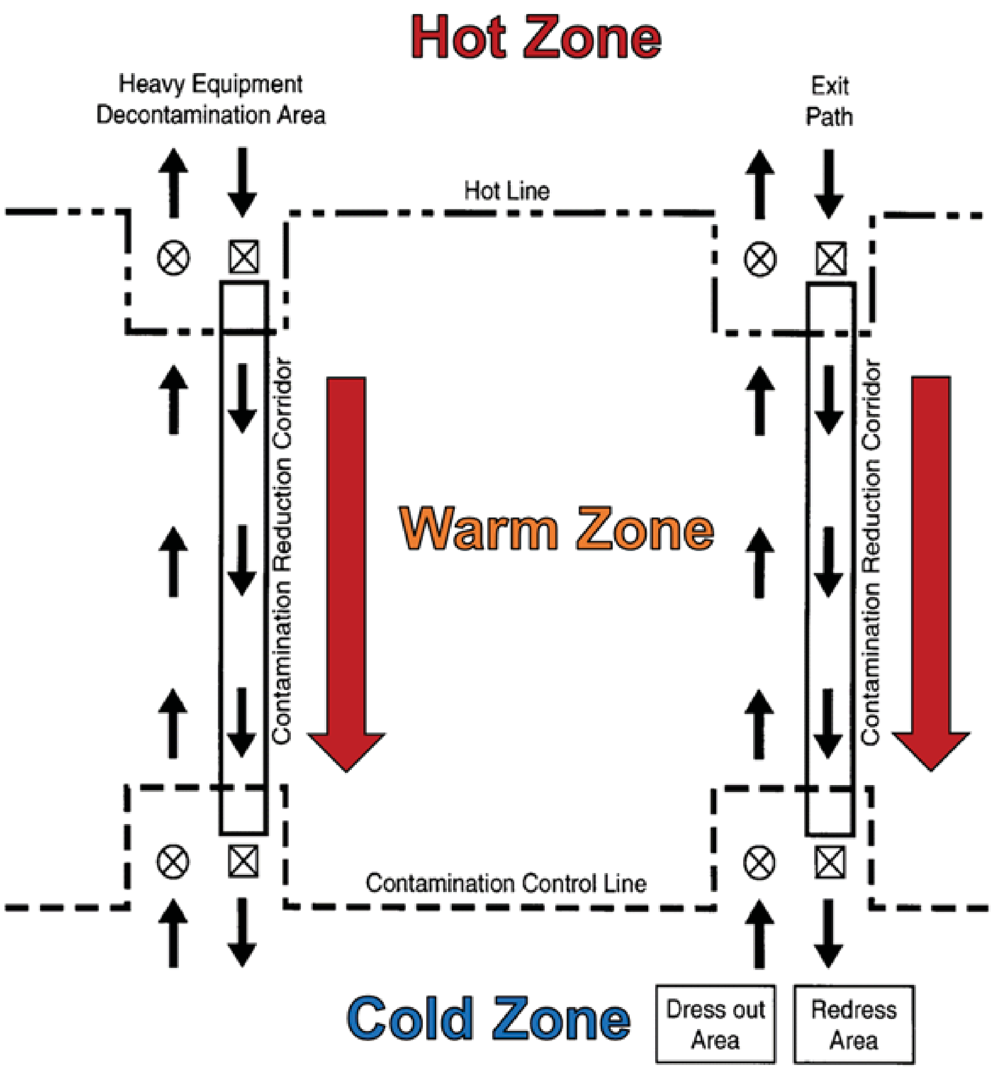
**Protective clothing and equipment must be decontaminated, cleaned, maintained, or replaced as often as necessary to protect the workers.** You must remove and discard contaminated clothing and PPE that cannot be decontaminated because it is permeable and/or not chemically resistant.

**The decon line must be set up and operational before anyone starts work in the Hot Zone or Exclusion Zone.**

**Decontamination must occur:**

- When PPE or clothing becomes contaminated;
- Before personnel go from a hot zone to a cold zone;
- Before workers eat, drink, smoke, or use restroom facilities; and
- Before equipment or vehicles leave the site.

**Decontamination takes place as you leave the hot zone and pass through a series of wash stations in the Warm Zone.** This area is called the decontamination line or the decon line. The decontamination line is made up of a series of stations that reduce contamination. **The stations are arranged in order of decreasing contamination, preferably in a straight line.** Most decontamination activities take place in the Warm Zone (also known as the Contamination Reduction Corridor Zone) but gross decontamination may take place in the Hot Zone. The only way out of the Hot Zone should be through the decon line.




Adapted from: Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities, DHHS 85-115 NIOSH, OSHA, U.S. Coast Guard, EPA.

**Hazards are present in the Hot Zone.** The “Hot line” is the outer boundary and should be clearly marked with hazard tape, signs, or ropes.

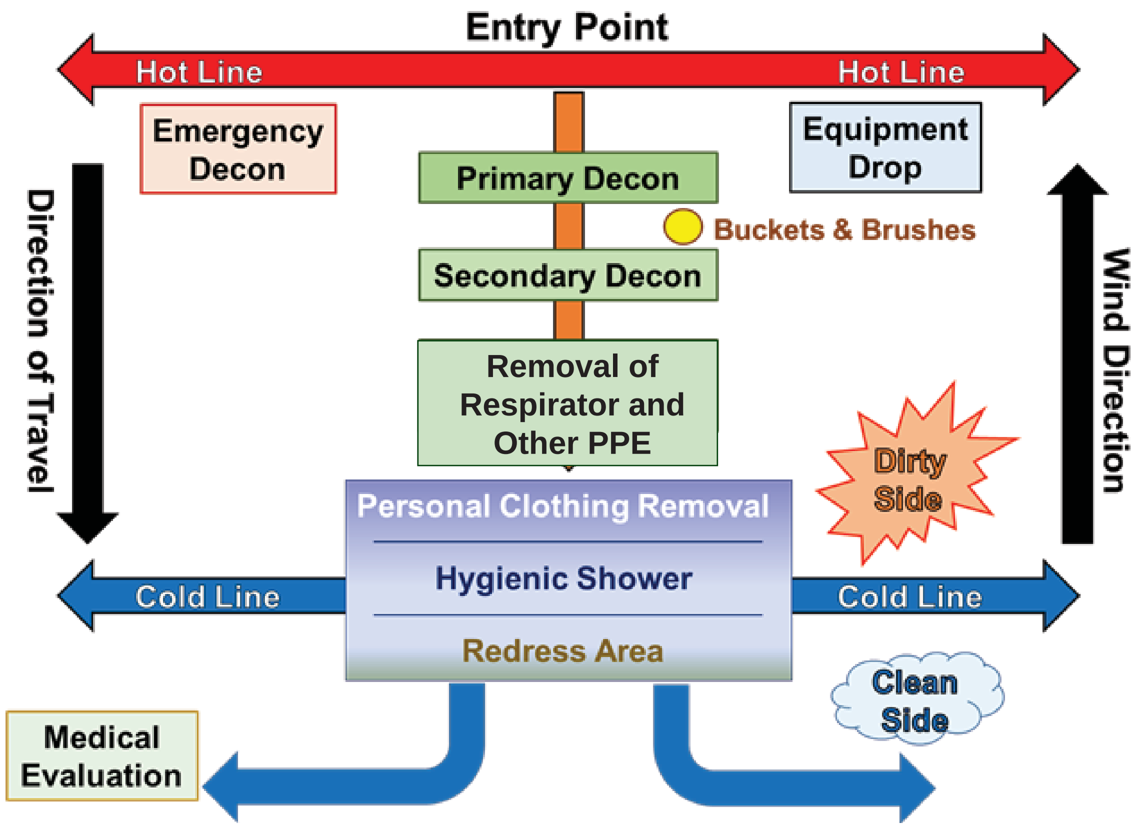
**Decontamination activities occur in the Warm Zone.** Protective equipment and clothing are removed to prevent the transfer of hazardous substances to cleaner areas.

**The Cold Zone is free of contamination.** If necessary, workers who have been in the Hot Zone receive a medical exam in the Cold Zone. The Cold Zone contains the administrative and other support personnel who keep the zones running smoothly.

**Personnel decontamination must occur before workers enter clean areas.** Workers in suits and respirators may be assigned to the decon line to scrub and rinse personal protective equipment and help you take it off. Outer, more heavily contaminated items such as boots, gloves, and suits should be decontaminated and removed first. Less contaminated items, for example inner boots and gloves, are removed next. You must go through decon every time you leave the Hot Zone.

**The number of stations, their configuration, and the procedures at each station is site-specific and will vary with the nature (type of chemicals) and extent (amount or concentration) of the contamination.** On most decon lines you will stand in a tub and your suit gloves and outer boots will be scrubbed with brushes and a compatible cleaner. Then you will step into two other tubs in succession, one for a full-body wash and the last tub for a rinse. You will take off your outer boots, inner gloves, and then your suit, carefully rolling them inside out so you do not get chemicals from the outside of the suit on your skin. You take off your respirator last. Some decon lines are very long and complicated and some are short but the basic idea is always the same.

See the sample decontamination line diagram shown below.




**Decontamination begins as you exit the Hot Zone and ends before you enter the Cold Zone.**

**All personnel, clothing, equipment, and sample containers leaving contaminated areas must be decontaminated.**

**The process of decontamination uses one or more methods to remove or neutralize hazardous substances.** The decon methods must be site-specific. Just as no one pair of gloves will protect you from every chemical, no single decon method will remove all types of contamination.

- Contaminants may be removed by washing and rinsing, dissolving contaminants in a solvent (water, alcohol, dilute acid, etc.), wiping, scrubbing, scraping, evaporating, heating, freezing, melting, or adsorption/adsorption (with powdered lime or kitty litter).
- Contaminants may be neutralized or inactivated by using a weak acid or base, chemical detoxification (making the hazardous substance less toxic), disinfecting or sterilizing equipment with chemical disinfectants, heat, or steam,

Particulate (dust) that cling to PPE and machinery may become trapped in small openings, such as the weave of the fabric, can be removed with water or a liquid rinse. Surfactants, such as detergent, improve the effectiveness of washing and rinsing by making the contaminants dissolve more readily into a solvent and reducing the ability of contaminants to stick to surfaces. Multiple rinses with clean solutions will remove more contaminants than a single rinse with the same volume of solution.

Volatile liquid contaminants can be removed from protective clothing or equipment by evaporation followed by a water rinse. Make sure that you wear an appropriate respirator or use other protection from the vaporized chemicals.

Chemicals, heat, and radiation may be used as disinfectants to kill some microorganisms such as bacteria and viruses. Disposable PPE is recommended for use with infectious agents. All equipment that cannot be decontaminated, such as wooden handles, and any contaminated cleaning solutions must be properly disposed.

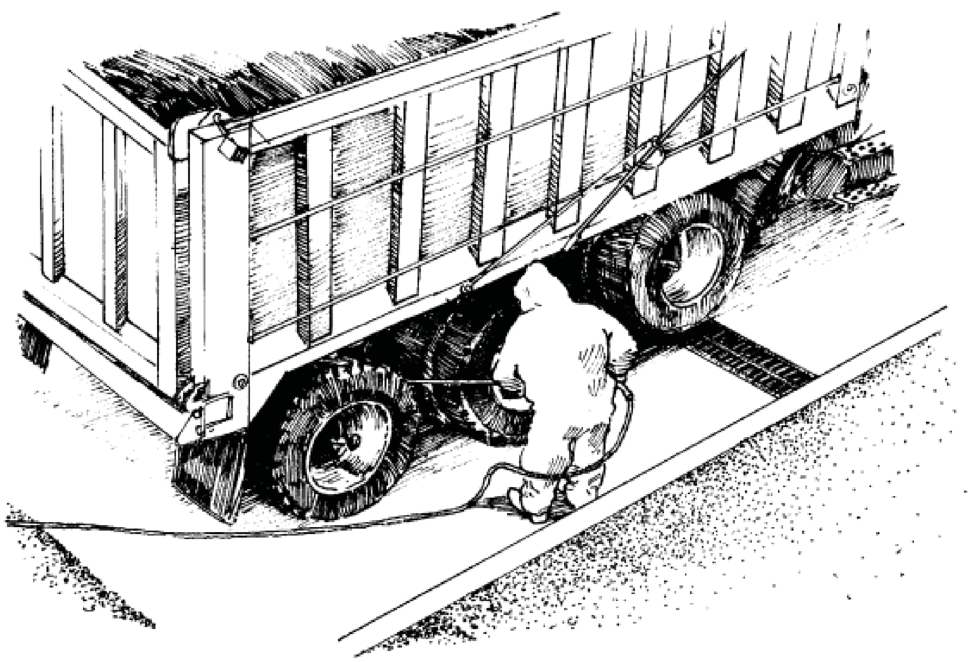
**It is important to select and follow proper decon procedures. The methods used must be compatible with the clothing and equipment being cleaned and capable of removing the contaminant without creating hazardous byproducts.** Decontamination through chemical neutralization requires careful planning and training.

**Decontamination of equipment prevents deterioration of the equipment and controls the spread of hazardous substances.** The specific decontamination procedure depends on the equipment and the hazardous substance.

Contaminated monitoring equipment requires special cleaning. EPA regional laboratories or the manufacturer can provide information on proper decontamination methods.

Metal tools should be cleaned, as appropriate, by chemical or physical means. Wooden tools and tools with wooden handles are difficult to decontaminate because they absorb chemicals.

The safety and health plan must detail the methods for decontaminating all respirators. Certain parts of contaminated SCBAs and other respirators, such as the harness assembly and leather or cloth components, are difficult to decontaminate. If grossly contaminated, they may need to be discarded. Rubber components can be soaked in soap and water and scrubbed with a brush, depending on the contaminant. Regulators must be maintained according to the manufacturer's recommendations.



**Worker using high-pressure water to decontaminate tires of a truck leaving a Superfund site**

**Contaminated wash and rinse solutions must be contained and properly disposed of to prevent pollution and the spread contamination.** Tools used in the Hot Zone must not be removed from the Hot Zone unless they have been decontaminated. Contaminated clothing, tools, buckets, brushes, etc. must be secured in drums or other containers and properly labeled. The spent solutions and runoff must be transferred to properly labeled drums and disposed of according to local, state, and federal regulations.

Workers at the start of the decon line (toward the Hot Zone) will need more protection from contaminants than workers at the end of the decon line. **Decon workers should wear the same level of PPE as Hot Zone workers or no more than one level of protection lower. Decon workers must never wear less than Level C protection.** The safety and health plan should specify the level of PPE to be worn by workers at all positions on the decon line.

- **Level A workers entering decon are met by level A or B;**
- **Level B workers entering decon are met level B or C;**
- **Level C workers entering decon are met by level C.**

While it is intended to protect workers, the community, and the environment, **decontamination can result in health and safety hazards if not done properly.**

**To reduce health and safety risks during decontamination:**

- Make sure that decontamination solutions are compatible with the hazardous substances being removed to prevent a reaction, which could produce an explosion, heat, or toxic products
- Make sure there are enough decon workers to help each person through the line
- Provide hand-holds while boots are being washed or boot covers removed
- Use “gripper” decals or other methods of increasing traction to reduce the likelihood of slips on plastic sheeting and slippery surfaces
- Provide benches or chairs (not wooden unless they will be disposed of after the job) for personnel to sit on at stations where boots or suits are removed
- Be sure all work areas are adequately decontaminated and cleaned
- Prevent unauthorized employees from removing protective clothing or equipment from change rooms

**How do you know if decontamination was effective?**

You can inspect decontaminated items to make sure there are no visible signs of contamination.  In most cases there will not be an on-the-spot test to assure total decontamination.  Wipe samples can be collected from decontaminated equipment and sent to a lab for analysis.  PPE can be sent to a lab to be analyzed for the presence of contamination.  The final rinse can also be analyzed to help determine the effectiveness of decontamination.

# Summary:
# Decontamination

Decontamination is important to prevent worker exposure and the spread of hazardous substances beyond the site. Proper procedures must be developed before a clean-up job begins. Remove contamination from personnel and expensive equipment such as SCBAs and air monitors. Properly dispose of PPE and less expensive equipment that cannot be decontaminated.

**The decontamination line is a series of station organized in a specific sequence.** The stations are arranged in order of decreasing contamination and to result in the most efficient decontamination. Decontamination reduces levels of contamination on personnel, PPE, and equipment until acceptable levels of the contaminant are present. Anything that cannot be decontaminated or packaged for reuse must be disposed of. The decon line must be set up and ready to go before anyone enters the Hot Zone.

During the development of the work plan, work zones should be established to control the spread of contaminants. **There are three zones:**

**The Hot Zone is the work area.** Only personnel in proper PPE should be in the Hot Zone.

**The Warm Zone is the area where decontamination occurs.** Decon workers usually wear PPE equal to, or one level less than, cleanup workers.

**The Cold Zone is the area for support personnel.** There are no hazardous waste materials in the cold zone.

**Methods for decontamination depend on the PPE or equipment and the hazardous substances at the site and include:**

- Rinsing or dissolving
- Scraping, brushing, and wiping
- Evaporation, then rinsing
- Washing with soap and water
- Chemical disinfection or neutralization
- A combination of the above.

**Decon workers must be decontaminated before they leave the decon line.** All decon equipment must be properly decontaminated or disposed of properly.

# Background Reading Material: Decontamination

*Hazardous Waste Operations and Emergency Response; Final Rule*
OSHA, March 6, 1989 (29CFR1926.65)

*Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities*
(NIOSH #85-115) October, 1985
Chapter 9 - Site Control, p. 1-7
Chapter 10 - Decontamination, p. 1-7

*Occupational Safety and Health Administration Hazardous Waste Decontamination Training.*
https://www.osha.gov/SLTC/hazardouswaste/training/decon.html

Notes:

# Chapter 8:
# Emergency Response

**Site management must provide a detailed SOP for emergencies, including fire, explosion, spills, or other situations that cannot be handled by workers on site.** The site safety and health plan is required by **29CFR1926.65** and includes a section on Emergency Response. Knowing what to do during an emergency and practicing it beforehand helps workers protect their safety and health.

**Chapter Objectives:**

After completing this module, you will be able to:

1. Explain OSHA's requirements for a written, site-specific emergency response plan
2. Identify the important parts of an emergency response plan
3. Explain the need for the Incident Command System (ICS)

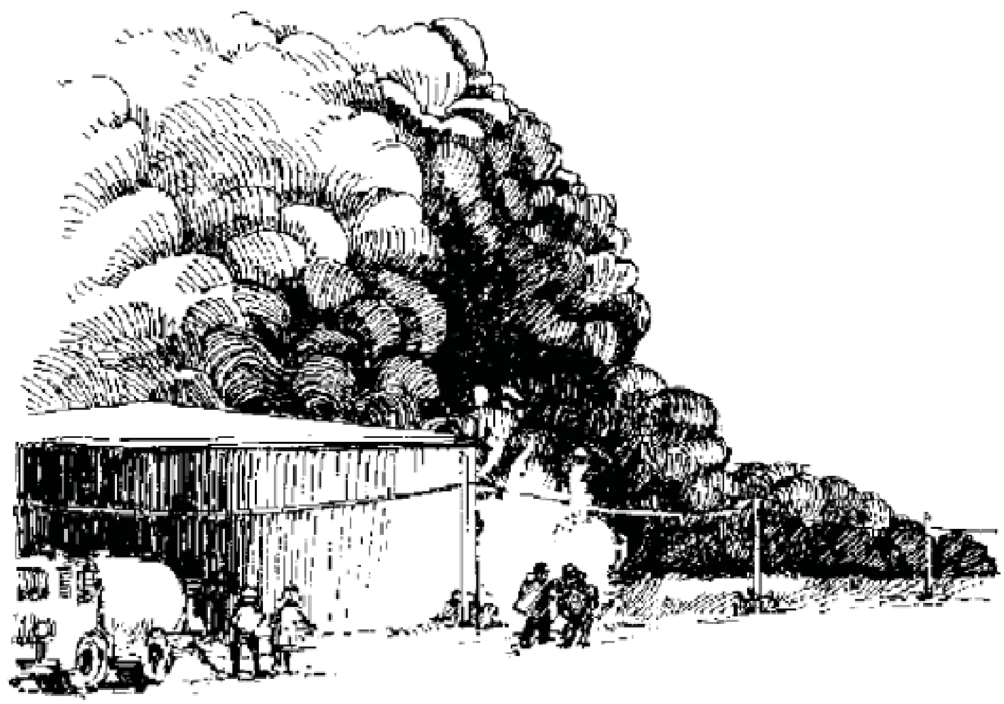
## Case Study

Workers were cleaning out an old factory in Brooklyn that used potassium cyanide and many different acids. During cleanup two leaking drums were put next to each other by accident. The chemicals combined to form hydrogen cyanide, a highly toxic gas. Workers struggled to see the exits due to the gas in the air and left the building slowly. Once they got outside there were not enough showers to hose the chemicals off everyone quickly. Finally, the first worker who finished decon called the fire department. **Why did this happen?**

No one thought ahead about what kinds of emergencies could happen on this job. They did not plan ahead with exit signs, a sufficient number of showers, and SOPs for notifying the fire department. In this chapter, you will learn about planning for emergency response to prevent these kinds of problems.

## What is an Emergency Response?

**According to OSHA, emergency response is an effort by employees, or by other designated responders (i.e., mutual-aid groups, local fire departments, etc.), from <u>outside</u> the immediate release area to an occurrence that results in an uncontrolled release of a hazardous substance.** OSHA defines "outside help" as anyone other than employees working in the immediate area or maintenance personnel. Notify your supervisor whenever you detect a spill or release. The supervisor will decide whether outside help is required. **Responses are not considered emergency responses when employees in the immediate area can control the hazardous substance at the time of the release.** Controlled means the substance has been absorbed or neutralized, or that the safety and health hazards have been eliminated by other means. For example, a spill of 100 milliliters (3 ounces) of acetone can be cleaned up by workers in the area and is unlikely to result in safety or health hazards. Responses to releases with no potential safety or health hazard are not considered to be emergency responses. The most common emergencies at waste sites are spills, fires, and explosions.



**Site characterization & analysis includes knowing the status and capabilities of emergency response teams that would provide assistance to hazardous waste clean-up site employees at the time of an emergency.**
**A <u>haz</u>ardous <u>mat</u>erials (HAZMAT) response team is:**

- An organized group tof employees and may include a team that is established by fire departments, local, regional or state governments.
- Designated by the employer
- Expected to perform work to stabilize and control leaks or spills of hazardous substances
- Required to approach to the hazardous substance in some situations
- Not the same as a fire brigade

A HAZMAT team responds to potential releases of hazardous substances to control or stabilize the incident.  A HAZMAT team may be a separate component of a fire brigade or fire department.

## Emergency Response Plan (ERP)

In accordance with 1926.65(q)(1), **employers must develop and implement an emergency response plan (ERP) as part of the site-specific safety and health program.** The ERP must be designed to handle anticipated emergencies and be put in place prior to the start of emergency response operations. The plan shall be in writing and available for inspection and copying by workers, their representatives, and OSHA personnel.

**The emergency response plan must be consistent with the disaster, fire, and/or other emergency response plans of local, state, and federal agencies and address:**

- Evacuation routes and procedures, including safe distances and places of refuge
- Pre-emergency coordination with outside parties
- Emergency recognition and prevention
- Lines of authority, training, and communication
- Site security and control
- Rescue, medical treatment, and first aid
- Decontamination, PPE and emergency equipment
- Procedures for reporting emergencies to responders and governmental agencies
- Post emergency review and follow-up

**Employers who evacuate their workers from the danger area and prohibit them from assisting in an emergency are not required to have an ERP. Instead, these employers must provide an emergency action plan that meets the requirements of 1926.35 or 1910.38**

**The ERP must be reviewed periodically.** If site conditions have changed or new information is available concerning hazards, the employer must update the ERP.

**The emergency response plan must be rehearsed regularly as a part of the overall training for site operations.** Make sure you know where to go and what to do before an emergency occurs. When it happens, it is too late to read the plan!

**Workers shall not be permitted to participate in or supervise field activities until they have been trained to a level required by job function and responsibility. Employees who may be exposed to hazardous substances while responding at hazardous waste sites must be trained to respond to expected emergencies.**

First aid training is not typically included in the basic 40-hour Site Worker mandated by 1926.65. However, first aid considerations and emergency medical treatment are required components of the site safety and health plan. **Personnel designated to provide first aid require advanced training and are necessary for emergency response.**

In a medical emergency, get the victim out of the hot zone, decon as completely as you can, wipe off and remove PPE, and tell medical personnel what has happened.

**An employee alarm system shall be installed to:**

- **Notify employees of an emergency situation;**
- **Stop work activities if necessary;**
- **Lower background noise in order to speed communication; and**
- **Begin emergency procedures**

The alarm system must produce a signal (noise, light, etc.) that can be perceived by all affected workers. All alarms must be distinct and recognized as signaling a specific action. The employer shall ensure that all components of the alarm system are approved for the work site and operating properly.

**The alarm system must be tested at least every two months.** The system must be operational at all times and during repairs or maintenance a back-up system must be operational. Maintenance work must be done by trained personnel only.

**During site-specific training,** the employer must explain the alarm system and how to report an emergency. Emergency telephone numbers must be posted near the telephone or in obvious locations.

If you observe a life-threatening situation, it is your responsibility to:

1. Activate the alarm system;
2. Notify the supervisor or emergency coordinator; and
3. Carry out your designated activities.

**Post emergency response is the portion of a response performed after the immediate threats have been stabilized or eliminated and clean-up has begun.** If these activities are performed by the workers who were a part of the initial emergency response then they are not considered post emergency response.

## Incident Command System (ICS)

The **Incident Command System (ICS)** is the chain-of-command system used in emergency and disaster response plans. The number of people involved and the roles of each person depend on the types of emergencies that could occur at a site. Planning, training, and practice are required to make sure that each team member knows his or her role. **Site-specific training is required for effective response to an emergency situation.**

**Incident Command System (ICS) is used to manage emergency situations (like chemical releases) by providing:**

- Unity of command (one person in charge)
- Span of control to manage personnel (3 - 7 people under one supervisor)
- Life safety code (priorities of protection are life, environment, then property)
- A modular system to manage resources (a system that can expand and contract with the emergency event)
- Common terms to promote seamless communication.

**An ICS separates emergency response personnel into five groups or sections: Command, Operations, Planning, Logistics, and Finance and Administration.**

**The Command Staff is responsible for health and safety, communicating with the public, and coordinating with other agencies and groups.** The Incident Commander/Unified Commander remains responsible for these activities or may assign individuals to carry out these responsibilities and report directly to the IC/UC.

Although a single Incident Commander normally handles the command function, an ICS organization may be expanded into a Unified Command (UC). The UC is a structure that brings together the “Incident Commanders” of all major organizations involved in the incident in order to coordinate an effective response while at the same time carrying out their own jurisdictional responsibilities. The UC links the organizations responding to the incident and provides a forum for these entities to make consensus decisions. Under the UC, the various jurisdictions and/or agencies responders may blend together throughout the operation to create an integrated response team.

**The Operations Staff is responsible for all operations directly applicable to the primary mission of the response.**

**The Planning Staff is responsible for collecting, evaluating, and disseminating the tactical information related to the incident,** and for preparing and documenting Incident Action Plans (IAP's). An IAP is prepared at a decided upon frequency (1, 2, 4 times per days) to set response priorities and objectives and to allocate resources to meet those objectives.

**The Logistics Staff is responsible for providing facilities, services, and materials for the incident response.**

**The Finance and Administrative Staff is responsible for all financial, administrative, and cost analysis aspects of the response.**

**The ICS structure is fixed but the size and specifics can be adjusted for the incident.** ICS is a standardized on-scene incident management concept designed specifically to allow responders to adopt an integrated organizational structure without being hindered by jurisdictional boundaries. Many smaller incident responses will not require Planning, Logistics, or Finance sections while larger responses will require many people in each of the five sections.

Anyone involved in emergency response would benefit from a better understanding of the ICS. Addition information and training is available from:

- FEMA - http://www.training.fema.gov/is/nims.aspx
- OSHA - http://www.osha.gov/SLTC/etools/ics/index.html

# Summary: Emergency Response

**An emergency is any sudden or unexpected event requiring outside help.** Emergency response workers need sufficient training before they may respond to an emergency incident. **This course does not qualify you as an emergency response worker.**

**The emergency response plan is a written plan that is put into action before cleanup work begins. The plan must be site specific and it must be available for workers to copy or read.**

You will be able to clean up small spills on site without outside help. For large spills or medical emergencies, you will need to get out and call for trained help. In a medical emergency, get the victim out of the hot zone, decon as completely as you can, wipe off and remove PPE, and tell medical personnel what has happened.

**Work sites must be properly equipped to respond to emergencies.** Telephones, horns, fire extinguishers, spill control equipment, and other equipment are needed when responding to incidents and alerting employees.

Part of planning for emergencies is deciding who is in charge. **The Incident Command System (ICS) is a pre-planned chain of command that specifies lines of authority, communication, and responsibilities.**

## Background Reading Material: Emergency Response

*OSHA Incident Command System (ICS) eTool*
http://www.osha.gov/SLTC/etools/ics/index.html

*Hazardous Waste Operations and Emergency Response*
(29CFR1926.65) (l) Emergency Response

*Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities*
October 1985. (NIOSH #85-115)

*EPA's Standard Operating Safety Guides.* July, 1988.
Part 9 Site Safety Plan, p.2-3, 7-8
Annex 7 Emergency Operations Color Codes

*NIOSH Pocket Guide to Chemical Hazards.*
http://wwwn.cdc.gov/pubs/CDCInfoOnDemand.aspx?ProgramID=147

Notes:

CPWR

## Activities:

## Activity 2: Health Effects

You are assigned to work in a large abandoned warehouse on a brownfield site. The building is being renovated for use as a parts assembly shop. Large doors on either end of the warehouse provide natural ventilation. Using the NIOSH Pocket Guide, find the OSHA Permissible Exposure Limits (PELs), the Immediately Dangerous to Life or Health Level (IDLH) concentrations, the routes of entry, the target organs, and the symptoms of overexposure for the chemicals listed. Then, answer the questions on next page.

| Chemical | OSHA PEL | IDHL | Routes of Entry | Target Organs | Symptoms |
|---|---|---|---|---|---|
| Methylene chloride | | | | | |
| Lead | | | | | |
| Acetone | | | | | |
| Toluene | | | | | |
| Muriatic Acid (Hydrogen chloride) | | | | | |
| Toluene-2,4-diisocyanate (TDI) | | | | | |

1. Which of these chemicals would you have the most health concerns about? Why?

2. For which chemicals would you want to wear chemical eye protection?

## Activity 3: Hazard Recognition

You are **Chris Worker**, a construction worker working as part of a mixed crew on a CERCLA hazardous waste site erecting an entombment chamber for 55-gallon drums. The site characterization and analysis crew has finished work. You are working for the contractor hired to clean up the site and are dressed in Level C protection (air-purifying respirators and splash suits). Soon after starting the excavation, **you spotted 30 - 40 unmarked drums buried** where you were going to build the chamber. Upon closer examination, **these drums are corroded and appear to be leaking**. This spot was listed on the site map as having no barrels and was therefore not included in the initial site characterization and analysis.

To save time and stay on schedule, your supervisor decides to go ahead and use the crew to clear these drums **without any additional assessment, even though they weren't included in the original site analysis or plan.**

You refused to do any work with the buried drums until the contractor had the drums sampled and all the hazards identified. Your employer did this and told you not to worry. They sampled the nearest drum and found that it contained **waste phosphorus trichloride**. Therefore, your team still dressed in Level C protection with HEPA (High Efficiency Particulate Air) filters, could now overpack the drums and store them to one side while you continued building the concrete forms.

You are still concerned and decide to use the ***NIOSH Pocket Guide*** to find some information on this chemical.

1. What is the UEL ______ and LEL ________of this chemical?

   What is the flashpoint of this chemical? _________

   What does this mean? _______________________________________________

   ____________________________________________________________

2. What is the vapor pressure of this chemical? __________________

3. What are this chemical's target organs? ________________________________

________________________________________________________________

________________________________________________________________

4. What are the routes of entry to the body? ________________________________

________________________________________________________________

________________________________________________________________

5. What is the PEL of this chemical? ________

   What is the IDLH of this chemical? ________

   What do these numbers mean? ______________________________________

________________________________________________________________

________________________________________________________________

6. What level of protection would you want to be wearing for your job?

________________________________________________________________

________________________________________________________________

7. Using the above information, what concerns, if any, would you have about entering the excavation to overpack these leaking drums?

________________________________________________________________

________________________________________________________________

________________________________________________________________

## Activity 4: Hazard Recognition

You are **Kim Worker**, a construction worker assigned to a mixed crew on a CERCLA hazardous waste site erecting an entombment chamber for 55-gallon drums. The site characterization and analysis crew has finished their work. You are working for the contractor hired to clean up the site and are dressed in Level C protection (air-purifying respirators and splash suits). Soon after starting the excavation, **you spotted 30 - 40 unmarked drums buried** where you were going to build the chamber. Upon closer examination, **these drums are corroded and appear to be leaking**. This spot was listed on the site map as having no barrels and was therefore not included in the initial site characterization and analysis.

To save time and stay on schedule, your supervisor decides to go ahead and use your crew to clear these drums **without any additional assessment, even though they weren't included in the original site analysis or plan.**

You refused to do any work with the buried drums until the contractor had the drums sampled and all the hazards identified. Your employer did this and told you not to worry. They sampled the nearest drum and found that it contained **waste phosphorus trichloride.**

Therefore, your team still dressed in Level C protection with HEPA (High Efficiency Particulate Air) filters, could now overpack the drums and store them to one side while you continued building the concrete forms. You checked the ***NIOSH Pocket Guide*** and gathered information about this chemical.

As you were finishing your research in the ***NIOSH Pocket Guide***, your foreman came up to tell you that there was reason to believe that some of the barrels also contained **TDI**, also known as **toluene-2,4-diisocyanate**. You immediately returned to your ***Pocket Guide*** to get some information on this newly identified chemical.

1. What are the physical characteristics of **toluene-2,4-diisocyanate**

______________________________________________

______________________________________________

______________________________________________

2. What is the UEL ________and LEL of this chemical __________?

3. What is the flashpoint? _________

   What does this mean? ______________________________________________

   ____________________________________________________________________

4. What is the vapor pressure of this chemical? _______________

5. What is the PEL of this chemical? __________

   What is the IDLH concentration of this chemical? __________

   What do these numbers mean? ______________________________________

   ____________________________________________________________________

6. What are this chemical's target organs? _________________________________

   ____________________________________________________________________

   ____________________________________________________________________

7. What are the routes of entry to the body? ________________________________

   ____________________________________________________________________

   ____________________________________________________________________

8. What level of protection would you want to be wearing for your job?

9. Using the above information, what concerns, if any, would you have about entering the ditch to overpack these leaking drums?

## Activity 5: Physical and Chemical Properties

Knowing a compound's physical and chemical properties can help you to determine how much of a risk it will pose to people and to the environment. Look up the properties of these chemicals in the ***NIOSH Pocket Guide*** and then answer the questions below.

| Chemical | M.W. | V.P. | BP | Fl.P. | LEL | PEL | Sol. | Sp.Gr. |
|---|---|---|---|---|---|---|---|---|
| Kerosene | | | | | | | | |
| MEK | | | | | | | | |
| TCA | | | | | | | | |
| Ammonia | | | | | | | | |

1. Which chemicals pose a fire hazard? ______________________________

   ______________________________________________________

2. Which chemicals would mix readily with water? Which would sink in water? Which would float in water?

| Mix | Sink | Float |
|---|---|---|
| | | |

3. Remembering that 1% = 10,000 ppm, are the LELs more or less that the PELs? By about how much?

   ______________________________________________

   ______________________________________________

4. What chemical would get into the air (evaporate) the fastest? ____________

   Which would get in the air the slowest? ____________

5. Which chemical vapor would be most likely to rise above the site of a spill or release? (Remember, air has a M.W. of 29.5)

   ______________________________________________

   Which chemical vapor would be most likely to settle near the site of a spill or release? (Remember, air has a M.W. of 29.5)

   ______________________________________________

# Activity 6: Hazard Information Sources

**Use the label on the next page to answer the following questions:**

1. What is the name, address and telephone number of the chemical manufacturer, importer or other responsible party?

   ______________________________________________

2. What is the Product Identifier used to identify the hazardous chemical?

   ______________________________________________

3. What Signal Word(s) are used to indicate the relative level of severity of the hazard?

   ______________________________________________

   ______________________________________________

4. What Hazard Statement is used to describe the nature of the hazard(s) of a chemical?

   ______________________________________________

   ______________________________________________

5. What Precautionary statements are used on the label?

   ______________________________________________

6. What First Aid measures are identified on the label?

   ______________________________________________

7. What should you do in case of a fire while using this chemical?

______________________________________________________________

______________________________________________________________

8. What is the proper disposal procedure for this chemical?

______________________________________________________________

______________________________________________________________

______________________________________________________________

**OXI252**
(disodiumflammy)
CAS #: 111-11-11xx

**Danger**
May cause fire or explosion; strong oxidizer
Causes severe skin burns and eye damage

Keep away from heat. Keep away from clothing and other combustible materials. Take any precaution to avoid mixing with combustibles. Wear protective neoprene gloves, safety goggles and face shield with chin guard. Wear fire/flame resistant clothing. Do not breathe dust or mists. Wash arms, hands and face thoroughly after handling. Store locked up. Dispose of contents and container in accordance with local, state and federal regulations.

**First aid:**
IF ON SKIN (or hair) or clothing[6]: Rinse immediately contaminated clothing and skin with plenty of water before removing clothes. Wash contaminated clothing before reuse.
IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.
IF INHALED: Remove person to fresh air and keep comfortable for breathing.
IF SWALLOWED: Rinse mouth. Do NOT induce vomiting.
Immediately call poison center.
Specific Treatment: Treat with doctor-prescribed burn cream.

**Fire:**
In case of fire: Use water spray. In case of major fire and large quantities: Evacuate area. Fight fire remotely due to the risk of explosion.

Great Chemical Company, 55 Main Street, Anywhere, CT 064XX — Telephone (888) 777-8888

# Activity 7: SDS Worksheet

**Use the SDS sheet starting on page A-15 to answer these questions.**

1. What is the name of the product? ______________________________

2. When was the SDS last issued? ______________________________

3. What pictogram(s) are found on the SDS?

   ______________________________

   ______________________________

4. Are there OSHA PELSs listed for the ingredients? Yes ☐ No ☐

5. List the OSHA TWAs and any other TWAs listed for each ingredient.

   ______________________________

   ______________________________

   ______________________________

6. What "Serious Eye damage/Irritation" hazard classification category is this chemical?

   ______________________________

   ______________________________

7. Which organ does this chemical cause damage to?

   ______________________________

   ______________________________

8. Does this product contain any cancer causing materials? Yes ☐ No ☐

9. What first aid measures should be taken if the product comes into contact with the eyes?

________________________________________________

________________________________________________

10. What types of materials will react with this product?

________________________________________________

________________________________________________

11. What are some possible health effects of a single exposure to this chemical?

________________________________________________

________________________________________________

12. What eye/face protection is recommended when using this chemical?

________________________________________________

13. What NFPA Flammability Hazard Classification does this chemical receive?

________________________________________________

14. Would this material be safe to use near a kerosene heater? Yes ☐ No ☐

# Safety Data Sheet



| | | | |
|---|---|---|---|
| **Document Group:** | 16-3472-4 | **Version Number:** | 37.00 |
| **Issue Date:** | 09/11/14 | **Supercedes Date:** | 04/19/12 |

## SECTION 1: Identification

**1.1. Product identifier**
3M(TM) Super 77(TM) Multipurpose Adhesive (Aerosol)

**Product Identification Numbers**
62-4977-4730-3, 62-4977-4925-9, 62-4977-4929-1, 62-4977-4930-9, 62-4977-4935-8

**1.2. Recommended use and restrictions on use**

**Recommended use**
general purpose aerosol adhesive, General Purpose Aerosol adhesive

**1.3. Supplier's details**

| | |
|---|---|
| **MANUFACTURER:** | 3M |
| **DIVISION:** | Industrial Adhesives and Tapes Division |
| **ADDRESS:** | 3M Center, St. Paul, MN 55144-1000, USA |
| **Telephone:** | 1-888-3M HELPS (1-888-364-3577) |

**1.4. Emergency telephone number**
1-800-364-3577 or (651) 737-6501 (24 hours)

## SECTION 2: Hazard identification

**2.1. Hazard classification**
Flammable Aerosol: Category 1.
Serious Eye Damage/Irritation: Category 2A.
Reproductive Toxicity: Category 2.
Simple Asphyxiant.
Specific Target Organ Toxicity (single exposure): Category 1.
Specific Target Organ Toxicity (central nervous system): Category 3.

**2.2. Label elements**
**Signal word**
Danger

**Symbols**
Flame | Exclamation mark | Health Hazard |

**Pictograms**

**Hazard Statements**
Extremely flammable aerosol.

Causes serious eye irritation.
May cause drowsiness or dizziness.
Suspected of damaging fertility or the unborn child.
May displace oxygen and cause rapid suffocation.

Causes damage to organs:
cardiovascular system |

**Precautionary Statements**
**General:**
Keep out of reach of children.

**Prevention:**
Obtain special instructions before use.
Do not handle until all safety precautions have been read and understood.
Keep away from heat/sparks/open flames/hot surfaces. - No smoking.
Do not spray on an open flame or other ignition source.
Pressurized container: Do not pierce or burn, even after use.
Do not breathe dust/fume/gas/mist/vapors/spray.
Use only outdoors or in a well-ventilated area.
Wear protective gloves and eye/face protection.
Do not eat, drink or smoke when using this product.
Wash thoroughly after handling.

**Response:**
IF INHALED: Remove person to fresh air and keep comfortable for breathing.
IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.
If eye irritation persists: Get medical advice/attention.
IF exposed or concerned: Get medical advice/attention.
Specific treatment (see Notes to Physician on this label).

**Storage:**
Protect from sunlight. Do not expose to temperatures exceeding 50C/122F.
Keep container tightly closed.
Store locked up in a well-ventilated place.

**Disposal:**
Dispose of contents/container in accordance with applicable local/regional/national/international regulations.

**Notes to Physician:**
Exposure may increase myocardial irritability. Do not administer sympathomimetic drugs unless absolutely necessary.

**2.3. Hazards not otherwise classified**
None.

36% of the mixture consists of ingredients of unknown acute dermal toxicity.

## SECTION 3: Composition/information on ingredients

| Ingredient | C.A.S. No. | % by Wt |
|---|---|---|
| Non-volatile components (N.J.T.S. Registry No. 04499600-6433P) | Trade Secret* | 20 - 30 Trade Secret * |
| Acetone | 67-64-1 | 20 - 30 Trade Secret * |
| Propane | 74-98-6 | 15 - 25 Trade Secret * |
| Cyclohexane | 110-82-7 | 10 - 20 Trade Secret * |
| Petroleum distillates | 64742-49-0 | 10 - 20 Trade Secret * |
| Hexane | 110-54-3 | < 0.5 |

*The specific chemical identity and/or exact percentage (concentration) of this composition has been withheld as a trade secret.

## SECTION 4: First aid measures

**4.1. Description of first aid measures**

**Inhalation:**
Remove person to fresh air. Get medical attention.

**Skin Contact:**
Wash with soap and water. If signs/symptoms develop, get medical attention.

**Eye Contact:**
Immediately flush with large amounts of water. Remove contact lenses if easy to do. Continue rinsing. Get medical attention.

**If Swallowed:**
Rinse mouth. If you feel unwell, get medical attention.

**4.2. Most important symptoms and effects, both acute and delayed**
See Section 11.1. Information on toxicological effects.

**4.3. Indication of any immediate medical attention and special treatment required**
Exposure may increase myocardial irritability. Do not administer sympathomimetic drugs unless absolutely necessary.

## SECTION 5: Fire-fighting measures

**5.1. Suitable extinguishing media**
Use a fire fighting agent suitable for the surrounding fire.

**5.2. Special hazards arising from the substance or mixture**
Closed containers exposed to heat from fire may build pressure and explode.

**Hazardous Decomposition or By-Products**

| Substance | Condition |
|---|---|
| Aldehydes | During Combustion |
| Carbon monoxide | During Combustion |
| Carbon dioxide | During Combustion |

**5.3. Special protective actions for fire-fighters**

Water may not effectively extinguish fire; however, it should be used to keep fire-exposed containers and surfaces cool and prevent explosive rupture.

## SECTION 6: Accidental release measures

**6.1. Personal precautions, protective equipment and emergency procedures**
Evacuate area. Keep away from heat/sparks/open flames/hot surfaces. - No smoking. Use only non-sparking tools. Ventilate the area with fresh air. For large spill, or spills in confined spaces, provide mechanical ventilation to disperse or exhaust vapors, in accordance with good industrial hygiene practice. Warning! A motor could be an ignition source and could cause flammable gases or vapors in the spill area to burn or explode. Refer to other sections of this SDS for information regarding physical and health hazards, respiratory protection, ventilation, and personal protective equipment.

**6.2. Environmental precautions**
Avoid release to the environment.

**6.3. Methods and material for containment and cleaning up**
If possible, seal leaking container. Place leaking containers in a well-ventilated area, preferably an operating exhaust hood, or if necessary outdoors on an impermeable surface until appropriate packaging for the leaking container or its contents is available. Contain spill. Cover spill area with a fire-extinguishing foam. An appropriate aqueous film forming foam (AFFF) is recommended. Working from around the edges of the spill inward, cover with bentonite, vermiculite, or commercially available inorganic absorbent material. Mix in sufficient absorbent until it appears dry. Remember, adding an absorbent material does not remove a physical, health, or environmental hazard. Collect as much of the spilled material as possible using non-sparking tools. Place in a metal container approved for transportation by appropriate authorities. Clean up residue with an appropriate solvent selected by a qualified and authorized person. Ventilate the area with fresh air. Read and follow safety precautions on the solvent label and SDS. Seal the container. Dispose of collected material as soon as possible.

## SECTION 7: Handling and storage

**7.1. Precautions for safe handling**
Keep out of reach of children. Do not handle until all safety precautions have been read and understood. Keep away from heat/sparks/open flames/hot surfaces. - No smoking. Do not spray on an open flame or other ignition source. Do not pierce or burn, even after use. Do not breathe dust/fume/gas/mist/vapors/spray. Do not get in eyes, on skin, or on clothing. Do not eat, drink or smoke when using this product. Wash thoroughly after handling. Avoid release to the environment. Avoid contact with oxidizing agents (eg. chlorine, chromic acid etc.) Use personal protective equipment (gloves, respirators, etc.) as required.

**7.2. Conditions for safe storage including any incompatibilities**
Store in a well-ventilated place. Keep container tightly closed. Protect from sunlight. Do not expose to temperatures exceeding 50C/122F. Store away from heat. Store away from acids. Store away from oxidizing agents.

## SECTION 8: Exposure controls/personal protection

**8.1. Control parameters**

**Occupational exposure limits**
If a component is disclosed in section 3 but does not appear in the table below, an occupational exposure limit is not available for the component.

| Ingredient | C.A.S. No. | Agency | Limit type | Additional Comments |
|---|---|---|---|---|
| Hexane | 110-54-3 | OSHA | TWA:1800 mg/m3(500 ppm) | |
| Hexane | 110-54-3 | ACGIH | TWA:50 ppm | Skin Notation |
| Cyclohexane | 110-82-7 | ACGIH | TWA:100 ppm | |
| Cyclohexane | 110-82-7 | OSHA | TWA:1050 mg/m3(300 ppm) | |
| Petroleum distillates | 64742-49-0 | CMRG | TWA:50 ppm | |
| Acetone | 67-64-1 | OSHA | TWA:2400 mg/m3(1000 ppm) | |

| | | | | |
|---|---|---|---|---|
| Acetone | 67-64-1 | ACGIH | TWA:500 ppm;STEL:750 ppm | A4: Not class. as human carcin |
| Propane | 74-98-6 | ACGIH | Limit value not established: | |
| Propane | 74-98-6 | OSHA | TWA:1800 mg/m3(1000 ppm) | |

ACGIH : American Conference of Governmental Industrial Hygienists
AIHA : American Industrial Hygiene Association
CMRG : Chemical Manufacturer's Recommended Guidelines
OSHA : United States Department of Labor - Occupational Safety and Health Administration
TWA: Time-Weighted-Average
STEL: Short Term Exposure Limit
CEIL: Ceiling

**8.2. Exposure controls**

**8.2.1. Engineering controls**
Do not remain in area where available oxygen may be reduced. Use general dilution ventilation and/or local exhaust ventilation to control airborne exposures to below relevant Exposure Limits and/or control dust/fume/gas/mist/vapors/spray. If ventilation is not adequate, use respiratory protection equipment.

**8.2.2. Personal protective equipment (PPE)**

**Eye/face protection**

Select and use eye/face protection to prevent contact based on the results of an exposure assessment. The following eye/face protection(s) are recommended:
Indirect Vented Goggles

**Skin/hand protection**
Select and use gloves and/or protective clothing approved to relevant local standards to prevent skin contact based on the results of an exposure assessment. Selection should be based on use factors such as exposure levels, concentration of the substance or mixture, frequency and duration, physical challenges such as temperature extremes, and other use conditions. Consult with your glove and/or protective clothing manufacturer for selection of appropriate compatible gloves/protective clothing.
Gloves made from the following material(s) are recommended: Butyl Rubber
Nitrile Rubber

**Respiratory protection**

An exposure assessment may be needed to decide if a respirator is required. If a respirator is needed, use respirators as part of a full respiratory protection program. Based on the results of the exposure assessment, select from the following respirator type(s) to reduce inhalation exposure:
Half facepiece or full facepiece supplied-air respirator

For questions about suitability for a specific application, consult with your respirator manufacturer.

## SECTION 9: Physical and chemical properties

**9.1. Information on basic physical and chemical properties**

| | |
|---|---|
| **General Physical Form:** | Liquid aerosol |
| **Specific Physical Form:** | Aerosol |
| **Odor, Color, Grade:** | Clear, sweet, fruity odor |
| **Odor threshold** | *No Data Available* |
| **pH** | *No Data Available* |
| **Melting point** | *No Data Available* |
| **Boiling Point** | *Not Applicable* |
| **Flash Point** | -42.00 ºF [*Test Method:* Tagliabue Closed Cup] |
| **Evaporation rate** | 1.90 [*Ref Std:* ETHER=1] |

| | |
|---|---|
| **Flammability (solid, gas)** | Not Applicable |
| **Flammable Limits(LEL)** | *No Data Available* |
| **Flammable Limits(UEL)** | *No Data Available* |
| **Vapor Density** | 2.97 [*Ref Std:* AIR=1] |
| **Density** | 0.726 g/ml |
| **Specific Gravity** | 0.726 [*Ref Std:* WATER=1] |
| **Solubility in Water** | Nil |
| **Solubility- non-water** | *No Data Available* |
| **Partition coefficient: n-octanol/ water** | *No Data Available* |
| **Autoignition temperature** | *No Data Available* |
| **Decomposition temperature** | *Not Applicable* |
| **Viscosity** | *Not Applicable* |
| **Hazardous Air Pollutants** | <=0.4 % weight [*Test Method:* Calculated] |
| **VOC Less H2O & Exempt Solvents** | <=51 % [*Test Method:* calculated SCAQMD rule 443.1] |
| **Solids Content** | >=22.4 % |

## SECTION 10: Stability and reactivity

**10.1. Reactivity**
This material may be reactive with certain agents under certain conditions - see the remaining headings in this section.

**10.2. Chemical stability**
Stable.

**10.3. Possibility of hazardous reactions**
Hazardous polymerization will not occur.

**10.4. Conditions to avoid**
Heat

**10.5. Incompatible materials**
Strong oxidizing agents

**10.6. Hazardous decomposition products**

| Substance | Condition |
|---|---|
| None known. | |

Refer to section 5.2 for hazardous decomposition products during combustion.

## SECTION 11: Toxicological information

**The information below may not be consistent with the material classification in Section 2 if specific ingredient classifications are mandated by a competent authority. In addition, toxicological data on ingredients may not be reflected in the material classification and/or the signs and symptoms of exposure, because an ingredient may be present below the threshold for labeling, an ingredient may not be available for exposure, or the data may not be relevant to the material as a whole.**

**11.1. Information on Toxicological effects**

**Signs and Symptoms of Exposure**

**Based on test data and/or information on the components, this material may produce the following health effects:**

**Inhalation:**
Intentional concentration and inhalation may be harmful or fatal.

Simple Asphyxiation: Signs/symptoms may include increased heart rate, rapid respirations, drowsiness, headache, incoordination, altered judgement, nausea, vomiting, lethargy, seizures, coma, and may be fatal.

Respiratory Tract Irritation: Signs/symptoms may include cough, sneezing, nasal discharge, headache, hoarseness, and nose and throat pain.

May cause target organ effects after inhalation.

**Skin Contact:**
Dermal Defatting: Signs/symptoms may include localized redness, itching, drying and cracking of skin.

**Eye Contact:**
Severe Eye Irritation: Signs/symptoms may include significant redness, swelling, pain, tearing, cloudy appearance of the cornea, and impaired vision.

**Ingestion:**
Gastrointestinal Irritation: Signs/symptoms may include abdominal pain, stomach upset, nausea, vomiting and diarrhea.

May cause target organ effects after ingestion.

**Target Organ Effects:**

**Single exposure may cause:**
Central Nervous System (CNS) Depression: Signs/symptoms may include headache, dizziness, drowsiness, incoordination, nausea, slowed reaction time, slurred speech, giddiness, and unconsciousness.

Single exposure, above recommended guidelines, may cause:
Cardiac Sensitization: Signs/symptoms may include irregular heartbeat (arrhythmia), faintness, chest pain, and may be fatal.

**Reproductive/Developmental Toxicity:**
Contains a chemical or chemicals which can cause birth defects or other reproductive harm.

**Toxicological Data**
If a component is disclosed in section 3 but does not appear in a table below, either no data are available for that endpoint or the data are not sufficient for classification.

**Acute Toxicity**

| Name | Route | Species | Value |
|---|---|---|---|
| Overall product | Dermal | | No data available; calculated ATE > 5,000 mg/kg |
| Overall product | Ingestion | | No data available; calculated ATE > 5,000 mg/kg |
| Propane | Inhalation-Gas (4 hours) | Rat | LC50 > 200,000 ppm |
| Acetone | Dermal | Rabbit | LD50 > 15,688 mg/kg |
| Acetone | Inhalation-Vapor (4 hours) | Rat | LC50 76 mg/l |
| Acetone | Ingestion | Rat | LD50 5,800 mg/kg |
| Cyclohexane | Dermal | Rat | LD50 > 2,000 mg/kg |
| Cyclohexane | Inhalation-Vapor (4 hours) | Rat | LC50 > 32.9 mg/l |
| Cyclohexane | Ingestion | Rat | LD50 6,200 mg/kg |
| Petroleum distillates | Dermal | Rabbit | LD50 > 3,160 mg/kg |

| | | | |
|---|---|---|---|
| Petroleum distillates | Inhalation-Vapor (4 hours) | Rat | LC50 > 14.7 mg/l |
| Petroleum distillates | Ingestion | Rat | LD50 > 5,000 mg/kg |
| Non-volatile components (N.J.T.S. Registry No. 04499600-6433P) | Ingestion | | LD50 estimated to be 2,000 - 5,000 mg/kg |
| Hexane | Dermal | Rabbit | LD50 > 2,000 mg/kg |
| Hexane | Inhalation-Vapor (4 hours) | Rat | LC50 170 mg/l |
| Hexane | Ingestion | Rat | LD50 > 28,700 mg/kg |

ATE = acute toxicity estimate

**Skin Corrosion/Irritation**

| Name | Species | Value |
|---|---|---|
| Propane | Rabbit | Minimal irritation |
| Acetone | Mouse | Minimal irritation |
| Cyclohexane | Rabbit | Mild irritant |
| Petroleum distillates | Rabbit | Irritant |
| Non-volatile components (N.J.T.S. Registry No. 04499600-6433P) | | Minimal irritation |
| Hexane | Human and animal | Mild irritant |

**Serious Eye Damage/Irritation**

| Name | Species | Value |
|---|---|---|
| Propane | Rabbit | Mild irritant |
| Acetone | Rabbit | Severe irritant |
| Cyclohexane | Rabbit | Mild irritant |
| Petroleum distillates | Rabbit | Mild irritant |
| Hexane | Rabbit | Mild irritant |

**Skin Sensitization**

| Name | Species | Value |
|---|---|---|
| Petroleum distillates | Guinea pig | Not sensitizing |
| Hexane | Human | Not sensitizing |

**Respiratory Sensitization**

| Name | Species | Value |
|---|---|---|

**Germ Cell Mutagenicity**

| Name | Route | Value |
|---|---|---|
| Propane | In Vitro | Not mutagenic |
| Acetone | In vivo | Not mutagenic |
| Acetone | In Vitro | Some positive data exist, but the data are not sufficient for classification |
| Cyclohexane | In Vitro | Not mutagenic |
| Cyclohexane | In vivo | Some positive data exist, but the data are not sufficient for classification |
| Petroleum distillates | In Vitro | Not mutagenic |
| Hexane | In Vitro | Not mutagenic |
| Hexane | In vivo | Not mutagenic |

**Carcinogenicity**

| Name | Route | Species | Value |
|---|---|---|---|
| Acetone | Not Specified | Multiple animal species | Not carcinogenic |
| Petroleum distillates | Inhalation | Mouse | Some positive data exist, but the data are not sufficient for classification |
| Hexane | Dermal | Mouse | Not carcinogenic |
| Hexane | Inhalation | Mouse | Some positive data exist, but the data are not sufficient for classification |

## Reproductive Toxicity

### Reproductive and/or Developmental Effects

| Name | Route | Value | Species | Test Result | Exposure Duration |
|---|---|---|---|---|---|
| Acetone | Ingestion | Not toxic to female reproduction | Mouse | NOAEL 11,298 mg/kg/day | 13 weeks |
| Acetone | Ingestion | Some positive male reproductive data exist, but the data are not sufficient for classification | Rat | NOAEL 1,700 mg/kg/day | 13 weeks |
| Acetone | Inhalation | Some positive developmental data exist, but the data are not sufficient for classification | Rat | NOAEL 5.2 mg/l | during organogenesis |
| Cyclohexane | Inhalation | Not toxic to female reproduction | Rat | NOAEL 24 mg/l | 2 generation |
| Cyclohexane | Inhalation | Not toxic to male reproduction | Rat | NOAEL 24 mg/l | 2 generation |
| Cyclohexane | Inhalation | Some positive developmental data exist, but the data are not sufficient for classification | Rat | NOAEL 6.9 mg/l | 2 generation |
| Hexane | Ingestion | Not toxic to development | Mouse | NOAEL 2,200 mg/kg/day | during organogenesis |
| Hexane | Inhalation | Some positive developmental data exist, but the data are not sufficient for classification | Rat | NOAEL 0.7 mg/l | during gestation |
| Hexane | Ingestion | Toxic to male reproduction | Rat | NOAEL 1,140 mg/kg/day | 90 days |
| Hexane | Inhalation | Toxic to male reproduction | Rat | LOAEL 3.52 mg/l | 28 days |

## Target Organ(s)

### Specific Target Organ Toxicity - single exposure

| Name | Route | Target Organ(s) | Value | Species | Test Result | Exposure Duration |
|---|---|---|---|---|---|---|
| Propane | Inhalation | cardiac sensitization | Causes damage to organs | Human | NOAEL Not available | |
| Propane | Inhalation | central nervous system depression | May cause drowsiness or dizziness | Human | NOAEL Not available | |
| Propane | Inhalation | respiratory irritation | All data are negative | Human | NOAEL Not available | |
| Acetone | Inhalation | central nervous system depression | May cause drowsiness or dizziness | Human | NOAEL Not available | |
| Acetone | Inhalation | respiratory irritation | Some positive data exist, but the data are not sufficient for classification | Human | NOAEL Not available | |
| Acetone | Inhalation | immune system | Some positive data exist, but the data are not sufficient for classification | Human | NOAEL 1.19 mg/l | 6 hours |
| Acetone | Inhalation | liver | Some positive data exist, but the data are not sufficient for classification | Guinea pig | NOAEL Not available | |
| Acetone | Ingestion | central nervous system depression | May cause drowsiness or dizziness | Human | NOAEL Not available | poisoning and/or abuse |
| Cyclohexane | Inhalation | central nervous system depression | May cause drowsiness or dizziness | Human and animal | NOAEL Not available | |
| Cyclohexane | Inhalation | respiratory irritation | Some positive data exist, but the data are not sufficient for classification | Human and animal | NOAEL Not available | |
| Petroleum distillates | Inhalation | central nervous system depression | May cause drowsiness or dizziness | | NOAEL Not available | |

| | | | | | | |
|---|---|---|---|---|---|---|
| Petroleum distillates | Inhalation | respiratory irritation | Some positive data exist, but the data are not sufficient for classification | | NOAEL Not available | |
| Hexane | Inhalation | central nervous system depression | May cause drowsiness or dizziness | Human | NOAEL Not available | not available |
| Hexane | Inhalation | respiratory irritation | Some positive data exist, but the data are not sufficient for classification | Rabbit | NOAEL Not available | 8 hours |
| Hexane | Inhalation | respiratory system | Some positive data exist, but the data are not sufficient for classification | Rat | NOAEL 24.6 mg/l | 8 hours |

**Specific Target Organ Toxicity - repeated exposure**

| Name | Route | Target Organ(s) | Value | Species | Test Result | Exposure Duration |
|---|---|---|---|---|---|---|
| Acetone | Dermal | eyes | Some positive data exist, but the data are not sufficient for classification | Guinea pig | NOAEL Not available | 3 weeks |
| Acetone | Inhalation | hematopoietic system | Some positive data exist, but the data are not sufficient for classification | Human | NOAEL 3 mg/l | 6 weeks |
| Acetone | Inhalation | immune system | Some positive data exist, but the data are not sufficient for classification | Human | NOAEL 1.19 mg/l | 6 days |
| Acetone | Inhalation | kidney and/or bladder | Some positive data exist, but the data are not sufficient for classification | Guinea pig | NOAEL 119 mg/l | not available |
| Acetone | Inhalation | heart \| liver | All data are negative | Rat | NOAEL 45 mg/l | 8 weeks |
| Acetone | Ingestion | kidney and/or bladder | Some positive data exist, but the data are not sufficient for classification | Rat | NOAEL 900 mg/kg/day | 13 weeks |
| Acetone | Ingestion | heart | Some positive data exist, but the data are not sufficient for classification | Rat | NOAEL 2,500 mg/kg/day | 13 weeks |
| Acetone | Ingestion | hematopoietic system | Some positive data exist, but the data are not sufficient for classification | Rat | NOAEL 200 mg/kg/day | 13 weeks |
| Acetone | Ingestion | liver | Some positive data exist, but the data are not sufficient for classification | Mouse | NOAEL 3,896 mg/kg/day | 14 days |
| Acetone | Ingestion | eyes | All data are negative | Rat | NOAEL 3,400 mg/kg/day | 13 weeks |
| Acetone | Ingestion | respiratory system | All data are negative | Rat | NOAEL 2,500 mg/kg/day | 13 weeks |
| Acetone | Ingestion | muscles | All data are negative | Rat | NOAEL 2,500 mg/kg | 13 weeks |
| Acetone | Ingestion | skin \| bone, teeth, nails, and/or hair | All data are negative | Mouse | NOAEL 11,298 mg/kg/day | 13 weeks |
| Cyclohexane | Inhalation | liver | Some positive data exist, but the data are not sufficient for classification | Rat | NOAEL 24 mg/l | 90 days |
| Cyclohexane | Inhalation | auditory system | Some positive data exist, but the data are not sufficient for classification | Rat | NOAEL 1.7 mg/l | 90 days |
| Cyclohexane | Inhalation | kidney and/or bladder | Some positive data exist, but the data are not sufficient for classification | Rabbit | NOAEL 2.7 mg/l | 10 weeks |
| Cyclohexane | Inhalation | hematopoietic system | Some positive data exist, but the data are not sufficient for classification | Mouse | NOAEL 24 mg/l | 14 weeks |
| Cyclohexane | Inhalation | peripheral nervous system | All data are negative | Rat | NOAEL 8.6 mg/l | 30 weeks |
| Hexane | Inhalation | peripheral nervous | Causes damage to organs | Human | NOAEL Not | occupational |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | system | through prolonged or repeated exposure | | available | exposure |
| Hexane | Inhalation | respiratory system | Some positive data exist, but the data are not sufficient for classification | Mouse | LOAEL 1.76 mg/l | 13 weeks |
| Hexane | Inhalation | liver | Some positive data exist, but the data are not sufficient for classification | Rat | NOAEL Not available | 6 months |
| Hexane | Inhalation | kidney and/or bladder | Some positive data exist, but the data are not sufficient for classification | Rat | LOAEL 1.76 mg/l | 6 months |
| Hexane | Inhalation | hematopoietic system | Some positive data exist, but the data are not sufficient for classification | Mouse | NOAEL 35.2 mg/l | 13 weeks |
| Hexane | Inhalation | auditory system \| immune system \| eyes | Some positive data exist, but the data are not sufficient for classification | Human | NOAEL Not available | occupational exposure |
| Hexane | Inhalation | heart \| skin \| endocrine system | All data are negative | Rat | NOAEL 1.76 mg/l | 6 months |
| Hexane | Ingestion | peripheral nervous system | Some positive data exist, but the data are not sufficient for classification | Rat | NOAEL 1,140 mg/kg/day | 90 days |
| Hexane | Ingestion | endocrine system \| hematopoietic system \| liver \| immune system \| kidney and/or bladder | Some positive data exist, but the data are not sufficient for classification | Rat | NOAEL Not available | 13 weeks |

**Aspiration Hazard**

| Name | Value |
|---|---|
| Cyclohexane | Aspiration hazard |
| Petroleum distillates | Aspiration hazard |
| Hexane | Aspiration hazard |

**Please contact the address or phone number listed on the first page of the SDS for additional toxicological information on this material and/or its components.**

## SECTION 12: Ecological information

### Ecotoxicological information

Please contact the address or phone number listed on the first page of the SDS for additional ecotoxicological information on this material and/or its components.

### Chemical fate information

Please contact the address or phone number listed on the first page of the SDS for additional chemical fate information on this material and/or its components.

## SECTION 13: Disposal considerations

**13.1. Disposal methods**
Dispose of contents/ container in accordance with the local/regional/national/international regulations.

Dispose of waste product in a permitted industrial waste facility. Facility must be capable of handling aerosol cans.

**EPA Hazardous Waste Number (RCRA):** D001 (Ignitable)

## SECTION 14: Transport Information

For Transport Information, please visit **http://3M.com/Transportinfo** or call 1-800-364-3577 or 651-737-6501.

# SECTION 15: Regulatory information

## 15.1. US Federal Regulations

Contact 3M for more information.

**311/312 Hazard Categories:**

Fire Hazard - Yes Pressure Hazard - Yes Reactivity Hazard - No Immediate Hazard - Yes Delayed Hazard - Yes

**Section 313 Toxic Chemicals subject to the reporting requirements of that section and 40 CFR part 372 (EPCRA):**

| Ingredient | C.A.S. No | % by Wt |
|---|---|---|
| Cyclohexane | 110-82-7 | 10 - 20 |

## 15.2. State Regulations

Contact 3M for more information.

## 15.3. Chemical Inventories

The components of this product are in compliance with the chemical notification requirements of TSCA.

Contact 3M for more information.

## 15.4. International Regulations

Contact 3M for more information.

**This SDS has been prepared to meet the U.S. OSHA Hazard Communication Standard, 29 CFR 1910.1200.**

# SECTION 16: Other information

**NFPA Hazard Classification**
**Health:** 2 **Flammability:** 4 **Instability:** 0 **Special Hazards:** None
**Aerosol Storage Code:** 3

National Fire Protection Association (NFPA) hazard ratings are designed for use by emergency response personnel to address the hazards that are presented by short-term, acute exposure to a material under conditions of fire, spill, or similar emergencies. Hazard ratings are primarily based on the inherent physical and toxic properties of the material but also include the toxic properties of combustion or decomposition products that are known to be generated in significant quantities.

**HMIS Hazard Classification**
**Health:** *2 **Flammability:** 4 **Physical Hazard:** 0 **Personal Protection:** X - See PPE section.

Hazardous Material Identification System (HMIS® III) hazard ratings are designed to inform employees of chemical hazards in the workplace. These ratings are based on the inherent properties of the material under expected conditions of normal use and are not intended for use in emergency situations. HMIS® III ratings are to be used with a fully implemented HMIS® III program. HMIS® is a registered mark of the American Coatings Association (ACA).

| | | | |
|---|---|---|---|
| **Document Group:** | 16-3472-4 | **Version Number:** | 37.00 |
| **Issue Date:** | 09/11/14 | **Supercedes Date:** | 04/19/12 |

DISCLAIMER: The information in this Safety Data Sheet (SDS) is believed to be correct as of the date issued. 3M MAKES

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**3M USA SDSs are available at www.3M.com**

## Activity 8: Decon

Your group has been given the identity of a chemical found on site. Your task is to design a decontamination line to properly decontaminate workers. Research your chemical in the *NIOSH Pocket Guide* and, as a group, decide what level of protection the workers in the Hot Zone (Exclusion Zone) and all areas of the decon line will be wearing. Another consideration is what materials will be used in the decon line.

Chemical: ______________________________________________

1. What level of protection will the Hot Zone (Exclusion Zone) workers be wearing and why? ______________________________________________

   ______________________________________________

2. What level of protection will the Warm Zone (Contamination Reduction Zone) workers who meet the Hot Zone workers be wearing and why? ______________

   ______________________________________________

3. What level of protection will your Warm Zone (Contamination Reduction Zone) workers who help the Hot Zone workers remove their PPE be wearing and why? ______________________________________________

   ______________________________________________

4. List any special hazards that this chemical might present. ____________________

______________________________________________________________________

______________________________________________________________________

______________________________________________________________________

______________________________________________________________________

# Activity 9: Wireless Information System for Emergency Response (WISER) Leaking Barrels in a Warehouse

**Adapted from WISER's Warehouse training scenario**
http://wiser.nlm.nih.gov/training.html

If you have not already done so, **search for and download the WISER application on your smartphone or tablet.** Alternatively, this exercise may be completed on a personal computer with internet access by visiting
http://webwiser.nlm.nih.gov/getHomeData.do.

**Scenario Overview:** This training scenario will demonstrate how to use WISER's "help identify" feature to narrow down the possible identity of an unknown substance based on the physical properties of the substance and the symptoms of the exposed workers.

The scenario involves an incident at a warehouse where drums are leaking an unknown substance and exposed workers have been affected. The scene has been cleared of exposed workers and the situation stabilized. You are part of a team consisting of a HAZMAT specialist and skilled support personnel who have been asked to identify the contents of the leaking drums and provide information and recommendations to the Incident Commander.

**The substance in question has been described as a colorless liquid with an alcohol-like smell.**

1. Open the WISER application or website and
2. Select "Help Identify Chemical".
3. Select "Properties" then select "State" and indicate that the unknown is a liquid.
4. Return to the list of properties, select "Color", and indicate that the substance is colorless.
5. Return to the list of properties, select "Odor", and indicate that the substance has an alcohol-like odor.

**Now the list of likely chemicals has been narrowed from 438 to 31.**

**The workers from the warehouse are showing symptoms of nausea, dizziness, headache, and eye irritation.**

1. Select “Symptoms” then select “Gastro/Urinary”. This can be accomplished by clicking on the stomach area of the human body image or by using the list of symptom categories (the list icon in the lower right corner of the application) and selecting “Gastro/Urinary”.
2. From the “Gastro/Urinary” list, select “nausea”.
3. Return to the human body image or the list of symptom categories and select “Neurological”. Select “dizziness” and “headache” from the list of neurological symptoms.
4. Return to the human body image or the list of symptom categories and select “Eyes”. Select “Eye irritation/redness” from the list of eye symptoms.
5. Tap on “Results” at the bottom of the mobile application or click on “Results” on the left hand side of the website.

**After entering physical properties of the substance and the symptoms of the workers, the list of likely chemicals has been narrowed to 11 substances.**

**You see an NFPA label on the barrels indicating the substance is serious (3) flammability hazard.**

1. Select “NFPA 704,” click on the red diamond, then select “3 – Serious”.
2. Tap on “Results” at the bottom of the mobile application or click on “Results” on the left hand side of the website.

**The results list has been reduced to 3 potential substances.The “Group By” feature allows the results list to be grouped by any of the property and symptom categories, as well as NFPA 704 categories and the supported substance categorizations (WMDs, meth lab, chemical weapons precursors, DOT hazard classifications). This allows you to identify a property, symptom, or other piece of information that would help you eliminate a number of potential substance.**

**The HAZMAT specialist on your team uses a hydrometer to determine that the substance floats on water so you know that it's specific gravity is less than one.**

1. While viewing the list of results, tap on the drawers icon in the upper right corner of the application, select group by "Property", then "Specific Gravity". You should see one substance that you can remove from the results because it sinks in water (specific gravity >1) and are left with two possible substances.
2. Tap and hold on the substance with a specific gravity greater than one for the option of removing it from the list.

This will likely be as far as you can narrow the list, and it is likely that you don't need to go further. **The remaining substances are very similar alcohols with similar characteristics, effects, and handling procedures.** For example, they each reference the same DOT guidelines and the same or similar treatment information. Enough information is likely now known to recommend appropriate initial hazmat response procedures.

# Activity 10: Decatur Abandoned Storage Facility

**Background**
An abandoned waste storage building has been scheduled for clean-up and demolition. The now-vacated building was used for storage of industrial waste chemicals for several years before being abandoned in the late 1990s. Most of the firm's records were destroyed when the adjoining office building annex was burned in 2005 (suspected homeless "campers"). Your firm has been hired to remove the remaining chemicals, demolish the building, and haul off all debris to help prepare the site for the city's first casino, hotel, and shopping complex.

**Site Characterization**
Located in the building are approximately 80 drums of waste. Most of the drums have been sampled and they contain:

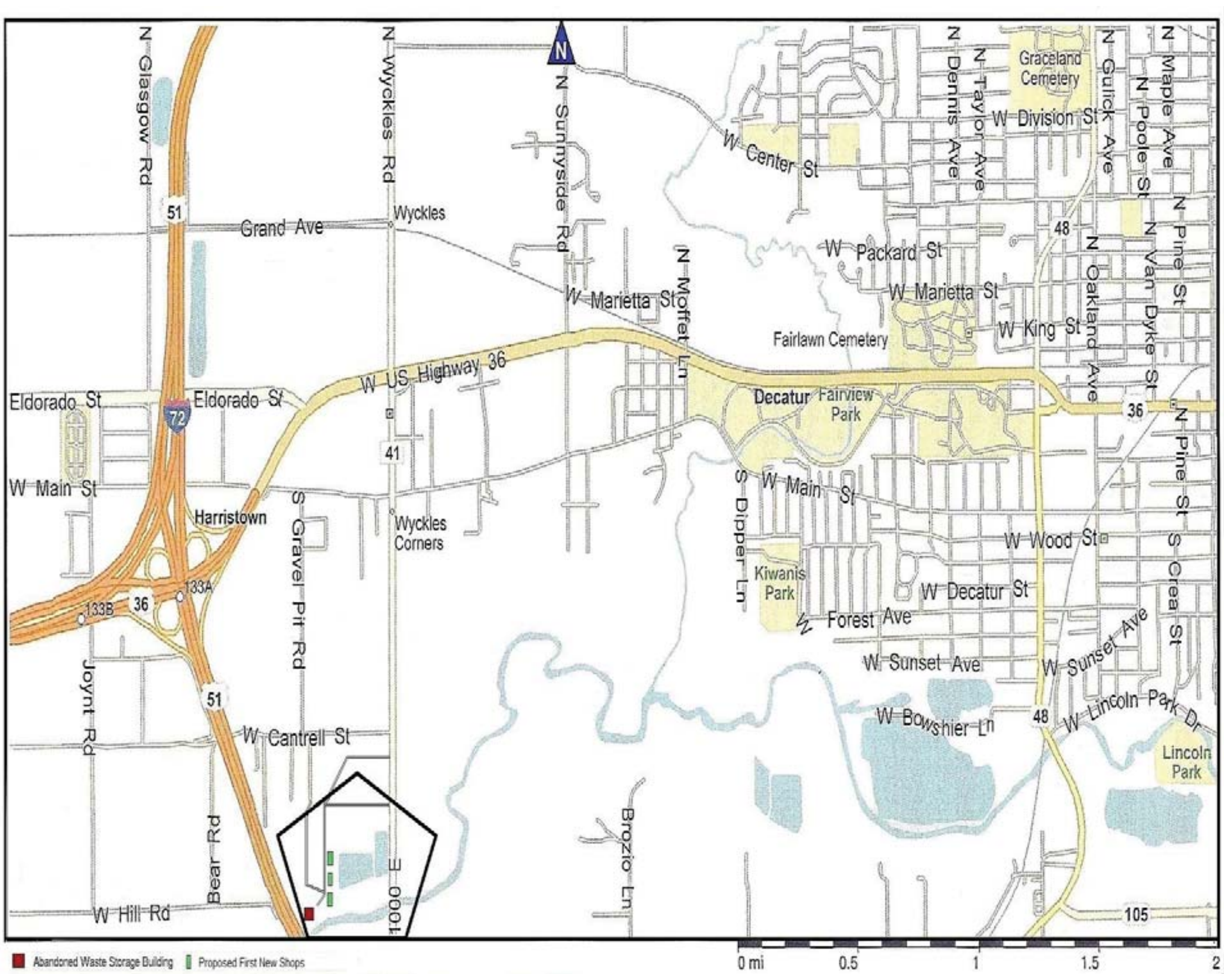
- Nickel Carbonyl – stored in steel 55-gallon drums;
- Nitric Acid Sludge – stored in PVC-lined steel 55 gallon drums; and
- Magnesite – stored in 30-gallon plastic bag-lined cardboard drums.

The building suffered a partial collapse to one section because of an unusually heavy snow last winter. The building has been vandalized with many of the drums upset and other drums apparently used as fire "pits". Some of the cardboard drums were used for cooking/heating fuel. Trash, pizza boxes, cans, and broken bottles litter the floor. Most of the remaining cardboard and steel drums are showing signs of extreme wear. Magnesite can be found on the floor around the bases of many cardboard drums while several steel drums can be seen "weeping" through badly corroded drum walls and "bung hole" screw-on caps.

**Other Important Information**
It is early April in central Illinois. Temperatures range from a low of 45°F at night to a high of 80°F at mid-afternoon. Severe thunderstorms have blanketed the area for the past two days, but the forecast is for normal temperatures and sunshine for the next week to ten (10) days. Humidity is averaging 70% but this might lessen with the expected good weather. Westerly to northwesterly winds are blowing at around 5 mph. The Sangamon River's north bank may be in danger of flooding. The building is located in an old industrial park with a major interstate highway one mile away and a 4-lane US highway is located on the western edge of the property. Access to the abandoned waste storage building is limited to a single north/south road with access to CR 41 (also north/south). There is another north/south access road to the west, but is unfinished and it connects to an inhabited neighborhood street. The main access

road is occasionally blocked for short periods of time while crews install curbing and waste water culverts on its "pond" side.

Two grown-over demolished warehouse sites on the eastern side of the industrial park will be home to luxury condominiums. A third site will be home to a boutique shopping store-front. These structures were demolished and removed over the past several years.



## Planning the Job

1. What additional information would you want before beginning work?

2. Are there any “basic” construction safety and health hazards your company ought to be concerned with?

3. Are there any chemical hazards that your company should be concerned with?

4. Are there possible threats of fire and/or explosion? Why or Why Not?

5. How will you prep the site for all its work activity? (Again, basic construction site setup, including work site/area access [security?] and communication in all 3 [three] control zones.)

6. How will the Superintendent of the job and the supervisors enforce healthy and safe work practices?

7. Where will the Exclusion (Hot) Zone, the Contamination Reduction (Warm) Zone, and the Support Zone be? The Contamination Reduction Corridor (Decon Line)?

   Draw boundaries for these zones on the map on the last page of this exercise, then transfer the information to a large sheet of paper to present to the class.

8. What Level(s) of PPE will be worn on this site and why?

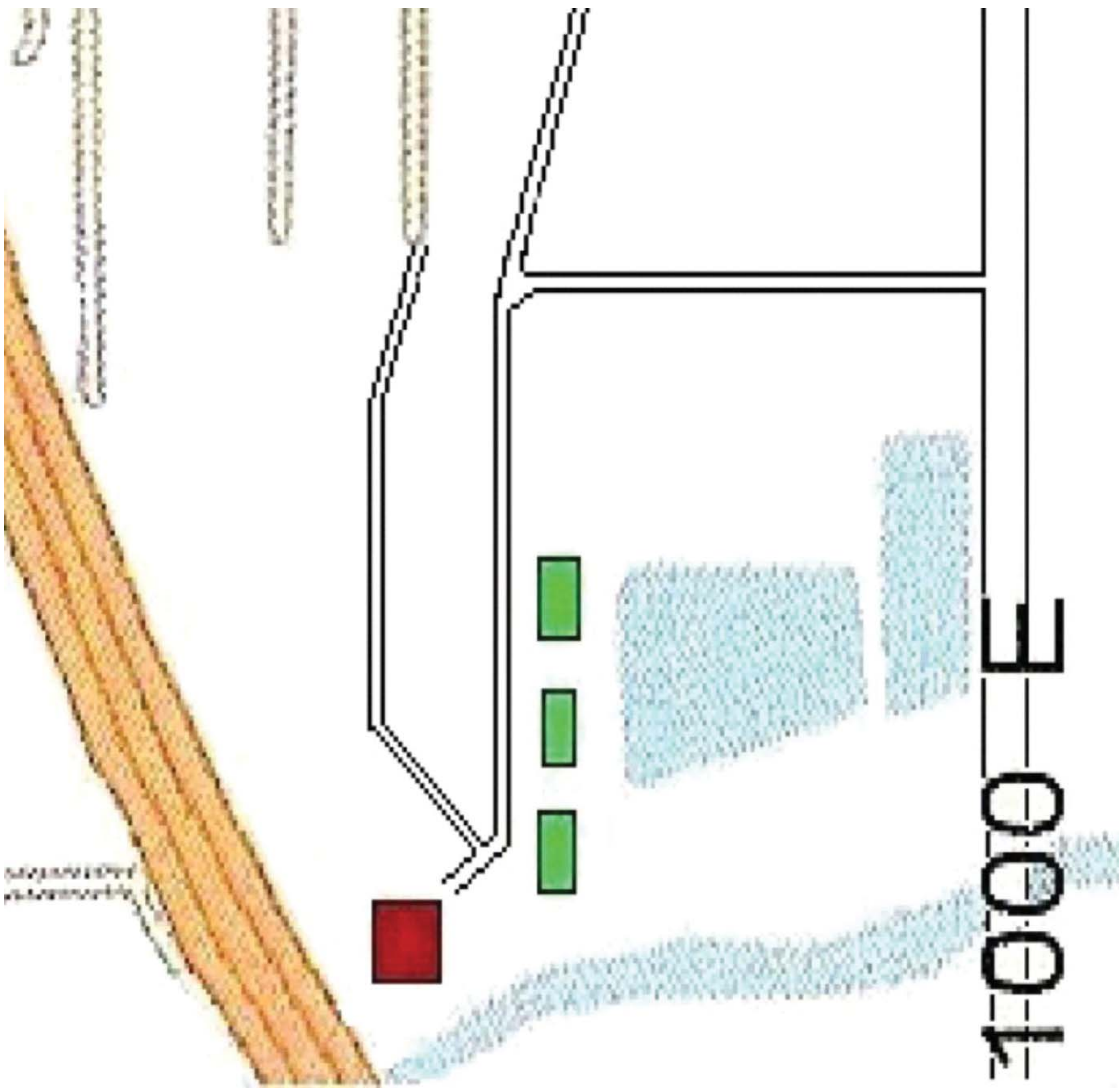
   Hot Zone:

   Warm Zone/Decon Line:

   Cold Zone:

9. What will you do if an emergency occurs that requires immediate evacuation of an injured or ill Hot Zone worker?

# Sketch the Key Elements of Your Site Control and Health & Safety Plan



Pfaltz & Bauer
RARE AND FINE CHEMICALS
www.pfaltzandbauer.com

# SAFETY DATA SHEET

## SECTION 1: CHEMICAL PRODUCT and COMPANY IDENTIFICATION

| | |
|---|---|
| Product Name: | Nickel carbonyl 99.9% in a non-returnable cylinder |
| Product Code: | N04690 |
| Supplier: | Pfaltz & Bauer, Inc.<br>172 E. Aurora Street<br>Waterbury, CT 06708 USA |
| Phone: | 203 574-0075 |
| Fax: | 203 574-3181 |
| Emergency Phone: | CHEMTREC, US: 1-800-424-9300<br>CHEMTREC, International: 1-703-527-3887 |

## SECTION 2: HAZARDS IDENTIFICATION

| | |
|---|---|
| Statements of Hazard: | Flammable liquid, Toxic, Pyrophoric liquid, Environmentally hazardous |
| Acute Health Hazard: | Irritant to eyes, skin, mucous membranes and respiratory system. May be harmful by ingestion or skin absorption. Fatal by inhalation. |
| Chronic Health Hazard: | Teratogen, Carcinogen |
| HMIS Rating: | H:4 F:3 P:3 |
| NFPA Rating: | H:4 F:3 R:3 |

To the best of our knowledge, the toxicological properties of this chemical have not been thoroughly investigated. Use appropriate procedures and precautions to prevent or minimize exposure.

Pictogram:

Signal Word: Danger

Hazard Statement(s):

**H225** Highly flammable liquid and vapor.
**H250** Catches fire spontaneously if exposed to air.
**H302** Harmful if swallowed
**H312** Harmful in contact with skin.
**H315** Causes skin irritation.
**H319** Causes serious eye irritation.
**H330** Fatal if inhaled.
**H335** May cause respiratory irritation.
**H351** Suspected of causing cancer.

| | |
|---|---|
| | **H361** Suspected of damaging fertility or the unborn child.<br>**H411** Toxic to aquatic life with long lasting effects. |
| Precautionary Statement(s): | **P210** Keep away from heat/sparks/open flames/hot surfaces. No smoking.<br>**P222** Do not allow contact with air.<br>**P240** Ground/bond container and receiving equipment.<br>**P260** Do not breathe dust/ fume/ gas/ mist/ vapors/ spray.<br>**P271** Use only outdoors or in a well-ventilated place.<br>**P284** Wear respiratory protection.<br>**P301+P310** IF SWALLOWED: Immediately call a POSION CENTER or doctor/physician.<br>**P302+P352** IF ON SKIN: Wash with plenty of soap and water.<br>**P304+P340** IF INHALED: Remove victim to fresh air and keep at rest in a position comfortable for breathing.<br>**P305+P351+P338** IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.<br>**P308+P313** IF exposed or concerned: Get medical advice/attention.<br>**P332+P313** If skin irritation occurs: Get medical advice/ attention. |

## SECTION 3: COMPOSITION/INFORMATION on INGREDIENTS

| | |
|---|---|
| Chemical Name: | Nickel carbonyl |
| Synonyms: | Not Available |
| CAS Number: | 13463-39-3 |
| MDL Number: | MFCD00016250 |
| EINECS Number: | 236-669-2 |
| Beilstein Registry Number: | 26039 |
| Molecular Formula: | $Ni(CO)_4$ |
| Molecular Weight: | 170.73 |
| Content: | 99.9% |
| Notes: | In a non-returnable cylinder |

## SECTION 4: FIRST AID MEASURES

| | |
|---|---|
| Eye Contact: | Flush eyes with large amounts of water for fifteen minutes. Separate eyelids with fingers. If irritation persists, seek medical attention. |
| Skin Contact: | Wash skin with soap and water. If irritation persists, seek medical attention. |

| | |
|---|---|
| Ingestion: | Do not induce vomiting. Seek medical attention. |
| Inhalation: | Move to a fresh air environment. Contact a physician if breathing becomes difficult. |

## SECTION 5: FIRE FIGHTING MEASURES

| | |
|---|---|
| Flash Point: | -4 ºC |
| Explosion Limits: | Lower: 4% by volume<br>Upper: 34% by volume |
| Auto Ignition Temperature: | 60 ºC |
| Extinguishing Media: | Carbon dioxide, dry chemical powder, alcohol-resistant foam or water spray. |
| Protective Equipment: | Wear self-contained respirator and fully protective impervious suit. |
| Specific Hazards: | May emit hazardous fumes under fire conditions. |

## SECTION 6: ACCIDENTAL RELEASE MEASURES

| | |
|---|---|
| Personal Protection: | Wear a self-contained breathing apparatus, rubber boots and gloves, and disposable coveralls. Dispose of coveralls after use.<br>Keep unprotected persons away. |
| Environmental Protection: | Keep spills out of sewers and bodies of water. Dike and contain the spill with inert material. Absorb on sand, vermiculite or diatomite. Transfer material to a container for disposal or recovery. Ventilate area and wash spill site after material pickup is complete. |

## SECTION 7: HANDLING and STORAGE

| | |
|---|---|
| Handling: | Avoid breathing dust, vapor, mist or gas. Avoid contact with skin and eyes. Avoid prolonged or repeated exposure. Use only in a chemical fume hood. Open and handle container with care. Keep ignition sources away. |
| Storage: | Store in a tightly closed container in a dry, well-ventilated place. |
| Sensitivities: | Air, Heat |
| Storage Temperature: | 15 – 30 ºC |

## SECTION 8: EXPOSURE CONTROLS/PERSONAL PROTECTION

| | |
|---|---|
| Eyes: | Wear appropriate protective eyeglass or chemical safety goggles. Make sure that there is an eyewash facility in your vicinity. |
| Skin: | Wear impervious gloves and protective clothing. |
| Respiratory: | Use a NIOSH approved respirator when exposure limits are exceeded or if irritation or other symptoms are experienced. |

Exposure Limits:

| Country | Source | Type | Value |
|---|---|---|---|
| USA | ACGIH | TWA | Not Available |
| USA | OSHA | STEL | Not Available |
| USA | OSHA | PEL | Not Available |

## SECTION 9: PHYSICAL and CHEMICAL PROPERTIES

| | |
|---|---|
| Appearance: | Colorless to very pale yellow liquid |
| Odor: | Musty, like brick dust |
| Melting Point: | -19 - (-17) ºC |
| Boiling Point: | 43 ºC |
| pH Value: | Not Available |
| Density: | 1.319 g/cm$^3$ |
| Refractive Index, $n^{20}_D$: | Not Available |
| Viscosity: | 3.05 x 10-4 Pa s |
| Solubility in Water: | Soluble, 0.018 g/100mL |
| Vapor Pressure: | 480 mmHg |
| Vapor Density(Air=1): | Not Available |

## SECTION 10: STABILITY and REACTIVITY

| | |
|---|---|
| Stability: | Stable under normal temperatures and pressures. |
| Incompatibility: | Strong oxidizing agents. |
| Conditions to Avoid: | Heat, Flame, Sparks, other ignition sources |

Hazardous Decomposition Products: Carbon oxides, Nickel oxides

## SECTION 11: TOXICOLOGICAL INFORMATION

| | |
|---|---|
| RTECS Reference: | QR6300000 |
| Target Organs: | Not Available |
| Toxicity Data: | Not Available |
| Skin corrosion/irritation: | Not Available |

Fisher Scientific
Part of Thermo Fisher Scientific

# SAFETY DATA SHEET

**Creation Date** 12-Mar-2009 **Revision Date** 02-Apr-2014 **Revision Number** 1

## 1. Identification

**Product Name** **Nitric acid (65 - 70%)**

**Cat No. :** **A198C-212, A200-212, A200-212LC, A200-500, A200-500LC, A200-612GAL, A200C-212, A200S-212, A200S-212LC, A200S-500, A200SI-212, A467-1, A467-2, A467-250, A467-500, A483-212; S719721**

**Synonyms** Azotic acid; Engraver's acid; Aqua fortis

**Recommended Use** Laboratory chemicals

**Uses advised against** No Information available

**Details of the supplier of the safety data sheet**

**Company**
Fisher Scientific
One Reagent Lane
Fair Lawn, NJ 07410
Tel: (201) 796-7100

**Emergency Telephone Number**
CHEMTREC®, Inside the USA: 800-424-9300
CHEMTREC®, Outside the USA: 001-703-527-3887

## 2. Hazard(s) identification

**Classification**

This chemical is considered hazardous by the 2012 OSHA Hazard Communication Standard (29 CFR 1910.1200)

| | |
|---|---|
| Oxidizing liquids | Category 3 |
| Corrosive to metals | Category 1 |
| Skin Corrosion/irritation | Category 1 A |
| Serious Eye Damage/Eye Irritation | Category 1 |
| Specific target organ toxicity (single exposure) | Category 3 |
| Target Organs - Respiratory system. | |
| Specific target organ toxicity - (repeated exposure) | Category 2 |
| Target Organs - Kidney. | |

**Label Elements**

**Signal Word**
Danger

**Hazard Statements**
May intensify fire; oxidizer
May be corrosive to metals

Causes severe skin burns and eye damage
May cause respiratory irritation
May cause damage to organs through prolonged or repeated exposure

**Precautionary Statements**
**Prevention**
Do not breathe dust/fume/gas/mist/vapors/spray
Wash face, hands and any exposed skin thoroughly after handling
Wear protective gloves/protective clothing/eye protection/face protection
Use only outdoors or in a well-ventilated area
Keep away from heat/sparks/open flames/hot surfaces. - No smoking
Keep/Store away from clothing/ other combustible materials
Take any precaution to avoid mixing with combustibles
Keep only in original container
**Response**
Immediately call a POISON CENTER or doctor/physician
**Inhalation**
IF INHALED: Remove victim to fresh air and keep at rest in a position comfortable for breathing
**Skin**
IF ON SKIN (or hair): Take off immediately all contaminated clothing. Rinse skin with water/shower
Wash contaminated clothing before reuse
**Eyes**
IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing
**Ingestion**
IF SWALLOWED: Rinse mouth. DO NOT induce vomiting
**Fire**
In case of fire: Use CO2, dry chemical, or foam for extinction
**Spills**
Absorb spillage to prevent material damage
**Storage**
Store locked up
Store in a well-ventilated place. Keep container tightly closed
Store in corrosive resistant polypropylene container with a resistant inliner
Store in a dry place
**Disposal**
Dispose of contents/container to an approved waste disposal plant

**Hazards not otherwise classified (HNOC)**
None identified

**Unknown Acute Toxicity**
.? % of the mixture consists of ingredients of unknown toxicity.

## 3. Composition / information on ingredients

**Haz/Non-haz**

| Component | CAS-No | Weight % |
|---|---|---|
| Nitric acid | 7697-37-2 | 65 - 70 |
| Water | 7732-18-5 | 30 - 35 |

**Thermo Fisher Scientific - Nitric acid (65 - 70%)** **Revision Date** 02-Apr-2014

## 4. First-aid measures

| | |
|---|---|
| **Eye Contact** | Rinse immediately with plenty of water, also under the eyelids, for at least 15 minutes. Immediate medical attention is required. |
| **Skin Contact** | Wash off immediately with plenty of water for at least 15 minutes. Immediate medical attention is required. |
| **Inhalation** | Move to fresh air. If breathing is difficult, give oxygen. Do not use mouth-to-mouth resuscitation if victim ingested or inhaled the substance; induce artificial respiration with a respiratory medical device. Immediate medical attention is required. |
| **Ingestion** | Do not induce vomiting. Call a physician or Poison Control Center immediately. |
| **Most important symptoms/effects** | Causes burns by all exposure routes. . Ingestion causes severe swelling, severe damage to the delicate tissue and danger of perforation. Product is a corrosive material. Use of gastric lavage or emesis is contraindicated. Possible perforation of stomach or esophagus should be investigated. |
| **Notes to Physician** | Treat symptomatically. |

## 5. Fire-fighting measures

| | |
|---|---|
| **Suitable Extinguishing Media** | Substance is nonflammable; use agent most appropriate to extinguish surrounding fire.. |
| **Unsuitable Extinguishing Media** | No information available. |
| **Flash Point** | Not applicable |
| **Method -** | No information available |
| **Autoignition Temperature** | No information available. |
| **Explosion Limits** | |
| **Upper** | No data available |
| **Lower** | No data available |
| **Oxidizing Properties** | Oxidizer |
| **Sensitivity to Mechanical Impact** | No information available |
| **Sensitivity to Static Discharge** | No information available |

**Specific Hazards Arising from the Chemical**
Oxidizer: Contact with combustible/organic material may cause fire. Corrosive Material. Causes severe burns by all exposure routes. Thermal decomposition can lead to release of irritating gases and vapors. May ignite combustibles (wood paper, oil, clothing, etc.).

**Hazardous Combustion Products** Nitrogen oxides (NOx).

**Protective Equipment and Precautions for Firefighters**
As in any fire, wear self-contained breathing apparatus pressure-demand, MSHA/NIOSH (approved or equivalent) and full protective gear

**NFPA**

| Health | Flammability | Instability | Physical hazards |
|---|---|---|---|
| 4 | 0 | 0 | OX |

## 6. Accidental release measures

| | |
|---|---|
| **Personal Precautions** | Wear self-contained breathing apparatus and protective suit. Evacuate personnel to safe areas. Keep people away from and upwind of spill/leak. Ensure adequate ventilation. Do not get in eyes, on skin, or on clothing. |

## 6. Accidental release measures

**Environmental Precautions** Should not be released into the environment. Do not flush into surface water or sanitary sewer system. See Section 12 for additional ecological Information.

**Methods for Containment and Clean Up** Soak up with inert absorbent material. Keep in suitable, closed containers for disposal. Sweep up and shovel into suitable containers for disposal.

## 7. Handling and storage

**Handling** Use only under a chemical fume hood. Wear personal protective equipment. Do not get in eyes, on skin, or on clothing. Keep away from clothing and other combustible materials. Do not breathe vapors/dust. Do not ingest. Contents under pressure.

**Storage** Keep containers tightly closed in a cool, well-ventilated place. Do not store near combustible materials

## 8. Exposure controls / personal protection

**Exposure Guidelines**

| Component | ACGIH TLV | OSHA PEL | NIOSH IDLH |
|---|---|---|---|
| Nitric acid | TWA: 2 ppm<br>STEL: 4 ppm | (Vacated) TWA: 2 ppm<br>(Vacated) TWA: 5 mg/m$^3$<br>(Vacated) STEL: 4 ppm<br>(Vacated) STEL: 10 mg/m$^3$<br>TWA: 2 ppm<br>TWA: 5 mg/m$^3$ | IDLH: 25 ppm<br>TWA: 2 ppm<br>TWA: 5 mg/m$^3$<br>STEL: 4 ppm<br>STEL: 10 mg/m$^3$ |

| Component | Quebec | Mexico OEL (TWA) | Ontario TWAEV |
|---|---|---|---|
| Nitric acid | TWA: 2 ppm<br>TWA: 5.2 mg/m$^3$<br>STEL: 4 ppm<br>STEL: 10 mg/m$^3$ | TWA: 2 ppm<br>TWA: 5 mg/m$^3$<br>STEL: 4 ppm<br>STEL: 10 mg/m$^3$ | TWA: 2 ppm<br>STEL: 4 ppm |

***Legend***
***ACGIH*** *- American Conference of Governmental Hygienists*
***OSHA*** *- Occupational Safety and Health Administration*
***NIOSH IDLH:*** *The National Institute for Occupational Safety and Health Immediately Dangerous to Life or Health*

**Engineering Measures** Use only under a chemical fume hood. Ensure that eyewash stations and safety showers are close to the workstation location. Ensure adequate ventilation, especially in confined areas.

**Personal Protective Equipment**

**Eye/face Protection** Wear appropriate protective eyeglasses or chemical safety goggles as described by OSHA's eye and face protection regulations in 29 CFR 1910.133 or European Standard EN166.

**Skin and body protection** Wear appropriate protective gloves and clothing to prevent skin exposure.

**Respiratory Protection** Follow the OSHA respirator regulations found in 29 CFR 1910.134 or European Standard EN 149. Use a NIOSH/MSHA or European Standard EN 149 approved respirator if exposure limits are exceeded or if irritation or other symptoms are experienced

**Hygiene Measures** Handle in accordance with good industrial hygiene and safety practice

## 9. Physical and chemical properties

| | |
|---|---|
| **Physical State** | Liquid |
| **Appearance** | Clear Colorless, Light yellow |
| **Odor** | strong Acrid |

## 9. Physical and chemical properties

| | |
|---|---|
| **Odor Threshold** | No information available. |
| **pH** | 1.0 (0.1M) |
| **Melting Point/Range** | -41°C / -41.8°F |
| **Boiling Point/Range** | 120.5°C / 248.9°F |
| **Flash Point** | Not applicable |
| **Evaporation Rate** | No information available. |
| **Flammability (solid,gas)** | Not applicable |
| **Flammability or explosive limits** | |
| **Upper** | No data available |
| **Lower** | No data available |
| **Vapor Pressure** | 0.94 kPa (20°C) |
| **Vapor Density** | No information available. |
| **Relative Density** | 1.40 |
| **Solubility** | No information available. |
| **Partition coefficient; n-octanol/water** | No data available |
| **Autoignition Temperature** | No information available. |
| **Decomposition temperature** | No information available. |
| **Viscosity** | No information available. |
| **Molecular Formula** | $HNO_3$ |
| **Molecular Weight** | 63.02 |

## 10. Stability and reactivity

| | |
|---|---|
| **Reactive Hazard** | Yes |
| **Stability** | Oxidizer: Contact with combustible/organic material may cause fire. |
| **Conditions to Avoid** | Incompatible products. Combustible material. Excess heat. |
| **Incompatible Materials** | Strong bases, Reducing agents, Organic materials, Aldehydes, Alcohols, Cyanides, Metals, Powdered metals, Ammonia, Strong reducing agents, Combustible material |
| **Hazardous Decomposition Products** | Nitrogen oxides (NOx) |
| **Hazardous Polymerization** | Hazardous polymerization does not occur. |
| **Hazardous Reactions** | None under normal processing. |

## 11. Toxicological information

**Acute Toxicity**

**Product Information**

| | |
|---|---|
| **Oral LD50** | Based on ATE data, the classification criteria are not met. ATE > 2000 mg/kg. |
| **Dermal LD50** | Based on ATE data, the classification criteria are not met. ATE > 2000 mg/kg. |
| **Vapor LC50** | Based on ATE data, the classification criteria are not met. ATE > 20 mg/l. |

**Component Information**

| Component | LD50 Oral | LD50 Dermal | LC50 Inhalation |
|---|---|---|---|
| Nitric acid | Not listed | Not listed | 130 mg/m$^3$ ( Rat ) 4 h<br>67 ppm ( Rat ) 4 h |
| Water | - | Not listed | Not listed |

**Toxicologically Synergistic Products** No information available.

**Delayed and immediate effects as well as chronic effects from short and long-term exposure**

**Irritation** Causes severe burns by all exposure routes

**Sensitization** No information available.

**Carcinogenicity** The table below indicates whether each agency has listed any ingredient as a carcinogen

| Component | CAS-No | IARC | NTP | ACGIH | OSHA | Mexico |
|---|---|---|---|---|---|---|
| Nitric acid | 7697-37-2 | Group 2A | Not listed | Not listed | Not listed | Not listed |
| Water | 7732-18-5 | Not listed | Not listed | Not listed | Not listed | Not listed |

**Mutagenic Effects** No information available.

**Reproductive Effects** Experiments have shown reproductive toxicity effects on laboratory animals.

**Developmental Effects** No information available.

**Teratogenicity** Teratogenic effects have occurred in experimental animals..

**STOT - single exposure** Respiratory system.

**STOT - repeated exposure** Kidney.

**Aspiration hazard** No information available.

**Symptoms / effects, both acute and delayed** Ingestion causes severe swelling, severe damage to the delicate tissue and danger of perforation. Product is a corrosive material. Use of gastric lavage or emesis is contraindicated. Possible perforation of stomach or esophagus should be investigated.

**Endocrine Disruptor Information** No information available

**Other Adverse Effects** See actual entry in RTECS for complete information.

## 12. Ecological information

**Ecotoxicity**

Do not empty into drains. Harmful to aquatic organisms, may cause long-term adverse effects in the aquatic environment. The product contains following substances which are hazardous for the environment.

| Component | Freshwater Algae | Freshwater Fish | Microtox | Water Flea |
|---|---|---|---|---|
| Nitric acid | Not listed | 72 mg/L LC50 96 h | Not listed | Not listed |

**Persistence and Degradability** No information available.

**Bioaccumulation/ Accumulation** No information available

**Mobility** .

| Component | log Pow |
|---|---|
| Nitric acid | -2.3 |

## 13. Disposal considerations

**Waste Disposal Methods** Chemical waste generators must determine whether a discarded chemical is classified as a hazardous waste. Chemical waste generators must also consult local, regional, and national hazardous waste regulations to ensure complete and accurate classification.

## 14. Transport information

## 14. Transport information

**DOT**

| | |
|---|---|
| **UN-No** | UN2031 |
| **Proper Shipping Name** | NITRIC ACID |
| **Hazard Class** | 8 |
| **Subsidiary Hazard Class** | 5.1 |
| **Packing Group** | II |

**TDG**

| | |
|---|---|
| **UN-No** | UN2031 |
| **Proper Shipping Name** | NITRIC ACID |
| **Hazard Class** | 8 |
| **Packing Group** | II |

**IATA**

| | |
|---|---|
| **UN-No** | UN2031 |
| **Proper Shipping Name** | NITRIC ACID |
| **Hazard Class** | 8 |
| **Subsidiary Hazard Class** | 5.1 |
| **Packing Group** | II |

**IMDG/IMO**

| | |
|---|---|
| **UN-No** | UN2031 |
| **Proper Shipping Name** | NITRIC ACID |
| **Hazard Class** | 8 |
| **Subsidiary Hazard Class** | 5.1 |
| **Packing Group** | II |

## 15. Regulatory information

**All of the components in the product are on the following Inventory lists:**

**International Inventories**

| Component | TSCA | DSL | NDSL | EINECS | ELINCS | NLP | PICCS | ENCS | AICS | IECSC | KECL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Nitric acid | X | X | - | 231-714-2 | - | | X | X | X | X | X |
| Water | X | X | - | 231-791-2 | - | | X | - | X | X | X |

**Legend:**
**X - Listed**
**E - Indicates a substance that is the subject of a Section 5(e) Consent order under TSCA.**
**F - Indicates a substance that is the subject of a Section 5(f) Rule under TSCA.**
**N - Indicates a polymeric substance containing no free-radical initiator in its inventory name but is considered to cover the designated polymer made with any free-radical initiator regardless of the amount used.**
**P - Indicates a commenced PMN substance**
**R - Indicates a substance that is the subject of a Section 6 risk management rule under TSCA.**
**S - Indicates a substance that is identified in a proposed or final Significant New Use Rule**
**T - Indicates a substance that is the subject of a Section 4 test rule under TSCA.**
**XU - Indicates a substance exempt from reporting under the Inventory Update Rule, i.e. Partial Updating of the TSCA Inventory Data Base Production and Site Reports (40 CFR 710(B).**
**Y1 - Indicates an exempt polymer that has a number-average molecular weight of 1,000 or greater.**
**Y2 - Indicates an exempt polymer that is a polyester and is made only from reactants included in a specified list of low concern reactants that comprises one of the eligibility criteria for the exemption rule.**

**U.S. Federal Regulations**

**TSCA 12(b)** Not applicable

**SARA 313**

| Component | CAS-No | Weight % | SARA 313 - Threshold Values % |
|---|---|---|---|
| Nitric acid | 7697-37-2 | 65 - 70 | 1.0 |

**SARA 311/312 Hazardous Categorization**

| | |
|---|---|
| **Acute Health Hazard** | Yes |
| **Chronic Health Hazard** | Yes |
| **Fire Hazard** | No |
| **Sudden Release of Pressure Hazard** | No |
| **Reactive Hazard** | Yes |

**Clean Water Act**

| Component | CWA - Hazardous Substances | CWA - Reportable Quantities | CWA - Toxic Pollutants | CWA - Priority Pollutants |
|---|---|---|---|---|
| Nitric acid | X | 1000 lb | - | - |

**Clean Air Act** Not applicable

**OSHA** Occupational Safety and Health Administration
**OSHA -** Occupational Safety and Health Administration

| Component | Specifically Regulated Chemicals | Highly Hazardous Chemicals |
|---|---|---|
| Nitric acid | - | TQ: 500 lb |

**CERCLA**
This material, as supplied, contains one or more substances regulated as a hazardous substance under the Comprehensive Environmental Response Compensation and Liability Act (CERCLA) (40 CFR 302)

| Component | Hazardous Substances RQs | CERCLA EHS RQs |
|---|---|---|
| Nitric acid | 1000 lb | 1000 lb |

**California Proposition 65** This product does not contain any Proposition 65 chemicals.

**State Right-to-Know**

| Component | Massachusetts | New Jersey | Pennsylvania | Illinois | Rhode Island |
|---|---|---|---|---|---|
| Nitric acid | X | X | X | X | X |

**U.S. Department of Transportation**

| | |
|---|---|
| Reportable Quantity (RQ): | Y |
| DOT Marine Pollutant | N |
| DOT Severe Marine Pollutant | N |

**U.S. Department of Homeland Security**
This product contains the following DHS chemicals:

| Component | DHS Chemical Facility Anti-Terrorism Standard |
|---|---|
| Nitric acid | 2000 lb STQ |

**Other International Regulations**

**Mexico - Grade** No information available

**Canada**
**This product has been classified in accordance with the hazard criteria of the Controlled Products Regulations (CPR) and the MSDS contains all the information required by the CPR.**

| | |
|---|---|
| **WHMIS Hazard Class** | C Oxidizing materials<br>E Corrosive material<br>D2B Toxic materials |

## 16. Other information

| | |
|---|---|
| **Prepared By** | Regulatory Affairs<br>Thermo Fisher Scientific<br>Email: EMSDS.RA@thermofisher.com |
| **Creation Date** | 12-Mar-2009 |
| **Revision Date** | 02-Apr-2014 |
| **Print Date** | 02-Apr-2014 |
| **Revision Summary** | This document has been updated to comply with the US OSHA HazCom 2012 Standard replacing the current legislation under 29 CFR 1910.1200 to align with the Globally Harmonized System of Classification and Labeling of Chemicals (GHS). |

**Disclaimer**
**The information provided on this Safety Data Sheet is correct to the best of our knowledge, information and belief at the date of its publication. The information given is designed only as a guide for safe handling, use, processing, storage, transportation, disposal and release and is not to be considered as a warranty or quality specification. The information relates only to the specific material designated and may not be valid for such material used in combination with any other material or in any process, unless specified in the text.**

**End of SDS**

# SAFETY DATA SHEET

**Creation Date** 07-Dec-2010 **Revision Date** 07-Dec-2015 **Revision Number** 1

## 1. Identification

| | |
|---|---|
| **Product Name** | **Magnesium carbonate** |
| **Cat No. :** | **M26-3** |
| **Synonyms** | No information available |
| **Recommended Use** | Laboratory chemicals. |
| **Uses advised against** | No Information available |

**Details of the supplier of the safety data sheet**

**Company**
Fisher Scientific
One Reagent Lane
Fair Lawn, NJ 07410
Tel: (201) 796-7100

**Emergency Telephone Number**
CHEMTREC®, Inside the USA: 800-424-9300
CHEMTREC®, Outside the USA: 001-703-527-3887

## 2. Hazard(s) identification

**Classification**
Classification under 2012 OSHA Hazard Communication Standard (29 CFR 1910.1200)

Based on available data, the classification criteria are not met

**Label Elements**
None required

**Hazards not otherwise classified (HNOC)**
None identified

## 3. Composition / information on ingredients

| Component | CAS-No | Weight % |
|---|---|---|
| Magnesium carbonate | 546-93-0 | >95 |

## 4. First-aid measures

| | |
|---|---|
| **Eye Contact** | Rinse immediately with plenty of water, also under the eyelids, for at least 15 minutes. Obtain medical attention. |
| **Skin Contact** | Wash off immediately with plenty of water for at least 15 minutes. Get medical attention immediately if symptoms occur. |

**Magnesium carbonate** **Revision Date** 07-Dec-2015

| | |
|---|---|
| **Inhalation** | Move to fresh air. If breathing is difficult, give oxygen. Get medical attention immediately if symptoms occur. |
| **Ingestion** | Do not induce vomiting. Obtain medical attention. |
| **Most important symptoms/effects** | No information available. |
| **Notes to Physician** | Treat symptomatically |

## 5. Fire-fighting measures

| | |
|---|---|
| **Suitable Extinguishing Media** | Use water spray, alcohol-resistant foam, dry chemical or carbon dioxide. |
| **Unsuitable Extinguishing Media** | No information available |
| **Flash Point** | No information available |
| **Method -** | No information available |
| **Autoignition Temperature** | No information available |
| **Explosion Limits** | |
| **Upper** | No data available |
| **Lower** | No data available |
| **Sensitivity to Mechanical Impact** | No information available |
| **Sensitivity to Static Discharge** | No information available |

**Specific Hazards Arising from the Chemical**
Thermal decomposition can lead to release of irritating gases and vapors.

**Hazardous Combustion Products**
Magnesium oxides Carbon monoxide (CO) Carbon dioxide ($CO_2$)
**Protective Equipment and Precautions for Firefighters**
As in any fire, wear self-contained breathing apparatus pressure-demand, MSHA/NIOSH (approved or equivalent) and full protective gear.

**NFPA**

| Health | Flammability | Instability | Physical hazards |
|---|---|---|---|
| 1 | 1 | 0 | N/A |

## 6. Accidental release measures

| | |
|---|---|
| **Personal Precautions** | Ensure adequate ventilation. Use personal protective equipment. Avoid dust formation. |
| **Environmental Precautions** | Should not be released into the environment. |
| **Methods for Containment and Clean Up** | Sweep up or vacuum up spillage and collect in suitable container for disposal. Avoid dust formation. |

## 7. Handling and storage

| | |
|---|---|
| **Handling** | Wear personal protective equipment. Ensure adequate ventilation. Avoid contact with skin, eyes and clothing. Avoid ingestion and inhalation. Avoid dust formation. |
| **Storage** | Keep containers tightly closed in a dry, cool and well-ventilated place. |

## 8. Exposure controls / personal protection

**Exposure Guidelines**

| Component | ACGIH TLV | OSHA PEL | NIOSH IDLH |
|---|---|---|---|
| Magnesium carbonate | | | TWA: 10 $mg/m^3$<br>TWA: 5 $mg/m^3$ |

| Component | Quebec | Mexico OEL (TWA) | Ontario TWAEV |
|---|---|---|---|
| Magnesium carbonate | TWA: 10 $mg/m^3$ | | |

***Legend***

***OSHA*** *- Occupational Safety and Health Administration*
***NIOSH IDLH:*** *The National Institute for Occupational Safety and Health Immediately Dangerous to Life or Health*

| | |
|---|---|
| **Engineering Measures** | Ensure that eyewash stations and safety showers are close to the workstation location. Ensure adequate ventilation, especially in confined areas. |

**Personal Protective Equipment**

| | |
|---|---|
| **Eye/face Protection** | Wear appropriate protective eyeglasses or chemical safety goggles as described by OSHA's eye and face protection regulations in 29 CFR 1910.133 or European Standard EN166. |
| **Skin and body protection** | Wear appropriate protective gloves and clothing to prevent skin exposure. |
| **Respiratory Protection** | Follow the OSHA respirator regulations found in 29 CFR 1910.134 or European Standard EN 149. Use a NIOSH/MSHA or European Standard EN 149 approved respirator if exposure limits are exceeded or if irritation or other symptoms are experienced. |
| **Hygiene Measures** | Handle in accordance with good industrial hygiene and safety practice. |

## 9. Physical and chemical properties

| | |
|---|---|
| **Physical State** | Solid |
| **Appearance** | No information available |
| **Odor** | Odorless |
| **Odor Threshold** | No information available |
| **pH** | No information available |
| **Melting Point/Range** | No data available |
| **Boiling Point/Range** | No information available |
| **Flash Point** | No information available |
| **Evaporation Rate** | No information available |
| **Flammability (solid,gas)** | No information available |
| **Flammability or explosive limits** | |
| **Upper** | No data available |
| **Lower** | No data available |
| **Vapor Pressure** | No information available |
| **Vapor Density** | No information available |
| **Specific Gravity** | No information available |
| **Solubility** | No information available |
| **Partition coefficient; n-octanol/water** | No data available |
| **Autoignition Temperature** | No information available |
| **Decomposition Temperature** | No information available |
| **Viscosity** | No information available |
| **Molecular Formula** | C Mg O3 |
| **Molecular Weight** | 84.31 |

## 10. Stability and reactivity

| | |
|---|---|
| **Reactive Hazard** | None known, based on information available |
| **Stability** | Stable under normal conditions. |
| **Conditions to Avoid** | Incompatible products. Excess heat. Avoid dust formation. |
| **Incompatible Materials** | Strong oxidizing agents, Acids |
| **Hazardous Decomposition Products** | Magnesium oxides, Carbon monoxide (CO), Carbon dioxide ($CO_2$) |

**Hazardous Polymerization** Hazardous polymerization does not occur.

**Hazardous Reactions** None under normal processing.

## 11. Toxicological information

**Acute Toxicity**

**Product Information**
**Component Information**

| Component | LD50 Oral | LD50 Dermal | LC50 Inhalation |
|---|---|---|---|
| Magnesium carbonate | 8000 mg/kg (Rat) | Not listed | Not listed |

**Toxicologically Synergistic Products** No information available

**Delayed and immediate effects as well as chronic effects from short and long-term exposure**

**Irritation** May cause eye, skin, and respiratory tract irritation

**Sensitization** No information available

**Carcinogenicity** The table below indicates whether each agency has listed any ingredient as a carcinogen.

| Component | CAS-No | IARC | NTP | ACGIH | OSHA | Mexico |
|---|---|---|---|---|---|---|
| Magnesium carbonate | 546-93-0 | Not listed | Not listed | Not listed | Not listed | Not listed |

**Mutagenic Effects** No information available

**Reproductive Effects** No information available.

**Developmental Effects** No information available.

**Teratogenicity** No information available.

**STOT - single exposure** None known
**STOT - repeated exposure** None known

**Aspiration hazard** No information available

**Symptoms / effects,both acute and delayed** No information available

**Endocrine Disruptor Information** No information available

**Other Adverse Effects** The toxicological properties have not been fully investigated. See actual entry in RTECS for complete information.

## 12. Ecological information

**Ecotoxicity**
Do not empty into drains.

**Persistence and Degradability** No information available
**Bioaccumulation/ Accumulation** No information available.

**Mobility** No information available.

## 13. Disposal considerations

**Waste Disposal Methods** Chemical waste generators must determine whether a discarded chemical is classified as a hazardous waste. Chemical waste generators must also consult local, regional, and national hazardous waste regulations to ensure complete and accurate classification.

## 14. Transport information

**Magnesium carbonate** **Revision Date** 07-Dec-2015

| | |
|---|---|
| **DOT** | Not regulated |
| **TDG** | Not regulated |
| **IATA** | Not regulated |
| **IMDG/IMO** | Not regulated |

## 15. Regulatory information

**International Inventories**

| Component | TSCA | DSL | NDSL | EINECS | ELINCS | NLP | PICCS | ENCS | AICS | IECSC | KECL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Magnesium carbonate | X | X | - | 208-915-9 | - | | X | X | X | X | X |

**Legend:**
**X - Listed**
**E - Indicates a substance that is the subject of a Section 5(e) Consent order under TSCA.**
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**N - Indicates a polymeric substance containing no free-radical initiator in its inventory name but is considered to cover the designated polymer made with any free-radical initiator regardless of the amount used.**
**P - Indicates a commenced PMN substance**
**R - Indicates a substance that is the subject of a Section 6 risk management rule under TSCA.**
**S - Indicates a substance that is identified in a proposed or final Significant New Use Rule**
**T - Indicates a substance that is the subject of a Section 4 test rule under TSCA.**
**XU - Indicates a substance exempt from reporting under the Inventory Update Rule, i.e. Partial Updating of the TSCA Inventory Data Base Production and Site Reports (40 CFR 710(B).**
**Y1 - Indicates an exempt polymer that has a number-average molecular weight of 1,000 or greater.**
**Y2 - Indicates an exempt polymer that is a polyester and is made only from reactants included in a specified list of low concern reactants that comprises one of the eligibility criteria for the exemption rule.**

**U.S. Federal Regulations**

**TSCA 12(b)** Not applicable

**SARA 313** Not applicable

**SARA 311/312 Hazard Categories**

| | |
|---|---|
| **Acute Health Hazard** | No |
| **Chronic Health Hazard** | No |
| **Fire Hazard** | No |
| **Sudden Release of Pressure Hazard** | No |
| **Reactive Hazard** | No |

**CWA (Clean Water Act)** Not applicable

**Clean Air Act** Not applicable

**OSHA** Occupational Safety and Health Administration
Not applicable

**CERCLA**
Not applicable

**California Proposition 65** This product does not contain any Proposition 65 chemicals

**U.S. State Right-to-Know Regulations**

| Component | Massachusetts | New Jersey | Pennsylvania | Illinois | Rhode Island |
|---|---|---|---|---|---|
| Magnesium carbonate | X | - | - | - | X |

**U.S. Department of Transportation**

| | |
|---|---|
| Reportable Quantity (RQ): | N |
| DOT Marine Pollutant | N |
| DOT Severe Marine Pollutant | N |

**U.S. Department of Homeland Security**
This product does not contain any DHS chemicals.

**Other International Regulations**

**Mexico - Grade** No information available

**Canada**
**This product has been classified in accordance with the hazard criteria of the Controlled Products Regulations (CPR) and the MSDS contains all the information required by the CPR**

**WHMIS Hazard Class** Non-controlled

## 16. Other information

| | |
|---|---|
| **Prepared By** | Regulatory Affairs<br>Thermo Fisher Scientific<br>Email: EMSDS.RA@thermofisher.com |
| **Creation Date** | 07-Dec-2010 |
| **Revision Date** | 07-Dec-2015 |
| **Print Date** | 07-Dec-2015 |
| **Revision Summary** | This document has been updated to comply with the US OSHA HazCom 2012 Standard replacing the current legislation under 29 CFR 1910.1200 to align with the Globally Harmonized System of Classification and Labeling of Chemicals (GHS) |

**Disclaimer**
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**End of SDS**

## Activity 11: We have a problem!

While removing the waste from the building, a large pit covered by old sheets of drywall and paneling is found. Several drums have fallen or were dumped into this pit. Liquid can be seen outside the barrels and puddled around them. The rising red fumes causes one to cough – choke if you get a deep enough breath.

1. What chemical do we think is causing the fuming in the pit?

2. With your three days of site-specific training from your employer, are you trained and equipped to clean this pit out? Explain.

3. What are your concerns about being exposed and/or near these fuming drums?

CPWR

## Abbreviations and Acronyms; Glossary; OSHA Regional Offices and NIOSH Pocket Guide Abreviations, Terms and Definitions:

## ABBREVIATIONS and ACRONYMS

| | |
|---|---|
| **ACGIH** | American Conference of Governmental Industrial Hygienists |
| **ACM** | Asbestos Containing Material |
| **ANSI** | American National Standards Institute |
| **APF** | Assigned Protection Factor |
| **APR** | Air-Purifying Respirator |
| **atm** | Atmosphere, a measure of pressure. |
| **BP** | Boiling Point |
| **°C** | Celsius, Centigrade; International temperature scale in which boiling is 100 °C and freezing is 0 °C. |
| **CAS** | Chemical Abstracts Service |
| **cfm** | Cubic Feet per Minute |
| **CFR** | Code of Federal Regulations |
| **CGI** | Combustible Gas Indicator |
| **C** | Ceiling Limit |
| **cm** | Centimeter (measure of length, 1 cm = 0.394 in) |
| **$cm^2$** | Square Centimeter |
| **$cm^3$ or cc** | Cubic Centimeter |
| **CNS** | Central Nervous System |
| **CPC** | Chemical-Protective Clothing |
| **CPR** | Cardiopulmonary Resuscitation |
| **CRC** | Contamination Reduction Corridor |

| | |
|---|---|
| **CRZ** | Contamination Reduction Zone |
| **dB** | Decibels (measure of sound intensity) |
| **DOD** | U.S. Department of Defense |
| **DOE** | U.S. Department of Energy |
| **DOT** | U.S. Department of Transportation |
| **EL** | Excursion Limit |
| **EPA** | Environmental Protection Agency |
| **ERP** | Emergency Response Plan |
| **ESLI** | End-of-service-life Indicator |
| **f** | Fiber |
| **FID** | Flame Ionization Detector |
| **Fl. P. or FP** | Flash Point |
| **FRZ** | Freezing Point for liquids and gases |
| **g** | Gram |
| **GFI or GFCI** | Ground Fault (Circuit) Interrupter |
| **HEPA** | High Efficiency Particulate Air |
| **IARC** | International Agency for Research on Cancer |
| **IDLH** | Immediately Dangerous to Life or Health |
| **IP** | Ionization Potential |
| **l** | Liter |
| **LEL** | Lower Explosive Limit |

| | |
|---|---|
| **LFL** | Lower Flammable Limit |
| **m** | Meter |
| **$m^2$** | Square Meter |
| **$m^3$** | Cubic Meter |
| **mg** | Milligram |
| **mil** | a measure of thickness |
| **ml** | Milliliter |
| **mm** | Millimeter |
| **mmHg** | Millimeters of mercury |
| **MP or MLT** | Melting Point |
| **MUC** | Maximum Use Concentration |
| **MW** | Molecular Weight |
| **NFPA** | National Fire Protection Association |
| **NIOSH** | National Institute for Occupational Safety and Health |
| **NPL** | National Priority List |
| **NOAEL** | No-observed-adverse-effect-level |
| **ORM** | Other Regulated Material |
| **OSHA** | Occupational Safety and Health Administration |
| **PAPR** | Powered Air-Purifying Respirator |
| **PCB** | Polychlorinated Biphenyl |
| **PEL** | Permissible Exposure Limit (OSHA) |

| | |
|---|---|
| **PF** | Protection Factor |
| **PID** | Photoionization Detector (monitor) |
| **PPE** | Personal Protective Equipment |
| **ppm** | Parts Per Million |
| **PRCS** | Permit-Required Confined Space |
| **psi** | Pounds Per Square Inch |
| **REL** | Recommended Exposure Limit (NIOSH) |
| **SAR** | Supplied-air Respirator |
| **SCBA** | Self-Contained Breathing Apparatus |
| **SDS** | Safety Data Sheet |
| **SG** | Specific Gravity |
| **SOL** | Solubility in Water |
| **SOP** | Standard Operating Procedure |
| **Sp. Gr. or SG** | Specific Gravity |
| **STEL** | Short-Term Exposure Limit |
| **TLV** | Threshold Limit Value |
| **TLV-C** | Threshold Limit Value—Ceiling |
| **TLV-STEL** | Threshold Limit Value—Short-Term Exposure Limit |
| **TSDF** | Treatment, Storage, and Disposal Facility |
| **TWA** | Time-Weighted Average |
| **UEL** | Upper Explosive Limit |

| | |
|---|---|
| **UFL** | Upper Flammable Limit |
| **µg** | Microgram (millionth of a gram) |
| **µm** | Micron or Micrometer (1/1000 mm or 0.001 mm) |
| **USCG** | U.S. Coast Guard |
| **VOC** | Volatile Organic Compound |
| **VD** | Vapor Density (air = 1) |
| **VP** | Vapor Pressure (air = 760 mmHg) |

# GLOSSARY

## A

**Absorption**—a route of entry into the body by which chemicals are absorbed through the skin.

**Acid**—a chemical with a pH between 1 and 6.9 with the strongest acids having the lowest pH.  Acids are sour, turn litmus red and can cause skin or tissue damage (pH goes from 1-14).

**Acute effect**—an adverse health effect which develops rapidly.  Common acute effects include dizziness, headache, difficulty breathing, eye and throat irritation.

**Additive effect**—one in which the combined effect of two chemicals is equal to the sum of the agents acting alone.

**Administrative controls**—work and personnel practices that reduce exposure to chemical and physical hazards.

**Adsorbent**—a substance that holds other substances.  Adsorbents such as activated carbon are used to remove odors and vapors.

**Air-purifying respirator**—protective mask with absorbent filters that remove toxic materials form the air.

**Alkali**—a base:  any chemical with a pH above 7 and up to 14.  Alkalis are bitter and turn litmus paper blue.

**Alpha particle**—positively charged radioactive particle capable of traveling only a few inches in air.  Although it cannot penetrate the skin it does a lot of damage if it gets into the body.

**Alveoli**—the small air spaces deep in the lung where oxygen goes into the blood.

**American Conference of Governmental Industrial Hygienists** (ACGIH)—A private organization that develops and publishes recommended occupational exposure limits (see TLV).

**Anhydrous**—inorganic compound that does not contain water.

**Asphyxiant**—a vapor or gas which can cause unconsciousness or death by suffocation (lack of oxygen). Asphyxiation is a major hazard of confined spaces.

## B

**Base**—see alkali

**Beta particle**—a radiation particle which can cause skin burns and harm if inside the body. Beta particles can be stopped by a thin sheet of metal.

**Boiling point**—temperature at which a liquid changes to a vapor.

**Buddy system**—a safety measure where workers, especially those exposed to hazards work in pairs.

## C

**Carcinogen**—a substance which can cause cancer.

**CAS Number**—a unique number assigned to a chemical by the Chemical Abstract Service.

**Catalyst**—a substance that speeds up a chemical reaction.

**$cm^3$** (cc)—cubic centimeter, a metric measurement (cm x cm x cm) about the size of a sugar cube.

**Ceiling** (C)—the maximum allowable exposure limit for an airborne substance, not to be exceeded during the shift.

**Central Nervous System** (CNS)—The brain and the spinal cord.

**Chemical cartridge**—a filtering device which is attached to an air-purifying respirator.

**Chemical-resistant material**—prevents chemicals from penetrating through your clothes to your skin.

**Chronic effect**—an adverse health effect which develops slowly over a long period of time.

**Comprehensive Environmental Response, Compensation and Liability Act** (CERCLA)—The “Superfund” law administered by the EPA, regulates clean-up of hazardous waste.

**Concentration**—the amount of one material in another, i.e. the amount of a chemical vapor in air.

**Confined space**— has limited or restricted means for entry or exit, are large enough for workers to enter and perform certain jobs and is not designed for continuous occupancy.

**Corrosive**—a liquid or solid that eats away another material or skin. Both acids and bases (alkalis) are corrosive.

## D

**Decibels**—a unit of measurement of noise levels.

**Decomposition**—the breakdown of a material by heat, chemical reaction, decay, or other processes.

**Decontamination**—the chemical or physical process of reducing and preventing the spread of contamination from persons and equipment.

**Decontamination line**—a line set up with stations for decontamination procedures between the Hot Zone and the Cold Zone.

**Degradation**—process which diminishes or destroys protective properties of chemical protective clothing.

**Department of Transportation (DOT)**—Government agency that regulates shipments and transfer of hazardous materials.

**Dermatitis**—redness or irritation of the skin often caused by chemical exposures.

**Dilution**—method of reducing the concentration of a contaminant, generally in air or water by adding more air or water.

**Dose**—the quantity of a chemical taken into the body.

**Dose response**—the relationship between the amount of the chemical and the severity of response in humans or animals.

## E

**Emergency response plan**—A written plan detailing actions and personnel responsibilities during chemical emergencies.

**Engineering control**—substitution, isolation, and ventilation methods used to reduce the level of the contaminant at the source.

**Environmental Protection Agency** (EPA)—federal agency concerned with the quality of the air, water, and land.

**Evaporation rate**—how fast a liquid becomes a vapor

**Exclusion zone** —The Hot Zone or contaminated area.

**Exposure**—the concentration of a material in the air to which a worker can come into contact. Usually, exposure is measured within the worker's breathing zone.

## F

**Flammable**—The ability of a material to ignite and burn. According to OSHA, flammable liquids have a flash point of not more than 199.4°F.

**Flash Point**—the temperature at which a liquid will give off enough vapors that they will burn if ignited.

## G

**Gram** (g)—a metric unit of weight. 454g = 1 pound.

## H

**Hazardous material**—A chemical which is either flammable, corrosive, reactive or toxic.

**Hazardous Waste Operations and Emergency Response** (HAZWOPER)—OSHA standard which was developed to protect hazardous waste personnel and emergency responders.

**Hazards**—the properties of a material that may cause injury, or death by contact, inhalation, or ingestion.

**HAZCOM**—OSHA Hazard Communication Standard (1910.1200).

**Heat exhaustion**—prolonged exposure to intense heat exceeds the body's ability to cool down, causing excessive sweating and sodium deficiency.

**Heat stroke**—a life-threatening condition requiring medical attention in which the body is unable to sweat; skin is hot and dry.

**Heavy metals**—the major toxic metals, for example; mercury and arsenic.

**Hematotoxin**—toxic to the blood or organs where blood is made. "Hem-" or "Hema-" or "Hemo-" has to do with blood, as on "hemolysis," which means bursting blood cells.

**Hepatotoxin**—toxic to the liver. "Hep-" or "Hepat-" has to do with the liver, as in "hepatitis," which means swelling of the liver, usually caused by a germ (virus or bacteria), but can also caused by some chemicals.

## I

**Immediately Dangerous to Life or Health** (IDLH)—According to the OSHA Respiratory Protection Standard, "an atmosphere that poses an immediate threat to life, would cause irreversible adverse health effects, or would impair an individual's ability to escape from a dangerous atmosphere."

**Incident Command System** (ICS)—an organized system of personnel and delegation of responsibilities which controls the response to an emergency.

**Incident commander**—person in charge of on-site management of all activities at a hazardous materials emergency.

**Incompatible chemicals**—chemicals which produce a negative reaction when mixed.

**Ingestion**—taking a substance in through the mouth.

**Inhalation**—Breathing in substances (usually as gas, vapor, fume, mist, or dust). The most common route of entry for workplace chemical exposures.

**Irritant**—a substance which causes an inflammatory response when brought into contact with the eyes, skin, or respiratory system.

**Isolation**—method of decontamination in which contaminated equipment and materials are bagged or covered and set aside, usually for subsequent shipment to an approved landfill for disposal.

## L

**Latency**—the time interval between exposure to a substance and the development of a disease.

**Lock-out**—a procedure to prevent energy from reaching equipment being serviced or repaired. Energy source is locked out and the equipment tagged off.

**Lower explosive limit** or **Lower flammable limit**—the lowest concentration (percentage of the substance in air) that will burn when an ignition source is present.

## M

**m**—meter; a metric unit of length equal to about 39 inches

**$m^3$**—cubic meter-a measure of volume, close to a yard X a yard X a yard.

**Manifest form**—required by EPA to track hazardous wastes.

**Melting point**—the temperature at which a solid substance changes to a liquid state.

**Metabolism**—the chemical reactions that go on in the body to maintain life.

**Milligrams per cubic meter** (mg/m3)—unit of measurement which is a weight per unit volume of air.

**Monitoring**—measuring concentrations of substances in the workplace.

**Mutagen**—a substance which can change the genetic material (DNA) in a living cell.

## N

**National Fire Protection Association** (NFPA)—produces fire standards, and the four-color diamond used on labels to indicate hazard.

**National Institute for Environmental Health Sciences** (NIEHS)—a federal agency responsible for issues related to the environment.

**National Institute for Occupational Safety and Health** (NIOSH)—The federal occupational health and safety research agency.

**Neurotoxin**—a substance which is toxic to the brain and nerves.

**Neutralization**—method of decontamination in which a chemical is mixed with another chemical to lessen the hazards.

**Nuclear Regulatory Commission** (NRC)—a federal agency responsible for community and worker protection from radiation hazards.

## O

**Occupational Safety and Health Administration** (OSHA)—a federal unit responsible for creating and enforcing occupational safety and health regulations.

**Oxidation**—a reaction in which a substance combines with oxygen, rusting is an example of oxidation.

**Oxidizer**—a substance that gives up oxygen readily.

**Oxygen-deficient**—air which contains less than 19.5% oxygen.

**Oxygen-enriched**—air containing more than 23.5% oxygen.

## P

**Parts per million** (ppm)—a volume measure of chemical concentration.  For example one part of chemical in a million parts of air.

**Penetration**—the flow of a chemical through zippers, stitched seams, pores, or imperfections in the material.

**Permeation**—process by which a chemical dissolves in or moves through a protective clothing material on a molecular level.

**Permissible Exposure Limit** (PEL)— set and enforced by OSHA is the highest concentration of a substance to which a person can be legally exposed during a typical weekday.

**pH**—measures acidity/alkalinity of substances and ranges from 1 to 14. Strong bases are closer to 14, strong acids closer to 1 water, pH 7, is neutral.

**Physical agent**—light, heat, cold, noise, radiation, vibration, etc. which affect health and safety.

**Pulmonary toxin**—a substance which is toxic to the lungs.

## Q

**Qualitative fit-test**—measures effectiveness of a respirator by exposing wearer to a test atmosphere containing an irritating or smelly substance. Wearer should not be able to detect the substance.

**Quantitative fit test**—measures effectiveness of a respirator in preventing substance from entering the facepiece while wearer is in a test chamber. Concentration of substance is measured inside the facepiece of the respirator.

## R

**Rad**—A measure of radiation energy absorbed by the body.

**Reactivity**—tendency of a substance to undergo chemical reaction with the release of energy.

**REM** (Roentgen Equivalent Man)—A unit used to measure the dose equivalent, which combines the amount of energy (from any type of ionizing radiation that is deposited in human tissue), along with the medical effects of the given type of radiation.

**Renal**—pertaining to the kidney.

**Residual volume** (RV)—the amount of air remaining in the lung after breathing out.

Risk—the chance of injury or loss.

**Route of Entry**—how material gets into the body: inhaled, ingested, through skin or eye contact absorption.

## S

**Safety Data Sheet** (SDS)—chemical information sheet required by OSHA's Hazard Communication Standard. Lists health effects, chemical properties, emergency response actions, reactivity data, control measures, safe handling procedures, etc.

**Self-Contained Breathing Apparatus** (SCBA)—a supplied-air respirator with an air tank carried on wearer's back.

**Sensitizer**—a substance which on first exposure causes little or no reaction but which on repeated exposure may cause a marked serious allergic response.

**Short-Term Exposure Limit** (STEL)—the maximum concentration of a chemical a worker can be exposed to during a 15-minute period, set by OSHA.

**Solubility** (in water)—a measure of how much of a material will dissolve in water.

**Stability**—ability of a material to remain unchanged. A material is considered stable if it remains in the same form under expected and reasonable conditions of storage or use.

**Standard Operating Procedures** (SOP)—written descriptions of tasks and activities to be followed during work.

**Support zone** (cold zone)—area where administrative and support functions not requiring respiratory protective equipment are performed.

**Synergistic Effect**—a combined effect of two or more substances which is greater than the sum of the effect of each.

**Systemic**—relating to the whole body

## T

**Teratogen**—a substance which can cause birth defects in a developing fetus.

**Threshold**—the lowest dose or exposure to a chemical at which a specific effect is observed.

**Threshold Limit Value** (TLV)—A concentration limit similar to the OSHA PEL TLVs are set by ACGIH and not legally enforceable.

**Time-Weighted Average** (TWA)—measurement to determine the worker's average exposure to a substance over a typical 8-hour work shift. OSHA PELs are time weighted averages.

**Toxicity**—Ability of a chemical to cause health damage.

## U

**United Nations Identification Number** (UN Number)—A number used internationally to identify a hazardous material.

**United States Coast Guard** (USCG)—concerned with the transportation of hazardous materials on navigable waterways.

**Upper Explosive Limit** or **Upper Flammable Limit** (UEL/UFL)—The highest concentration (percentage of the substance in air) that will burn when an ignition source is present. At higher concentration, the mixture is too "rich" to burn.

## V

**Vapor**—gaseous form of a substance normally in the liquid or solid state at room temperature.

**Vapor density**—the weight of a vapor or gas compared to air. Materials lighter than air have vapor densities less than 1.0. Materials heavier than air have vapor densities greater than 1.0. Also called Relative Gas Density or RGasD.

**Vapor pressure**—indicates the tendency of a liquid to evaporate into the air. Normal air has a vapor pressure of 760 mmHg at sea level (less at higher elevations).

**Ventilation**—means controlling a hazardous atmosphere using continuous forced-air mechanical systems.

**Viscosity**—resistance to flow.

# OSHA REGIONAL OFFICES

NOTE: In case of a workplace fatality, explosion, emergency call OSHA at 1-800-321-6742

**Region 1: CT, ME, MA, NH, RI, VT**
U.S. Department of Labor—OSHA
JFK Federal Bldg. Rm. E340
Boston, MA 02203
Phone: (617) 565–9860
Fax: (617) 565–9827

**Region 2: NJ, NY, PR**
U.S. Department of Labor—OSHA
201 Varick St., Rm. 670
New York, NY 10014
Phone: (212) 337–2378
Fax: (212) 337–2371

**Region 3: DE, DC, MD, PA, VA, WV**
U.S. Department of Labor—OSHA
The Curtis Center
170 S. Independence Mall West
Suite 740 West
Philadelphia, PA 19106-3309
Phone: (215) 861-4900
Fax: (215) 861-4904

**Region 4: AL, FL, GA, KY, MI, NC, SC, TN**
U.S. Department of Labor—OSHA
61 Forsyth St., SW
Atlanta, GA 30303
Phone: (678) 237-0400
Fax: (678) 237-0447

**Region 5: IN, IL, MI, MN, OH, WI**
U.S. Department of Labor—OSHA
230 S. Dearborn St., Rm. 3244
Chicago, IL 60604
Phone: (312) 353–2220
Fax: (312) 353–7774

**Region 6: AR, LA, NM, OK, TX**
U.S. Department of Labor—OSHA
525 Griffin St., Rm. 602
Dallas, TX 75202
Phone: (972) 850-4145
Fax: (972) 850-4149

**Region 7: IA, KS, MO, NE**
U.S. Department of Labor—OSHA
City Center Square
1100 Main St., Ste. 800
Kansas City, MO 64105
Phone: (816) 426–5861
Fax: (816) 426–2750

**Region 8: CO, MT, ND, SD, UT, WY**
U.S. Department of Labor—OSHA
1244 Speer Blvd., Suite 551
Denver, CO 80204
Phone: (720) 264-6550
Fax: (720) 264-6585

**Region 9: AZ, CA, HI, NV, American Samoa, Guam, Trust Territory of Pacific Islands**
U.S. Department of Labor—OSHA
90 7th Street, Suite 18100
San Francisco, CA 94103
Phone: (415) 625-2547
Fax: (415) 625-2534

**Region 10: AK, ID, OR, WA**
U.S. Department of Labor—OSHA
300 Fifth Ave., Ste. 1280
Seattle, WA 98101–3212
Phone: (206) 757-6700
Fax: (206) 757-6705

# NIOSH Pocket Guide Abbreviations, Terms, and Definitions for Exposure Routes, Symptoms, and Target Organs

| Abbreviation | Term | Definition |
|---|---|---|
| abdom | Abnormal | Involving to the part of the body between the chest and the pelvis and containing the stomach, intestines, liver, kidneys, and bladder |
| abnor | Abnormal/ Abnormalities | Unusual, other than normal |
| abs | Skin absorption | Substances that enter the body by passing through the skin |
| album | Albuminuria | Excess protein in the urine; symptoms may include whitish foam in urine and swelling of ankles, hands, belly, or the face |
| anes | Anesthesia | Unconsciousness, loss of memory, reduced pain, and muscle relaxation |
| anor | Anorexia | An eating disorder causing a person to be obsessed with their body weight and eating. |
| anos | Anosmia | Loss of the sense of smell |
| anxi | Anxiety | Feeling of worry, nervousness, or unease |
| arrhy | Arrhythmias | Irregular, fast, or slow heart beat |
| aspir | Aspiration | Breathing in a foreign object or substance |
| asphy | Asphyxia | Suffocation from lack of oxygen |
| BP | Blood Pressure | The pressure of blood against the blood vessels |
| breath | Breath/breathing | The process of moving air in and out of the lungs |
| bron | Bronchitis | Inflammation of the bronchial tubes (airways within the lungs) |
| BUN | Blood urea nitrogen | A blood test to determine how well the kidneys are working |

| Abbreviation | Term | Definition |
|---|---|---|
| [carc] | Potential occupational carcinogen | A substance or condition that may cause cancer |
| card | Cardiac | Involving to the heart |
| chol | Cholinesterase | Enzyme involved the proper function of the nervous system and muscles |
| cirr | Cirrhosis | Irreversible scarring (fibrosis) of the liver |
| CNS | Central nervous system | The brain and spinal cord |
| conc | Concentration | The amount of a substance in another substance |
| con | Skin and/or eye contact | Contact with the skin or eyes may be hazardous (cause burns, irritation, etc.) |
| conf | Confusion | Inability to think as quickly or clearly as normal. Difficulty paying attention, remembering, and making decisions. |
| conj | Conjunctivitus | Inflammation of the mucous membrane that lines the eyelids and covers the white part of the eyeball |
| constip | Constipation | Fewer than three bowel movements per week |
| convuls | Convulsions | Uncontrolled muscle contractions |
| corn | Corneal | Pertaining to the cornea, the transparent surface that transmits light into the eye |
| CVS | Cardiovascular system | The heart, arteries, veins, and capillaries |
| cyan | Cyanosis | Blue appearance of the skin due to lack of oxygen in the blood |
| decr | Decreased | Reduced, diminished, or lessened |
| depres | Depressed/ depression | Reduced or diminished bodily function or activity |

| Abbreviation | Term | Definition |
|---|---|---|
| derm | Dermatitus | Inflammation of the skin |
| diarr | Diarrhea | Abnormal liquidity of feces and frequent bowel movements |
| dist | Disturbance | Different than normal |
| dizz | Dizziness | Loss of the sense of balance and may include loss of consciousness, dimmed vision, lightheadedness, or feeling that the surrounding are spinning |
| drow | Drowsiness | Feeling unusually sleepy |
| dysp | Dyspnea | Difficulty breathing, short of breath |
| emphy | Emphysema | A lung disease involving damage to the air sacs that transfer oxygen to the blood and increases breathing resistance, leading to shortness of breath |
| eosin | Eosinophilia | A higher than normal levels of eosinophils (a type of white blood cells) in the blood |
| epilep | Epileptiform | Resembling epilepsy, loss of consciousness or convulsive seizures |
| epis | Epistaxis | Nosebleed |
| equi | Equilibrium | Balance between powers, influences, or effects |
| eryt | Erythema | Skin redness |
| euph | Euphoria | Intense happiness or confidence |
| fail | Failure | Malfunction or stop working |
| fasc | Fasciculation | Involuntary contraction or twitching of muscles |
| FEV | Forced expiratory volume | The amount of air a person can exhale in one breath |

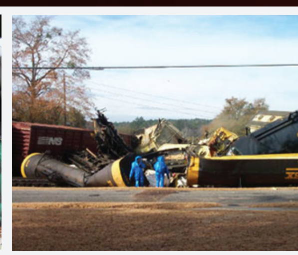
| Abbreviation | Term | Definition |
|---|---|---|
| fib | Fibrosis | The development of extra tissue, called scarring when in the lungs. Fibrosis is commonly caused by exposure to asbestos or silica |
| ftg | Fatigue | Weariness or tiredness |
| func | Function | The action or purpose of an organ or body system |
| GI | Gastrointestinal | Involved with the stomach or intestines |
| halu | Hallucinations | Seeing or hearing something that does not exist |
| head | Headache | Pain in the head |
| hema | Hematuria | Blood in the urine |
| hemato | Hematopoietic | A substance that promotes the formation of blood cells |
| hemorr | Hemorrhage | Bleeding, loss of blood |
| hyperpig | Hyperpigmentation | Darkening or an increase in the natural color of the skin |
| hypox | Hypoxemia | Reduced oxygen in the blood |
| inco | Incoordination | Lack of muscular coordination resulting in stumbling or uneven movement |
| incr | Increased | Greater than past or normal |
| inebri | Inebriation | Drunkenness or intoxication |
| inflamm | Inflammation | A response to tissue injury that may be indicated by pain, heat, or redness |
| ing | Ingestion | Eating or bringing a substance into the body through the mouth |
| inh | Inhalation | Bringing air or other substances into the lung |

| Abbreviation | Term | Definition |
|---|---|---|
| inj | Injury | A wound, damage, or harm to the body |
| insom | Insomnia | Difficulty falling or staying asleep |
| irreg | Irregular/ Irregularities | Uneven or not uniform |
| irrit | Irritation | Inflammatory reaction from contact with substances or objects |
| irrity | Irritability | Easily annoyed or angered |
| jaun | Jaundice | Yellowing of the skin and the whites of the eyes often caused by liver problems |
| kera | Keratitus | Inflammation of the cornea, the clear tissue covering the front of the eye |
| lac | Lacrimation | Discharge of tears, often due irritation |
| lar | Laryngeal | Involving the larynx (voice box) |
| lass | Lassitude | Weakness, exhaustion, lack of energy |
| leucyt | Leukocytosis | Increased white blood cell (leukocytes) count |
| leupen | Leukopenia | Reduced white blood cell (leukocytes) count |
| liq | Liquid | A substance that takes the shape of its container but<br>maintains a constant volume |
| local | Localized | Restricted to a particular place, not widespread |
| low-wgt | Weight loss | A decrease in body weight or mass |
| mal | Malaise | Vague feeling of discomfort or illness |
| malnut | Malnutrition | Lack of the proper amount of types of food or nutrition |

| Abbreviation | Term | Definition |
|---|---|---|
| methemo | Methmoglobinemia | The presence of elevate amounts of methemoglobin in the blood. Methemoglobin is a form of hemoglobin that cannot provide oxygen to tissues. |
| muc memb | Mucous membrane | Mucous-secreting membranes that line the mouth, nose, eyes, lungs, etc. |
| musc | Muscle | Body tissues that contract to produce motion |
| Narco | Narcosis | Depression of the central nervous system that may result in stupor or unconsciousness |
| nau | Nausea | Feeling of stomach sickness or the need to vomit |
| nec | Necrosis | Death of a cell, tissue, or organ |
| neph | Nephritis | Inflammation of the kidney |
| numb | Numb/numbness | Lacking feeling or physical sensation |
| opac | Opacity | Not transparent or allowing light through |
| palp | Palpitations | Unusually rapid heart beat |
| para | Paralysis | Inability to move |
| pares | Paresthesia | Sensation of burning, numbness, tingling, itching, or prickling |
| perf | Perforation | A hole |
| peri neur | Peripheral neuropathy | Weakness, numbness, and pain, often in the hands or feet |
| periorb | Periorbital | Situated around the eye |
| phar | Pharyngeal | Involving the pharynx (simply, the throat) |
| photo | Photophobia | Abnormal visual intolerance to light |

| Abbreviation | Term | Definition |
|---|---|---|
| pneu | Pneumonitis | Inflammation of the lung |
| PNS | Peripheral nervous system | Nerves other than those in the brain and spinal cord (central nervous system) |
| polyneur | Polyneuropathy | A disease involving several nerves |
| prot | Proteinuria | Excess protein in the urine and may result in whitish foam in urine |
| pulm | Pulmonary | Involving the lungs |
| RBC | Red blood cell | Blood cells that contain hemoglobin and transport oxygen |
| repro | Reproductive | Involving reproduction or the ability to produce children |
| resp | Respiratory/ respiration | The system for or act of breathing. Involves the mouth, nose, larynx, trachea, and lungs |
| restless | Restlessness | Unable to rest, relax or be still |
| retster | Retrosternal | Occurring behind the sternum or breastbone |
| rhin | Rhinorrhea | A runny nose or the discharge of thin nasal mucus |
| salv | Salivation | To produce saliva, a watery fluid in the mouth |
| sens | Sensitization | An immune reaction causing a person to become allergic to a substance |
| short | Shortness | Lack of sufficient |
| sneez | Sneezing | An involuntary exhalation through the nose often due to irritation in the nose |
| sol | Solid | The state of matter characterize by fixed shape and volume |
| soln | Solution | The state of matter characterize by fixed shape and volume |

| Abbreviation | Term | Definition |
|---|---|---|
| subs | Substernal | Occurring beneath the sternum or breastbone |
| sweat | Sweating | The release of watery fluid on the skin to cool the body |
| swell | Sweeling | The enlargement of organ or skin due to the buildup of fluids |
| sys | System | A collection or group of body parts or organs |
| tacar | Tachycardia | A rapid heart rate |
| tend | Tenderness | Easily hurt or bruised |
| terato | Teratogenic | Capable of causing damage to an embryo or fetus |
| throb | Throbbing | Pulsating or pounding with abnormal force or speed |
| tight | Tightness | Constricting or restraining feeling |
| twitch | Twitching | Small uncontrollable muscle movements |
| uncon | Unconsciousness | When a person is unaware of their environment and unable to respond |
| vap | Vapor | Gaseous phase of a substance that is normally a liquid or solid at room temperature |
| vesic | Vesiculation | The formation of vesicles |
| vis | Visual | Relating to vision or the ability to see |
| vomit | Vomiting | The involuntary emptying of the stomach's contents, also known as throwing up |
| weak | Weak/weakness | Lacking strength or energy |
| wheez | Wheezing | A whistling sound made while breathing and indicates that a part of the respiratory system is obstructed or narrowed |

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