Industrial Emergency Council

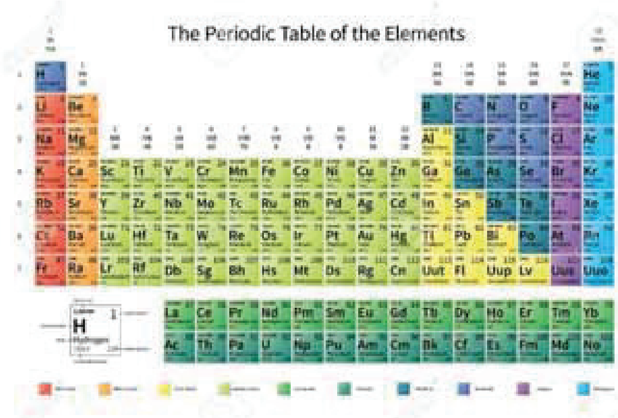
Emergency Response Training

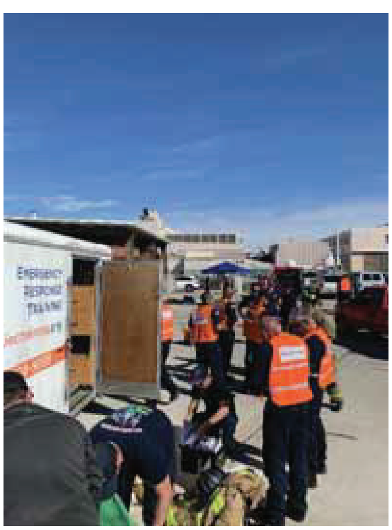
Hazardous Materials

Technician Series : Incident Considerations & Offensive Operations

Module C & D

Participant Manual





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CALIFORNIA SPECIALIZED

CSTI

TRAINING INSTITUTE

Hazardous Materials Technician Course

Incident Considerations & Offensive Operations Modules (C & D)

PARTICIPANT MANUAL

September 1, 2002
Revised July 20, 2020

CSTI, Camp San Luis Obispo, 10 Sonoma Ave, Building 904, San Luis Obispo • CA • 93405

For those who go in harm's way, to benefit and protect others, this book is gratefully dedicated

ACKNOWLEDGMENTS

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INTRODUCTION

The purpose of this student manual is to provide the same basic information to all students as an aid in standardizing the curriculum.

This manual has been designed to include essential student notes and information sheets that contain subject matter related to specific topics within the curriculum. Assignment Sheets are included in the manual to provide both individual and group activities, allowing the students to benefit from direct application of the new skills and knowledge received during the course.

The intent of this curriculum is to provide each student with the resources and information necessary to perform the duties of a Hazardous Materials Technician, as referenced in Sub-section 5192(q)(6) of Title 8 California Code of Regulations (and/or 29 CFR 1910.120(q)(6)), when all four modules have been completed. This module is designated as Module C, Incident Considerations as referenced in Title 19, California Code of Regulations, Section 2520. A certificate for Hazardous Materials Technician will be issued by CSTI/CSFM only after completion of the *entire* program, Modules A-D, as referenced in Title 19, California Code of Regulations, Section 2510-2560.

STUDENT INFO

Each page within the student manual is identified in the upper left corner with the heading - STUDENT INFO. The material on these pages is considered to be essential information for use by the students.

INFORMATION SHEETS

Information sheets are used to present ideas or information to the student when the desired information is not in printed form or otherwise not available to the student.

Recommended Changes or Corrections to the Hazardous Materials Technician/Specialist Curriculum

The California Specialized Training Institute would like to enlist your help in our continuing effort to improve the Hazardous Materials Technician/Specialist curriculum. If you locate an error in one of the manuals, or if you have a suggestion regarding improvement of the course content or material, please fill out this page and return it to CSTI.

Date: _______________ Name:______________________________ Tel__________________

Address:

____

Which module do your comments apply to? (circle one): C D

Manual	Chapter and Page	Section or Paragraph	Comment or Suggestion

Signature:

____

Fold Along This Line

Hazardous Materials Section
CALIFORNIA SPECIALIZED TRAINING INSTITUTE
Building 904, 10 Sonoma Ave
Camp San Luis Obispo, CA 93405-7605

ATTN: Hazardous Materials Technician Modules C & D
Program Coordinator

Fold Along This Line

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CHAPTER

1

Chapter One

Chapter 1: Orientation and Administration Hazardous Materials Tech/Spec 1C & D

Summary: Introduction to the course and description of topics to be presented.

Time Allocated: <30 Minutes>

Method of Instruction: Interactive Lecture

Terminal Learning Objective: The objective of this chapter is to introduce the student to the class and provide an understanding of what they will gain and what is expected of each student.

Enabling Objectives:

Instructional Resources Required:

1. Student Workbook
2. Audio-Video Media system
3. Dry erase, paper chart and / or chalk board with appropriate markers

Instructional Resources Recommended: None

Instructor to Student Ratio: 1:40

References:

1. Title 29 CFR 1910.120
2. Title 8 CCR 5192

Practical Exercise: None

Evaluation Strategy: Students will satisfactorily pass a written test with a score of 70% or Better.
Students will successfully complete practical exercises, as evaluated by a Certified Instructor.

Chapter 1

Orientation and Administration Hazardous Materials Technician Modules 1C & D

Welcome to the third week of the CSTI Hazardous Materials Technician Course. This course builds on the last two classes, and focuses on psycho-motor skills development of the foundation already laid.
With your knowledge of what chemicals are, how to detect them, and how they can affect us, we will now address how to protect our team from these hazards.

This week is dedicated to providing the knowledge and tools you will need to determine the appropriate Personal Protective Equipment (PPE), Zones, Decontamination and other skills needed for a given incident. Practical application will include plugging and patching a variety of containers including Chlorine tanks and cylinders, using pneumatic patching equipment, pipe tree patching and the types and categories of sampling equipment.

Here are some suggestions to help get the most out of this class.

40 hours -- 100% attendance required

Start time 8AM and end time 5PM daily

Recommended study for each night – Take notes in the book and read ahead at night

Final Practical Exams & Exercises - Participate fully in all manipulative exercises

Final Written Exam
30-50 T/F & Multiple Choice questions, 70% passing score

Place ALL media devices in "silent mode" or remove them from the classroom. Various modules of instruction will allow you to make use of them for practical applications, but only when directed by Instructor(s)...

Class Attire –Work casual attire is expected. *No "flip-flops" (or open toe shoes) are to be worn on the training grounds or in the classroom.* No 'cut-off's' or shorts are allowed, unless you are wearing a Chemical Protective ensemble (weather and location dictating).

Clean up after class daily.

Review – Will be conducted as time permits

Question and answer – PLEASE! Do not hesitate to ask questions. That's what the Instructors are there for!

Technician Module C Terminal Learning Objectives:
The objectives for this module:

1. Define the hazardous materials incidents command concepts associated with hazardous materials response activities and positive incident outcomes, including a basic ICS organizational review, as well as a description of the hazardous materials group ICS positions descriptions, duties and responsibilities.

2. Demonstrate the utilization of methods, procedures, and equipment for decontamination.

3. Identify tactical considerations concerning hazardous materials triage.

4. Demonstrate the ability to utilize chemical protective clothing while maneuvering through an obstacle course.

5. Identify the methods and procedures for the preservation of evidence.

6. Define the EMS considerations at a hazardous materials incident, including medical monitoring, rescue, and transport of victims.

7. Identify meteorological considerations influencing hazardous materials response activities and incident outcomes, including basic meteorological processes, local synoptic weather influences, micro climatic influences, and forecasting weather effects.

8. Demonstrate the use of respiratory protective equipment and chemical protective clothing.

Performance expectations:

1. The student shall identify how various meteorological factors may influence a hazardous materials incident.

2. The student shall recognize general protective action concepts associated with hazardous materials response, with specific emphasis on evacuation and shelter-in-place options.

3. The student shall identify the factors to be considered in selecting proper respiratory protection. Students shall describe the advantages, limitations, proper use and operational components of air purifying respirators at a hazardous materials incident.

Performance expectations, Cont.

4. The student shall identify the three types of vapor-protective, splash-protective and support-function clothing and describe the advantages and disadvantages of each. The student shall identify the four levels of chemical protection (EPA/NIOSH) and match both the equipment required for each level and the conditions under which each level is used. The student shall explain the significance of degradation, penetration and permeation as they relate to suit selection.

5. The student shall identify the factors to be considered and the process involved in selecting the proper chemical protective clothing, at least three indications of material degradation of chemical protective clothing, and the relative advantages and disadvantages of various cooling methods/devices.

6. The student shall recognize basic ICS concepts as they apply to hazardous materials incidents, the general organization of the Incident Command System and some of the standard ICS forms.

7. The student shall describe the duties of a member of the Command Staff within the Incident Command System at a hazardous materials incident.

   (7a) The student shall describe the duties of the Haz Mat Group Supervisor within the Incident Command System at a hazardous materials incident.

8. The student shall recognize the importance of establishing control zones and identify the three control zones to be established at a hazardous materials incident.

9. The student shall describe the duties of the Site Access Control Leader within the Incident Command System at a hazardous materials incident.

10. The student shall describe the duties of the Entry Team Leader within the Incident Command System at a hazardous materials incident.

11. The student shall describe the duties of the Decontamination Team Leader within the Incident Command System at a hazardous materials incident.

12. The student shall describe the duties of the Mass Decon Leader within the Incident Command System at a hazardous materials incident.

13. The student shall identify various environmental, mechanical, physiologic and psychological stresses that personnel working in chemical protective clothing are subjected to.

Performance expectations, Cont.

14. The student shall describe the duties of the Safe Refuge Area Manager within the Incident Command System at a hazardous materials incident.

15. Student shall identify the mechanisms by which heat builds up in workers operating in chemical protective clothing, and the appropriate measures to take for someone experiencing a heat related illness.

16. Student shall identify procedures by which hazardous materials response personnel shall be medically evaluated at incidents.

17. The student shall identify guidelines for dealing with injured or trapped persons at a hazardous materials incident.
18. The student shall identify some of the problems and resources which must be evaluated in order to triage hazardous materials incidents.

19. The student shall identify the various decontamination methods, the types of decontamination, factors that can affect the decon process and resources needed to set up a Contamination Reduction Corridor. The student shall also identify general guidelines for Emergency Decon, including sources for selecting appropriate decon procedures and solutions.

20. The student shall describe the procedures for donning and doffing SCBA, and describe how to properly respond to emergencies with the SCBA.

21. The student shall describe the procedures for donning and doffing Level “A” Chemical protective clothing.

22. The student shall describe the importance of recognizing and preserving evidence found at a hazardous materials incident and describe the procedures for the use of a chain of custody form.

23. The student shall identify some of the chemicals used in illegal drug manufacturing operations and the hazards associated with drug labs. The students shall also identify several warning signs indicating the presence of a drug lab, as well as appropriate safety and tactical considerations to take at an incident scene.

24. The student shall demonstrate the use of grounding and bonding equipment for product transfer.

25. The student shall demonstrate the use of plugging and patching equipment for drums.

Performance expectations, Cont.

26. The student shall demonstrate the use of transfer pumps for product transfer between drums.

27. The student shall demonstrate the safe use of a drum hand truck.

28. The student shall identify some of the key components of a hazardous materials area plan.

29. The student shall demonstrate the safe use of a drum up-ender (manual drum lifter).

30. The student shall define search warrants and proper documentation; and identify important guidelines regarding the collection of specific types of evidence.

31. The student shall demonstrate over-packing of a 55 gallon drum by the “V-Roll” and “End Over” Techniques.

32. The student shall demonstrate the use of plugging and patching equipment for repairing leaks on piping systems.
33. The student shall demonstrate the use of plugging and patching equipment for horizontal and vertical storage tanks.

34. The student shall demonstrate the safe use of chemical sampling equipment for solids and liquids.

35. The student shall demonstrate the safe use of absorbent materials for containing a liquid spill.

36. The student shall demonstrate the collection of evidence at a hazardous materials incident, including the use of chain of custody forms, evidence seals, scene mapping and photography.

37. The student shall demonstrate the safe application of a “Chlorine Institute A & B Kits”.

Exercises:

--Participation in an Introduction to Protective Clothing Exercise, including successful completion of the following objective:

--Student shall be able to identify and discuss the basic concept of chemical protective clothing, component parts, types of manufacturer, and the importance of compatibility charts.

Exercises, Cont.

--Participation in an Introduction to Levels of Chemical Protective Clothing Exercise including successful completion of the following objectives:

--Student shall be able to identify and discuss the basic concept of levels of chemical protective clothing and which one is most applicable to exercise being conducted

38. Participation in an evaluation scenario including successful completion of the following objectives:

    (i) Analyze the simulated hazardous materials incident to determine the problem and predict the outcome;

    (ii) Identify and perform the appropriate positions within the Incident Command System required to manage the simulated incident;

    (iii) Identify and utilize the technical references used for providing information for product identification, chemical protective clothing selection, tactical operations and decontamination procedures;

    (iv) Select and use proper chemical protective clothing, (CPC) and equipment;

    (v) Develop and utilize a Site Safety Plan;

    (vi) Develop and utilize and Incident Action Plan;

    (vii) Identify and use the accepted standard operating procedures for hazardous materials incidents; and,

    (viii) Participate in a post-scenario analysis.

39. Participation in a Chemical Protective Clothing Considerations Exercise including successful completion of the following objective:

    (i) Student shall be able to identify and discuss the protocols necessary to support a hazardous materials team when readying to use CPC.

40. Participate in a functional exercise, as a member of the team. The exercise will implement the SSP, IAP, Decon Plan, Site access control plan, medical plan, PPE plan and air monitoring plan as specified above, in a live exercise scenario.

Technician Module D Terminal Learning Objectives:

(1) The student shall describe the components of a site safety plan for a hazardous materials incident and identify key points that should be made in a safety briefing prior to working on the scene.

(2) The student shall describe the duties of the Assistant Safety Officer - Haz Mat within the Incident Command System at a hazardous materials incident.

(3) The student shall identify various non-bulk and intermediate bulk packaging, the types of materials they contain, basic design and construction features, and some of the marking requirements for the various packages.

(4) The student shall identify the following regarding intermodal tank containers: tank construction features, tank markings, general classes of tanks, tank fittings and how to handle hazardous materials in tank containers.

(5) The student shall describe the type of carrier and material most commonly involved in highway hazardous materials incidents.

(6) The student shall identify operational situations which may exceed the capabilities of responders training, equipment or technical feasibility.

(7) The student shall identify some of the ways in which chemicals could be used for terrorism.

(8) The student shall identify the types of shipping papers that may be found on rail cars, as well as the types of information they contain.

(9) The student shall identify some of the general types of transport vehicles used in rail transportation.

(10) The student shall identify various tank cars by type, capacity and contents they typically transport. The student shall also identify various tank markings and construction features.

(11) The student shall identify various tank car fittings that may be found on the different types of tank cars.

(12) The student shall identify how a liquid pipeline may carry different products, the types of information which may be found on a pipeline marker, basic guidelines to follow for mitigating pipeline incidents and some of the regulations pertaining to pipeline construction and safety.

Technician Module D Terminal Learning Objectives, Cont.

(13) The student shall identify various offensive control options that may be utilized at a hazardous materials incident including repositioning leaking drums, over-packing, using absorbents, plugging, patching and catching. The student shall describe the purpose of, procedures for, equipment required and safety precautions appropriate for each method. The student shall also identify guidelines for taking samples of a hazardous material.
(14) The student shall identify basic design and construction features of storage tanks found at fixed facilities, the types of materials they may contain, and the types of damage that they could incur. The student shall identify some of the fire and safety protection systems that may be required at a fixed facility or bulk storage facility, and how these systems impact the behavior of the products during an incident. The student shall also identify some guidelines for managing a hazardous materials incident at a fixed facility.

(15) The student shall identify the types of vessels that may be involved in maritime incidents and some of the hazards associated with them, as well as the types of shipping papers that will be carried on these vessels and some of the information they contain. The student shall identify who the responsible authority will be and some basic guidelines to follow in the event of a maritime incident.

(16) The student shall identify some of the metals used in aircraft construction, and the advantages and disadvantages of each, as well as the fuels and fluids generally found aboard aircraft and their associated hazards. The student shall identify regulations pertaining to air transport of hazardous materials, and the types of shipping papers required and some of the information they contain. The student shall also identify some basic airport safety considerations

(17) The student shall demonstrate the use of emergency hand signals.

(18) The student shall recognize the significant federal and state laws and regulations pertaining to hazardous materials and hazardous waste, as well as some of the key provisions of each. The student shall recognize potential areas of liability in dealing with hazardous materials incidents, as well as guidelines that can be implemented both before and during an incident to minimize liability for response personnel.

(19) The student shall demonstrate the use of grounding and bonding equipment for product transfer.

(20) The student shall demonstrate the use of plugging and patching equipment for drums.

(21) The student shall demonstrate the use of transfer pumps for product transfer between drums.

Technician Module D Terminal Learning Objectives, Cont.

(22) The student shall demonstrate the safe use of a drum hand truck.

(23) The student shall demonstrate the safe use of a drum up-ender.

(24) The student shall demonstrate over-packing of a 55 gallon drum by the "V- Roll" and "End Over" Techniques.

(25) The student shall demonstrate the use of plugging and patching equipment for repairing leaks on piping systems.

(26) The student shall demonstrate the use of plugging and patching equipment for horizontal and vertical storage tanks.

(27) The student shall demonstrate the safe use of chemical sampling equipment for solids and liquids.

(28) The student shall demonstrate the safe use of absorbent materials for containing a liquid spill.

(29) The student shall demonstrate the safe application of a "Chlorine Institute A Kit".

(30) The student shall demonstrate the safe application of a "Chlorine Institute B Kit".

(31) The student shall demonstrate the ability to perform the following functions at a simulated hazardous materials incident:

(a) Analyze the simulated hazardous materials incident to determine the problem and predict the outcome.

(b) Identify and perform the appropriate ICS positions required to manage the simulated incident.

(c) Utilize appropriate technical references to determine product identification and hazards, chemical protective clothing required, and appropriate tactical operations and decon procedures.

(d) Select and use proper chemical protective clothing and equipment.

(e) Develop and utilize a site safety plan.

(f) Develop and utilize an Incident Action Plan.

(g) Identify and perform appropriate decontamination procedures.

Technician Module D Terminal Learning Objectives, Cont.

(h) Identify and use the appropriate tools and equipment necessary to mitigate the simulated problem.
(i) Identify and use accepted Standard Operating Procedures for hazardous materials incidents.

(32) The student shall participate in an Incident Debriefing and a Post Incident Analysis.

(33) The student shall identify components of the three phases of an effective incident termination: debriefing, post-incident analysis and critique

SECTION –B TRAINING EXERCISES:

(1) Participation in a Solid and Liquid Sampling Exercise including successful completion of the following objectives:

(2) Identify and use the appropriate tools and equipment required for taking a sample of a solid hazardous material.

(3) Identify and use the appropriate tools and equipment required for taking a sample of a liquid hazardous material.

(4) Participation in a Weather and Plume Prediction Exercise or a Damming, Diking and Diverting Exercise including successful completion of the following objectives:

(5) Use a Belt Weather Kit to evaluate current weather conditions.

(6) Using a desktop or laptop computer air dispersion prediction program and given a chemical do a plume prediction based on current weather.

Or

(6a) Construct an overflow dam to control flowing products.

(7) Construct an underflow dam to control flowing products.

(8) Construct a dike to control flowing product from entering a storm drain or sewer.

(9) Construct a diversion channel to control flowing product.

(10) Participation in a Plugging, Patching and Over-packing Exercise including successful completion of the following objectives:

(11) Demonstrate patching various size leaks in a fifty-five gallon drum.

<u>Technician Module D Terminal Learning Objectives, Cont.</u>

(12) Demonstrate over-packing a fifty-five gallon drum.

(13) Demonstrate the proper use of a Chlorine "A" kit.

(14) Demonstrate proper use of a Chlorine "B" kit.

(15) Demonstrate controlling various leaks in a pipe prop.

(16) Demonstrate proper use of a pneumatic tank bandage to control a leak in an above-ground tank.

SECTION – C SCENARIO PARTICIPATION:

(1) Analyze the simulated hazardous materials incident to determine the problem and predict the outcome.

(2) Identify and perform the appropriate positions within the Incident Command System required to manage the simulated incident.

(3) Identify and utilize the technical references used for providing information for product identification, chemical protective clothing selection, tactical operations and decontamination procedures.

(4) Select and use proper Chemical Protective Clothing and equipment.

(5) Develop and utilize a Site Safety Plan.

(6) Develop and utilize an Incident Action Plan.

(7) Identify and perform appropriate decontamination procedures.

(8) Identify and use the appropriate tools and equipment necessary to mitigate the simulated problem.

(9) Identify and use the selected method for field identification of the simulated released hazardous material.

(10) Identify and use the accepted standard operating procedures for hazardous materials incidents.

(11) Participate in a post-scenario analysis.

2

Chapter Two

Chapter 02: Medical Management and Rehabilitation

Overview: Hazmat response personnel face a variety of dangers when responding to an incident. Dealing with the chemical hazard is discussed throughout this course. Dealing with the physical and physiological aspect of the individual is the subject of this chapter. It provides an orientation to mandated and optional programs developed to protect responders by establishing requirements and recommendations for initial health assessments, on-going medical management and rehabilitation.

Time Allocated: 1 Hour

Method of Instruction: Interactive Lecture

Terminal Learning Objective:

At the conclusion of this class, the participant will be able to discuss the importance and process of medical monitoring during a hazardous materials response and list the elements of a model on-scene pre-entry/post-entry medical monitoring program.

Enabling Objectives:

A. At the conclusion of this section the participant will be able to three important programs which protect the health of first responders
B. Identify the elements of an OSHA mandated medical monitoring program
C. List the elements of an on-scene pre-entry/post-entry medical monitoring program
D. List the re-entry and exclusion criteria for entry team members

Instructional Resources Required:

1. Student Notebook
2. Projection system for PowerPoint (or other similar program)
3. Dry erase, paper chart and or chalk board with appropriate markers

Instructional Resources Recommended:

1. ICS-206 Form
2. Work Mission Duration worksheet
3. Medical Monitoring form.

Instructor to Student Ratio: 1:40

References:

1. NFPA 1584, Standard on the Rehabilitation Process for Members during Emergency Operations and Training Exercises, 2008 Edition
2. Title 8 CCR 5192/1910.120
3. U.S. Fire Administration, Emergency Incident Rehabilitation, February 2008. FEMA
4. NFPA 1582, Standard on Comprehensive Occupational Medical Program for Fire Departments, 2007 Edition
5. NFPA1521, Standard for Fire Department Safety Officer, 2008 Edition
6. NFPA 1584, Standard on the Rehabilitation Process for Members during Emergency Operations and Training Exercises, 2008 Edition
7. NFPA 1582, Standard on Comprehensive Occupational Medical Program for Fire Departments, 2007 Edition
8. NFPA1521, Standard for Fire Department Safety Officer, 2008 Edition
9. NIOSH Occupational Exposure to Hot Environments, Publication # 86-113, 1986 U.S. Fire Administration, Emergency Incident Rehabilitation, February 2008. FEMA

Practical Exercise: In conjunction with Full Functional Exercises during C & D Weeks

Evaluation Strategy: Participants will complete a written examination at the conclusion of the class.

Medical Management and Rehabilitation

The most common cause of injury to workers involved in hazardous materials emergency response is heat stress induced by the wearing of chemical protective clothing. With the availability of higher capacity/longer duration breathing systems, the restricting factor on work periods has become the health of the individual. We must adequately assess the health threats to all workers in CPC and properly implement the necessary safeguards to ensure safety and well-being. Stress management techniques and medical monitoring of emergency response personnel are the principal points in accomplishing that goal.

Stress Management Programs

For responders to hazardous substance incidents, OSHA requires medical programs, training and specialized equipment under two principal regulations and as implied by a third. These three important examples include:

1. The HAZWOPER regulation

8 CCR 5192(q)(9) (29CFR1910.120(q)(9)) Medical surveillance and consultation

(A) 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 subsection (f) of this section.
(B) Any emergency response employee 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 subsection (f)(3)(B) of this section.

2. The Respiratory Protection regulation

8 CCR 5144 (e) Medical evaluation

This regulation requires a medical evaluation for responders who will wear respiratory protection. It describes the requirements of the medical evaluation, medical examination and on-going program. It also ties into the medical program required under the Hazwoper regulation.

3. Heat Illness Prevention

Title 8 CCR 3395: Heat Illness Prevention in Outdoor Places of Employment

Heat illness prevention does not require a medical evaluation, however it does require the employer do an assessment of the current environmental conditions in (and around) the work area.

3. Heat Illness Prevention, Cont.

Based on the findings of the assessment, the employer is required to take specific steps to prevent heat illness by providing training, hydration, rehabilitation and shade as needed.
Title 8 CCR 3395: Heat Illness Prevention in Outdoor Places of Employment (Cont.)

These three programs establish the base from which employers can build an effective medical management program. These programs reference a pre-employment physical, on-going and on-scene medical management (during and after an incident) and post-employment physical examinations.

This chapter will highlight many important points from the above-mentioned programs and focus on the Safety issues as they apply to hazmat emergency response safe practices.

Incident Stressors

Personnel operating in chemical protective clothing are typically subjected to four types of stressors: environmental, mechanical, psychological, and physiological.

- Environmental stressors include temperature and humidity both outside and inside the suit, wind conditions, terrain, confined spaces, etc.

- Mechanical stressors are caused by faults or defects in the protective equipment; limitations inherent in the CPC (mobility, dexterity, visibility, etc.); or objects that come into contact with the garments creating punctures, tears, rips or abrasions.

- Physiologic stressors are created by the physical characteristics of the individual: age, fitness, health, and personal habits.

- Psychological stressors are manifested by anxiety and/or claustrophobic reactions to operating in adverse environments, with dangerous materials, or under unfamiliar conditions.

Stresses of Encapsulating Garments

Technological advances in chemical protective clothing, SCBA's, supplied air systems, and rebreathers make it possible to work in hazardous environments for much longer periods than was possible in the past. This presents a significant increase in the health risk to personnel as they become limited more by their own physical conditions than by the limitations of their protective equipment.

Physiological Factors

Just wearing an encapsulating garment puts personnel at considerable risk for injuries ranging from heat-related illnesses to various physical traumas, chemical toxicity, or psychological harm. Individual physical and emotional characteristics of the personnel are also significant contributing factors. These factors include, but are not limited to:

- **Lack of physical fitness-** Personnel who have low work capacities are more susceptible to heat-related injuries.

- **Lack of familiarity** Personnel should practice and drill with various CPC until they are as comfortable with them as they are with any other tool. Continual practice and drills are necessary to maintain confidence when working in CPC.

- **Anxiety** may be overcome with time and training. **Claustrophobia** is a condition that adversely affects a team member's ability to perform, and must be addressed by the Team's Officer In Charge.

- **Age** affects personnel in numerous ways; general health, reaction time, stamina, and dexterity are a few of the abilities affected by age.

- **Dehydration** caused by sweating, diarrhea, or other conditions is one of the principal causes of heat-related injuries. Therefore, anyone who exhibits symptoms of dehydration (unusual thirst, etc.) or signs of other maladies (such as a cold or flu) should not be assigned to duties that require the use of CPC.

- **Obesity** causes excessive stress on the body, especially to the cardiovascular system, even under normal conditions. Wearing CPC will put additional stress on the body. Obese individuals should not be chosen for tasks requiring the use of CPC.

- **Personal habits** can greatly affect an individual's health. Alcohol, smoking, and drug use can result in diminished lung capacity and mental alertness. Use of intoxicants, over-the-counter medications, etc., needs to be evaluated by the ASO/HazMat before a decision to 'suit up' is made involving the team member involved.

- **Infections or other illnesses** preclude personnel from operating at peak efficiency. Sunburn, gastro-intestinal illness, and other conditions affect a team member's ability to perform safely, and at peak efficiency.

- **Chronic diseases**, such as emphysema and bronchitis, can severely limit the physical capabilities of personnel. Emergency response personnel who manifest signs of chronic illnesses should be medically evaluated for duty on a hazardous materials teams.

Physical Heat Responses

The human body deals with heat regulation in three general ways, by opening the blood vesicles in the surface of the skin (peripheral vasodilatation), the production of perspiration -- which leads to the evaporative cooling process and finally through respiration. Interrupt either of these three and the body begins to heat up and has to work harder to offload the excess heat.

Ultimately, the fluid loss can begin to affect the circulating volume. A 5% body weight loss of perspiration is dangerous, as the viscosity of blood increases, making it more difficult to circulate through the body. There is also the possibility that body temperature exceeding 104^0f can affect the thermos-regulatory center (hypothalamus) in the brain. Injury to the hypothalamus can cause deregulation of the body temperature and rapid heating of the core (heart, lungs, brain). Body temperatures over 106^0f are generally considered the point at which seizures can begin and are not uncommon. Heat Stroke is a true medical emergency. Once a person enters the heat stroke phase, seconds equate to brain damage. The longer they are in heat stroke, the more damage to the brain.

Hazmat personnel must be able to recognize the signs and symptoms of heat related illness. Departments and agencies must have guidelines, SOP's, SOG"s, policies and/or procedures for the recognition and treatment of heat illness.

Heat-Related Injuries

If the body's physiological processes fail to maintain a normal body temperature and excessive heat is allowed to build up, a number of physical reactions can occur. These may include:

Heat Rash: Caused by continuous exposure to heat and humid air and aggravated by chafing clothes. Heat rash decreases the ability to tolerate heat and is a general nuisance.

Sunburn: Caused by prolonged unprotected exposure to the sun. Effects can range from mild irritation to blistering and second degree burns with body fluid loss.

Heat Cramps: Caused by profuse perspiration with inadequate fluid intake and chemical replacement (especially salts). Signs of heat cramps include muscle spasms and pain in the extremities and abdomen.

Heat Exhaustion: Is caused by increased stress on various organs to meet increased demands to cool the body. While the body is still capable of producing sweat, a condition known as cardiovascular insufficiency is developing. The body temperature is between 37.5°C and 38.5°C (99.5°F - 101.3°F)

Heat Stroke: This is the catastrophic failure of the body's thermoregulatory system and is a true medical emergency that can rapidly result in death. The body must be cooled immediately. Signs and symptoms include red, hot, dry skin; no perspiration (but still may be wet from earlier perspiration); nausea; dizziness and confusion; strong, rapid pulse; hypotension; coma. The body temperature is over 40.8°C (104.9°F)

Treatment of Heat Illnesses

Responders exhibiting the signs or symptoms of a heat-related illness require immediate medical attention. These individuals should be removed to a shaded area and cooled by evaporative or active cooling methods. Intravenous therapy should be considered anytime that cardiovascular insufficiency is a factor in the patient's condition. The treatment for all heat-related injuries includes maintaining vital signs and rehydrating and cooling the patient. Continue to monitor the patient, and transport to the nearest medical facility if appropriate.

Internal thermal change can occur from the body's internal mechanisms working to maintain homeostasis (normal body temperature). Internal thermal changes can be made by direct cooling which include cold or hot drinks, breathing warm air and in hospital settings, re-warming the blood.

External thermal change can occur when heating or cooling is applied directly to the body surface and the heat or cold is *reflected* into the body – to the core. Reflected thermal change is a slower process then internal thermal change and can be difficult to control. Monitoring core temperature becomes critical to avoid overstepping the goal and pushing the patient into the opposite of what is being treated.

Effects of Cold Exposure

Personnel exhibiting signs of hypothermia should be immediately removed from the environment, placed in a warm location, covered with blankets, and provided with warm liquids to drink.

Local injury resulting from cold is included in the generic term *frostbite.* Areas of the body that have high surface-to-volume ratios, such as fingers, toes, and ears, are the most susceptible to frostbite.

Two factors influence the development of a cold injury: ambient air temperature and wind velocity. When either increases, the impact on unprotected or stressed workers increases along with the proportionate danger to the worker. Vigilance by all members involved in working at an incident in temperatures:
Under 40 degrees F is essential in preventing cold injuries.

Work Tolerance

Chemical protective clothing directly influences work tolerance. Heavy, bulky suits are much more difficult to work in than lighter suits. Level A suits have been known to reduce work tolerance by as much as 50%. The slight margin of comfort created by multi-piece suits helps to explain their popularity over the encapsulating type.

Heat stress and work tolerance are interrelated. As the work duration increases, heat tolerance decreases. Chemical protective clothing adds weight, bulk, and heat to the wearer. It also severely reduces the effectiveness of normal heat exchange mechanisms, such as evaporation of sweat, convection from cooling currents, and radiation of body heat. The interior of the suit begins to behave much as a sauna. The temperature inside the suit can be more than 25% higher than the external ambient temperature. At the same time, interior suit humidity rises until it is near 100%. This not only severely represses the body's cooling mechanisms; it acts to reflect heat back toward the body, elevating core temperatures even further. The result can quickly become catastrophic if not recognized and treated quickly.

Medical Monitoring

Introduction

Medical monitoring includes a medical examination by doctor and is often referred to as a *Hazmat Medical*. This exam, completed before the official assignment to a hazmat team, establishes your physical ability to perform work and the current status of your health. It is a comprehensive and in depth examination and the baseline against which all future medical exams will be compared. The Annual Hazmat Medical is required unless the physician determines it can be held off for one more year (to a total of 2 years) based on specific requirements. There exists a need to have all members leaving a HazMat team undergo an *Exit Medical.*

On-scene, OSHA requires a medical evaluation for responders exposed to known or suspected hazardous chemicals. Most HazMat teams consider this issue a *must do* rather than a *should do* and require a medical examination (post-entry exam) on each responder exiting the exclusion zone or contamination reduction zone after a period of time in CPC.

The most accepted criteria for these necessary medical examinations at scene is "If you don both Chemical Protective Clothing and supplied air Respiratory protection, you undergo medical exam/vital sign recording".

On-scene medical monitoring is a combination of OSHA specific requirements, NIOSH, NFPA and other industry standards and recommendations. The result is a model system incorporating many facets of governmental and industrial best practices.

Field Monitoring

Field monitoring must include conditions relating to the health and well-being of emergency response personnel. Temperature, relative humidity, and wind speed are the minimum components necessary to define the environmental parameters for personnel at the site.

Assessing current conditions by vehicle mounted weather station, Belt Weather kit or other weather instruments are critical for incident planning. Results of weather monitoring is supplied to the Technical-Reference Specialist and the ASO/HazMat. That data is then factored in as part of the on-scene medical and entry plans.

Pre-entry and Post-entry Assessment Model

The concept is simple: Take vital signs before making entry, and then take them again after entry and determine if there is a need for further medical action. Repeat as needed.

Before entrants, back-up and decon personnel suit up, the medical monitor will do a pre-entry medical exam using the elements listed below. This will establish a baseline of vital signs and heat stress indicators. Documenting the information gathered is essential in every incident.

The medical monitor will check the baseline against the exclusion criteria, to confirm the entrant is not having medical issues and all readings fall within acceptable parameters. Exceeding exclusion parameters will prevent him/her from making entry. Once the entrant is medically cleared, the Entry Team Leader should be notified.

Upon exit from the exclusion zone, and subsequently the decontamination station, the entrant is examined by the medical monitor, who repeats the pre-entry medical exam, now called the post entry exam (with an additional element).

Pre-planning is the key. Determining who, how and where medical monitoring will be accomplished, in advance, will go a long way in reducing unnecessary injuries and speed response set-up.

Elements of Medical Monitoring

Standard of care in HazMat response accepts that a more accurate assessment is gained by measuring the patient’s body core temperature, heart rate, and water weight loss. Therefore, an effective medical monitoring program should include assessments of these essential factors.

It is crucial for medical teams (Whether they be part of the HazMat team, an EMS Provider, or another agency with medical authority) to ensure documentation of necessary medical monitoring occurs.

Body weight: It is possible for individuals to have a sweat rate as high as 3.5 liters per hour when they are wearing chemical protective clothing. Fluid loss is an element of heat stress management that cannot be made up quickly. Fluid metabolism is a slow process that must occur throughout the day to be truly effective. Don't guess. Rely on a measurable index.

Suggested water weight loss parameters are as follows:

- *Body weight loss should not be allowed to exceed 1.5% of total body weight.*
- *A 3% loss of body weight should require that the individual be immediately removed from all duties pending a thorough assessment by a qualified medical authority.*
- *A 5% loss of body weight shall require that the individual be immediately transported to the nearest medical facility for a thorough assessment.*

Be cautious when taking the post-entry body weights. Post-entry assessment is intended to weigh the amount of fluid remaining in the body tissues. Weighing individuals who have rehydrated, or are still in sweat soaked garments defeats the purpose of the measurement. Pools of liquid in the stomach or hanging on the body serve no immediate value and may mask a serious condition. Make sure the post-entry weight is a "dry" weight.

Body Temperature: Normal body temperature is around 98.6^0 f and can vary. Oral temperatures tend to be about one degree off and tympanic temperatures about 2 degrees off. The most common form of body temperature assessment is the oral thermometer.

- A maximum rise in temperature should not exceed 1.5°F upon post entry examination.
- No personnel should be permitted to continue working until their temperatures return to within 0.5°F of normal.
- To be valid, the temperature must be acquired as quickly as possible after the individual has exited the work zones.

Pulse or heart rate: The pulse is the best indicator of the overall stress being applied to the body. It is a direct measurement of how fast the body is attempting to cool itself, and it indicates the aerobic exercise recently generated by the individual. The most widely accepted pulse measurement is known as the *age-adjusted maximum heart rate.* This figure represents the limit to which an individual can maintain aerobic exercise for extended periods without damaging the heart muscles. To figure the age-adjusted maximum heart rate, subtract the individual's age from the number 220.

Note that this number is an estimate and can be plus or minus 10 beats per minute. NFPA 1584 (2008) recommends the formula, and this program endorses the formula of:

220 - age = Adjusted Heart Rate

(220 – Age) (.85)

(EX: 220 – (age) 40 = 180. 180 x .85 = 153. A Heart rate of 153+ removes the worker)

Blood pressure: This is a health component that is not believed to be affected early in the heat stress process, until the patient is in crisis. It indicates the health status and stress level of an individual and can raise as a reaction to stress and lower (even below baseline) afterwards.

Pulse Oximetry: This non-invasive test provides a snapshot of the individual's current perfusion status. Measured in SpO_2, normal readings should fall between 95 and 100 percent. Readings below 91 percent may indicate the onset of hypoxia and further medical assessments are needed.

Electrocardiograph strip: These devices are available in the field when Paramedics are on scene, they are a good, qualitative baseline when they are available.

General health: General health is an overall indicator of the responders' fitness for stressful working environments.

Neurological status: Neurological status can be an early indicator of stress and/or exposure, especially in the post-entry evaluation. A check of the level of consciousness will give an indication of trouble.

Rehabilitation

Fluid Replacement, Rest, and Recuperation Guidelines

Factors include fluid replacement, rest, and heart recovery, and should be a part of every team's Rehab plan. They can also be found in most agency's IIPP.

Water is the best fluid replacement. Fruit juices and electrolyte solutions should be diluted with water prior to consumption. This will improve the body's ability to assimilate these liquids. Alcohol and caffeinated drinks should be avoided because they promote dehydration. Additionally, drinks that are cooled to between 50°F - 60°F better facilitate the absorption of water by the body.

Rest Periods

The Environmental Protection Agency and OSHA have established guidelines for responder rehabilitation times based on research of endurance rates. This is one tool available to response teams. Drills and training exercises should be used as an avenue to measure and test rest period durations in given environments.

Rest Periods, Cont.

However, regardless of how an agency determines adequate rest periods, the time frames must be predicated upon measurable factors, such as the anticipated work levels, environmental conditions, type of protective garments, individual workers' characteristics and fitness, and medical monitoring results.

The medical monitoring plan may use a variety of methods to determine rest and recuperation periods. As an example, aerobically fit personnel working under normal conditions for twenty minutes should rest as shown in Table 2.1 below.

Table 2.1: Recommended Rest Periods

Ambient Air Temperature	Rest Period
< 70°F	30 minutes
70-85°F	45 minutes
> 85°F	60 minutes

Table 2.2: Minimum Suggested Health Guidelines

Vital Sign	Minimum Guideline
Temperature	A return to within .5 degrees of normal
Body Weight	A return to within 1.5% of normal
Pulse	A return to within 5%, and
	< 90 beats per minute
Blood Pressure	< 150/90

These guidelines should be amended, deleted, or added to, based upon the guidance of your team physician.

Guidelines for Removing Workers

A responder manifesting any one of the following signs should be removed from work. Responders removed from work due to these medical signs are not allowed to return to work until cleared by a qualified medical authority:

Table 2.3: Guidelines for Removing Workers

Vital Sign	Point at Which Responders Should Be Removed from Work
Body Temperature	> 38°C (100.4°F) - This is an OSHA requirement
Pulse	> 85% of the maximum heart rate (Maximum 220-age)
	> 110 beats per minute while the individual is at rest
Heartrate recovery	< 10 beats per minute *
Body weight loss	> 3%
Other	Other signs and symptoms of heat-related illness such as skin temperature and cardiac rhythms

* Heart rate recovery is measured by taking the first- and third-minute pulse rates immediately upon exiting the work zone and then determining the difference. It is stated as follows:

(Heart rate recovery = 1 minute rate - 3 minute rate)

Maintaining Adequate Blood Sugar Levels

One parameter that is seldom considered, but which can be important nonetheless, is maintaining adequate blood sugar levels. This is particularly important for individuals who are known to be diabetic or hypoglycemic. Once the blood sugar level starts dropping, a person may experience irritability, difficulty concentrating, or difficulty making decisions.

EMS Standby

OSHA requires "Advanced first aid support personnel, at a minimum, shall also stand by with medical equipment and transportation capability." (8 CCR 5192(q)(3)(f)) As a general practice the Emergency Medical Technician 1 staffed EMS unit is considered the minimum and must be in place before entry.

Every agency must develop plans or SOGs to address this requirement. The trend is to have a Paramedic Unit on scene to fulfill the requirement. In an ideal situation, the EMS transport unit will be Paramedic level with First Responder Operations Decontamination level training. The transport unit and personnel will be capable of transporting a partially contaminated patient under exigent circumstances.

Personal Exposure Records

Personal exposure records are required by Title 8 CCR 5192 and 3204 (29 CFR 1910.120) for all emergency response personnel. This requirement covers all employees who were exposed to, or were potentially exposed to, hazardous materials.

This regulation requires the employer to document exposures in the employee's records and maintain those files for thirty years beyond the last day of the individual's employment. Title 8 CCR 3204 requires the employer to provide employees a copy of their medical record when requested – at no charge.
However, records can get lost, or accidentally destroyed. Therefore, it is essential that the employees maintain their own copies of the file.

Table 2.4: SOGs

STANDARD OPERATING GUIDELINE FOR REHABILITATION (continued)
PROCEDURES:
(1) All personnel shall maintain hydration on an ongoing basis (pre-incident, incident, post-incident).
(2) Members shall be sent to rehabilitation as required.
(3) All members shall be sent to rehabilitation following the use of two 30-minute SCBA cylinders or one 45- to 60-minute SCBA cylinder. Shorter times might be considered during extreme weather conditions.

Rehabilitation Plans

Any complete program that attempts to reduce the potential for abnormal physical stress or mental anxiety should incorporate pre-incident, on-site, and post-incident components:

- Workers must be periodically examined by medical authorities to determine if they are physically and, if possible, psychologically fit to perform their duties.
- Continual practice and training must be provided in using PPE, especially self-contained breathing apparatus and chemical protective clothing.
- An effective safety program must be implemented and concerted efforts made to protect the worker.

Summary

The encapsulating suit may be the most dangerous environment encountered at a hazardous materials incident. Some parameters can be modified to improve personnel safety. Consider improving the fit(ness) of the responder, rather than improving the fit of the suit to the responder. Account for those conditions that cannot be modified, and always provide for safety first.

Heat-related illnesses are the number one cause of injuries to hazardous materials emergency responders. Limiting the occurrence of these injuries is dependent upon controlling the physical processes that lead to them. Prevention begins with awareness and ends with preparation. Preparation must be an on-going process for each responder before the incident occurs, while awareness of these hazards will help the responder to travel safely through the incident.

Medical monitoring of responders is important, not just because it is required. Establish an SOG for medical monitoring for your agency. Ask for guidance from your team physician.

REFER TO WORK MISSION DURATION SHEET APPEARING SM PAGE 121

MEDICAL MONITORING "CHEAT SHEET" OF VALUES IN VITAL SIGNS IS ATTACHED TO THIS FILE DIGITALLY

3

Chapter Three

Chapter 3: In-Suit Emergencies and Rescue

Overview:
Emergency response personnel face many hazards when operating in chemical protective clothing (CPC). Response personnel must enter hostile environments that may include hazardous atmospheres, adverse weather, darkness, trip and fall hazards, confined spaces, etc. To make matters worse, we enter these hostile environments wearing heavy CPC that increases heat stress, impairs vision, restricts mobility, and reduces dexterity. Understanding how to rescue oneself and others will reduce stress and enhance safety.

Time Allocated: 1.5 Hour

Method of Instruction: Lecture

Terminal Learning Objective:

At the conclusion of this chapter, the participant will be able to list the types and causes of Suit emergencies that can occur when wearing Chemical Protective Clothing (CPC), describe the types of rescues which may be needed, the types of persons who may need rescue and explain the concept of Buddy System as it relates to an entry and back-up team.

Enabling Objectives:

A. Identify the types of in-suit emergencies that can occur
B. List the common methods used to prevent in-suit emergencies
C. Define the term Buddy System and describe how it relates to a hazmat emergency response
D. List the elements of a rescue plan
E. Describe the difference between the rescue of a responder vs the rescue of a non-responder

Instructional Resources Required:

1. Student Notebook
2. Projection system for PowerPoint (or other similar program)
3. Alternate: Overhead projection with Overhead Slides
4. Dry erase, paper chart and or chalk board with appropriate markers

Instructional Resources Recommended:

1. The technical data package for the CPC being used

Instructor to Student Ratio: 1:40

References:

1. Title 8 CCR 5192/1910.120
2. NFPA 1991, Standard on Vapor-Protective Ensembles for Hazardous Materials Emergencies, 2005 Edition
3. Street Smart Haz Mat Response, Michael Callan, Red Hat Publishing Co., 2001
4. NFPA 1992, Standard on Liquid Splash Ensembles and Clothing for Hazardous Materials Emergencies, 2005 Edition
5. NFPA 1994, Standard on Protective Ensembles for First Responders to CBRN Terrorism Incidents, 2007 Edition
6. NFPA 1999, Standard on Protective Clothing for Emergency Medical Operations, 2008 Edition
7. Chemical Protective Clothing, Second Edition, Daniel Anna, AIHA Press, 2003
8. Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities, NIOSH/OSHA/USCG/EPA, October 1985
9. NFPA 472 Standard for Competence of Responders to Hazardous Materials/Weapons of Mass Destruction Incidents, 2008 Edition

Practical Exercise: None

Evaluation Strategy:

Participants will complete a written examination at the conclusion of the class.

In-Suit Emergencies

Emergency response personnel face many hazards when operating in chemical protective clothing (CPC). Some hazards are environmental hazards, while others relate to the inherent hazard of CPC. Response personnel must enter hostile environments that may include hazardous atmospheres, adverse weather, darkness, trip and fall hazards, confined spaces, etc. To make matters worse, we enter these hostile environments wearing heavy CPC that increases heat stress, impairs vision, restricts mobility, and reduces dexterity.

Careful planning is required to reduce possibility of injury to response personnel. Potential hazards must be identified and procedures developed to handle in-suit emergencies. Once procedures are developed, all personnel must be trained on the procedures to ensure the safety of response personnel. In this chapter, we will look at some of the causes of in-suit emergencies and procedures for dealing with these emergencies.

Types of In-Suit Emergencies

Heat stress is one of the most common in-suit injuries encountered by response personnel. Other in-suit injuries can include cardiac problems, respiratory problems, running out of air, chemical exposures, burns, and injuries from trips, falls, or falling objects. The best way to deal with these emergencies is by taking steps to prevent them.

Medical monitoring prior to entry may identify personnel at risk of injury. If there is a high potential for heat stress, measures should be taken to reduce work load and limit work time. Entry operations should be stepped off prior to entry to try to increase efficiency and reduce exposure time. Entry team personnel should be briefed on all hazards in the exclusion zone (e.g., chemical hazards, trip and fall hazards, electrical hazards, and confined spaces). The entry team leader must take steps to ensure PPE selected will provide the highest degree of safety. (Remember that monitoring instruments are a component of PPE.) Unfortunately, even with the best of planning, preventive measures cannot completely prevent in-suit emergencies from occurring. For that reason, procedures must be in place to deal with in-suit emergencies.

Buddy System

Anytime an entry is made into the exclusion zone, the buddy system must be followed. This means that a minimum of two people must make entry. Buddies should watch out for each other and keep in close visual contact. They should constantly monitor each other and watch for signs of fatigue or heat stress. If a team member is showing signs of fatigue or appears to be disoriented, the entry team should leave the exclusion zone immediately.

Buddy system, Cont.

One entry team member should be assigned most of the tasks to be accomplished, while the other entry person should act primarily as a safety/radio person and watch for hazards. If more one person is needed to carry out the tasks, additional personnel should be assigned to the entry team.

If an entry team member goes down, the buddy must immediately alert the entry team leader. If it appears that the team member went down due to a chemical exposure from permeation of material through the suit, his or her buddy should notify the entry team leader and proceed to decon immediately. If it appears that the team member went down due to other causes, his or her buddy should notify the entry team leader and stay with the down entry team member and render aid until the backup team arrives, unless advised otherwise by the entry team leader.

Backup Team

Establishing a backup team is one of the most important steps toward dealing with in-suit emergencies. The backup team must be in place and ready to go at a moment's notice to rescue a down entry team member. The backup team should work with the entry team leader to develop a plan on how to rescue entry team members should they go down. This rescue plan should be discussed at the pre-entry briefing. All equipment necessary to carry out the rescue plan should be in place prior to entry by the entry team. Backup team members must remain focused on their primary objective - to rescue the entry team. OSHA has specified a minimum 2 in 2 out as their back-up requirement. Ideally, there should be at least one person on the backup team for every person on the entry team. However, if it is determined that more personnel will be needed to effect a rescue, additional personnel should be assigned to the backup team.

Communication Systems

Radios are generally the best form of communications for entry personnel. However, experience has shown that radios are not always reliable. There are many factors that can affect radio performance at hazmat emergencies. Concrete buildings, electrical interference, high humidity inside Level A suits, and loud background noise can all render radios useless. For this reason, backup communication systems must be in

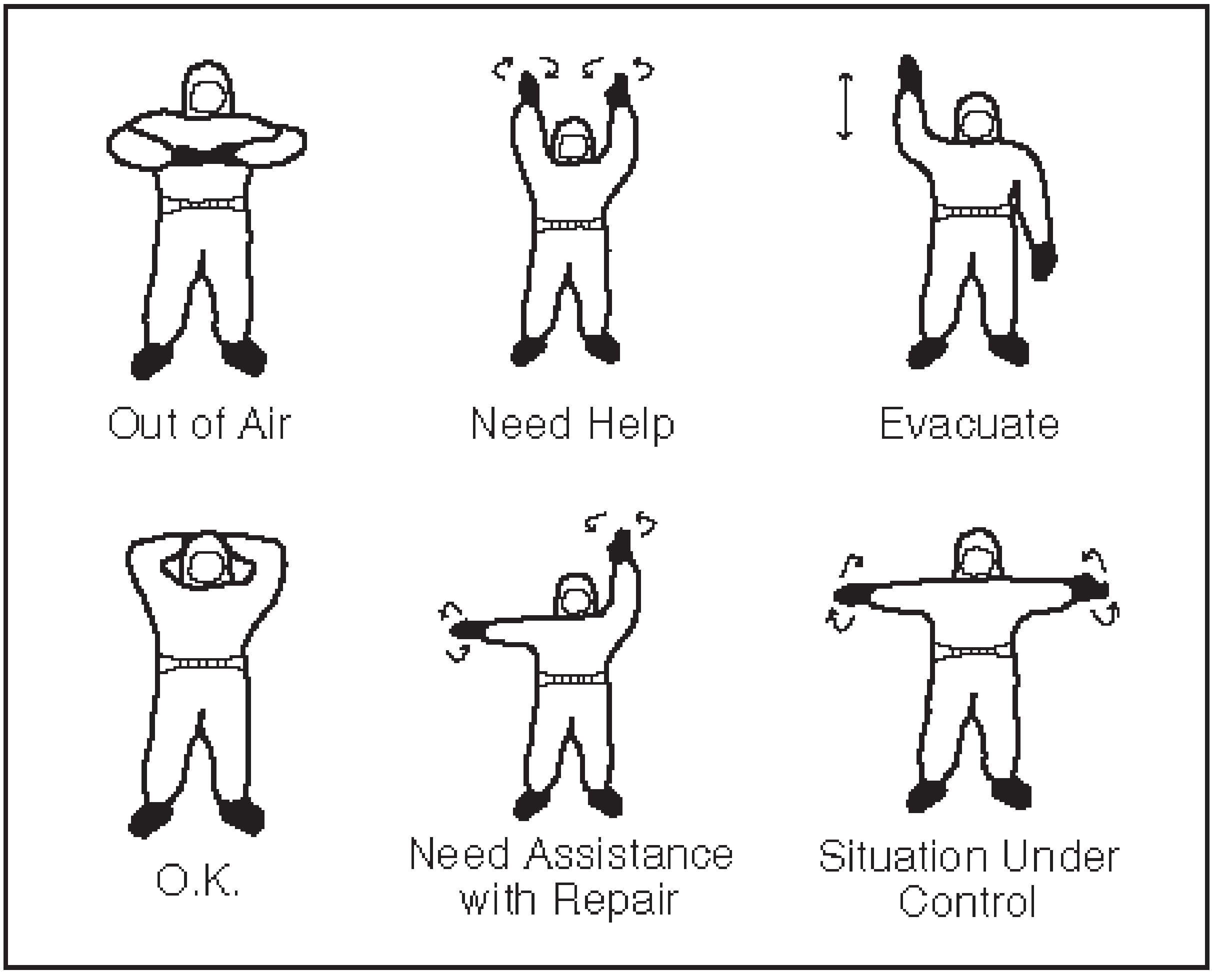
Place to ensure the safety of entry personnel. Forms of backup communications include things such as hand signals, white boards, safety line (OATH), and emergency signals.

Hand signals are an excellent form of backup communication, but to be effective, line of sight must be maintained and the hand signals must be known and agreed upon. (Recommended hand signals are included on the following page.) In loud environments, entry team personnel can communicate by writing on a clipboard-sized white board. A lifeline can be a good form of secondary communications if personnel are trained to use the "rope OATH" (O = OK, A = Advance, T = Take Up, H = Help). A lifeline is also an excellent safety device in situations where it may be possible for entry team members to

Communication Systems, Cont.

Become lost or disoriented. An emergency signal (such as three loud blasts on an air horn) should always be identified to notify personnel to evacuate due to imminent danger.

Figure 3.1: Emergency Hand Signals



Escape Plan

Prior to entry, the entry team should discuss an emergency escape plan. If there is an in-suit emergency, entry personnel are usually advised to proceed to decon or to the safe refuge area.

A secondary means of egress should also be identified whenever possible. The secondary egress would be used if the primary egress became blocked or unusable. A full decon is not usually required at the secondary exit point, but a means for emergency decon should be in place. Entry personnel should be briefed as to the location and route of travel to the secondary exit point. An emergency signal should be established to notify entry personnel that they should proceed to the secondary exit point.

CPC Selection

When selecting PPE, it is important to select the appropriate level of protection for the hazards to be encountered. Keep in mind that Level A protective clothing will not always provide the highest degree of safety. In fact, in many cases, placing personnel in Level A protection may be detrimental to personnel safety.

When selecting CPC, select a suit that fits properly to permit ease of movement. Level A suits should be loose enough that wearers can pull an arm out of the sleeve to check the regulator, clear the face shield, remove a mask, etc. Entry personnel should check each other to see that CPC is properly donned prior to entering the exclusion zone.

Reduced Profile

In an emergency, response personnel may need to use reduced profile techniques to escape through a tight or small opening. The idea is to make oneself as “skinny” and agile as possible within the confines of an encapsulating suit by removing the SCBA backpack assembly. The responder must first pull one arm out of the suit sleeve, slip that arm out of the SCBA shoulder harness, and then rotate the air bottle to one side. He or she can then escape from a smaller opening than would otherwise be possible, maneuvering the SCBA as needed within the suit. Note: Reduced profile techniques are designed for emergency escape and should not be used to *enter* an area unless there are extreme circumstances.

Water/Liquid Emergencies

If entry personnel become immersed in water or other liquids (e.g., from falling into a swimming pool), it’s important not to panic. CPC will float. In fact, Level A suits float very well. And most SCBA will continue operate for a limited time in shallow water.

If entry personnel fall into a pool of water or another liquid, they should float and paddle to a location where they can safely escape. Once out of the liquid, they should leave the exclusion zone immediately.

SCBA Emergencies

Responders must know how to react properly when a problem occurs with the SCBA. There are some “fixes” you can do inside of a suit when problems are minor. However, these fixes are very limited.
If there is a problem with your breathing apparatus, you should plan on leaving the contaminated area immediately. If you are working with a single partner, that person should exit with you. No one should be working alone in a potentially hazardous atmosphere.

Many of the problems you may experience will require you to adjust the SCBA in some manner. Fortunately, most suits will allow you to remove your hand from the outer glove and pull your arm in through the suit to make any necessary adjustments. You should practice this so that you can do it easily if you need to.

Red tag and make sure that a malfunctioning SCBA is placed out of service until it can be repaired.

Insufficient Air Supply

The SCBA is equipped with a warning bell that will activate when the unit has approximately five minutes of air remaining. Proper planning by the entry team leader includes making sure that personnel have time to exit the exclusion zone and complete decon before running out of air. However, should you hear this bell go off, leave the contaminated area immediately, taking your partner with you.

If you run out of air before completing decon, you can remove your mask while still inside a Level A suit and breathe suit air. There is sufficient air inside the suit to support your breathing for a limited amount of time. (However, if the suit has been damaged for some reason and there's a possibility of a contaminant inside the suit, you will not want to breathe suit air. Decon personnel must have a backup plan to quickly get you out of the suit and provide fresh air.) If you're wearing a Level B suit with the SCBA on the outside, decon personnel can provide you with a fresh bottle so that you do not have to remove your mask until decon is complete.

Although responders generally rely on assistants to help them get in and out of their suits, personnel should routinely practice opening their own suits for emergency purposes. This isn't easy to do with gloves on. However, it can be made easier by attaching a cord or strap to the suit zipper.

Problems with the Pressure-Demand Valve

If there's a problem with the pressure-demand valve, open the red emergency bypass valve. Immediately leave the contaminated area, taking your partner with you. (Note: This is the only time you should ever use the emergency bypass valve in a Level A suit. Using the bypass valve can over-pressurize the suit and damage your eardrums.)

Free Flow of Air Supply

If the unit is free flowing, you will notice air blowing into the facepiece and out of the exhalation valve. Use the cylinder valve to control airflow, turning it off and on as required to provide sufficient air supply. Immediately leave the contaminated area, taking your partner with you.

Damaged Facepiece or Breathing Tube

If your facepiece or breathing tube becomes damaged, immediately leave the contaminated area, taking your partner with you. Realize that if something has happened to cause damage to the facepiece or breathing tube, it may have caused damage to your suit as well. You could be accidentally exposed to a hazardous atmosphere. Advise the entry team leader so that he or she can take any appropriate follow-up actions.

Rescue Considerations

Rescuing an entry team member is very different from rescuing a civilian or a responder who is not in chemical protective equipment. Both require pre-planning and equipment, however the entry team member has a measure of protection which allows decontamination to be carried out in a Responder Decon setting. Civilians and other non-suited personnel, which we will call victims, require a separate decontamination and treatment area which is designed to prevent exposure and contamination of unprotected skin. Responder Decontamination stations should be designed with an adjoining victim decontamination station in the event of an unforeseen rescue or suit breech.

Rescue of a Victim in the Exclusion Zone

Before starting any rescue operation, response personnel must assess the situation and take appropriate precautions for their own safety. These precautions should all be listed in the agency's SOPs/SOGs, and practiced on a regular basis. The first step is just to determine the probability of patient survival. This is the risk analysis or "risk versus gain" portion of the decision-making process. There is no reason to risk the safety of response personnel for a body recovery. However, keep in mind that it is generally not possible to make a positive determination of death from a distance; that usually requires a close-up patient assessment.

A quick assessment of patient survivability can be done by directing the "walking wounded" to a refuge area for decontamination. This immediately distinguishes the

Victims who can walk from those who cannot, with minimal risk to the rescuers. The next step is to develop a rescue plan to move the non-ambulatory patients to an appropriate area of refuge or decontamination. Careful assessment of the scene is essential. What are the hazards to response personnel? Can the victim be rescued successfully, or is this a body retrieval operation? How many victims are there? What is the availability of backup? It will be necessary to triage multiple victims in order to do the greatest good for the largest number.

Rescue of a Victim in the Exclusion Zone, Cont.

The mechanism of injury or exposure will also give an indication of patient survivability. The health effects of the materials must be considered as well. STEL and IDLH values

will be significant in determining the patient's chances of survival. Other values, such as TLV-TWA, TLV-C, PEL, and Lethal Dose or Lethal Concentration, may also be helpful.

Some form of decon must be established prior to (or during) an emergency rescue effort. Emergency Decontamination is generally the first consideration, and since time may not permit setting up an elaborate contamination reduction corridor (CRC) due to toxicity or life safety, Emergency Decon may be an adequate life saving measure.

Proper personal protective equipment (PPE) must be used. If the chemical identity is unknown, response personnel must use the maximum level of protection for the given situation. The physical state of the material will also dictate the level of protection needed. While Level A is the highest level of protection, it most likely will not be needed for an unknown solid, however, it may be needed for an unknown gas.

A HazMat Specialist, Technical Reference or a designated responder who is skilled at CPC selection, will know their resources and reference materials well enough to make solid, accurate decisions. The more proficient a responder is at selecting CPC the faster the selection process will be. Accuracy in the details and knowledge of what is available will reduce the need to guess which CPC will work and reduce the risk by selecting CPC that fits the need.

Personnel must use the "Buddy System" for any rescue. This is a two-person entry. No one goes in alone. A backup team must also be identified. This backup team is to be used for rescue of the entry team only, not for mitigation.

All members should be familiar with the communication system in use. The teams should have a dedicated radio channel and backup hand signals.

EMS personnel should be on scene and thoroughly briefed prior to a rescue. They should notify the local receiving hospital and get treatment protocols from the Poison Control Center.

Equipment must be prepared for the rescue and should provide for both victim (non-suited) and responder (suited) patients. A stokes litter, Sked or a backboard should be provided. The stokes is preferred. Rope, hauling equipment, shears, ground cover and other miscellaneous equipment should be included as needed. Only a minimal amount of medical equipment should be brought into the exclusion (hot) zone. A cervical collar should be used if C-spine injuries are suspected. Maintaining the airway is probably the only other medical care that might be provided in the exclusion zone.

Rescue of a Victim in the Exclusion Zone, Cont.

The use of oxygen in the exclusion zone is generally not recommended since it could react with the contaminant. However, it is possible to provide a patient with fresh air through an escape SCBA, buddy-breather, full SCBA, or a supplied air respirator (SAR). Response teams will need to establish local policies for rescue operations.
It's important to remember that any equipment brought into the exclusion zone may have to be discarded (or decontaminated) once it is contaminated.

All personnel must be thoroughly briefed as to their responsibilities prior to entry. This includes a review of the site safety plan and the hazardous materials data sheet(s).

The entry team should minimize their contact with the patient and the contaminant in the exclusion zone. They should look for any obvious injuries that need immediate or special attention as they approach the patient. Again, C-spine precautions and maintaining an open airway are generally the only measures that will be taken in the exclusion zone. The patient should be taken to the decon area as quickly as possible.

Table 3.1: Elements to Consider for Exclusion Zone Rescue

Elements to Consider For HazMat Exclusion Zone Rescue		
Subject	**Sub-Issues or Concepts**	**Notes**
1.Rescue Personnel	First-In Rescue: FRO in Turn-outs Victim (non-responder) Rescue: HM Team in CPC Entry Team Rescue: Back-up Team (Designated back-up team or using Decon personnel)	
2. Training (Pre-incident)	Rescue Systems – Lifting RIT SOP/SOGs	Train on equipment available for use
2 (a) Practice	Life sized and weighted Skills matching (identify good teams), practice SOPs	Handling Issues Decon Compatibility with non-ambulatory equipment
3. SOP/SOGs	A. Go- and No-Go: Who makes the call, what are the criteria B. Training Requirements: ID Mandatory vs voluntary C. Transportation Methods: Mechanical Advantage Preferred D. First Aid: Permitted in exclusion zone? Decon? E. Lifting and Carry: Require Mechanical Advantage F. Hospital Notification and preferences	
4. Risk VS Gain Assessment	CPC compatibility with chemical involved, Sufficient Air? Life Safety of the victim vs life safety of the rescuers Evaluating victims in the exclusion zone Body Recovery: No-Go until it is safe and Coroner Approved	
5. Safety Equipment	Rescue gear to protect team and victim/patient	Hard Hat Ropes Gloves Linkages Eye Protection Pulleys Patient air supply (escape)
6. Pt. Packaging Equipment	Stretchers -- Pole, Body Bag, Sked – Stokes – Scoop	Chemical Resistant and ability to decon, self - supporting
7. Pt. Transportation Equipment Methods	Wheels – Stokes/Gurney Slide (Sked) Rope Tow System	Chemical Resistant and ability to decon. Single system or detachable.
8. Decontamination Process	Begin with emergency decon in life threatening situations. A. Rescue Team: Responder Decon/ Emergency Decon B. Patient: Ambulatory: Emergency and Precautionary Decon C. Rescue Non-Ambulatory/Emergency Response Personnel	
9. Spotter	Has eyes on the Rescue Team and Reports progress. In direct Communications with Entry Leader and Decon Leader.	
10. Rescue Plan	In an emergency, the initial plan may be verbal; however, it must be captured in some written form. Suggest check-off sheet with an area to list objectives and rescue sequence.	

Injured Hazmat Member in the Exclusion Zone

One of the worst situations that response personnel can encounter is an injury to a member of the hazmat team. Aside from the obvious delay in mitigating the incident, injury to a team member affects all response personnel on an emotional level. Proper preplanning and training are essential to improving survival when decisions need to be made quickly.

Key Planning Questions should include (but are not limited to):

1. Risk Vs. Gain

2. Is this a *relatively* safe situation where the greatest risk to response personnel is heat exhaustion or heat stroke from working in chemical protective clothing?

3. What is the potential for a much more involved rescue? (Escalating chemical danger?)

4. Is the cause mechanical (broken ankle), chemical in the suit or bad air?

5. What other resources will be needed? High angle rescue from a rail car? Confined Space?

6. Can the back-up team handle the victim or does it require more personnel? (Decon)

Rescue equipment should be assembled prior to any entry into the exclusion zone. A Sked, backboard or stokes litter is recommended for removing an injured team member to help maintain C-Spine precautions, however, backboards and litters are difficult to carry and may not easily accommodate someone wearing SCBA. The backup team may need to improvise depending on the conditions. SCBA should not be removed until after decon efforts are complete if contamination is suspected. Skeds are good for moving a non-ambulatory patient from point A to point B, but are not self-supporting when spanning a decon pool.

If a hazmat team member is injured, his/her “buddy” should evaluate the mechanism of injury. If the injury appears to be due to permeation of the chemical through the suit, the uninjured team member should notify the Entry Team Leader as they leave the exclusion zone, go to the refuge area, and advise the backup team of the danger. The backup team should then perform the rescue. If chemical permeation does not appear to be the cause, the uninjured team member should stand by and offer whatever assistance is possible until the arrival of the backup team, then leave the exclusion zone, go to the refuge area (exclusion zone), and await instructions.

Injured Hazmat Member in the Exclusion Zone, Cont.

Rescue techniques, such as lifting a non-ambulatory team member, in CPC, into a stokes or changing their position in the stokes; transferring a victim from a contaminated backboard to a clean backboard; or simply loading a patient or victim on to a board, lifting in unison and then carrying them several hundred feet (without them sliding off or dropping them) requires practice and pre-panning. Are two persons sufficient, or three. Are four required for safety? Practice and experience are the best way to find out.

Hazmat Mass Casualty Incidents

A mass casualty incident involving hazardous materials will require many of the same procedures as any other mass casualty incident. Arriving units may be faced with multiple ambulatory patients who need assessment/Decon and the possibility of multiple rescues, at the same time. Resources will be thin or non-existent and decisions must be made quickly. The priority is life safety; however, an assessment must be made to determine if performing rescue for injured/contaminated victims will save more lives than mitigating the hazard, which is creating the incident and possibly injuring more people.

It is anticipated that responding units will divide into two groups, a mass rescue group and a hazard mitigation group. This will accomplish both objectives, provided the resources are available. One possible resource is the California National Guard Civil Support Team's: CERF-P. This team will bring personnel trained in Level-C rescue, triage, decon and security (to name a few). It requires approximately 8 hours of lead time and is requested by the Civil Support Team (CST) Commander. The CST is requested through the State Warning Center.

Depending on the location, it may also be necessary to rescue persons who are sheltered in place. A little creativity is often required to deal with the conditions present. Preplanning is the key to success.

Summary

Perhaps the most difficult hazardous materials incident is one that involves the rescue of injured persons. Rescue must be implemented quickly to give the victim a better chance of survival. However, jumping into a situation too quickly, without adequate planning and precautions, may jeopardize the safety of response personnel. Whether this is a single victim, a mass casualty incident, or an injured team member, the same basic guidelines will apply. Response personnel must assess the situation to determine patient survivability, don proper protective equipment, prepare needed rescue equipment, plan out the rescue in advance, and brief all personnel on the plan.

4

Chapter Four

Chapter 4: **Decontamination**

Overview:

In this chapter we will look at the issues pertaining to decontamination (decon). The purpose of decontamination is to prevent the spread of contamination.

Time Allocated: 1-2 Hours, Course dependent

Method of Instruction: Interactive Lecture

Terminal Learning Objective:

At the conclusion of this class the participant will be able to assess a given situation, determine the type of decontamination system required and discuss the variables which affect the design, staffing and equipping of the decontamination area.

Enabling Objectives:

A. List the types of decontamination
B. List the components of a Contamination Reduction Corridor (CRC)
C. List the considerations used when designing a CRC
D. Name the titles of the Decontamination Team and describe their duties
E. Describe Mass Decon and how it differs from conventional types of Decon
F. Name two types of Mass Decon and describe the differences

Instructional Resources Required:

1. Student Notebook
2. Projection system for PowerPoint (or other similar program)
3. Dry erase, paper chart and or chalk board with appropriate markers
4. One copy of the ICS Field Operations Guide (FOG) or similar document

Instructional Resources Recommended:

1. One copy state or federal version of 29 CFR 1910.120 (q)

Instructor to Student Ratio: 1:40, class 1:15 for Practical component

References:

1. FIRESCOPE Field Operations Guide, Updated 2011
2. Title 8 CCR 5192/1910.120
3. Decontamination for Hazardous Materials Emergencies, Henry, Tim; Delmar Publishers 1999
4. NFPA 472, Competence of Responders to Hazardous Materials Incidents (2008 Ed)
5. Guideline for the Decontamination of Chemical Protective Clothing and Equipment, AIHA, 2005
6. Agricultural, Chemical and Petroleum Industry Terrorism Handbook, DOJ/FBI, 2010
7. Emergency Care for Hazardous Materials Exposure, 3rd. Ed., Currance and Bronstein; Elsevier-Mosby Publishers, 2005
8. Occupational Safety and Health Guideance Manual for Hazardous Waste Site Activities, NIOSH/OSHA/USCG/EPA, US Department of Health and Human Services, October 1985

Practical Exercise: Under the supervision of instructional staff, participants will establish a three pool responder decon corridor with a gross decon and functional water system. Five volunteers will staff the decon in Level-B CPC, while two volunteers in Level-A CPC will function as an entry team returning from the exclusion zone.
A full, wet decontamination exercise will follow, under the direction of the Instructor Cadre & Staff. Live feed-back and a de-briefing will conclude this exercise.

Evaluation Strategy:

Participants will complete a written examination at the conclusion of the class.

Decontamination

In this chapter we will look at the issues pertaining to decontamination (decon). The purpose of decontamination is to prevent the spread of contamination. Whether it is carried on shoes, dripping off a suit or evaporating into the air, a well planned and organized decontamination procedure will protect responders, the public and the environment.

All participants in this class will have some knowledge of decontamination from their First Responder Operation class, a prerequisite to this class. This chapter will focus on the skills required of Hazmat Technicians in selecting the right suits, equipment and decontamination station design for a given chemical hazard.

The three most important reasons for decontaminating exposed victims are:

1. Removing the agent from the victim's skin and clothing, thereby reducing further possible agent exposure and further effects upon victims.

2. Protecting emergency responders and medical personnel from secondary transfer exposures.

3. Providing victims and responders with psychological comfort at, or near, the incident site, so as to prevent them from spreading contamination over greater areas.

Decontamination Awareness

A good rule of thumb is to plan for decontamination at all hazardous materials incidents. The level and type of Decon will be dependent on the chemical/substances state, concentration and toxicity. The key is that Decon must be considered at all incidents. The take-away on this is to document that *the need for Decon* was evaluated and the results were entered into the official report.

Basic Decontamination Concepts

There are several methods and types of De-con to be considered and applied in the field:

Gross The process of removing heavy visible contaminants generally using copious amounts of water, wet media or dry media.

Discarding The process of removing and disposing of contaminated clothing and equipment.

Basic Decontamination Concepts, Cont.

Dilution	The use of copious amounts of water, soap and water, or a specific decon solution to flush off or dilute the contaminants.
Absorption	The use of an absorbing material to trap and hold contaminants.
Neutralization	Chemically altering the contaminant to an innocuous or less harmful state.

Generally speaking, discarding and dilution are the preferred methods of removing contaminants. These methods are easy to implement, effective and relatively inexpensive. Water for dilution is generally plentiful at an emergency scene.

Types of Decontamination

There are five generally recognized types of decon, six including "Mass Decon":

Emergency Decon refers to decon that is urgent and field expedient. Most often it is performed on response, or civilian, personnel who have had a direct exposure to hazardous chemicals and who may or may not be displaying related symptoms.

Emergency Decontamination is performed as a life saving procedure. Environmental concerns and modesty are secondary when dealing with life-threatening injuries/exposures.

However, Emergency Decon may be followed by **Precautionary Decontamination** if deemed necessary by local protocol, the Hazmat team, and/or the Poison Control Center.

It should be noted not all incidents require Emergency Decontamination, however, all incidents should plan for it.

If victims will not be harmed by a delay in Decon, Precautionary Decontamination may be established to protect modesty and insure the decontamination process is effective and complete.

Precautionary Decontamination, Cont.

Precautionary Decontamination, generally refers to decontamination provided to responders and civilians who are displaying related symptoms and have been through emergency decon. It may also be appropriate for those who may have been exposed to hazardous chemicals, but are not displaying any related symptoms of exposure. With Precautionary Decontamination there is time to contain runoff water and provide for modesty. This level of decon may involve the use of tents, trailers, tarps, containment basins and/or showers. Precautionary Decon is generally too time-consuming for victims with immediate life-threatening injuries/exposures and should follow Emergency Decontamination.

Responder Decontamination refers to that form of decontamination which is provided to personnel working in the Exclusion Zone or the Contamination Reduction Zone at a Hazmat or WMD event. This generally includes Hazmat Entry and Decontamination Teams working in Level A or Level B protective clothing, but may include Law Enforcement Force Protection Squads and EMS personnel working in Level C chemical protective clothing.

Exhibit 4.1 A typical multi-pool corridor, established to thoroughly decon all personnel, equipment, and materials used.

Note: *When decontaminating victims at an incident it is generally not acceptable to put them through the same procedures used for responders in Chemical Protective clothing.*

Directed Self Decontamination Cases where the victims are conscious, alert and ambulatory and are be directed to disrobe to the appropriate level and wash themselves whether in an Emergency or Precautionary Decontamination process.

Respiratory Decon is provided to persons who have had an inhalation exposure to a chemical, which is toxic, but poses little or no risk of secondary contamination to rescue and EMS personnel. It may include the administration of oxygen. Bulky clothing capable of trapping gas should be removed outdoors prior to turning the victim over to medical personnel.

Equipment Decon refers to the cleaning of equipment so that it can be returned to service, whether at the scene or following later off site.

NFPA 472 addresses:
Emergency Decontamination (as listed above);
Gross Decontamination (for suited and non-suited personnel);
Emergency Decon;
Mass Decontamination: (as listed below)
And
Technical Decontamination (Responder and possibly Precautionary Decontamination).

Contamination Reduction Corridor Components

The Contamination Reduction Corridor (CRC) connects the Exclusion Zone via the Hot Line with the Support Zone (via the Support Line) as an exit point from the contaminated area. The shape and configuration will vary based on the terrain and physical layout of the site.

The ideal or model diagram involves three concentric circles to make up the Exclusion Zone at the core, the Contamination Reduction Zone (CRZ) in the center and the Support Zone as the outer circle. The CRC connects the Exclusion Zone to the Support Zone in a straight line. Within the CRC is the Decontamination station or area, most often referred to as simply, *Decon*.

Outside of Decon, but within the Exclusion Zone is the **Refuge Area**. This area is designed to be a holding area for contaminated persons, awaiting entry into decon. It can be a safety area for taking refuge from downrange dangers and it can be a holding area for entry teams waiting to exit through Decon.

Inside the CRZ is the **Safe Refuge Area**. This area is usually used for staging decontaminated persons for medical evaluation or holding persons who have no known exposure or contamination.
The *Safe Refuge Area* may be dual purposed with a corridor from Decon and a corridor into the exclusion zone, making it functional for quick bottle changes and reentry of the exclusion zone.

There is no hard and fast rule on how to set up Decon. The regulations require that the IC "implement appropriate decontamination procedures". The EPA has *provided recommendations* on how a Decon should be set up and the teaching model uses those recommendations.

There are *no written, hard and fast rules, governing how Decon must be set up; only guidelines.*

For the contaminate removal process, still in the Exclusion Zone:

A ***Gross Decon*** can be set up in the Exclusion Zone to allow returning entrants to remove gross contamination. Containers such as an over-boot drop, over-glove drop, equipment drop and a pool or capture area for a gross wash down (hose or Hudson type sprayers) or an initial dry decon with disposable chemical compatible wipes. There should be a protective tarp under this area and it should extend to the Decon Entry Point to prevent runoff and contamination of the ground.

For the contaminate removal process, in the CRZ --CRC:

1. One Tarp or salvage cover, large enough to hold all the elements listed below and roll (or berm) the edges to prevent liquid from leaving the protective surface.
2. One Boot Wash Tub at the entrance to the first pool
3. One or more (up to as many as 4) Decontamination Pools (to capture the contaminated water)
4. One suit brush and one sprayer for each pool, non-slip mats and support posts are recommended
5. One boot brush for each pool
6. One hose connection for each sprayer (unless using Hudson type sprayers, then one per pool)
7. One bucket per pool for decontamination solution mixtures and an applicator (soft brush or sponge)
8. Small bucket(s), wipe materials and repackaging supplies for samples, based on the agency specific decontamination protocols for forensic or non-forensic samples
9. A pre-arranged procedure for removing contaminates and moving from pool to pool
10. Lined Drums for the capture of contaminated knee pads, boot covers, outer gloves and other items.
11. An Area just outside the last Decon Pool for checking the effectiveness of the decon process

For the contaminate removal process, in the CRZ –CRC, Cont.

12. A dividing line separating the Decon area into clean and dirty sides.
13. A set aside area for extra Clean/Full SCBA bottles and one for contaminated empties

Clean Side Options

A. One VERY stable low platform (dry wall bench) or stool for each entrant
B. One plastic bag to receive the recently decontaminated suit, boots, inner gloves and possibly the SCBA mask. (drum liners work well)
C. The entrant's shoes should be staged behind them for ease of access once the CPC is removed.
D. Lined Drums or containers for the bagged equipment
E. Shade as needed
F. A pre-arranged procedure for doffing equipment

The rehabilitation area should be in close proximity to the Decon exit.

Note: There is a procedure which involves the rapid turn-around of the entry team, either for re-entry, or to move into back-up status. In either case, the entrant is decontaminated but the suit is not completely removed. One common name for this technique is "Hot Swap". This procedure can be dangerous if it is not properly planned and executed. Check with your hazmat safety and/or training officer for more information.

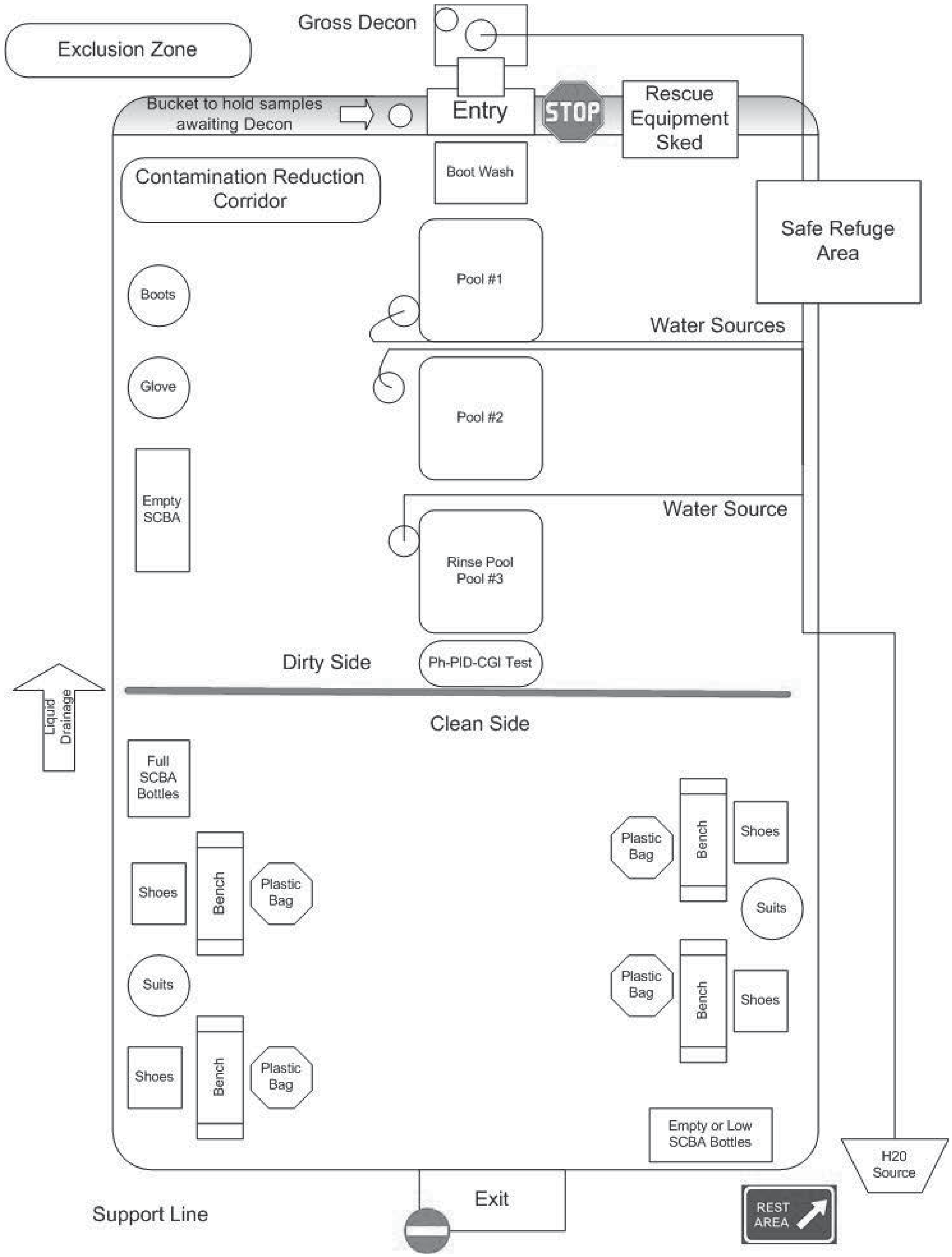
Communication is critical during a Decontamination operation. In an ideal world, the Decon Team Leader stands outside the Decon and communicates with the team processing incoming contaminated personnel.

The Decon Team Leader is in close communication with the Entry Team Leader and Assistant Safety Officer in order to insure that the Decon team is performing as expected, the Entry Team (being decontaminated) is following directions and to make any needed corrections in the process.
It is recommended that the Decon Team Leader brief the Entry Team Leader, and preferably, the whole Entry and Back-up Teams in the procedure to be used for decontamination. Issues to discuss include: what to do when the low air alarm sounds, where to place equipment for reuse (or cleaning), how to handle samples, how to indicate distress and site specific cautions (uneven ground, slip/trip hazards and etc.), steps taken to conduct Decon procedures (Tapping a shoulder or a boot to indicate the person being Decon'd should turn ¼ turn or lift that boot up, etc.). A dry walkthrough has been found to be helpful.

Sample Decon is the process of preparing a sample, generally taken from the exclusion zone, for transport out of the CRZ and to one of a variety of locations. Depending on why the sample was taken (forensic, hazard categorization, archival and etc.) it must be cleaned and/or repackaged before leaving the decon area. Often this involves triple bagging the sample; however the process will be based on the agencies requirements and laboratory protocols. In some cases, the team's HM Specialist, Technical Reference will request a sample in order to perform a chemical analysis, and the sample container may need minimal decontamination.

The key is to contain the contaminate and safely remove it from the responder.

Illustration 4.1: Sample of a Model Responder Decon Layout, on the following page:


Exclusion Zone
Gross Decon
Bucket to hold samples awaiting Decon
Entry
STOP
Rescue Equipment Sked
Contamination Reduction Corridor
Boot Wash
Safe Refuge Area
Boots
Pool #1
Water Sources
Glove
Pool #2
Empty SCBA
Water Source
Rinse Pool Pool #3
Dirty Side
Ph-PID-CGI Test
Liquid Drainage
Clean Side
Full SCBA Bottles
Plastic Bag
Bench
Shoes
Suits
Empty or Low SCBA Bottles
H20 Source
Exit
Support Line
REST AREA

Emergency Decontamination

Exposure vs. Contamination

Exposure: "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.) (29CFR1910.1200)
You were within immediate proximity to the contaminate, but it didn't touch you.

Contamination: A hazardous substance that has come in contact with the human body or equipment and physically remains on the surface or within body cavities. There can also be risk of secondary contamination to others through direct contact with the exposed surfaces or contaminated discharge from the victim.
The contaminate physical touched you, or entered your body.

Secondary Contamination is contamination from a person or object that is not the primary source.
You got it on your CPC, then carried it past the Decon corridor to someone/something else.

General Guidelines for Emergency Decontamination

Emergency Decon can range from using a garden hose to wash someone down, to a high volume, low pressure wash-down in a pre-planned section of a formal decon lay-out set aside for this purpose. It can be a two-stage decontamination process which consists of a soap-and-water scrub and rinse. Exposure to the eyes will involve flushing for 15 minutes or longer.

Emergency decontamination may be performed by persons certified at the First Responder level and that training may be enhanced by FRO Decontamination training.

The first and most important consideration is for the safety of the emergency response personnel. The proper use of personal protective clothing and SCBA, along with a pre-established decon site, will greatly reduce the hazards associated with emergency decontamination. Structural firefighting clothing is not designed or recommended for working in hazardous chemical environments, and should be avoided when possible.

Those responders that have limited training or equipment should follow basic First Responder actions. If the victims are ambulatory and symptomatic, they may require emergency decontamination to lessen symptoms or buy them time until a formal decontamination station can be established.

General Guidelines for Emergency Decontamination, Cont.

The risk of secondary contamination to rescue personnel, medical personnel on scene and at the hospital, other citizens, and transport vehicles and equipment must be adequately assessed and protected against. *Contaminated patients shall not be placed in transport vehicles or transported to medical facilities unless the transport crew is trained and equipped to handle the contamination.*

Related Versus Unrelated Symptoms

Determining the appropriate type of decontamination is dependent on whether or not patients are exhibiting symptoms of exposure.

If a patient is symptomatic, the symptoms can be classified as either:
Related symptoms (Those which are expected or anticipated following exposure to the chemical)
OR
Unrelated symptoms (When someone may be experiencing symptoms which are **not** known to be associated with exposure to the chemical are referred to as.
These can be identified by consulting appropriate reference sources and/or the Poison Control Center.

Example:
Related symptoms for organophosphate exposure include nausea, vomiting, diarrhea, excessive salivation, and blurred vision. **Unrelated symptoms** might be burned skin, bleeding from the nose or eyes, and dilated pupils.

Note that under Title 8 CCR 342 (b) OSHA requires all serious illnesses or fatalities of persons in the course of their employment to be reported to OSHA by the responding agency. Failure to do so will result in adverse OSHA actions (citations).

Responder Decontamination

Responder Decontamination is designed to protect emergency response personnel who have made entry into the exclusion zone or staffed the Decon. It is configured for personnel in CPC who may or may not have been contaminated during the course of their entry.

Factors That Can Affect the Decontamination Process

Each jurisdiction should have standard decontamination procedures, and all personnel should be thoroughly trained to carry out their responsibilities. However, the decontamination process must have enough flexibility to respond to specific hazards or

Factors That Can Affect the Decontamination Process, Cont.

Conditions on scene. Factors that can affect the decontamination process include: number of victims, amount of contamination, chemical hazards and physical state,

Contact time, temperature and weather conditions, water supply, personnel and equipment.

Setting Up the Contamination Reduction Corridor

The Contamination Reduction Zone and the Contamination Reduction Corridor should be located upwind and upgrade from the Exclusion Zone. The CRC must be established in a location that is safe to work in initially without SCBA or specialized chemical protective clothing. The boundaries of the CRC should be marked off with specific entry and exit points. Barricade tape, delineators, cones or natural barriers may be utilized.

A number of resources are needed for decontamination procedures:

- **Personnel.** Usually a minimum of three people will be needed to perform adequate decontamination, one of whom should fill the ICS position of Decon Leader. One person should do the initial washing and scrubbing. The second person should rinse and assist with removing clothing/outer garments. The number of personnel required is dependent on availability and sophistication of personnel training and resources.

- **Water** will almost always be required in the Contamination Reduction Corridor (CRC). The Contamination Reduction Zone should have access to a booster line from an engine or truck.

- **Decontamination solutions and supplies.** Copious amounts of water, Mild soap (Baby Shampoo, for example), and soft bristle brushes will generally deal effectively with almost any chemical likely to be encountered. For solutions other than mild soap and water, the Tech-Ref and/or other Specialist(s) will need to be consulted.

- **Dry Decontamination** will be appropriate in situations where the chemical contamination is reactive to the solvent being used (generally water). Dry Decon may incorporate the use of whisk brooms, HEPA vacuums and contaminate compatible wipes.

- **SCBAs or umbilical air supplies** are usually required for the Entry Team. Spare air bottles should be available in the decon area so that no one is allowed to run out of air before the decon process is complete.

Decontamination resources and procedures, Cont.

- **Protective clothing.** The level of protective clothing worn by the Decon Team should be determined by Hazmat Specialist, Technical Reference or the person assigned Tech/Ref responsibility. In most cases, the level of protective clothing for the Decon Team does not have to be as great as it does for the Entry Team. Exceptions might arise when extremely hazardous materials are present.

- **Electricity or generators** may be needed to operate equipment, heaters and lights.

- **Miscellaneous tools**, shelters, water heaters, brushes, brooms, wands, sponges, sprayers, towels, tarps, buckets, bags, liners, horns, chairs or stools, and some form of catch basin or pools may be needed. SOPs should contain a thorough list of equipment used at each station within the Contamination Reduction Corridor.

Additional Considerations

Environmental Concerns. The Environmental Protection Agency (EPA) has addressed the issues of acceptable levels of contamination in runoff and first responder liability for the spread of contamination caused by efforts to save lives.
Additionally, the EPA recognizes that any level of contamination represents a threat to the environment. The threat is also dependent on variables including the involved chemicals, their concentrations, and the runoff watershed.

Disposal of Contaminated Materials

Items such as clothing and tools which are not completely decontaminated on site should be secured in the appropriate containers (drums with liners or double-bagged) and labeled prior to being removed from the site. Wash and rinse solutions used for decon should be tested for possible contaminants, and rendered as safe as possible, prior to disposal.

Determining the Effectiveness of Decontamination

Some symptoms of exposure do not become apparent for weeks, months or years. Some chemicals accumulate in the body and tend to weaken it over time. Some combine with other substances in the body and become even more toxic. Many cause cancers and respiratory problems later in life. For this reason, immediate and continued medical monitoring should be done for contaminated persons.

Prevention of Further Contamination

Minimizing contact with potential contaminants is essential to keep the incident from escalating. The following guidelines should be utilized:

- Avoid unnecessary contact with potentially hazardous substances. Personnel should not touch or walk through areas of obvious contamination if it can be avoided.
- Use remote sampling devices with long handles.
- Protect monitoring and sampling instruments by bagging or wrapping.
- Wear disposable outer garments and use disposable equipment when possible.
- Place all discarded contaminated equipment in a designated area.
- Contain all rinse water until tested (when possible).
- Have the Contamination Reduction Zone in place prior to personnel entering the Exclusion Zone.
- Minimize contact time with contaminants.
- Establish drop-off pads or tables in the exclusion zone for equipment that may need to be reused or are staging for decontamination or disposal.

- **Physical and chemical properties of hazardous materials.** The very properties that make a chemical more hazardous also make it more difficult to decon. The more hazardous the chemical properties, the more involved the decontamination process may be.

- **The amount and location of contamination.** If contaminants are located on or near the face, there is a greater likelihood of harm due to inhalation or ingestion. If a product is located in other body cavities, folds, nails or hair, there is greater likelihood of absorption or permeation into the body. For this reason it is normally recommended to start decontamination with the head and then work down.

  Eyes, ears, nose, mouth, hair, armpits, etc., need to be thoroughly decontaminated. Open wounds also need to be completely irrigated.

  For CPC, preplanning signals by the entry team to indicate the most contaminated areas on their CPC will help the decon team focus on those areas of highest risk. On Level-A suits, pay attention to the zippers, as low air may necessitate opening the suit before the decon process is complete.

- **Contact time and temperature.** The longer a contaminant is in contact with an object, the greater the probability and extent of permeation/penetration or degradation. Minimize exposure time whenever possible.

- **Level of protection and work function.** The level of suit (A, B or C), the type of suit material, whether the suit is disposable or not, and the number of pieces to the suit are all-important factors that need to be considered in developing SOPs for decon.

Level of protection and work function, Cont.

The likelihood of contamination is also related to the specific work function. For example, a person who enters the Exclusion Zone to stop a high flow leak is more likely to become contaminated than a person conducting recon, taking samples, or transferring product.

- **Reason for leaving the hazard site.** Personnel leaving the Exclusion Zone to pick up or drop off tools may need little or no decon. People with life-threatening medical emergencies may need very rapid emergency decontamination.

Mass Decontamination

Mass Decontamination refers to the need to decontaminate a number of victims quickly and efficiently. Rapid physical removal of a chemical agent from the victim is the single most important action associated with effective mass decontamination. Physical removal includes scraping or blotting off visible agent from the skin, disrobing, using adsorbents to soak up the agent, and flushing or showering with large quantities of soap and water. After a chemical exposure, vapor or aerosol hazards still may be present, especially if the chemical was disseminated within an enclosed structure. Potentially toxic levels of chemical agent vapor may be trapped inside clothes and can continue to affect people even after they leave the incident site.

The most important aspect of decontamination is the timely and effective removal of the agent. The precise methods used to remove the agent are not nearly as important as the speed by which the agent is removed.

The two principal methods of Mass Decontamination are:
Emergency Wash Down of Victims, (Containment of run off is not controlled due to the shear numbers of people who are symptomatic and in need of an immediate water wash down);
Or
Planned Mass Decon, (Facilities are established to capture run off, assure proper decontamination and afford a measure of privacy).
Planned Mass Decon can include mobile decon trailers, portable tanks and tent cities (CERF-P) with Triage, Medical, Decon, Redress and Transportation capabilities.

Decontamination must be conducted as soon as possible to save lives. Since they can bring large amounts of water to bear, the most expedient approach is to use currently

Methods of Mass Decontamination, Cont.

Available equipment to provide an emergency low-pressure deluge (1 3/4” to 2 1/2” hose at low pressure).
The following forms of water-based decontamination should be considered:

- Water alone. Flushing or showering uses shear force and dilution to physically remove chemical agents from skin. Water alone is an excellent decontamination solution. Using a formula of “30-30-30” will aid in the rapid and effective decon of large numbers of people. 30 PSI, 30 GPM, at a 30% Fog Nozzle setting.

- Soap and water. By adding soap, a marginal improvement in results can be achieved by ionic degradation of the chemical agent. One disadvantage is having sufficient quantities on hand.

- Bleach and water. Bleach (sodium hypochlorite) and water solutions remove, hydrolyze, and neutralize most chemical agents. While a dilute solution of bleach and water is appropriate for materials, tools, and equipment, it is NOT to be used on people, service animals, etc.

Decontamination Procedures

Decontamination by removing clothes and flushing or showering with water is the most expedient and the most practical method for mass casualty decontamination. Disrobing and showering meets all the purposes and principles of decontamination. Showering is recommended whenever liquid transfer from clothing to skin is suspected. Disrobing should occur prior to showering for chemical agents; however, the decision to disrobe should be made by the Incident Commander based upon the situation.

Occupational Safety & Health Administration (OSHA) standard for a chemical accident (high-volume, low-pressure) is the recommended “default standard.”

Decontamination Approaches

Ladder Pipe Decontamination System. To provide a large capacity shower of high-volume, low-pressure water spray, one proposed method is to employ a Ladder Pipe Decontamination System (LDS). Ladder pipes, wagon pipes, monitor nozzles, and 2 1/2” fog nozzles attached to pump dischargers and other fire apparatus (i.e., fire engines or trucks) are positioned strategically to create decon corridors for large quantities of exposed people to travel through. Once the decon corridor has been formed, the objective is to spray water from every feasible direction.

Ladder Pipe Decontamination System, Cont.

A single ladder Pipe decontamination system is comprised of two engines (also creating the corridor) that provide water spray from both sides using hose lines and deck guns, while the ladder pipe provides a high-volume, low-pressure flow from above.

Multiple ladder pipe decontamination systems employ more than one ladder pipe in order to increase the decon corridor length to accommodate extremely large groups of victims.
Multiple corridors can be established for ambulatory or non-ambulatory victims; victims are woven through multiple overhead sprays.

Exhibit 4.2: Suspected anthrax incident decontamination corridor, Palm Desert 1999

Engine Corridor

Position two engine companies approximately 20 feet apart to form a decontamination corridor between the apparatus. Use the 30-30-30 rule of water flow as a guide for maximum discharges.

Exhibit 4.3: The Emergency Decontamination Engine Corridor System.

Other Field-Expedient Water Decontamination Methods. Emergency responders should not overlook existing facilities when identifying means for rapid decontamination methods. As a last resort alternative, having victims wade and wash in water sources, such as public fountains, chlorinated swimming pools, swimming areas, opening fire sprinklers, etc., provides an effective, high-volume decontamination technique.

Prioritizing Casualties for Decontamination

Triage is the medical process of prioritizing treatment urgency within a large group of victims. The number of apparent victims from a chemical agent terrorist incident, agricultural pesticide, or industrial accident, may exceed emergency responders' capabilities to effectively rescue, decontaminate, and treat victims, whether or not they have been exposed to a chemical agent. Responders, therefore, must prioritize victims for receiving decontamination, treatment, and medical evacuation, while providing the greatest benefit for the greatest number.

Although many emergency response services prepare for such incidents, few are currently capable of treating victims inside the Exclusion Zone. Therefore, whenever large numbers of victims are involved, it is recommended that they be sorted into ambulatory and non-ambulatory triage categories. Prioritization for decontamination can effectively be performed in a manner that will maximize treatment while minimizing the number of emergency responders exposed to chemical agent.

Definition of Ambulatory and Non-Ambulatory Casualties

Non-Ambulatory Casualties: Victims who are unconscious, unresponsive, or unable to move unassisted. These victims may be more seriously injured than ambulatory victims and will remain in place while further prioritization for decontamination occurs. It is recommended that prioritization of non-ambulatory victims for decontamination should be done using medical triage systems, such as START (Simple Triage and Rapid Treatment/Transport).

Ambulatory Casualties. Victims able to understand directions, talk, and walk unassisted. Most ambulatory victims are triaged as minimal (green tag/ribbon or Priority 3) unless severe signs/symptoms are present.

Ambulatory Casualties, Cont.

These casualties should be directed to move upwind into an assembly area within the Contamination Reduction Zone where they can be prioritized for decontamination by on-site responders. Factors that are recommended for determining the highest priority for ambulatory victim decontamination are highlighted.

The highest priority for ambulatory decontamination are those casualties who were **closest to the point of release and report they were exposed to an aerosol or mist, have some evidence of liquid deposition on clothing or skin or have serious medical symptoms (e.g., shortness of breath, chest tightness, etc).**

Factors That Determine Highest Priority for Ambulatory Victim Decontamination

- Casualties closest to the point of release
- Casualties reporting exposure to vapor or aerosol
- Casualties with evidence of liquid deposition on clothing or skin
- Casualties with serious medical symptoms (shortness of breath, chest tightness, etc.)
- Casualties with conventional injuries

Casualty Processing

If sufficient resources exist, two mass casualty decontamination systems should be established: one for ambulatory victims and one for non-ambulatory victims. ***If available resources are only sufficient for a single system, ambulatory victims triaged as immediate are higher priority than the non-ambulatory victims triaged as immediate***. Due to the complex nature of some of these casualties (i.e., mixed chemical and conventional casualties), the medical triage and decontamination teams should work closely together to maximize their collective sorting and management of casualties.

Recommendations

The most imperative principle of mass casualty decontamination is the timely physical removal of the agent from the skin of the victim. To support this, the following should be conducted:

- Decontaminate victims as soon as possible.

Recommendations, Cont.

- Consider disrobing as part of decontamination, head-to-toe, the more removal the better.

- Flushing with water generally is the best mass decontamination method.

Several equipment configurations are possible and have been described. The fundamental goal is to use pumping capability to set up showers as quickly as possible and get people disrobed, into, and through the showers, before further chemical agent effects can occur. It is not advisable to delay the decontamination process while obtaining soaps or other decontamination materials. If immediately available, such materials may be of benefit, but it is more important to begin decontamination as soon as possible.

Decontamination prior to leaving the Exclusion and Contamination Reduction Zones is essential for protecting people in the Support Zone. Emergency responders should expect at least a 5:1 ratio of unaffected to affected casualties expecting emergency care and decontamination.

Summary

Decontamination prevents victims, response personnel and equipment from spreading the contaminant beyond the Exclusion Zone. When it is safe to do a planned decontamination on victims, it allows the responder to address issues like cultural sensitivity, modesty and language. Decontamination should be tailored to the specific hazards presented to responders. Safety of responders and the public should always be the number one goal.

5

Chapter Five

Chapter 05: Respiratory Protection

Overview: Respiratory protection is the component of Personal Protective Equipment which is designed to prevent the inhalation and ingestion of hazardous levels of chemicals in the form of a vapor, gas or dust particle. This chapter introduces the participant to the regulations which require a Respiratory Protection program, some of the elements of that program and focuses on the types of respiratory protection and their use.

Time Allocated: 1 Hour

Method of Instruction: Lecture

Terminal Learning Objective:

At the conclusion of this section the participant will be able to list the regulations governing the use and selection of respiratory protective equipment, the major classifications of equipment and then describe the function, elements and limitations of the four principal types of respiratory protection equipment.

Enabling Objectives:

A. Describe the regulations governing the use and selection of respiratory protection
B. List the general classifications of respiratory protective equipment and describe each type
C. Describe the restrictions for each type of respiratory protection
D. Describe the selection process used to determine the appropriate respiratory protection

Instructional Resources Required:

1. Student Notebook
2. Projection system for PowerPoint (or other similar program)
3. Alternate: Overhead projection with Overhead Slides
4. Dry erase, paper chart and or chalk board with appropriate markers

Instructional Resources Recommended:

1. One each of the following for demonstration:

    a. Air Purifying Respirator (Half Face)
    b. Air Purifying Respirator (Full Face)
    c. Powered Air Purifying Respirator
    d. Self Contained Breathing Apparatus – Tank, Backpack and Mask
    e. Supplied Air Respirator
    f. Escape SCBA
    g. Closed Circuit (rebreather) Respirator

Instructor to Student Ratio: 1:40

References:

1. Title 8 CCR 5192/29CFR1910.120 and Title 8 CCR 5144/29CFR1910.134
2. NIOSH Respirator Selection Logic, 2004, Department of Health and Human Services
3. NFPA 472, Competence of Responders to Hazardous Materials Incidents (2008 Ed)
4. NIOSH Fact Sheet #183, 2011, CBRN Self Contained Breathing Apparatus
5. Respiratory Protection, Notes, Regulations and Lecture, 3M Corporation, Fourth Edition
6. OSHA CPL 02-01-050, 2011, Enforcement Guidance for Personal Protective Equipment in General Industry
7. OSHA CPL 2-2.54A, 7/2000, Respiratory Protection Program Guidelines

Practical Exercise: None

Evaluation Strategy:

Participants will complete a written examination at the conclusion of the class.

Respiratory Protection

This chapter provides an overview of three types of equipment: self-contained breathing apparatus, supplied-air respirators, and air purifying respirators. Although the chapter goes into some detail on the capabilities of each device, how and when to use them, and what to do if you experience a problem, it's vital that you be familiar with the particular respiratory protection equipment available to you in your department.

Introduction

A wide variety of chemicals exist that can damage the respiratory system. The type of respiratory protection needed is determined through an assessment of the chemical present, or potentially present and the damage it can cause to the human body. Choosing the correct respirator can protect the eyes, respiratory tract and some mucous membranes from gases, liquids, vapors, fumes and dusts. In many cases, OSHA requires the use of respiratory protection under Title 8 CCR 5144 and Title 8 CCR 5192 in known and suspected chemical environments. NIOSH establishes the industry standard for respiratory protection and many NIOSH standards are incorporated into law by reference. OSHA defines an unknown atmosphere as IDLH, which requires the highest level of respiratory protection.

Respiratory Protection is required for:

- High Levels of Toxic Materials
- Oxygen Deficient Atmospheres
- Radiation and Nuisance Dust Protection
- Bloodborne Pathogen/Biological Protection
- Unknown Atmospheres
- Regulatory Compliance

OSHA requires all employers who provide their employees respiratory protection to have a Respiratory Protection Program. The Respiratory Protection Program is found in Title 8 of the California Code of Regulations (CCR) Section 5144. This regulation provides a wide variety of information which includes establishment of plans, training, equipment selection and medical monitoring. These plans are different from employer to employer, based on equipment types, the need for protection and other factors. This chapter will highlight specific areas of importance from the Respiratory Protection Regulation and other critical documents.

The first step OSHA requires is to attempt to resolve the issue in the following order:
1. Administrative Controls -- Respiratory Protection Program, Plans, Avoidance
2. Engineering Controls – Mechanical methods, Scrubbers, Fans
3. Personal Protective Equipment -- Respirators – Gloves – Chemical Protective Suits

OSHA Defines IDLH (5192) as:

An atmospheric concentration of any toxic, corrosive, or asphyxiant substance that poses an immediate threat to life or would interfere with an individual's ability to escape from a dangerous atmosphere. (5144 adds "would cause irreversible adverse health effects")

Other regulations, which contain requirements for Respiratory Protection, include:

1.	8CCR5192	(29CFR1910.120)	HazWoper
2.	8CCR5144	(29CFR1910.134)	Resp. Protection
3.	8CCR5193	(29CFR1910.1030)	Bloodborne Pathogens
4.	8CCR3204	(29CFR1910.32)	Medical Records
5.	8CCR3401	(29CFR1910.132)	Fire Fighter Equip.
6.	8CCR5157	(29CFR1910.146)	Confined Space
7.	8CCR3203	No Federal Program	Injury and Illness Prevention Plan

Respiratory Protection

Equipment designed to protect the responder from atmospheric contaminates can be placed into one of two types, as determined by their function. Those that supply Grade D air from a separate source, such as a tank and those that filter the air. In general they are classified as:

IDLH or Atmospheric Supplying Respirators

- Self Contained Breathing Apparatus (SCBA)
- Air Line Respirators (SAR)
- Escape SCBA
- Re-Breather (Scrubs impurities, re-oxygenates and returns exhaled air)

Non-IDLH Air Purifying Respirators

- Full Face (Negative pressure)
- Powered Air Purifying (Positive Pressure)
- Systems -- Quarter Mask and Half Masks fall into this category but are almost never used in emergency response.

Atmosphere Supplying Respirators / SCBA

Atmosphere supplying respirators or self-contained breathing apparatus (SCBA or SAR) must be used when the contaminant is unknown. They provide a substitute source of clean air. Open-circuit SCBA are the most commonly used protective breathing apparatus. The air supply in open-circuit systems is compressed air. Exhaled air is vented to the outside atmosphere.

There are four basic components to SCBA:

- The backpack and harness assembly
- The air cylinder assembly - includes cylinder, valve, and pressure gauge
- The regulator assembly - includes high-pressure hose and low-pressure alarm
- Facepiece assembly - includes low-pressure hose (breathing tube), exhalation valve (for SCBA with harness-mounted regulator), and head harness

Other components may include:

- Built in PASS unit
- Heads-up Display in the mask
- Silent signals (light system or vibration) vs. bell or whistle for low air
- Integrated microphone and/or ear piece
- SCBA to APR Switchover

Backpack and Harness Assembly

The backpack assembly is designed to hold the air cylinder on the back as comfortably and secure as possible. Adjustable harness straps provide a secure fit for whatever size the individual requires. The waist straps are designed to help properly distribute the weight of the cylinder or pack.

Air Cylinder Assembly

Air cylinders come in different sizes and with a variety of high-pressure hose connections. Because the cylinder must be strong enough to safely contain the high pressure of compressed air, it constitutes the main weight of the breathing apparatus.

Low pressure tanks (<2216 psi) are being used in training and industry whereas high pressure tanks (<4,500 psi>) tend to be found in emergency response and Fire Service. Depending on the use, tanks can be ordered as 15 minute, 45 minute, 60 minute and even as high as 75 minute (new 5,500 psi tank from Scott).

When full, a 2216 psi 30-minute cylinder ranges from 9.6 pounds for a composite cylinder to 23.8 pounds for a steel cylinder. On the average, composite cylinders weigh about 16 pounds while steel and aluminum cylinders weight about 20 pounds. Lightweight aluminum and combination fiberglass-wrapped aluminum cylinders are the most common cylinder types, and are 10 percent stronger than steel.

Fully charged, the typical 30-minute cylinder contains 45 cubic feet of breathing air at 2216 psi. Cylinders rated for 60 minutes contain 88 cubic feet of breathing air at 4500 psi.

Remember: The time rating of a tank (cylinder or bottle) is an estimate. Responders use air at a rate unique to the individual. In most cases, particularly during periods of heavy exertion, the actual time to exhaust the tank will be less than the time the cylinder is rated for.

Regulator Assembly

Air from the cylinder travels through the high-pressure hose to the regulator. The regulator reduces the pressure of the cylinder air to slightly above atmospheric pressure and controls the flow of air to meet the respiratory requirements of the wearer. When the responder inhales, a partial vacuum is created in the regulator. The apparatus diaphragm moves inward, tilting the admission valve so that low-pressure air can flow into the facepiece. The diaphragm is then held open, which creates the positive pressure. Exhalation moves the diaphragm back to the closed position. Some SCBA units have regulators that fit into the facepiece. On other units, the regulator is on the chest or waist strap.

On most models, two external knobs, differing in color, shape, and location, control operating and emergency functions. These are the mainline valve and the bypass valve. During normal operation, the mainline valve is fully open and locked, if there is a lock. The bypass valve is closed. On some SCBA, the bypass valve controls a direct airline from the cylinder in the event that the regulator fails. Once the valves are set in their normal operating position, they should not be changed unless the emergency bypass valve is needed. On SARs, there is an emergency on/off valve located on top of the escape air cylinder. This valve is opened only in the event that the main air supply becomes interrupted. If this valve is opened, all persons must exit the work area to determine and fix the problems with the system.

A pressure gauge that shows the air pressure remaining in the cylinder is usually mounted on or near the regulator or on the high-pressure hose. On an SAR, the regulator is mounted at the air source and is monitored for the users by an attendant.

The regulator pressure gauge should read within 100 psi of the cylinder gauge. If increments are shown in other measurements, such as percents or fractions, both measurements should be the same. These pressure readings are most accurate at or near the upper range of the gauge’s rated working pressures. Low pressures in the cylinder may cause inconsistent readings between the cylinder and regulator gauges. If they are not consistent, rely on the lower reading and check the equipment for any needed repair before using it again. Most units have an audible alarm that sounds when the cylinder pressure decreases to a preset level of around 500 psi for low pressure tanks and 1,000 PSI for high pressure tanks, depending on the manufacturer. Teams should leave the area *immediately* when the first alarm sounds. On SARs, there are generally no alarms for low air at the user end. If any difficulty in breathing occurs, the user is to switch over to the escape bottle and exit immediately.

Face piece Assembly

The face piece assembly consists of the face piece lens, an exhalation valve, and if the regulator is separate, a low-pressure hose to carry the air from the regulator to the face piece. The face piece lens is made of clear safety plastic and is connected to a flexible rubber mask. The face piece is held snugly against the face by a head harness with adjustable straps, a net, or some other arrangement. The lens should be protected from scratches during use and storage. Some face pieces have a speech diaphragm to make communication easier.

The low-pressure hose brings air from the regulator into the face piece; therefore, it must be kept free of kinks and away from contact with abrasive surfaces.

Like the face piece, this hose is oil-resistant rubber, neoprene, silicone, or plastic resin, all of which are referred to generically as an *elastomer.*

The exhalation valve at the chin of the face piece is a simple, one-way valve that releases an exhaled breath without admitting any of the contaminated outside atmosphere. Dirt or foreign materials can cause the valve to become partially opened, which may permit the contaminated outside atmosphere to enter the face piece. Therefore, it is important that the valve be kept clean and free of foreign material. It is also important that the exhalation valve be tested by the responder during face piece-fit tests and before entering a hazardous atmosphere.

Many face piece assemblies include a breath deflector or nose cup. These simple devices help prevent the responders exhaled air from fogging the face piece.

Some face pieces include a system of colored LED lights in the upper right corner of the inside of the face piece. The LED lights indicate how much air is remaining in the tank using a manufacturer specific system. An example of this is a four light system where four red lights are aligned vertically.

When all four lights are illuminated, it means the tank is full (4,500 PSI), Three red lights is ¾ full, two lights are half full (2,250 PSI) and one red light is ¼ full (1,125 PSI). The interior lighting system may be in addition to an audible low pressure alarm and in special use system it may replace the audible low pressure alarm.

Supplied-Air Respirator (SAR)

Incidents involving hazardous materials or rescues often require a longer air supply than can be obtained from standard supplied-air respirators. In these situations, an airline attached to one or several large air cylinders can be connected to an open-circuit facepiece, regulator, and escape cylinder.

Supplied-Air Respirator (SAR), Cont.

Airline equipment enables the wearer to travel up to 300 feet from the regulated air supply source with the required auxiliary self-contained positive pressure air supply in the event of an unexpected loss of air. This type of respiratory protection enables the responder to work for several hours without the encumbrance of a backpack. If greater mobility is needed, the responder can also wear a standard SCBA with an airline option. The responder can then temporarily disconnect from the airline supply, using the SCBA to provide breathing air, and perform necessary tasks beyond the range of the airline equipment.

Be alert to the fact that compressed air traveling through long lines can build a static charge. Some precautions should be taken if the atmosphere is known to or is suspected of having flammable or explosive conditions.

The number and sizes of air cylinders used with airline equipment vary from several small bottles to large cascade-type cylinders. Air supply is available as long as there are spare full cylinders. All airline units should be capable of using more than one cylinder in order to provide a continuous air source to the wearer. A small 45-cubic-foot cylinder at 2216 psi is rated for 30 minutes. A large 240-cubic-foot cylinder at 2400 psi is rated for approximately 2 1/2 hours. The smallest cylinders are rated for 5 minutes and are to be used only for escape purposes.

Small SCBA cylinders are easily and readily transported, but have a limited capacity and require frequent changing. (A small cylinder here refers to a 45-cubic-foot cylinder, not the 5-minute escape cylinder used with some airline units.) The larger cylinders are difficult to maneuver in small spaces and may not be readily available, but they permit extended operations without cylinder changes.

Any airline respirator that is used in a hazardous atmosphere must be equipped with an auxiliary positive pressure self-contained air supply and be able provide enough breathing air for the wearer to escape in the event the airline is severed.

This requirement is usually accomplished by attaching the very small breathing cylinders, rated for 5 minutes, to the airline unit. Almost all airline units used in rescue situations will require an auxiliary self-contained air supply.
The 5-minute escape cylinders must not be disconnected from the air supply line for untethered work; they are for escape only! To perform untethered work, a 30- or 60-minute SCBA that can be augmented by an airline should be used.

Hazardous Materials response teams have had varying degrees of success using a supplied air respirator system for their decontamination team during extended operation with multiple entries.

The time a responder can work in an exclusion zone would not be limited by the air supply. It would be limited by heat stress, the number one cause of injury in hazmat response.

Exhibit 5.1: Sea Cliff Incident Decontamination Preparation Area and SAR 8 pack

Chemical Agent Permeation and Penetration Tests (Excerpt)

Chemical agent permeation and penetration tests assure that under specified laboratory conditions the materials used in the CBRN SCBA construction (face piece, valves, lens, hose, gaskets, etc.) resist chemical warfare agent (CWA) migration through the materials of the respirator assembly. Components and materials of a CBRN SCBA and other NIOSH-approved SCBA are different. Thus, only those components with exact part numbers shown on the full NIOSH CBRN SCBA approval label can be a component of the respirator assembly. Do not replace these components and materials with others that are not on the label even if they appear to be similar.

How to determine if an SCBA is NIOSH-approved for CBRN protection level?

There are three NIOSH labels for a CBRN SCBA:

1. NIOSH Respirator Approval Label provided in the manufacturer's user instructions or as an insert to the user instructions. This is a paper label.
2. SCBA harness label placed on the backframe carrier/harness assembly (adhesive label).

3. CBRN Agent Approved Label placed on the backframe carrier/harness assembly (adhesive label).

Note: See the continuation of this excerpt from the NIOSH bulletin in the supplemental section.

Air Quality

Table 5.1: Grade D Breathing Air

The air we breathe on a day to day basis is approximately 20.9 % Oxygen, 79% Nitrogen and .1 % mixed gasses. This is provided we do not have a smoggy day, stand down wind of a large brush fire or hazardous chemical spill. The quality of the air can vary from place to place and for that reason, NIOSH and OSHA have established grades of air for use in compressed gas systems. The box on the right describes the specifications for grade D Breathing air, which is used in SCBA and ALR systems. If you were going under water, your air would be Grade C in your SCUBA tank.

SCBA tanks are used and refilled as a regular part of their lifespan. SCBA tanks are filled by compressors which should be outfitted with a variety of sensors to detect Oxygen, Carbon Monoxide and Carbon Dioxide levels in the air being compressed. Departments and agencies should sample their SCBA tank air on a regular basis to assure the air meets the OSHA standard and is safe to breathe.

Grade D Breathing Air Specifications

The complete specifications are detailed in ANSI/Compressed Gas Association Commodity Specification for Air, G-7.1-1989, which include:

- Oxygen Content of 19.5-23.5%
- Hydrocarbon (condensed) content of 5 milligrams per cubic meter of air or less

On very rare occasions, an SCBA tank of air will be contaminated. The contamination is found either by periodic sampling or because a responder discovered it by breathing it! The danger is obvious, in that a responder in level-A CPC could experience a life threatening event while breathing bad air. While this type of incident is rare, it builds a strong case for the development of regular monitoring, early detection and prevention strategies.

While on the subject of air quality, it should be noted that in 1999, D. Alan Veasy and Kenneth Oldfield did a study called Measurements of Oxygen Concentration of Air Within Totally Encapsulating Chemical-Protective Suits.

In their conclusion, they make several important points. These points, summarized below, provide a common sense warning to all responders:

1. Loss of air supply in a TECP suit constitutes a major life threatening emergency
2. Agencies need SOP’s and rigorous SCBA maintenance programs
3. If air supply is lost, opening the TECP suit is not a reasonable response in many hazardous materials situations.
4. Responders using TECP suits must be trained to cope with the loss of air supply and the hazard of oxygen deficiency while in the hazard area.
5. Responders should immediately move toward a designated safe area while breathing air from inside the suit, but to remain on guard for symptoms of oxygen deficiency.
6. Further studies are required.

The key to this study is the estimation of remaining oxygen in a TECP suit after a designated amount of time. From the time a suit is closed (initial oxygen concentration at 21 percent) until the level of oxygen reaches IDLH, can be as little as 2 minutes. After approximately 8 minutes the oxygen concentration is less than 18.5%. A responder in a TECP suit, who experiences a loss of SCBA air, which requires breathing suit air, finds themselves in a dangerous situation.

According to the Department of Energy, (USDOE Potential Oxygen Deficiency while Wearing Air-Supplied Suits. S&H Note, Issue No. 96-1 (1996); they will experience the symptoms of oxygen deficiency within 40 seconds following the loss of air.

The loss of an air supply in the exclusion zone due to any cause is dangerous. Responders who practice and train on how to deal with the loss of their main air supply, will stand a better chance of survival than those who do not.

Closed Circuit Rebreather Systems

The SCBA and ALRs discussed above are classified as open circuit respirators. This means that air exhaled by the user is vented to the atmosphere. A closed circuit respirator provides air to the user and then captures and recycles that air when it is exhaled. The closed system removes the moisture, removes the CO_2, adds a percentage of pure oxygen, cools the air and then returns it to the user as clean air. This system has a long and successful history of use in the mining and marine industries.

Application to emergency response has been limited due to a number of factors. These issues include:

- Until recently, positive pressure demand was not available in a closed circuit unit. OSHA requires all hazmat response SCBAs (open and closed circuit) to be Positive Pressure Demand.
- The units require cooling during the scrubbing process and the use of ice or ice packs add weight to the unit.
- The unit requires extensive maintenance after use.
- The unit carries a small cylinder of pure oxygen.
- Two to four hour operating time provides long duration entries are possible.
- Long operating times raise heat stress considerations for first responders.
- Closed Circuit units are considerably more expensive than open circuit units.

Closed Circuit Rebreathers have many positive aspects which offer promising technology in the future. At present, the use of these units are limited and not frequently seen in fire service.

Air Purifying Respirators / APR

Air purifying respirators remove contaminants by passing breathing air through a purifying element. Air purifying respirators are further classified into two subclasses:

•Particulate air respirators that use a mechanical filter element to remove particulates.

•Gas and vapor respirators that use a chemical sorbent that reacts chemically to purify air.

There are two types of masks: half masks that cover just the nose and mouth and full-face masks that cover the eyes also. The EPA recommends full-face masks as a minimum level of protection. The basic components of an APR are the mask, a purifying element and an exhalation valve.

Powered Air Purifying Respirators (PAPR)

Powered Air Purifying Respirators (PAPRs) function the same as APRs except for a motor/filter unit that provides positive air flow over the face of the wearer. The motor/filter unit is usually worn on the lower back, and a low-pressure hose runs up to the mask or helmet. An advantage is that breathing is a little easier on the wearer due to the fact that the wearer does not have to suck air through the filter media. The criteria for wearing PAPRs is the same as it is for APRs.

Criteria for Using Air Purification Respirators:

Although air-purification respirators are useful for respiratory protection, there are use criteria that limits their use in emergency situations. In order to use them, the following criteria must be met:

- The respiratory hazard must be identified. This means that the identity of the contaminant(s) must be known.
- The respirator selected must be appropriate for the specific chemical state and physical form of the contaminant.
- Respirators used for protection against gases and vapors must be equipped with an end of service life indicator (ESLI) certified by NIOSH for the contaminant; or
- If there is no ESLI appropriate for the conditions in the workplace, then a change schedule for canisters and cartridges before the end of their service life must be implemented.
- The workplace must be evaluated to determine a reasonable estimate of the employee exposure, the concentration of product in air must be known; or
- If the employer cannot identify or reasonably estimate the exposure, the atmosphere shall be considered to be IDLH.
- The environment cannot be considered IDLH, this includes situations where the oxygen concentration is less than 19.5%. APRs cannot be used in IDLH atmospheres.

There are several sources to aid in the selection of appropriate respirators. These include the NIOSH Respirator Decision Logic, ANSI Respirator Standard Z88.2-1992, as well as the respirator manufactures published selection guides.

Medical Evaluations

To ensure the employee can safely wear respiratory protection, medical evaluations are required to be done by a physician or other licensed health care professional. These evaluations must be done using a specific questionnaire or an exam that will obtain the same information, before the employee is fit tested and required to use the respirator. The official OSHA Respirator Medical Evaluation Questionnaire can be found in 8CCR5144 Appendix C. You are permitted to obtain a copy of your exam at no cost (8CCR3204). Keeping your own copy is advised, in the event the originals are lost or not available.

Care and Cleaning of Respirators and SCBA: General Requirements

Any organization using respirators or SCBA on a routine basis should have a program for their care and cleaning. The purpose of such a program is to ensure that all respirators or SCBA are maintained at their original effectiveness.

If they are modified in any way, their protection factors may be voided. The program should be based on the number and types of respiratory equipment, working conditions, and hazards involved. The program should include inspection procedures (including a leak check), cleaning and disinfecting, repair, and storage.

Inspection of Respirators

Inspect respirators after each use. Respirators reserved for emergency use should be inspected prior to each use and have a detailed inspection on a monthly basis to ensure that they will perform satisfactorily. Thoroughly check all connections on respirators to ensure that gaskets and “O” rings are in place. Check for proper tightness. Check the condition of the face piece assembly, the connecting air tube and headbands. Inspect rubber or elastomer parts for pliability and signs of deterioration. Maintain a record for each respirator inspection. Each inspection record should include: inspection date, inspector’s name, and any unusual conditions or findings. Read the manufacturers instructions for more specific directions and inspection procedures.

Cleaning and Disinfecting of Respirators

Collect respirators at a central location. Brief employees required to wear respirators on cleaning and disinfecting procedures, and assure them that they will always receive a clean and sanitized respirator. Such assurances can boost morale. Clean and disinfect respirators as follows:

•Remove all cartridges, canisters, and filters, plus gaskets or seals not affixed to their seats.
•Remove elastic headbands.

Cleaning and Disinfecting of Respirators, Cont.

•Remove exhalation cover.

•Remove speaking diaphragm or speaking diaphragm-exhalation valve assembly.

•Remove inhalation valves.

•Wash face piece and breathing tube in a solution of cleaner/sanitizer powder mixed with
warm water, preferably at 120°F to 140°F.

•Wash components separately from the face piece, as necessary.

•Remove heavy soil from the surface with a hand brush.

•Remove all parts from the wash water and rinse twice in warm, clean water.

•Air dry parts in a designated clean area.

•Wipe facepieces, valves, and seat with a damp, lint-free cloth to remove any remaining soap or other foreign materials.

Note: *Most respirator manufacturers market their own cleaners/sanitizers as dry mixtures containing a bactericidal agent and a mild detergent. They are usually available in one-ounce packets for individual use and bulk packages for quantity use*.

Repairs

When respirators are found to be defective or fail an inspection, they must be removed from service, discarded or repaired before they can be used again. Repairs are completed by a brand trained and certified repair person using proper tools and replacement parts.

Never attempt to replace components or to make adjustments or repairs beyond the manufacturer’s recommendations. Installing parts from one brand of respirator on to another brand is not permitted. The only exception to this rule is the use of an SCBA cylinder of one brand, can be used on any other brand, as long as it fits. It may be necessary to send high-pressure-side components of SCBAs to an authorized facility for repairs.

Some parts, such as an O ring on an SCBA cylinder, can be replaced by the SCBA user. Keep a supply of these parts in stock. One damaged O ring can knock a complete SCBA out of service.

Storage

Follow manufacturers' storage instructions which are always furnished with new respirators or affixed to the lid of the carrying case. In addition, these general instructions may be helpful:

•After respirators have been inspected, cleaned and repaired, store them so as to protect against dust, excessive moisture, damaging chemicals, extreme temperatures and direct sunlight.

•Do not store respirators in clothes lockers, bench drawers or tool boxes. Either place them in wall compartments at work stations or in a work area designated for emergency equipment, or store them in the original cartons or carrying cases.

•Draw clean respirators from storage for each use. Each unit can be sealed in a plastic bag, placed in a separate box, and tagged for immediate use.

Summary

Response personnel will usually wear self-contained breathing apparatus at a hazmat incident because it's the most reliable and portable source of fresh air. It's important that responders know how to don and doff the units, as well as what to do if there is a problem with the SCBA. This chapter provided some general instructions. However, personnel must familiarize themselves with the specific units that they will be using at an incident.

This chapter also provided an overview of air purifying respirators and the criteria for their use. Although APR are commonly used for cleanup operations and are often used by industrial hygienists when the appropriate criteria are met, they are not often used during the emergency phase of an incident. Nonetheless, responders should have a basic awareness of APR and their potential role in mitigating hazmat emergencies.

Chapter Six

Chapter 6: Chemical Protective Clothing (CPC)

Overview: Emergency response personnel must be able to identify necessary levels of protection for entry into a hazardous atmosphere. To accomplish this, response personnel must thoroughly understand the selection criteria and equipment required for each level of protection.
Response personnel must develop and understand the many protocols necessary to support the use of CPC. Donning and doffing procedures must be established and practiced. In addition, protocols and procedures should be established for determining working time, personal use factors, medical monitoring, work tolerance, documentation, and step-off procedures. Training in the use of established procedures and protocols is the key to safety when using CPC.

Time Allocated: 2 Hours

Method of Instruction: Lecture and Demonstration

Terminal Learning Objective:

At the conclusion of this chapter the participant will understand the CPC available for Hazmat emergencies and be able to discuss the pro's and con's of each level.

Enabling Objectives:

A. The student will be able to list the regulations governing CPC use during Hazmat emergencies
B. List the levels of protective clothing
C. List the elements of each level of CPC and use/selection criteria
D. Discuss the precautionary issues pertaining to air use, cooling, maintenance and other issues
E. Describe work mission duration and how each element applies to the entry planning process
F. List the items to consider when selecting CPC

Instructional Resources Required:

1. Student Notebook
2. Projection system for PowerPoint (or other similar program)
3. Alternate: Overhead projection with Overhead Slides
4. Dry erase, paper chart and or chalk board with appropriate markers

Instructional Resources Recommended:

1. One box containing a Level-A Ensemble
2. One box containing a Level-B Ensemble
3. One box containing a Level-C Ensemble
4. One box containing a Level-D Ensemble
5. One box with additional items including:
    a. Sample: Air suit pass through valve
    b. Sample: Cool vest
    c. Sample: Radio communications
    d. Sample: Spectacle kit
    e. Sample: Emergency suit knife
    f. Sample: SCBA, PAPR and APR
    g. Sample: Fabric Types
    h. Flashlight

Instructor to Student Ratio: 1:40

References:

1. Title 8 CCR 5192/1910.120
2. NFPA 1991, Standard on Vapor-Protective Ensembles for Hazardous Materials Emergencies, 2005 Edition
3. NFPA 1992, Standard on Liquid Splash Ensembles and Clothing for Hazardous Materials Emergencies, 2005 Edition
4. NFPA 1994, Standard on Protective Ensembles for First Responders to CBRN Terrorism Incidents, 2007 Edition
5. NFPA 1999, Standard on Protective Clothing for Emergency Medical Operations, 2008 Edition
6. Chemical Protective Clothing, Second Edition, Daniel Anna, AIHA Press, 2003
7. Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities, NIOSH/OSHA/USCG/EPA, October 1985
8. Protecting Emergency Responders, Lessons Learned from Terrorist Attacks; Jackson, et. al. Rand Science and Technology Policy Institute, 2002
9. Hazardous Materials Response Handbook, Laughlin and Trebisacci, fourth edition, NFPA 2002

Practical Exercise: None

Evaluation Strategy:

Participants will complete a written examination at the conclusion of the class.

Chemical Protective Clothing

Chemical Protective Clothing (CPC) is the term for Personal Protective Ensembles (PPE) used to protect individuals from the chemical, physical, and biological hazards that may be encountered during hazardous materials operations. Engineers design CPC materials with a combination of layers of fabrics, films and coatings to protect against specific hazards. Welds, adhesives and fasteners are used to join the fabric parts and component attachments. No one CPC ensemble will protect against all hazards. CPC is engineered and tested to protect the wearer from specific hazards while performing in the work environment.

Chemical Protective Clothing features:

1. Fabric compatibility with specific Chemicals, Biological or Radioactive Materials
2. Base fabric or material (substrate)
3. Multiple layers of fabric and materials
4. Closure devices (Zipper) and seals
5. Single use vs. multiple use
6. NFPA Standards
7. Special function (Vapor Tight, Flash Protective, etc.)
8. Compatibility with other equipment (Tape, SCBA, Boots, and Gloves)

These features are part of the checklist the HazMat Technical Reference use to determine which CPC they should recommend for protection against a specific hazard. Selecting the Chemical Protective Clothing for an incident must be done carefully and accurately. The objective is to provide the entry and decontamination teams with CPC that protects them from the hazards and provides the flexibility to perform the work they were sent in to do. As you continue through the chapter, you will be provided with an in-depth understanding of the CPC selection process.

It is important to discuss the regulations and industry standards relating to CPC. OSHA regulations require the employer to provide the appropriate CPC. In the Emergency Response section of Title 8 CCR5192 OSHA states:

1. 5192(q)(3)(C) 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 PPE worn is appropriate for the hazards to be encountered. However, PPE shall meet, at a minimum, the criteria contained in Title 8 CCR3401-3408 when worn while performing firefighting operations beyond the incipient stage for any incident. *(Note: Sections 3401-3408 address article 10.1, Personal Protective Clothing and Equipment for Fire Fighters).*

Chemical Protective Clothing features, Cont.

2. 5192(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 subsections (g)(3) through (5) of this section.

   Item 2 refers to subsection (g)(3) – (5) which are sections titled: (3) Personal Protective Equipment Selection, (4) Totally-encapsulating chemical protective suits and (5) Personal protective equipment (PPE) program. Total-encapsulating chemical protective suits, as described in the OSHA regulation, are commonly referred to as Level-A Vapor Tight Suits.

Only Level A is described in detail in the regulations and is mandatory under specific conditions which we will discuss later in the chapter. For this text, PPE (Personal Protective Equipment) includes three elements: the chemical protective clothing (or suit ensemble), respiratory protection and air monitoring. PPE is the equipment, whereas CPC (Chemical Protective Clothing) addresses the ensemble without the respiratory protection or air monitoring; however, does include the suit, boots, and gloves.

Industry Standards for CPC are derived from the Federal Environmental Protection Agency, Occupational Safety and Health Administration (OSHA), National Fire Protection Association (NFPA) and the National Institute for Occupational Safety and Health (NIOSH) and the American National Standards Institute (ANSI).

These agencies/associations have established standards for CPC covering a wide range of issues. It is important to note that the standards they set establish which elements make up an ensemble and/or set the standard to which these elements must be manufactured to qualify for certification (or equivalency) under their standard. For example, the NFPA 1991, Standard on Vapor-Protective Ensembles for Hazardous Materials Emergencies include:

1. The chemicals and the duration of exposure must be subjected to, and the acceptable level of detection on the non-exposed side of the material.
2. Testing for Permeation Resistance
3. Flame Impingement Resistance
4. Cut Resistance
5. Puncture Resistance
6. Cold Weather Resistance

To be certified, manufacturers must receive written verification from a qualified third-party testing company (such as ASTM) that the components for use with a Vapor-Protective Ensemble have passed the NFPA 1991 tests standards.

Personal Protective Equipment (PPE) Program

The emergency response portions of the HazWOpER regulation (Title 8 CCR5192 and 29CFR1910.120) require the employer to establish a Personal Protective Equipment program. Under Title 8 CCR 5192(g)(5) (as required by 5192(q)(10)) that program is described below:
(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 subsection (b) of this section or required in subsection (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.

- (A) PPE selection based upon site hazards,
- (B) PPE use and limitations of the equipment,
- (C) Work mission duration,
- (D) PPE maintenance and storage,
- (E) PPE decontamination and disposal,
- (F) PPE training and proper fitting,
- (G) PPE donning and doffing procedures,
- (H) PPE inspection procedures prior to, during, and after use,
- (I) Evaluation of the effectiveness of the PPE program, and
- (J) Limitations during temperature extremes, heat stress, and other appropriate medical considerations.
- (K) Monitoring.

Some manufacturers make CPC that follow the NFPA standard but they do not certify the garment to the NFPA standard. Some manufacturers make CPC without addressing the NFPA standard. NFPA certification costs money and increases the price of the CPC and in some industrial settings, NFPA certification is not required.

A common question that is asked is “Are Company A’s suits (without NFPA certification) as good as Company B’s suit with NFPA certification? The answer is unknown (unless you test them) and it is up to the individual agency or department to determine which is best for them.

Note: most fire service and law enforcement agencies follow the NFPA standards for CPC.

Chemical Routes of Entry into a Suit

Understanding how a chemical can get into a suit will help you understand the designs and special modifications applied to CPC. There are three ways a hazard can enter CPC:

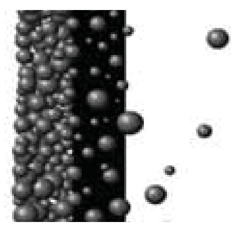
Permeation – a chemical moves through the material at the molecular level.

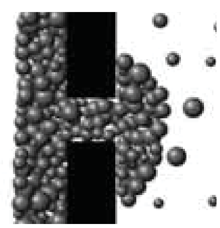
Penetration – a hazard enters the suit through openings, such as stitch holes, vents, or rips in the material or around the collar of non-vapor tight suits.

***Degradation* –** a chemical degrades (damage, melt, rot and etc) the suit material.

The possibility of chemical permeation or penetration of chemical protective clothing during the work mission is always a matter of concern. Possible causes of ensemble penetration are:

- Suit valve leaking, particularly under excessive hot or cold temperatures.
- Suit fastener leaking from the suit is not properly maintained or if the fasteners become brittle at cold temperatures.
- Exhalation valve leaking at excessively hot or cold temperatures.
- Small rips, tears, and pinhole leaks in the suit that were not discovered during inspections.
- Leaking around the face piece of the suit.


Permeation


Penetration


Degradation

NFPA Chemical Protective Clothing Standards

The NFPA Chemical Protective Clothing (CPC) standards specify *minimum* documentation, design criteria, performance criteria, and test methods for protective suits. When these NFPA standards are quoted as specifications in a typical purchase order, the manufacturer **must** provide a suit constructed in accordance with these standards. The suit must not only meet a uniform standard but must also be appropriate for the expected level of performance. These standards will provide the emergency responder with clear and precise definitions for various levels of chemical protective clothing and systems to be used by the fire service.

The NFPA standards for CPC are found in the following documents:

- NFPA 1991 — *Standard on Vapor-Protective Suits for Hazardous Chemical Emergencies, 2016 edition*
- NFPA 1992 — *Standard on Liquid Splash Ensembles and Clothing for Hazardous Materials Emergencies, 2018 edition*
- NFPA 1994 — *Standard on Protective Ensembles for First Responders to CBRN Terrorism Incidents, 2018 edition*
- NFPA 1999 — *Standard on Protective Clothing for Emergency Medical Operations, 2018 edition*

These standards include a strict set of tests and requirements that the suit must meet in order to earn NFPA approval. As indicated above, they can be used by a purchaser as a source for specifications when ordering these suits or garments.

The following pages will overview and discuss NFPA 1991, 1992 and 1994 standards. We will then address the levels of protection as found in the EPA/OSHA recommendations and individual issues such as work mission duration, suit cooling and personal use factors.

NFPA "Vapor-Protective Ensemble"

A "Vapor-Protective Ensemble" shall be designed to provide the highest level of protection available against vapors, gases, and liquids. The intent is that the suit be worn anytime the chemical is present at or above the IDLH concentration. SCBA should be worn on the inside of the suit.

To meet NFPA Standard #1991, the suit must pass a very rigid set of chemical *permeation* tests involving 21 specific chemicals, including anhydrous ammonia and chlorine gas, and any additional chemicals or specific chemical mixtures for which the manufacturer is certifying the suit. All parts of the suit, including the gloves, visor, boots, and seams, are subjected to all 21 chemicals. Permeation resistance shall not exceed normalized breakthrough times of one hour or less for each chemical in the ASTM F 1001, *Standard Guide for Chemicals to Evaluate Protective Clothing Materials*, test.

The suit must undergo a pressurization test to check for air-tight integrity. A water penetration test is used to ensure the suit provides full body protection against liquid splashes. Material testing for burst strength, tear strength, abrasion resistance, flammability resistance, flash fire protection, cold temperature performance, and flexural fatigue are required so that materials used for vapor-protective suits will afford adequate protection in the environment where they will be used.

The efficiency and performance of the suit during permeation resistance tests must be documented in a user's "Technical Data Package." This booklet must accompany every suit that earns the NFPA certification. It must contain all of the data regarding the success or failure of permeation to all parts of the suit. This booklet will also contain subsequent maintenance and testing information which is completed by the user.

Vapor-protective suits are the most expensive. Costs can vary significantly between non-certified suits and NFPA approved garments. Generally, the material used for vapor-protective suits is quite heavy and of high quality. Laminate Film technology (Teflon) has made it possible to reduce the suit weight and increase permeation resistance.

Vapor-protective suits must be maintained and tested per the manufacturer's technical manual.

Table 6.1: Sample Label (from NFPA 1991) for Vapor-Protective Ensemble

"THIS VAPOR-PROTECTIVE ENSEMBLE MEETS THE REQUIREMENTS OF NFPA 1991, STANDARD ON VAPOR-PROTECTIVE ENSEMBLES FOR HAZARDOUS MATERIALS EMERGENCIES, 2016 EDITION, AND ANY ADDITIONAL REQUIREMENTS NOTED BELOW.

THE TECHNICAL DATA PACKAGE CONTAINS INFORMATION ON CHEMICALS AND SPECIFIC CHEMICAL MIXTURES FOR WHICH THIS ENSEMBLE IS CERTIFIED. CONSULT TECHNICIAL DATA PACKAGE AND MANUFACTURER'S INSTRURCTIONS BEFORE USE. DO NOT REMOVE THIS LABEL."

ADDITIONAL REQUIREMENT	YES	NO
LIMITED CHEMICAL FLASH FIRE PROTECTION FOR ESCAPE ONLY IN THE EVENT OF A CHEMICAL FLASH FIRE		
LIQUIFIED GAS PROTECTION		

Other NFPA 1991 labels include ensemble Element labels, which include gloves and footwear.

"**Liquid Splash Ensembles and Clothing**"

A "Liquid Splash Ensemble" is designed to protect emergency response personnel against exposure to specified chemicals in liquid splash environments during hazardous chemical emergencies. It is not approved for protection against gases and vapors and should never be worn in place of a vapor-protective suit. A liquid splash-protective suit should never be worn if the chemical is present at or above the IDLH concentration. Is often referred to as a "splash suit."

Liquid splash-protective suits can be ordered to allow SCBA to be worn on either the inside or the outside. The suits can be one-, two-, or three-piece and may come either with or without gloves and booties. Wrists and ankles usually have to be banded. Liquid splash-protective suits are usually less durable, and do not have as high a chemical resistance rating as the vapor-protective suits. These suits are *not* tested for permeation resistance. Some manufacturers do permeation testing; however, it is not required for NFPA certification.

These suits must also undergo specific testing, though the requirements are not as extensive as they are for the vapor-protective suits. To meet NFPA Standard #1992, the suit must pass a set of chemical *penetration* tests against an NFPA series of *seven test chemicals*, plus any additional chemicals or specific chemical mixtures for which the manufacturer is certifying the suit. There must be no penetration detected within one hour of exposure.

A water penetration test is included to ensure the suit provides full body splash protection. Material testing includes burst strength, tear resistance, flammability resistance testing, abrasion resistance, cold temperature performance, and flexural fatigue testing. These tests are required so that garment materials will provide adequate protection in the environment in which they will be used.

Other tests include cold weather performance, encapsulating ensemble performance and an optional chemical flash fire escape protection performance.

The efficiency and performance of the tests must be documented in a user's "Technical Data Package." This booklet must accompany every suit that earns the NFPA certification. It must contain all of the data regarding the success or failure of penetration to all parts of the suit.

NFPA 1994, Standard on Protective Ensembles for First Responders to CBRNE Terrorism Incidents, 2018 Edition.

This standard identifies four levels of "CBRN Protective Ensemble and Ensemble Elements" for use at terrorism incidents;

Class 1 The identity or concentration of the vapor or liquid is unknown or where high vapor protection factor is required or where liquid contact is expected, requires use of SCBA

Class 2 Provides protection from vapor or liquid chemical hazards at or above IDLH and requires the use of SCBA.

Class 3 Provides protection from low levels of vapor or liquid chemical hazards where concentrations are below IDLH, CBRN APR's and PAPR's may be used.

Class 4 Provides protection from biological hazards and radiological particulate where concentrations are below IDLH and APR's and PAPR's may be used.

The key to this Standard is that it is specific to CBRN/Terrorist events. The Class 1 ensemble appears to describe an ensemble similar to an NFPA 1991 garment; however, the testing standards are different. The NFPA 1994 standard is not as stringent as the NFPA 1991 standard and therefore a suit certified only to the NFPA 1994 standard cannot be used in place of a suit which is required to meet the NFPA 1991 standard. Conversely, the NFPA 1991 suit could be used in place of an NFPA 1994, Class 1 suit, if the chemical used in the incident is one of challenge chemicals they used in testing the suit. The 1991 permeation test standard subjects the garment to 21 industrial chemicals, 4 TICs, and Mustard and Soman warfare agents. The 1994 standard tests the Class 1 garment against 6 TIC chemicals and Mustard and Soman warfare agents.

The NFPA 1994 Standard, as with other standards, requires testing to their specific standard. Testing methods and standards for the garment, gloves, footwear, hoods, exhaust valves and other components are listed in addition to quality assurance programs and recall systems.

These classes of ensembles were designed for the first responder to a terrorist event with the intent of having them readily available (large quantities) for fire and emergency services personnel. They will (according to the authors) "reduce the safety risks and health risks to personnel during assessment, extrication, rescue, triage, and treatment operations at or involving chemical or biological terrorism incidents".

Table 6.2: Overview of NFPA Standards for CPC

Overview of NFPA Standards	NFPA 1991 - 2016	NFPA 1992 - 2018	NFPA 1994 CLASS 1 - 2018	NFPA 1994 CLASS 2 - 2018	NFPA 1994 CLASS 3 - 2018	NFPA 1994 CLASS 4 - 2018
Scope	Hazmat Response Vapor	Hazmat Response Liquid	Chem/Bio Terrorism Incident Response Vapor	Chem/Bio Terrorism Incident Response Vapor	Chem/Bio Terrorism Incident Response Liquid	Chem/Bio Terrorism Incident Response Particle
Chemical vs Garment Fabric, Seams, Visors, Gloves, Boots	Permeation resistance 1 hr vs 21 industrial chemicals, 4 toxic industrial chemicals and warfare agents soman and mustard	Penetration resistance 1 hr vs 10 industrial chemicals	Permeation resistance 1 hr vs 6 toxic industrial chemicals and agents mustard and soman	Permeation resistance 1 hr vs 5 toxic industrial chemicals and agents mustard and soman	Permeation resistance 1 hr vs 5 toxic industrial chemicals and agents mustard and soman	
Challenge Level	100% concentration and full contact 100 g/m2 agents	100% concentration and full contact	Liquids 20g/m2 Gases 10000 ppm Closed Top Cell	Liquids 10g/m2 Gases 350 ppm Closed Top Cell	Liquids 10g/m2 Gases 40 ppm Open Top Cell	
Breakthrough Criteria	Cumulative Permeation 6.0 TIC's, 4.0 mustard, 1.25 soman	ASTM F 903 Visual liquid	Cumulative Permeation 6.0 TIC's, 4.0 mustard, 1.25 soman	Cumulative Permeation 6.0 TIC's, 4.0 mustard, 1.25 soman	Cumulative Permeation 6.0 TIC's, 4.0 mustard, 1.25 soman	
System	ASTM F 1052 Pressure Test MIST Inward Leakage PDDF >488 ASTM F 1359 Shower Test >60min	ASTM F 1359 Shower Test >20 min	ASTM F 1052 Pressure Test MIST PPDF >441 ASTM F 1359 Shower Test >60 min	MIST PDDF >328 ASTM F 1359 Shower Test >20 min	MIST PDDF >69 ASTM F 1359 Shower Test >4 min	Particle Inward Leakage Test <5%
Flame Resistance ASTM F 1358	Pass 3 second burn only Flash Option	Flash Option	Pass 3 second burn only Flash Option	Flash Option	Flash Option	Flash Option

Information Contained in the Technical Data Package

Prior to purchasing CPC, emergency response personnel should evaluate CPC test results. All data generated in the tests must be published and provided to the purchaser in a booklet entitled “Technical Data Package” for all CPC garments meeting NFPA standards 1991, 1992, or 1994. The Technical Data Package must contain a full and accurate description of all materials and components used in the assembly of the chemical protective garment including:

- Primary suit material
- Visor/face shield
- Gloves and assembly
- Boots and assembly
- Zipper or closure assembly
- Seams, types and composition
- Exhaust valves, fittings, and gaskets

The Technical Data Package must also contain information on:

- Cleaning instructions
- Marking and storing suggestions
- Frequency and details of inspections
- Maintenance criteria
- Use of testing equipment
- Methods and procedures for repairs
- Warranty information

The manufacturer shall provide the following information to the garment purchaser:

- Donning and doffing instructions
- Safety considerations
- Storage conditions
- Recommended shelf-life
- Decontamination recommendations
- Retirement considerations
- Closure lubricants
- Visor and anti-fog agents

The Individual Laboratory Test Results section is a very important part of the Technical Data Package. All of the mandated tests for the three different NFPA garment standards are referenced to a series of ASTM laboratory tests. These ASTM tests yield information on performance regarding the following:

- Chemical permeation (or penetration)
- Flammability
- Puncture and tears
- Abrasion
- Flex/fatigue
- Exhaust valve inward leakage
- Cold temperature
- Overall suit water tightness
- Suit closure penetration

Each ASTM test must be conducted on each and all principal parts of the chemical suit, including suit material, visor, gloves, boots, seams, and zippers or suit closures.

Typical Components of Chemical Protective Clothing (CPC)

Understanding how suits are constructed provides wearers with additional trust in their equipment and allows them to concentrate on the task at hand.

Primary garment material consists of a “substrate” that basically provides strength for the garment. This material generally does not contribute to the chemical resistance qualities of the overall suit. This substrate provides for resistance against tears, rips, and punctures. Examples of substrates include Tyvek, Nomex, fiberglass, and woven polymer. A film is applied to the substrate in multiple layers to provide the chemical resistance. This film may be of differing kinds of materials, depending on the chemicals they are designed to protect against.

Various types of seams may found on CPC, including folded/lap sealed (by heat), glued, stitched, sewn, or combinations of the above. Seams must be constructed in such a way that they do not leak into the suit.

On suits that have visors, the visor is considered a separate component. Visors are usually made of a material other than that used for the primary garment. Popular options include polyvinyl chloride (PVC), clear polycarbonate, semi-flexible Lexan and clear Teflon. In most cases, visors are permanently attached to the suit by glue or heat welding. Some suits have visors that can be removed and replaced. In either case, the visor attachment must prevent leakage.

Gloves are an important component of CPC. Gloves must be chemical-resistant and durable since work in the exclusion zone may require direct hand contact with the hazardous material (e.g., plugging and patching operations). Gloves may either be permanently attached to the suit or be a separate component.

The boot is the part of the suit most likely to come in contact with hazardous materials. Responders may have to walk through the material to perform a task or may accidentally walk through the material. Boots may either be permanently attached to the suit or may be separate. The suit may be designed with a bootie that fits into a rugged outer chemical resistant boot. The bootie is an extension of the suit, and therefore chemical resistant. According to the standards (After 2017), boots must meet and pass the same test criteria as the primary suit material. Over-boots may also be worn to extend the life of outer boots. The over-boots are not tested and are used simply to keep gross material off the more expensive tested boots.

Suit closure assemblies are the component that allows the wearer to enter (don) and exit (doff) the suit. Typically, they incorporate a zipper or an interlocking seam. When choosing CPC, emergency response personnel should pay particular attention to the type of closure used. The suit closure should provide for easy donning and doffing of the suit and must not leak.

Levels of Chemical Protective Clothing

CalOSHA and Federal OSHA have established recommended levels of Chemical Protective Clothing ensembles. These agencies, along with the Federal EPA published the Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities in October of 1985. To date, little has changed in this area. They can be found in Title 8 CCR 5192 Appendix B and Title 29 CFR 1910.120 Appendix B.

Most emergency response agencies and departments have adopted the recommended levels of protection and have established them as an accepted trade standard.

Personal protective equipment can be divided into four levels (A, B, C, and D) based on the degree of protection afforded. *Levels* refer to a full ensemble of protective equipment (i.e. protective garment, boots, gloves, and respiratory protection). For example, a liquid splash-protective suit ensemble when used with SCBA would provide Level B protection. The same suit used with an air-purifying respirator would be Level C protection. There can be many configurations of CPC for each level of protection.

Level A is the highest level of protection and is the same ensemble required by OSHA in (5192/1910.120 sub section (g)(3)(D) which states: “Totally-encapsulating chemical protective suits (protection equivalent to Level A protection as recommended in Appendix B) shall be used....”. Reviewing the description of Level A protection in the appendix, Total-encapsulating includes vapor tight.

The NFPA standards address how specific garments, gloves, boots and visors are made and establishes the quality standard they must meet in order to be certified. If we were to build a crosswalk from NFPA to OSHA/EPA it might look like the table below:

Table 6.3: Comparison of Levels with Standards

OSHA/EPA Level	***NFPA Standard***
Level A	Vapor-Protective Ensemble, NFPA 1991
Level B	Liquid Splash-Protective Ensemble, NFPA 1992, with SCBA
Level C	Liquid Splash-Protective Ensemble, NFPA 1992, with APR
Level D	NFPA Standard on General Work Clothing

The selection criteria and ensemble descriptions for each level of CPC are found on the following pages.

Level A Selection Criteria

Level A protection should be used when:

- The hazardous material has been identified and requires the highest level of protection for skin, eyes, and respiratory system based on either the measured (or potential for) high concentrations 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 the skin, are capable of being absorbed through the intact skin, or are considered an infectious material; or

- Substances with a high degree of hazard to the skin are known or suspected to be present and skin contact is possible; or

- Operations must be conducted in confined, poorly ventilated areas, and the absence of conditions requiring Level A have not yet been determined.

Level A Ensemble

A Level A Ensemble is 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. (An asterisk [*] after the description indicates optional, as applicable.)

- Positive pressure (PP) -- pressure-demand, full facepiece, self-contained breathing apparatus (SCBA); or (PP) pressure-demand supplied-air respirator with escape SCBA; approved by the National Institute of Occupational Safety and Health (NIOSH). CBRN certification required for CBRN incidents.

Vapor-protective suits: Totally Encapsulating chemical-protective suit (TECP suits) constructed of protective clothing materials; covering the wearer's torso, head, arms, and legs; having boots and gloves that may be an integral part of the suit, or separate and tightly attached; and completely enclosing the wearer by itself or in combination with the wearer's respiratory equipment, gloves, and boots. All components of a TECP suit, such as relief valves, seams, and closure assemblies, should provide equivalent chemical resistance protection. Vapor-protective suits should meet the requirements in NFPA 1991, Standard on Vapor-Protective Ensembles for Hazardous Materials Emergencies, 2016 Edition.

- Coveralls *
- Long underwear *
- Gloves, outer, chemical-resistant
- Gloves, inner, chemical-resistant
- Boots, chemical-resistant, steel toe and shank
- Hard hat (under suit) * -- OSHA requirement in overhead hazard situations.
- Disposable protective suit, gloves, and boots (depending on construction) may be worn over totally encapsulating suit *
- Communications (Two-way radio preferred) – Not listed in OSHA regulation but required

Level B Selection Criteria

Level B protection should be used when:

- The type and atmospheric concentration of substances have been identified and require a high level of respiratory protection but less skin protection;

  NOTE: This can include atmospheres with IDLH (immediately dangerous to life and health) concentrations of specific substances that do not represent a severe skin hazard or that do not meet the criteria for use of air-purifying respirators.

- The atmosphere contains less than 19.5% oxygen.

- The presence of vapors or gases is indicated by a gas detection device, but the vapors and gases are known not to contain high levels of chemicals harmful to skin or capable of being absorbed through the intact skin.

- The presence of liquids or particulates is indicated, but they are known not to contain high levels of chemicals harmful to skin or capable of being absorbed through the intact skin.

Level B Ensemble

The highest level of respiratory protection is necessary but a lesser level of skin protection is needed. The following constitutes Level B equipment; it may be used as appropriate. (An asterisk [*] after the description indicates optional, as applicable.)

- Pressure-demand, full facepiece, self-contained breathing apparatus (SCBA), or pressure-demand supplied-air respirator with escape SCBA, NIOSH approved. CBRN certification as needed
- Hooded chemical-resistant clothing that meets the requirements of NFPA 1992, *Standard on Liquid Splash Ensembles and Clothing for Hazardous Materials Emergencies, 2018 Edition* (overalls and long-sleeved jacket, coveralls, one- or two-piece chemical-splash suit, disposable chemical-resistant overalls).
- Coveralls *
- Gloves, inner and outer, chemical-resistant
- Boots, outer, chemical-resistant, steel toe and shank
- Boot-covers, outer, chemical-resistant (disposable) *
- Hard hat *
- Face shield *
- Communications (Two-way radio preferred) – Not listed in OSHA regulation but required

Level C Selection Criteria

Level C protection should be used when:

- The atmospheric contaminants, liquid splashes, or other direct contact will not adversely affect or be absorbed through any exposed skin;
- The types of air contaminants have been identified, concentrations measured, and an air-purifying respirator is available that can remove the contaminants; and
- All criteria for the use of air-purifying respirators are met.
- Atmospheric concentrations of chemicals must not exceed IDLH levels. The atmosphere must contain at least 19.5% oxygen.

Level C Ensemble

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. (An asterisk [*] after the description indicates optional, as applicable.)

Full-face or half-mask, air-purifying respirators, powered air purifying respirators, self-contained positive pressure breathing apparatus (NIOSH approved).

- Hooded chemical-resistant clothing (overalls, two-piece chemical splash suit, disposable chemical-resistant overalls).
- Coveralls *
- Gloves, outer, chemical-resistant
- Gloves, inner, chemical-resistant
- Boots, outer, chemical-resistant, steel toe and shank
- Boot-covers, outer, chemical-resistant (disposable) *
- Hard hat *
- Escape mask *
- Communications (Two-way radio preferred) – Not listed in OSHA regulation but required
- Face shield *

Level D Selection Criteria:

Level D protection should be used when:

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

Level D Ensemble

A work uniform affording minimal protection, used for nuisance contamination only. The following constitute Level D equipment; it may be used as appropriate. (An asterisk [*] after the description indicates optional, as applicable.)

- Coveralls
- Gloves *
- Boots/shoes, chemical-resistant steel toe and shank
- Boots, outer, chemical-resistant (disposable) *
- Safety glasses or chemical splash goggles *
- Hard hat *
- Escape mask *
- Face shield *

Variables in the Levels of Protective Clothing

There are several different types of CPC on the market for each level of personal protection. Suits may be totally encapsulating single or multi-piece. Most Level A ensembles are designed to be worn with SCBA on the inside of the suit. However, there are one or two suits which have the SCBA worn on the outside, although these are somewhat controversial. Others are designed to be used with an umbilical air system. Response personnel must make sure to choose the suits that are appropriate for the specific hazards at each incident.

Some of the other variables include:

1. Are Turn-outs considered CPC: Many turnout manufacturers provide a legal disclaimer stating "This clothing does not provide chemical protection." Turnouts should not be used in the place of rated chemical protective clothing.

2. Tape (chemical tape or "Duct" type tape) cannot be used to make a seal. Taping is done to keep suit surfaces in contact with each other.

3. It is recommended that chemical tape, tape with actual permeation ratings, be used to keep suit surfaces in contact with each other, provided the suit manufacturer permits it. Most manufacturers will void their warranty if a non-approved tape, glue or a marker is used on their suit.

4. Always follow the manufacturer's instructions for testing, use and maintenance. Outside sources, such as this text, provide general information. Failure to follow the manufacturer's guidelines could result in suit failure and having the warranty voided.

Using Chemical Protective Clothing

Rule Number One: No single ensemble will protect you from every chemical.

No chemical protective garment should be considered an indefinite barrier to prolonged chemical exposure. In many cases, chemicals will eventually permeate through the suit material.
Many factors must be considered when selecting CPC. The predicted type, measured concentration, and toxicity of a chemical substance in the ambient atmosphere must be determined. The resistance of CPC material to permeation, degradation, and penetration must be considered. The potential for exposure to substances through inhalation or skin contact should be evaluated. Chemical compatibility charts are a valuable tool that can assist in the selection process. Where type of chemical, concentration, and possibility of contact are not known, the level of protection must be selected based on judgment and previous experience. Available references should be used to determine the IDLH, LD_{50}, and TLV data. When in doubt, response personnel should use the maximum level of protection indicated for the specific incident.

Protective equipment reduces potential for contact with toxic substances. Ensuring the health and safety of responders requires safe work practices, proper decontamination, and established site entry protocols. The following are sample guidelines for some of the considerations under which a specific level of CPC could be selected.

Level	Conditions for Use
A	Confined space entry High potential for splash or immersion Skin destruction or dermal absorption threat IDLH dermal High concentrations of vapor, gases, or particulates
B	High respiratory threat Less than 19.5% O_2 Minimum level for initial assessment of unknown spills Only moderate splash threat Non-IDLH dermal
C	No IDLH dermal or respiratory threats All contaminants known Air purifying respirator requirements met
D	No known hazards Work functions preclude chemical exposure Provides basic safety at an incident

HazMat teams must also follow the manufacturer's schedule of inspections and maintenance and recordkeeping of exposures and maintenance.

Work Mission Duration

Before personnel actually begin work in their CPC, they should estimate the duration of the work mission. Several factors limit mission length:

- Air supply availability and consumption
- Garment permeation or penetration by the chemical contaminants
- Ambient temperature
- Suit cooling supply
- Time required to don/doff CPC
- Amount of physical work expected
- Physical condition of the wearer
- Travel time to the location and back to decon

Work Mission Duration, Cont.

Work-mission duration is an excellent planning tool to determine how long an entry may be able to last, given the current conditions. The key element is planning around the projected air supply, as discussed in the next section. A sample Work-Mission Duration worksheet is included at the end of this chapter.

Air Supply

The duration of air supplies must be considered before planning any activity requiring the use of SCBA. The anticipated operating time of the SCBA should be known. The use of a worksheet can assist in determining work time allowances.

In actual operations, several factors can reduce the rated operating time of the SCBA. When planning any operation requiring the use of SCBA and CPC, the following variables should be considered. Work actions and operating times should be adjusted accordingly.

- *Work Rate*: The actual operating time of the SCBA may be reduced by 1/3 to 1/2 during strenuous work or any task requiring speed of motion.

- *Fitness*: Well-conditioned individuals generally utilize oxygen more efficiently and can extract more oxygen from a given volume of air than unfit individuals, thereby slightly increasing the SCBA operating time.

- *Body Size*: Larger individuals generally consume air at a higher rate than smaller individuals, thereby decreasing SCBA operating time.

- *Breathing Patterns*: Quick, shallow, or irregular breaths use air more rapidly than deep, regularly spaced breaths.

- *Heat*: Heat-induced anxiety and lack of acclimatization may cause hyperventilation, thus decreasing SCBA operating time.

- *Claustrophobia*: Individuals should be checked out in advance during training to ensure that no one on the team suffers from claustrophobia.

Most emergency response personnel are aware that a one-hour SCBA bottle may last 30 minutes or less when personnel are working in CPC. Likewise, a 30-minute bottle may only last 15-minutes. The best way of establishing how long a bottle will last is to drill in the different types of CPC under various conditions. By logging work times at drills, response personnel can get an idea how long a bottle will last under actual conditions. Remember that the mental stress of an actual incident may increase breathing patterns, so adjust time accordingly.

Ambient Temperature

The ambient temperature has a major influence on work mission duration. It affects both the worker and the protective integrity of the ensemble. Ambient temperature can affect the efficiency of personnel working in CPC, often contributing to fatigue and discomfort. (Refer to the chapter on medical considerations for more information.) However, the greatest threat to personnel working in CPC is changes in body core temperature. Excessive heat buildup causes stress, while excessive heat loss will cause hypothermia. Heat stress, which can occur even in relatively mild temperatures, can be immediately life-threatening.

Other factors may decrease the duration of protection provided by a given piece of garment. Hot and cold ambient temperature affect:

- Valve operation on suits.
- The durability and flexibility of suit materials.
- The integrity of the suit fasteners and zippers.
- The breakthrough time and permeation rates of various chemicals. Heat usually speeds up permeation time.
- The concentration of airborne contaminants, particularly vapors and gases.

When these conditions are present or anticipated, other trained HazMat personnel should be ready to resume the task. Once a worker has been removed from the work task, his assignment for wearing a suit is terminated. The worker does no more work and should not be allowed back into a similar work environment using CPC for at least 8 hours or as recommended by the team physician.

Suit Cooling Supply

Under warm or strenuous work conditions, cooling measures may be implemented. There are a variety of cooling systems on the market, including umbilical-fed air from a cascade system, an auxiliary air tank for suit cooling, chilled air systems, chilled FREON systems, ice packs, circulating water systems, and full refrigeration systems. Some studies have shown that while cooling systems may make the wearer feel cooler, they actually do little to cool the core temperature of the wearer. It is recommended that teams conduct comprehensive research on the types of systems available and perform trial studies, before purchasing and utilizing a system.

Personal Use Factors

Certain personal features of workers may jeopardize safety during equipment use. Prohibitive or precautionary measures should be taken as necessary. All of the items listed below can be considered points of safety:

- *Facial Hair*: Facial hair or long hair may interfere with SCBA fit and obstruct the wearer's vision. Any hair that passes between the face and the sealing surface of the facepiece should be prohibited. Most respiratory equipment manufacturers will not support the presence of facial hair within the seal of a mask as an acceptable condition for proper use of the equipment. Furthermore, CFR 1910.134 prohibits facial hair in the seal area of respiratory equipment.

- *Eyeglasses*: Conventional eyeglasses will interfere with the SCBA facepiece seal and should be prohibited. A spectacle kit should be installed in the facepiece for workers requiring eye correction.

- *Chewing Gum*: Chewing products should be prohibited during SCBA use since they may cause ingestion of contaminants. If accidentally coughed up, they also can accidentally clog portions of the SCBA facepiece. This also applies to smokeless tobacco.

- *Jewelry*: Jewelry, such as earrings, rings, watches, arm bands and necklaces, should be banned. Removal of all jewelry and personal adornment should be routine before the donning of SCBA and CPC.

- *Personal Items*: Wallets, badges, name tags, keys, lighters, and other personal items should all be removed. These items can cause the CPC to become ripped or torn from the interior.

HazMat team members should adhere strictly to these guidelines. They are critical to the safety of all personnel. Team members should be disciplined to accept nothing that compromises their safety.

Selecting the Appropriate CPE

The following is a sample check off list which includes many of the items to consider when selecting CPC:

1. Manufacturer's user guide/technical manual and computer applications
2. Ensemble compatibility with the chemical: permeation/penetration/degradation times
3. State of the chemical: Solid, liquid, gas, cryogenic, hot, on fire
4. Type of work to be done: Reconnaissance verses climbing on a rail car to patch a leak
    A. Abrasion, rip and cut hazard resistance, falling objects, overhead work
    B. Flexural Fatigue
5. Ambient Temperature: Heat stress is the number one cause of injuries.
6. The potential for a flash fire or escalation of the incident (leak or spill)
7. Ability to protect wearer in spite of sudden changes: Changes from a gas phase to a liquid
8. Proper fit and size for the wearer and their ability to do work in the ensemble

These are some of the issues a response team should consider when selecting a CPC ensemble for the response team. Some can be managed with administrative controls, some can be managed with engineering controls and others will be managed at the time of the incident. Either way, CPC selection must be sufficiently precise to protect the wearer from the physical and physiological hazards incumbent in the use of chemical protective clothing.

Donning the Chemical Ensemble

Standard routines should be established, written, and practiced for donning each level of protective equipment. Donning (and doffing) of all chemical suits must be done utilizing the "buddy system," since these operations are difficult at best and almost impossible to perform alone. The buddy simultaneously looks for damage to all equipment and ensures that all safety steps and procedures are being followed. The wearer must have confidence that his/her assistant will meticulously carry out these steps. The manufacturer's recommendations for donning/doffing should be integrated into your SOGs.

Once the suit and equipment have been donned, the fit should be evaluated and inspected for work function and safety.

Donning the Chemical Ensemble, Cont.

In this course you will have the opportunity to practice donning and doffing chemical protective clothing (CPC). Your instructor will demonstrate the procedure. The Protective Clothing Checklists and Chemical Protective Clothing Layout located on the following pages can be used to guide you through the process and help you lay out the equipment you need in an organized fashion.

General Guidelines

How you don and doff CPC will vary slightly depending on the particular suits you have available. It's important that you familiarize yourself with the suits available in your department. However, the following are some guidelines that you should keep in mind regardless of the particular suit you use.

Having equipment laid out in an organized manner also helps to reduce the risk of damaging any of the equipment in the donning or doffing process. As indicated above, the checklists and CPC layout included in this chapter may be used as a guide, but these are only examples. Each department should develop its own standard operating procedures based on the particular suits they use.

Response personnel should inventory and inspect all equipment prior to donning. Equipment should be inspected again after use. Equipment that is damaged or not functioning properly should be either removed from service until it can be repaired by qualified personnel or replaced as needed.

An appropriate dress-out area should be selected for response personnel to don CPC. It should be an area where responders can be protected from the elements, such as heat, wind, or rain. It should be spacious enough to allow responders to lay out equipment in an organized manner and to don CPC without tripping over anything. The dress-out area should either already have a place for personnel to sit or chairs should be provided. The dress-out area should be located away from the exhaust pipes of response vehicles and preferably in a relatively quiet area so that responders are able to plan their activities with a minimum of distractions. Media and other nonessential personnel should be kept away from the dress-out area.

Because personnel wearing CPC are likely to experience some level of heat stress, they should delay donning the equipment until just prior to making the entry. That minimizes the time they need to spend wearing the suits. If possible, a partner should be assigned to assist each person who will be donning CPC. This partner should do whatever running around is needed to locate and set up equipment so that the entry team member doesn't have to expend unnecessary energy before the entry. The partner should assist the entry team member with donning both SCBA and the suit itself. Personnel should also hydrate prior to donning CPC even if they do not feel thirsty.

General Guidelines, cont.

It's not uncommon for the suits to fog up during use, thus limiting visibility. Many HazMat teams will use an anti-fog solution on the inside of both their SCBA masks and the suit face shield to help minimize this problem. Some responders will also attach a paper towel or terry cloth towel to their helmets so that they can wipe the inside of the suit face shield if it begins to fog up.

All wallets, watches, rings, or other jewelry should be removed prior to donning CPC so that they do not damage either the suit or gloves. There's also a risk that any personal items brought into the exclusion zone could become contaminated if the suit is breached for some reason and thus would need to be either decontaminated or disposed of later.

If the helmet or hard hat is equipped chin strap, the strap should be secured in place so that the helmet is less likely to fall off or become displaced.

Summary

Emergency response personnel must be able to identify necessary levels of protection for entry into a hazardous atmosphere. To accomplish this, response personnel must thoroughly understand the selection criteria and equipment required for each level of protection. Purchasing equipment that has earned the NFPA seal of approval ensures that it has been tested and has met very rigid and tough requirements.

Response personnel must develop and understand the many protocols necessary to support the use of CPC. Donning and doffing procedures must be established and practiced. In addition, protocols and procedures should be established for determining working time, personal use factors, medical monitoring, work tolerance, documentation, and step-off procedures. Training in the use of established procedures and protocols is the key to safety when using CPC. Remember, the proper use of CPC may make the difference between life and death.

INFORMATION SHEET #6.1

Work Mission Duration

Incident Name:______________________ Date:__________ Location:______________________


Out of Air


Need Help


Evacuate


O.K.


Need Assistance with Repair


Situation Under Control

Air Supply	30 Minutes	45 Minutes	60 Minutes	Umbilical Air
Safety Factor				
Travel Time (times 2)				
Environmental Conditions (L-0, M-5, H-10)				
Work Load (L-0, M-5, H-10)				
Decontamination (maximum)				
Other				
Operating Work Time (To be amended during incident as dictated by actual air supply.)				

Recommended Work Time (Between Rest Periods) *
When wearing impermeable or semi-impermeable Chemical Protective Clothing

Air Temperature (Maximum)	Sunshine (Radiant Heat Exposure)		
	Full Sun	Partly Sunny	Full Shade
70ûF	60 min. of work	90 min. of work	120 min. of work
75ûF	30 min. of work	60 min. of work	90 min. of work
80ûF	20 min. of work	30 min. of work	60 min. of work
85ûF	15 min. of work	20 min. of work	30 min. of work
90ûF	15 min. light work	15 min. of work	20 min. of work
95ûF	Extreme Danger	Danger	15 min. of work

* Reference: Occupational Safety & Health (OSHA) Guidance Manual for Hazwaste Site Activity (Table 8-10)

Work Mission Duration
Form Instructions

Each part of the Work Mission Duration Form that needs to be completed is explained below:

1. **Air Supply:** Across the top of the form are standard air supplies (30/45/60-minute air bottles and umbilical air). When completing the form, enter information into the column that corresponds to the air supply being used by the HazMat team.

2. **Safety Factor:** A standard rule of thumb is that personnel should be able to perform the task, exit the zone, complete decontamination, and begin doffing before the low-air alarm bell sounds. On most SCBAs, the bell will alarm with approximately a 5-minute reserve. Therefore, 5 minutes is an acceptable standard entry in this portion of the form.

3. **Travel Time:** This should be a close estimation of the travel time to and from the site.

4. **Environmental Conditions:** Environmental conditions impact emergency response personnel before they don PPE, while they are working, and after they doff the garments. Temperature and humidity are the primary factors to be concerned about. The recommended entries are as follows:

Entry	Environmental Condition
0	Cool and Dry
5	Warm and Moist
10	Hot and Wet

5. **Work Load:** The type of work is another measurable factor. The greater the work load, the greater the impact. The recommended entries are as follows:

Entry	Work Load
0	Light
5	Moderate
10	Heavy

6. **Decontamination:** Decon takes time to accomplish. The more people who need decontamination, the more time will be required. The number entered into this row should account for the time that it takes to decontaminate *all* team members.

7. **Other:** This row provides a place to account for other factors that impact air supply, such as age, obesity, or personal habits.

8. **Operating Work Time:** The estimated operating work time is entered at the bottom of the form. To determine the operating work time, add the entries from all the previous rows, then subtract that number from the total air supply available.

7

Chapter Seven

Chapter 7: **Practical Applications in Hazmat**

Overview: Emergency response personnel must utilize their training, experience, and common sense to assess every incident. Recognizing responder limitations is essential to survival. The process of identifying incident data and applying common sense can be used in every aspect at every type of incident. Whether the subject is safety, health, or operational tactics, look for the hidden information.

Time Allocated: 2 Hours

Method of Instruction: Interactive Lecture

Terminal Learning Objective: Describe the interrelated components which make up hazard assessment and how common sense is used during the assessment process.

Enabling Objectives:

1. Describe the terms used to describe Measurement
2. Discuss the relationship between Oxygen and concentration
3. Describe the Relationships Between Oxygen Levels and Contaminants
4. List the Three Threats and describe their relationships
5. List the common tests used in Hazmat wet chemistry
6. List five common sense techniques when using reference materials
7. Describe how the Chemical and Physical Properties relate to toxicity

Instructional Resources Required:

1. Student Notebook
2. Projection system for PowerPoint (or other similar program)
3. Alternate: Overhead projection with Overhead Slides
4. Dry erase, paper chart and or chalk board with appropriate markers

Instructor to Student Ratio: 1:40

References:

1. Title 8 CCR 5192/1910.120
2. NFPA 472, Competence of Responders to Hazardous Materials Incidents (2008 Ed)

Practical Exercise: None

Evaluation Strategy: Participants will complete a written examination at the conclusion of the class.

Practical Applications in Hazmat

Response personnel at a hazardous materials incident depend on the Technical Reference Specialist-Hazardous Materials ("Tech-Ref") to provide the information needed to ensure the safety of all responders and to competently mitigate the incident.

While we can provide each of you with training and some hands-on field experience, we cannot give you common sense. We can only show you how to use that skill. It will be up to you to develop and practice it.

Common Sense in Hazardous Materials

Common sense involves the ability to use reason and intuition to interpret and apply the technical information available on the chemical. This ability is *essential* in the technical or specialist and is desirable in all personnel operating at a hazardous materials incident.

Every aspect of an incident can benefit from the use of common sense. In this chapter, we will concentrate only on three things:

1) Threats to the responder;
2) Chemical test results;
And
3) Hazardous properties.

Common Sense in Hazards

There are three primary chemical threats in hazardous materials response: Asphyxiation (oxygen deficiency), thermal (flammability and oxidizers), and toxicity (poisons, radiation, corrosives etc.).

Each of these hazards is found within the hazard classes (Table 7.1). These threats correspond to the three monitoring requirements designated by state and federal laws: oxygen deficiency, flammability, and radioactivity.

Many of these materials have two of these hazards. Some present all three. The technician or specialist needs to learn to don protective equipment for all of the hazards a material has and certainly for the one that poses the most credible threat.

Table 7.1: The 9 Hazard Classes and the Threats They Present
(Check the box that is applicable and indicative which threat is present)

Hazard Class	Threat to Responder		
	Oxygen Deficiency	Flammability	Toxicity
1 – Explosives		☐	☐
2 – Gases	☐	☐	☐
3 - Flammable Liquids	☐	☐	☐
4 - Flammable Solids	☐	☐	☐
5 - Oxidizers and Organic Peroxides	☐	☐	☐
6 - Poisonous and Infectious Substances	☐	☐	☐
7 – Radioactives	☐	☐	☐
8 – Corrosives	☐	☐	☐
9 - Misc. Dangerous Substances	☐	☐	☐

Understanding Terms of Measurement

There are two terms of measurement commonly used to quantify the presence of a material in the atmosphere.
They are:
Percent by volume (%)
And
Parts per million (ppm).

You must understand how these values are related so you can address issues involving the translation of one value to the other (IE: What if your reference books list IDLH in parts per million (ppm), but your monitoring equipment is reading percent by volume (%)?)

Table 7.2: The Relationship Between Percent by Volume and Parts per Million

Percentage by Volume	Parts per Million
0%	0 ppm
1%	10,000 ppm
10%	100,000 ppm
50%	500,000 ppm
100%	1,000,000 ppm

1. Oxygen Deficiency

Under ideal conditions, normal atmospheric air is comprised of approximately 21% oxygen, 78% nitrogen, and 1% other miscellaneous gases. By federal definition, oxygen deficiency is described as an atmosphere containing *less than 19.5% oxygen*. This represents a decrease of 1.5% oxygen from the normal level (21%). If the oxygen level is falling, some other material must be displacing or bonding with the available oxygen. In going back to our conversion process, we see that 1.5% is equal to 15,000 ppm. That means there is *a lot* of some material displacing or bonding with the oxygen.

Any operations conducted within these environments require that responders use atmosphere supplying respiratory equipment such as SCBA to augment their oxygen levels.

Air is a homogeneous mixture, the oxygen portion of air cannot be displaced without displacing the nitrogen and other gases that comprise almost 80% of the atmosphere. Since the oxygen in air is only one-fifth of all the gases we breathe, we will have to displace more of the other gases to have much effect on the oxygen portion. In fact, we will have to displace four times as much of the nitrogen and other gases as we do the oxygen (oxygen = 20% or nitrogen = 80%).

The Relation Between Oxygen Levels and Contaminants

When a contaminant is present in the air, it displaces the normal oxygen levels. As the contaminant level increases, the oxygen level decreases. This relationship between oxygen levels and contaminants is an important concept. If you are monitoring an unknown atmosphere and see changes in oxygen concentration, it can be an indication that some other chemicals are present or oxygen is being used by some process.

2. Flammability

Flammability is the amount of a fuel in the presence of an oxidizing agent that is necessary for combustion to take place. We typically refer to the entire spectrum in which these materials will burn as the *flammable range*. Flammable range is given in percentages of the material in normal air.

Toxicity

In air, as an inhalation threat, it is typically reported in parts per million. As an example, tetrahydrofuran has an IDLH value of 2000 ppm (10% of the LEL). Converting this number into percentages is 0.2%

Comparing All Three Threats

Using tetrahydrofuran as an example again: In order to reach an oxygen-deficient atmosphere of 19.5%, there may be as much as 7.5% (75,000 ppm) of a contaminating gas present. A concentration of 7.5% is right in the middle of the flammable range for tetrahydrofuran (2% - 11.8%) and 37 times higher than the IDLH (2000 ppm or 0.2%).

Understanding the relation between these three threats is important when determining proper protective equipment. What type of respiratory protection is needed: supplemental oxygen (from SCBA or SAR) or air purification respirators (APR or PAPR)? Are firefighters' turnouts sufficient because there is a flammability hazard, but very little risk of being in a toxic atmosphere? Is chemical protective clothing required because of the toxicity hazard? Or are toxicity and flammability both significant risks, requiring the use of CPC with flash/thermal protection?

Once we know the toxicity and flammability are greater hazards than oxygen deficiency with this particular chemical, we can select the appropriate Chemical Protective Equipment and Respiratory Protection, and perform mitigation below the LEL.

A flammable atmosphere can be managed in different ways, depending on the circumstances. One option is to ventilate the area with fresh air, thereby displacing the flammable vapors. A second option would be to flood the area with an inert gas, such as nitrogen or carbon dioxide In some cases it may be appropriate to use foam or other materials to blanket a flammable liquid and suppress vapor production. Again, the circumstances will dictate what measures are most appropriate.

The relation between these three threats also helps us to determine what protective actions may be needed. The decision to shelter in place or evacuate an area will depend, in part, on which threat poses the greatest risk to people in the area. For example, you may have a chemical that is not toxic enough to warrant evacuation, but which is present in potentially explosive concentrations. Evacuation may be necessary if you cannot quickly reduce the vapor concentration.

The Three Worlds That Threaten Us

The *outdoor incidents* that pose significant potentials involve large clouds, large containers, and large spills. Each of these can involve great areas or numbers of people in a very short period. These have a tendency to make us react before we are properly set up and equipped.

The *indoor incidents* that pose significant potentials involve confined spaces, below-grade incidents, and natural or artificial barriers. Each of these has a tendency to create impediments or obstacles to safe operations or to create situations that would be far less hazardous in open areas. Recognize that indoor incidents can also result from large releases outdoors.

The *common sense incidents* that pose significant risk potential involve poisons, poison gases, biological indicators (injured citizens, dead animals or citizens, etc.), and anything that is unusual and does not make sense. Responders tend to diminish the hazards associated with these incidents even though each may create serious, long-term consequences. Rely on both your judgment and your training and always view your options carefully.

Common Sense in Chemistry

The HazMat Technician or Specialist will need to recommend protective equipment and mitigation measures based on information obtained, in part, through field identification. This information can come directly from the test results or indirectly from the application of common sense and a knowledge of chemistry.

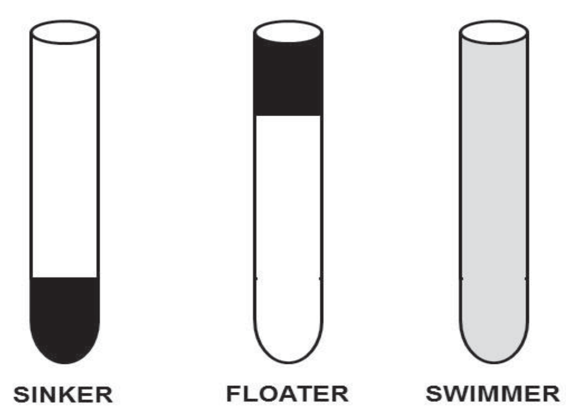
Water Behavior Test

This test can provide information on specific gravity, flammability, polarity, multiple bonding, toxicity, etc.

Potassium permanganate is used in this test because of its readily identifiable color and oxidizing ability. Materials that change the color of the potassium permanganate typically contain strong caustics (which can be confirmed by pH testing); have multiple bonds; or are strong reducing agents that are undergoing the oxidation process, such as ethers and furans, (which can be confirmed by the flammability test).

The addition of potassium permanganate also makes it easier to determine if you have a floater, sinker, or swimmer. If the potassium permanganate seems to completely dissolve in the solution consisting of water and the unknown substance, the material is a swimmer. However, if the material is a floater or a sinker, it will be visible above or below the burgundy colored water.

Figure 7.3: Comparison of properties in liquid



Floaters

"Floaters" are materials that are immiscible and lighter than water. They have a specific gravity less than 1. The most common floaters we encounter are either flammable or combustible hydrocarbons. (It's possible to distinguish between the two using the watch glass test.)
Because floaters are generally flammable or combustible, they require flash/thermal protection for safety. Responders can use either liquids or foam to blanket the product and suppress vapor production, reducing the risk of ignition.
Flammable and combustible liquids, regardless of their shading or color, are usually translucent. However, if the product is opaque or cloudy, it's a good clue that this may be a mixture in a flammable or combustible carrier agent.

Swimmers

"Swimmers," or miscible materials, are usually polar or carbonyl in structure. However, there are other substances that are miscible too: corrosives (confirmed by pH testing), amines (recognizable by their foul odor), nitriles, or aqueous solutions, such as poisons. (Poison liquids that use water to carry the active ingredient are also typically opaque or cloudy.) The "dirtiest" burners, the organic acids, can be determined by pH testing. Almost all of the miscible materials are toxic. These substances require flash, respiratory, and skin protection.

Diluting a flammable product reduces the vapor production to where the vapors are no longer within their flammable range. Diluting a toxic product reduces the concentration of toxic vapors and the threat of toxic exposure. Now instead of having an atmosphere at or above the IDLH level, it's possible to bring the concentration down to more acceptable levels, like PEL or TLV.

Because these materials mix with water, alcohol resistant foam should be used for vapor suppression.

Sinkers

"Sinkers" are immiscible materials that are heavier than water. They have a specific gravity greater than 1. These materials commonly include the alkyl halides and the flammable nonmetals phosphorus or sulfur in an organic compound (which can be determined during the watch glass test).

Sinkers are usually toxic. Some of them are flammable as well. Responders must consider respiratory, skin, and flash protection.

Light applications of water can be used to suppress the vapors produced by these materials because they are heavier than water. Other liquids with a lower specific gravity can also be used for this purpose.

The Watch Glass Test

The watch glass test can confirm or refute our suspicions about chemical properties like flammability, combustibility, and toxicity. However, this test is also useful in ascertaining volatility, vapor pressure, vapor travel, vapor content, evaporation rate, flash point, ignition point, melting point, freezing point, heat output, flammable range, molecular weight, polarity, branching, soot production (toxicity), viscosity, and vapor density (to a certain extent).

In physical properties, volatility is a measure of the viscosity of the liquid. The higher the volatility, the lower the viscosity. This also applies to properties like branching, polarity, and molecular weight. Polar materials, like the alcohols and aldehydes, are likely to be less volatile than their nonpolar cousins (hydrocarbons). Think of methane and methanol. One polar and one not. The methane at ambient temperatures is a gas, the methanol is not. Similarly, methane is more volatile than is gasoline. So shape, size, and weight affect volatility. Branching is an alteration of shape. It allows more places to attack and release energy.

Toxicity is also a relative determinant. Toxic materials that burn can be reasonably assessed by observing the type and amount of smoke, soot, and flame color produced by their burning. Generally, the more soot and smoke produced, the more toxic the material is. The same can be said about color. The color scale is often described as progressing from orange to yellow to blue and up to white. The brighter the color, the cleaner the smoke and soot. However, there are always exceptions to every rule.

When testing any material, it's important to be able to interpret the test results in terms of what it really means regarding hazards, protective measures, and mitigation techniques. You must be able to go beyond the obvious to look not just at the facts but also at what they tell you.

As volatility increases:

Vapor pressure (VP) increases,	Flash point (FP) decreases
Evaporation rate (ER) increases,	Boiling point (BP) decreases
Vapor content (VC) increases,	Melting point (MP) decreases
Vapor travel (VT) increases,	Freezing point (FRP) decreases
Ignition temperature (IT) increases,	Smoke/soot produc'n (SP) decreases

Common Sense in Reference Materials

The person assigned tech/ref responsibilities must be able to find and interpret the information available, as well as to "read between the lines" when that information may not be presented in a familiar format. They must also be able to properly apply that information in order to assist in determining an appropriate plan of action.

Review of Chemical and Physical Properties

The following section just reviews some of the chemical and physical properties and how they affect the decisions you make at an incident.

Polarity

*Polarity is a physical property of compounds which relate to other physical properties, such as melting and boiling points or solubility***.**

Bond polarities arise from bonds between atoms of different electronegativity. A molecule can be ionic, polar or non-polar.

These products require the use of other polar materials to suppress vapors or fire alcohol resistant foam.

Oxidizing Materials

An oxidizing agent is a substance that has the ability to oxidize other substances—in other words to cause them to lose electrons. Common oxidizing agents are oxygen, hydrogen peroxide and the halogens.

Look for over-pressurized containers or indications of drying (e.g., crystals or powder around the openings).

Odors

Many chemicals produce distinct odors. If the material does produce an odor, evaluate the odor threshold in relation to the toxicity values. Is the odor threshold safely below permissible exposure limits? Or will a person receive a harmful exposure before the odor is detected?

Flash Point

The lowest temperature at which vapors above a volatile combustible substance ignite in air when exposed to flame. Determinations need to be made as to the specific Flash Point of a material being technically referenced.
Materials such as dry ice or nitrogen can (in some cases) be used to control vapor by inserting the atmosphere within a confined space. This can make it safe to transfer product to another container.

Melting Point

The temperature at which a solid melts
This should be considered the temperature at which a material begins to evaporate, or produce vapors. When the vapors reach the correct concentration, they will ignite.

Boiling Point

The boiling point is the temperature at which the vapor pressure of the liquid equals atmospheric pressure. Materials that are close to their boiling points produce large amounts of vapors that can travel long distances to an ignition source.

Ignition Temperature

The ignition temperature is the temperature required to ignite the flammable vapors. What kind of ignition sources are present? Open flames can generate heat between 1000°F and 2000°F. Electrical sparks can be 1100°F. Eliminating ignition sources and maintaining a vapor concentration below the lower explosive limit (LEL) are crucial with materials that have low ignition temperatures.

Flammable/Explosive Range

Closely related to flammable range is proximity to an ignition source. Materials with a high or narrow flammable range will present the greatest risk close to the container or in enclosed spaces since the further the vapors travel away from the container, the more difficult it is to maintain an ignitable concentration. Materials with a low or wide flammable range will be easier to ignite in open spaces and at greater distances. They may be too rich to burn close to the container, but fall within the flammable range as they begin to disperse.

Specific Gravity

Specific gravity is the ratio of the density of a substance to the density of a reference substance; equivalently, it is the ratio of the mass of a substance to the mass of a reference substance for the same given volume

Knowing the specific gravity of the chemical will help you to determine what products can be used to blanket the material in order to suppress vapors and prevent ignition. It's also important in determining what type of dam to build for containing the material or separating it from the water.

Vapor Density

Vapor density is the density of a vapor in relation to that of hydrogen. It may be defined as mass of a certain volume of a substance divided by mass of same volume of hydrogen.

Gases and vapors that are lighter than air will rise away from the incident. Gases and vapors that are heavier than air will sink and follow terrain features. When Technically referencing the Vapor Density, consider location, potential travel distance, confined spaces, etc.

Vapor Pressure

Generally, as the boiling point decreases, the vapor pressure and rate of evaporation increase.

pH and concentration

Three things will increase the danger when dealing with chemicals:
1) **Heat** (The more heat generated/possessed, the more damage a substance will do)
2) **Time** (The longer one is exposed to or contaminated by contact with a substance, the more damage is likely to occur)
And
3) **Concentration** (The more concentrated, ie: less than 3 or more than 11, the more likely damage is to occur)

Toxic Properties

Table 7.4: Conversion Factors for Toxicity Values

1 mg = 1/1,000 gr = 1/1,000,000 kg
or 2.25 lb = 1 kg = 1,000 gr = 1,000,000 mg
(mg = milligram, gr = gram, kg = kilogram, lb = pound)

Common Sense in Toxicology

It is one concern when one deals with a given substance in a clinical/laboratory setting, and an entirely different concern for Technicians in the field when attempting to mitigate a chemical release. What value do they hold for responders? As you can see, the value in these numbers is relative. Regardless, if the numbers are very low (EG: less than 500 ppm), the material is very toxic.

Other Properties

This same common sense approach can be used with other chemical properties, such as radioactivity and incompatibilities. Any unknown substance, chemicals in high concentrations, and unstable materials (such as those that are temperature- or light-sensitive), those that have multiple bonds, monomers, and materials that are spontaneously combustible are examples of properties that have the potential for significant danger.

Summary

Emergency response personnel must utilize their training, experience, and *common sense* to assess their capabilities at every incident. Situations that are beyond the control of the responder must be identified and the appropriate assistance requested. There is no single response team in existence that has the tools and training to handle every situation that may occur.

The process of identifying incident data and applying common sense can be used in every aspect at every type of incident. Whether the subject is safety, health, or operational tactics, look for the hidden information. Develop and practice your common sense skills. Reference material will not keep you and your team safe. Correct interpretation of the data and proper protective equipment and mitigation tactics can.

Chapter Eight

Chapter 8: Crime Scene Recognition and Preservation

Overview: This chapter is an overview of the process of crime scene recognition and preservation for the hazmat responder with little or no law enforcement training. It discusses the importance of Evidence and Evidence Preservation, Chain of Custody and other important issues responders need to know in order to assist law enforcement efforts without sacrificing safety.

Time Allocated: 1 Hour

Method of Instruction: Interactive Lecture

Terminal Learning Objective:

Upon completion of this chapter the student will be able to define a crime scene, discuss the importance of crime scene and evidence preservation, and describe the role of the first responder in criminal prosecution.

Enabling Objectives:

A. List the types of Crime Scenes HazMat responders may face
B. Define Evidence and list the types of evidence
C. Define Chain of Custody and it's important to HazMat response personnel
D. Describe actions a responder can take to preserve a crime scene
E. Describe a sampling plan and why it is important

Instructional Resources Required:

1. Student Notebook
2. Projection system for PowerPoint (or other similar program)
3. Alternate: Overhead projection with Overhead Slides
4. Dry erase, paper chart and or chalk board with appropriate markers

Instructional Resources Recommended: None

Instructor to Student Ratio: 1:40

Practical Exercise: None

Evaluation Strategy:

Participants will complete a written examination at the conclusion of the class.

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3. Bennett/ Hess, ***Criminal Investigation, Sixth Edition***, Wadsworth Pub, 2001
4. ***California Evidence Pocketbook***, CA DOJ, Sixth Ed, California District Attorneys Assn, 2014
5. ***California Peace Officers Standards and Training (P.O.S.T.) Learning Domains 17 & 31 (January, 2019)***
6. ***Crime Scene and Evidence Collection Handbook****,* U.S. ATF and Explosives, 2004
7. ***Crime Scene Investigation, A Guide for Law Enforcement,*** U.S. Department of Justice, Office of Justice Programs, 1999
8. Drielak, Steven C., ***Environmental Crime, Evidence Gathering and Investigative Techniques***, Charles C. Thomas, 1998
9. ***Environmental Crimes Prosecution Manual****,* California District Attorney's Association. 2004
10. Rutledge, D, ***Search and Seizure Handbook,*** Sixth Edition, Copperhouse Publishing, 2000
11. Swanson, Charles R., Neil C. Chamelin, Leonard Territo, ***Criminal Investigation*****,** 7th Edition, McGraw-Hill Co., Inc., 2000

Crime Scene Recognition

Exhibit 8.1
Boston, MA 04-15-2013
Boylston Street near the first bomb detonated at the Boston Marathon.

Introduction

Hazardous materials emergencies occur for a variety of reasons; some accidental, and some intentional. When litigation results, or a criminal act is suspected, additional elements (Including Law Enforcement Agencies, and procedures for the handling of evidence) may come into play.

Technicians will always fill a role as a First Responder, prior to utilizing their advanced level skills. Recognizing a crime scene, taking safe, effective action, and maintaining the integrity of a suspected crime scene can prevent injury or death to themselves, the public, and can maintain the evidence to be found within a suspected crime scene.

From civil litigation to criminal prosecution, virtually every hazardous materials release event could end up being adjudicated in a court of law. Response personnel will always place life safety at the top of their response priority list. Preservation of evidence is a critical component of emergency response, because it affects many aspects of the response, and post-response legal issues. Evidence may indicate a cause, a person/suspect, and/or may link other events together.

"Crime" defined

California's Penal Code, section 15, defines "crime" as:

- An act or omission;
- In violation of a statutory law;
- Commanding or forbidding it;
- And, to which, upon conviction;
- Is punishable

Simply put, when you do something you are not allowed to do, or, you don't do something you are required to do, you have committed a criminal act. If you are apprehended for the criminal act, and a prosecution occurs, a punishment may be levied (Unless you are found not culpable, or not guilty for the act's occurrence).

When criminal acts occur, they are defined by their *elements.* Like the ingredients in a cake recipe, all of those *elements* must be present in order for a crime to have occurred.

Crime defined, Cont.

If a crime's elements include "depositing a dangerous substance in a public place" and the location where the substance deposited was either *not public* or *not dangerous*, the suspect may not be charged with that crime.

Evidence Vs. Sample

Evidence can be categorized in two forms:
Physical
And
Circumstantial

Physical evidence is that which is used to establish the existence, or non-existence of a *fact.* Physical evidence includes fingerprints, DNA, bodily fluids, broken objects that are directly connected to the emergency, etc.
In order for a Prosecutor to successfully proceed with a criminal case, they must have:
(Example)
A 55-gallon drum of hazardous waste is abandoned on piece of property, and blood, and bloody finger-prints are located on the bolt ring and head gasket. The finger-prints and DNA, are submitted for analysis. A small amount of liquid substance inside the 55-gallon drum is taken and also submitted for analysis.
The Crime lab reports that the fingerprints and DNA belong to a known Environmental Crimes Offender.
The liquid analyzed from inside the drum is determined to be a class 8 corrosive liquid.
These elements of physical evidence are submitted to the Prosecutor for a criminal case to be filed.

Circumstantial evidence is evidence that relies on an inference to connect it to a conclusion of fact. For example, a witness sees a person enter a building that this witness knows to be vacant. Moments later, the witness sees the person in question run away. Shortly after that, the vacant building is on fire. Even though the witness did not *see* the suspect start the fire, it can be inferred, circumstantially, that the suspect seen fleeing the vacant building started the fire.

Sampling (Or *Field Sampling*) is used for on-site presumptive analysis. This analysis can be destructive or non-destructive, depending on the test. It is important to understand that <u>samples</u> are taken to help responders understand what they are facing, and <u>evidence</u> is taken for the purpose of a legal proceeding (Criminal or civil).

People committing criminal acts approach, enter and depart the scene. In so doing, evidence is either created, left, taken or destroyed. Such evidence is used to determine what has happened, how and why. This evidence can be fragile or perishable, difficult to detect or readily observable.

Evidence can also provide clues as to the identity of those responsible. It may directly connect people to actions, events or items associated with the actions or events. It may imply a connection or association between or among people as well as to the items, actions or events. First responders to hazardous materials incidents should observe and take note of conditions at or near the scene, and pass it on to investigators.

Exhibit 8.2

San Francisco, CA. 09-30-2008
A criminal investigation into a fatal traffic collision where a secondary release of pathogenic agents were released.

Hazardous Materials Incident Sources or Origins

The following categories are potential sources and origins of Hazardous Materials incidents:

- **Acts of God – *"Meteorological and Geophysical Events"*** (generally incidents or events resulting from natural phenomena such as Floods, Earthquakes, Wildfires, etc.)

- **Acts of War – *"State of War Emergencies"*** (explosives, munitions, chemical and biological warfare agents - of and relating to conditions inherently hazardous on multiple levels.)

- **Criminal Acts – *"Crooks and Terrorists"*** (Intentional acts, incidents or events resulting in violations of Federal, State, and/or local Penal, Vehicle, Health & Safety, Wildlife protection, and other codes & ordinances.)

- **Industrial – *"Things Break"*** (Accidents, incidents or events involving mechanical failure, equipment design flaw or defect, failure to perform proper maintenance, etc.)

- **Mishaps – *"The Human Factor"*** (incident or events resulting from fatigue, inattention, misjudgment, misconduct, failure to follow established protocols, etc.)

- **Transportation – *"Failures of Containment"*** (Failure of containers, vehicles, piping, and vessels used to move, transport, or store Hazardous Materials or Hazardous Waste.)

Any combination of the above may cause, compound or contribute to any other category.

Regardless of location, magnitude, duration, All Hazardous Materials incidents must be investigated to determine the “6-W’s” of Who, What, Where, When, Why and hoW of the incident.
When it is established that the cause of a hazardous materials incident is related to criminal activity, a criminal investigation is commenced. All emergency responders must be alert to the fact that criminal activity may be an element of any Hazardous Materials incident. First Responders, Technicians, and other emergency response personnel must:

- Be alert to conditions and circumstances that indicate a crime may have occurred;
- Be particularly cautious to avoid the possibility of destroying items of *obvious* evidentiary value;
- Be aware of, and watch for irregularities at scene (**B**e **O**n the **L**ook **O**ut);
- Make a conscious effort to notice those things that appear to be out of place or inconsistent with conditions normally encountered under similar circumstances;

And

- Make every effort to limit the potential of their response actions interfering with the investigative process.

Evidence Collection

The collection of evidence at hazardous materials incidents is *not* a time-critical activity. At any particular moment in the response to, and management of, hazardous materials incidents, items with potential evidentiary value may be observed. Until the opportunity presents itself to recover these items safely, (while preserving their evidentiary value), their location should be noted (or marked) and carefully avoided.

The recovery of evidence is accomplished through forensic techniques compatible with the nature of the evidence to be seized, using instruments, containers and procedures deemed appropriate by responsible authorities. The storage, analysis and preservation of sensitive or perishable evidence requires special consideration, as its integrity (and the results of analysis) are of particular importance to the judicial process.

Evidence Collection, Cont.

The technique(s) used to collect evidence depend on the agency collecting the evidence, and what their prosecutors believe is the safest collection method for a successful prosecution.

It is critical that the evidence be collected in coordination with law enforcement. Certain categories of samples (or evidence) require special or unique methods to collect evidence, document, and transport them. Not all evidence is alike. How a biological agent is collected will be very different from how a chemical or radiological agent will be collected. A Generic Sample Plan is included in the digital Student Information files, should your agency not a have a plan of their own.

Important Note: Check with the law enforcement agency, who wants the evidence collected, (For example the FBI WMD Coordinator), for their specific requirements.

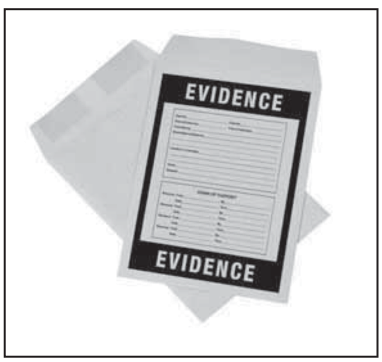
Chain of Custody

Once an item is collected as evidence, a record of everyone who handles or stores that item must be maintained. This record is to guarantee the integrity of the item and is commonly referred to as the "chain of custody."

Maintaining the chain of custody is essential to establishing the admissibility of the item of evidence presented in court. Failure to document the chain of custody may result in the evidence item being ruled as inadmissible.

Unless it is dangerous to do so, or is likely to destroy the evidence itself, the standard is that the person collecting the evidence places their initials on the item(s) for further authentication. In those instances, initials can be placed on the seal around the evidence container or packaging. Other markings may include: date, time, description, location found and case number, as determined by department or agency protocols.

Figure 8.3
Evidence Collection Envelope



Search Warrants

The 4th Amendment of the US Constitution guarantees that each person “Shall be protected from unreasonable search and seizure of person or property without due process of law”.

This right has been upheld and further defined in many cases heard by all levels of court, including the United States Supreme Court. Generally, in order to search a person’s property and seize items for evidence, one of the following must apply:

- The scene is in a public place. (e.g., on a roadway) or in a publicly accessed location (e.g., in a public parking lot).

- Permission has been obtained from the rightful owner.

- A signed search warrant has been obtained. The search warrant authorizes a search based on probable cause and through an affidavit with a court of competent jurisdiction meeting the “due process” mandate of the Constitution.

- The evidence is perishable. A search may be permitted if the evidentiary value will be destroyed before a warrant can be obtained.

- Exigent circumstances exist. The evidence involved in this type of case represents a threat to the public safety, requiring immediate action. Examples might include incidents involving explosives, bombs, and hazardous materials.

Response personnel should consult with their local Prosecuting Attorney’s Office regarding the need for search warrants.

Documentation

Documentation of a hazardous material incident is critical for criminal prosecution, reconstruction of events, and identification of suspects.
Types of documentation include:

Notes and Written Reports

Initial documentation of a hazardous materials incident will consist of handwritten notes taken at the scene. These notes should be thorough and document all investigative steps in chronological order. Emergency response personnel should keep in mind that all documents produced may be presented in court at the request of a defense attorney through a process known as a “discovery order.”
A formal written report should be completed as soon as possible after the incident. The report should be thorough, but simple enough that essential information can be easily located and understood. Slang terms or terms that would be understood only by police and fire personnel should be avoided. The report should be proofread and reviewed thoroughly before anyone approves and signs it.

Sketches and Diagrams

Sketches and diagrams help to clarify the overall scene and illustrate the exact location(s) where evidence was collected. Sketches should include overall scene dimensions, as well as exact measurements of evidence collected. Evidence items located on a sketch should be indicated by placement of a number that corresponds to the master evidence list.

The sketch should include a title block with the case number, date, location, orientation to north, identification of the person who drew the sketch, and the words *"not to scale."* The sketch should also include a legend for others to follow the order of information.

Photographs and Video Recording

Photographs and video recording are excellent supplements to written documentation and sketches. They should be used whenever possible to give an accurate picture of the incident scene.

Digital photos and video recordings should be saved to new storage media. New media is important to show that photos and recordings have not been altered and nothing was erased or hidden. If formerly used storage media is used, it is imperative that memory sticks/chips, etc., be cleared of their content prior to the use at a new incident. Digital data on these memory devices should be placed on a hard drive/burned to a CD/DVD, etc., before the old digital data is removed from the memory device. Check with your legal department to determine the best way to handle this issue, before an incident occurs.

Digital cameras, used for photographing situations which may result in litigation or criminal prosecution will have a wide variety of capabilities. Check with your Agency for specific details of requirements, features, etc.

Whenever possible, Crime Scene Investigations personnel from the local Law Enforcement Agency should be contacted and requested to process the scene once it has been rendered safe. Law Enforcement personnel who have been certified to wear Chemical Protective Clothing are a valuable resource to have available to conduct crime scene analysis and sampling as the event is progressing.

Video documentation should also start with an orientation of the entire scene before concentrating on specific elements. Moving the camera from one side to the other, known as panning, should be done very slowly. Zooming in and out on an object should generally be avoided as it becomes very distracting to the viewer. It is much better to pause the recording and zoom into the object before starting the recording process again.

It is important to remember that the media holding the digital image will become evidence and must be handled carefully. Never erase a picture from storage media. Due to numbering protocols, storage media will show a gap in the numbering sequence and indicate that something was erased.

Evidence Collection Plans

Evidence Collection plans are prepared to document collection activities and map the incident in order to identify, locate and if possible isolate items, substances and areas of concern in the investigative process. These plans include techniques to use in order to safely and effectively obtain specimens for field screening, to determine physical behaviors and chemical characteristics for incident response and management purposes. Evidence collection plans shall include the use of *"CERTIFIED LABORATORY CLEAN" containers* to capture and hold the sample taken.

A *minimum of TWO (2) people* shall be used to obtain the sample. One to collect the sample, physically, and the other to document the procedure and observe the process for safety.

Possible Misdirection (What To Look For)

Emergency responders could be dispatched to locations where legal activities may cause concern due to the presence of quantities of hazardous materials, specialized tools, unusual equipment, laboratory apparatus or peculiar odors. Examples of such facilities and assemblages that may call for the deployment of hazardous materials units include:

> **Handicraft Studios, Jewelry Making, Lapidary Workshops etc.** (May contain flammable gasses, cutting solvents, grinding agents, solvents, cyanide etc.)
>
> **Alcoholic Beverage Making (Beer & Wine) Hobbyists** (May involve cleaning compounds, laboratory apparatus, chemical containers, bottles, jars, reaction vessels etc.)
>
> **Radio Controlled Auto/Aircraft and Rocket Hobbyists** (May contain electrical circuitry, electronic components, flammable solvents, adhesives, and finishes etc.)
>
> **Small Arms Ammunition Reloading Benches and Military Reenactment Organizations** (May involve explosives, primers, propellants, fuses, ammunition, etc.)

Summary

Emergency response to incident sites and crime scenes involving hazardous materials, hazardous wastes or hazardous substances qualify as “hazardous materials incidents” as defined by the U.S. Occupational Safety and Health Administration’s (OSHA) Hazardous Waste Operations and Emergency Response regulations (HAZWOPER, 29 CFR 1910.120). The practices traditionally associated with investigations into criminal activity do not relieve managers, supervisors or senior investigators of the responsibility to comply with this law, or to follow good site safety procedures.

Recognizing that an incident is or may be a crime scene is critical for the protection of first responders. Recognition will aid in understanding what dangers are or could be present, how fast, and to what extent, additional resources will be needed and if entry will be made. If entry is made, knowing this is a crime scene will affect the entry process and alert responders to potential evidence. Understanding the importance of crime scene and evidence preservation will go a long way in assisting law enforcement agencies.

9

Chapter Nine

Chapter 09: Introduction to Clandestine Laboratories

Overview: The subject of this chapter is the clandestine laboratory in its many guises, as well as clandestine laboratory-related hazardous waste disposal/dump sites, pre-production caches of clandestine-related chemicals and emergencies likely to evolve out of these conditions**.**

Time Allocated: 1 Hour

Method of Instruction: Interactive Lecture

Terminal Learning Objective:

At the conclusion of this section the participant will be able to list the primary differences between a Drug Lab, an Explosives Lab and a Biological Lab, and list the response priorities.

Enabling Objectives:

A. List the types of drugs, explosives and chemicals which may found in a clandestine lab
B. List the general types of clandestine labs and their hazards
C. Describe and list the hazards which may be present in clandestine labs
D. Describe and list the pre-entry warning signs of clandestine lab
E. Describe the categories of chemicals which may be found in a clandestine lab
F. Describe difference in equipment/lab ware when comparing a drug lab to a chemical lab to a bio lab

Instructional Resources Required:

1. Student Notebook
2. AV-Media Projection system for PowerPoint (or other similar program)
3. Alternate: Overhead projection with Overhead Slides
4. Dry erase, paper chart and or chalk board with appropriate markers

Instructional Resources Recommended: None

Instructor to Student Ratio: 1:40

References:

1. Identifying and Differentiating among Clandestine Biological, Chemical, Explosives and Methamphetamine Laboratories. Feb. 14, 2008, Joint Special Assessment of the Los Angeles JRIC and DHS Office of Intelligence and Analysis FOUO
2. Distinguishing a Biological Agent Production Laboratory from a Methamphetamine Laboratory, January 22, 2008, Brian Souza, Z-Division Lawrence Livermore National Laboratory, FOUO
3. Network Environmental Systems, Inc**.,** *Clandestine Laboratory First Responder – Field Guide*
4. Indicators and Warnings of Improvised Chemical and Biological Agent Production, Second Edition, July 2005, cbrncsubgroup@tswg.gov, FOUO
5. Indicators and Warnings for Homemade Explosives, GPO Stock Number: 008-001-00185-1, First Edition, March 2008, FOUO
6. Title 8 CCR 5192/CFR 1910.120
7. P.O.S.T. LD-26 (Unusual Occurrences)

Practical Exercise: None

Evaluation Strategy:

Participants will complete a written examination at the conclusion of the class.

Introduction to Clandestine Laboratories

The ever-increasing demand for illegal drugs (controlled substances), explosives, poisons and chemicals used in their production provides an attractive, profitable opportunity for members of the criminal community.

Clandestine laboratories are capable of producing a wide variety and volume of illegal drugs, designer drugs (drugs intended to circumvent regulation), explosives, and poisons to meet the demand of those who use their products. The operators of these labs steal, smuggle or otherwise obtain all that is needed to establish and operate facilities dedicated to the production of essential ingredients, intermediate compounds and finished products on an impressive scale.

Drugs Illegally Produced in Clandestine Laboratories

Amphetamine (AMP)	Fentanyl (AMF, etc.)
Gamma hydroxy butyrate (GHB)	Lysergic acid diethylamide (LSD)
Methamphetamine (METH)	Methcathanone (CAT)
Phenethylamines (MDMA, etc.)	Phenylcyclohexyl piperidine (PCP***)***

The majority of the clandestine laboratories discovered in the past few years in California have been methamphetamine related. However, LSD, PCP, MDMA, amphetamine laboratories producing hard-to-get ingredients, (and explosives) are also encountered. Terrorist operated labs have been found, as well as “entrepreneur” labs.

Clandestine Laboratories are a serious problem for emergency responders called upon to manage emergencies associated with them. These hazards include, but are not limited to:
*Variety of suitable locations and production facilities;
*Hazardous nature of the chemicals and processes involved in production:
*Use of improvised equipment and systems used;
And
*The hazardous wastes generated.

Clandestine laboratory operators and their facilities are found in densely populated neighborhoods, within environmentally sensitive habitats, among industrial complexes, or along major transportation routes. Clandestine laboratories have been discovered in all conceivable locations including hotel rooms, adjacent to day care centers, and within mobile home parks.

Clan Lab operators are not concerned about the ultimate disposition of the wastes they generate, or the fate of the properties they contaminate. They focus on the use of the materials that profits the production, distribution and sale of their product can bring.

The most direct and easily identifiable cost is that incurred in clandestine laboratory cleanup. The cleanup of hazardous materials, wastes and other contaminants from clandestine laboratories is complicated and expensive. The level of training and kinds of equipment required to adequately prepare personnel to clean up clandestine laboratory sites is expensive to obtain and costly to maintain.

Clandestine Laboratory Locations and Facilities

In fact, a clandestine laboratory may be established anywhere. All elements and constituents may be brought to any location to accomplish a synthesis or cook. Furthermore, any facility will do, in fact no facility is necessary. Clandestine laboratories have been found in mine shafts, dugouts, caves, and even the wide-open spaces. The following is a partial list of potential locations:

Apartments	Attics	Basements
Boats	Campers	Farm labor camps
Garages	Houseboats	Orchards and vineyards
Mobile homes	Motel rooms	Motor homes
Sheds	Trailers	Self-storage units/lockers
Mines	Trucks and Vans	

The Clandestine Laboratory Definitions:

Clandestine: Done in secrecy or concealment for the purpose of subversion or deception.

Clandestine Laboratory: An illicit operation consisting of a combination of equipment and chemicals that either has been or could be used in the manufacture or synthesis of controlled substances.

Clandestine Laboratory Synthesis: Creation of a substance (drug, explosive, or poison) not found in nature by means of one or more chemical reactions. High temperatures, pressures and catalysts are usually required.

Clandestine Laboratory Types

Clandestine laboratories are defined by law enforcement based on the type of activity they are primarily engaged in. There are no hard and fast rules regarding this classification system however. The function of a particular laboratory site or facility may change based on the needs of the production process or whims of those engaged in operating them.

Extraction Laboratory – Facilities, equipment and chemicals used to separate precursors from plant materials or over-the-counter sources. (Examples – ephedrine from Ephedra plants, ephedrine from cold medications, red phosphorus from matchbook striker plates, iodine from tincture of iodine, etc.)

Manufacturing Laboratory – Facilities, equipment and chemicals used to synthesize new chemicals. (Examples – gunpowder manufacturing, methamphetamphetamine manufacturing, Ecstasy manufacturing, gamma hydroxy butyrate manufacturing, etc.)

An extraction laboratory could become a manufacturing laboratory with very little effort or expenditure. Furthermore, the production process can be separated into discrete stages that may be accomplished in facilities located at widely separated locations.

Conversion Laboratory – Facilities, equipment and chemicals used to change drugs or other chemicals to an alternate form. (Examples – conversion of methamphetamine base (oil) to methamphetamine hydrochloride.)

Tableting Laboratory – Facilities, equipment and chemicals used to process bulk controlled substances into tablet dosage units. (Examples – tableting Ecstasy, tableting methaqualone, etc.)

Clandestine Laboratory Hazards

The threat posed by the following conditions cause them to be considered as priority hazardous conditions likely to be encountered by emergency responders to clandestine laboratories. This is due to their potential for serious harm and the probability of any one or combination of them being encountered at any given laboratory. Clandestine Laboratory response and mitigation should be considered as High Risk/Low Frequency events.

Suspects – Unpredictable persons, whether under the influence, psychotic or simply criminal in disposition, present the number-one safety hazard to emergency response personnel deployed at clandestine drug laboratory incidents.

Explosions – Often result from inappropriate handling of solvents or incompatible and reactive materials. Explosions can also result from activation of booby traps or improvised explosive devices.

Fires – The frequent result of mishandling flammable solvents under conditions of poor ventilation with readily available sources of ignition.

Chemical Exposure – Usually the result of poor container handling practices, containers constructed of incompatible or inappropriate materials and the lack of adequate ventilation.

The Top Ten Clan Lab Hazards

1. Flammable and/or explosive atmospheres
2. Acutely toxic atmospheres
3. Leaking or damaged compressed gas cylinders
4. Clan labs located in confined spaces
5. Water reactive and pyrophoric chemicals
6. Damaged and leaking chemical containers
7. Electrical hazards and sources of ignition
8. Reactions in progress, hot and pressurized
9. Incompatible chemical reactions
10. Booby traps and improvised explosives

Exhibit 9.1 Suspected Clandestine drug Lab

Clandestine Laboratory Chemicals

Chemicals commonly used in synthesis of illegal drugs, explosives, and poisons, cleaning the finished product and other ingredients, and producing precursors in clandestine laboratories are generally easy to obtain from commercial sources or made by other clandestine laboratories dedicated to their production.

Precursors – chemicals that are changed to the desired controlled substance. They are usually very similar to the finished product in composition and require only minimal modification in structure and arrangement. (Examples – ephedrine, phenyl-2-propanone, phenylacetic acid, etc.)

Reagents – chemicals used in reactions to convert the precursor into the desired controlled substance. (Examples – hydrofluoric acid, sodium hydroxide, iodine, anhydrous ammonia, etc.)

Solvents – chemicals used to separate or purify precursors, other chemicals and controlled substances. Most are flammable and some are highly toxic. (Examples – Coleman fuel, Freon, alcohol, ether, etc.)

Catalysts – chemicals that initiate or encourage reactions without becoming part of the finished product. Most catalysts are highly reactive and potentially dangerous. (Examples – Lithium, sodium, Raney nickel, red phosphorus, etc.)

The volume and variety of chemicals used in the production of controlled substances in clandestine laboratories is large and many of these substances are quite common in the industrial context.

The following summary is offered to aid in understanding the general classes of clandestine laboratory chemicals, their attendant hazards, behaviors and characteristics. Also provided are examples of chemicals likely to be encountered.

Flammable Chemicals

Flammable liquids produce vapors which may form flammable atmospheres in air. These vapors also have toxic characteristics and may be inhaled. Because these chemicals are organic, they could be involved in dangerous reactions with oxidizing chemicals.

Examples of flammable clandestine laboratory chemicals – acetaldehyde, acetone, benzene, ethanol, ethyl ether, methanol, petroleum distillates, piperidine, toluene, Xylene.

Combustible and Non-Combustible Chemicals

Combustible chemicals provide fuel in the event of ignition. Decomposition generates acutely toxic by-products. Exposure to oxidizing chemicals generates incompatibility reactions. Toxic vapors may be inhaled and toxic liquids may be absorbed.

Examples of combustible clandestine laboratory chemicals – analine, benzyl chloride, cyclohexanone, diesel fuel, and kerosene.

Examples of non-combustible clandestine laboratory chemicals (often used as solvents) – carbon tetrachloride, Freon 11®, formic acid, methylene chloride.

Acid and Caustic (corrosive) Chemicals

Acids and caustics cause tissue destruction and chemical burns on contact. The acids can react with metals to liberate hydrogen which can cause explosions. The corrosives react with water to generate heat at dangerous levels. They will also react violently with each other.

Examples of acids - acetic acid, hydriodic acid, hydrochloric acid, hydrofluoric acid, nitric acid, phosphoric acid, sulfuric acid.

Examples of caustics – sodium hydroxide, potassium hydroxide, ammonium hydroxide

Reactive Chemicals

These chemicals may react with water, air or organic solvents. The resulting reactions can cause explosions, fires, and generate toxic or corrosive by-products.
Examples of reactive chemicals - lithium, lithium borohydride, Palladium black, phenyl magnesium bromide, Raney nickel, sodium, thionyl chloride.

Poisonous (toxic) Chemicals

These chemicals are toxic by inhalation, ingestion, and/or skin absorption. They may also be irritating, reactive, corrosive or carcinogenic.

Examples of poisonous chemicals – acetic anhydride, benzene, iodine, lead acetate, mercuric chloride, various pesticides, vinyl chloride.

Compressed Gases

The contents of compressed gas cylinders may be toxic, explosive, flammable, corrosive, or irritating. The gases are under high pressure, and the cylinders and appurtenances are usually abused and/or damaged.

Examples of compressed gases – acetylene, ammonia, hydrogen, hydrogen chloride, hydrogen sulfide, methylamine

Clandestine Laboratory Processes

Extraction – The process of separating a chemical from a commercial product, using a solvent. (Example – The extraction of ephedrine from cold medications, extraction of phenylpropanolamine from diet aids, extraction of ammonium bi-fluoride from window etching compounds, etc.)

Reflux – The process of trapping and condensing vapors, returning them to a chemical reaction. (Example – The reflux of psuedoephedrine, iodine and red phosphorus to produce methamphetamine.)

Distillation – The process of separating chemical compounds by heating, condensing and siphoning vapors, and returning them to a liquid state. (Example – The distillation of phenyl-2-propanone from a phenylacetic acid reaction.)

Hydrogenation – The chemical reaction accomplished under pressure using hydrogen gas and a metal catalyst to saturate a chemical compound. (Example – The hydrogenation of chloro-psuedoephedrine to methamphetamine hydrochloride.)

Clandestine Laboratory Materials and Equipment

The illegal manufacturing in a clandestine laboratory is dependent upon a series of procedures that may be broken down into phases, stages, and/or processes. Synthesis requires a precursor, reagents, solvents and catalysts (certain essential ingredients).
The selection of components for the clandestine production of anything is dependent upon availability, the imagination of the laboratory operator, and recommendations contained in the recipe for the method of production. Improvisations and substitutions are used to adapt suitable shapes and materials for clandestine laboratory purposes.

Glassware

Adaptors (connecting, distilling, vacuum, ground glass, other)
Beakers (Griffin)
Condenser Columns (Allihn, Liebig, Graham)
Flasks (boiling, Florence, Erlenmeyer , vacuum, volumetric)
Funnels (filter, addition, separatory)
Graduated Column, (beaker, flask)
Reaction Vessels (various sizes and types)

Exhibit 9.2 Glassware Assortment

Hardware

Balances, Scales, Measuring Cups
Fans, Fume Hoods
Heat Lamps, Hair Dryers, Desiccating Dish
Heating Mantles, Hot Plates, Electric Fry Pans, Crock Pots
Hydrogenators, Pressure Cookers
Pipes, Tubing, Hoses
Pumps (vacuum, liquid, suction)
Presses (bearing, filter)
Stands, Clamps, Fittings
Stirrers, Mixers, Blenders, Grinders

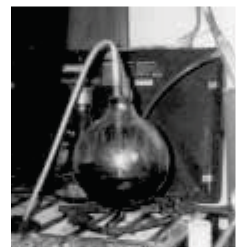


Exhibit 9.3 "Round-bottom" Beaker

Containers

Drums of steel, plastic, or fiberboard with or without polyethylene lining
Metal cans, pails
Plastic carboys
Steel cylinders (compressed gas)
Multiwall paper bags (dry powders, beads)
Glass and plastic bottles, vials, etc.

Exhibit 9.4 Clean up operations

Clandestine Laboratory Odors

Nearly all elements of clandestine laboratories have odors associated with them. Clandestine laboratory-related vapors, fumes and gases frequently have distinctive odors associated with them, with the vapors being recognizable from the chemical processes used in the manufacture of these illicit substances.

Some clandestine laboratory chemicals have no odor or taste threshold. In other instances, the odor threshold is minimal or closely approaches that of serious injury or death. In many instances, the chemicals themselves may cause a loss of the sense of smell.

Odors commonly encountered in association with clandestine drug laboratory activities include the following:

- Solvent-like (alcohol, hospital, paint thinner)
- Fuel-like (gasoline, barbecue lighter)
- Ether-like (sweet, pleasant)
- Vinegar-like (strong, biting)
- Ammonia-like (harsh, urine, unpleasant)
- Pungent (acrid, sour, putrid)

Hazardous Materials Technicians and Clandestine Laboratories

Clandestine laboratories come to the attention of emergency response and management personnel as a result of a variety of incidents. Firefighters may respond to clandestine laboratory-related fires, explosions or medical emergencies. Law enforcement personnel may be dispatched to crime scenes, family disputes or other activities and encounter drugs, clandestine laboratories, explosives, and individuals who are under the influence. Environmental and health professionals encounter clandestine laboratory-related conditions such as contaminated properties, health complaints, environmental damage, etc.

Hazardous materials teams are called upon to support narcotics task force personnel and others at the scene of such problems. Under these conditions they are asked to perform certain functions such as fire suppression, emergency medical support, or decontamination.

Occasionally the hazardous materials technician or specialist may encounter a clandestine laboratory, clandestine laboratory hazardous waste disposal site or chemical cache. Clandestine laboratory response calls for the exercise of all elements of hazardous materials response protocols, consistent with OSHA, EPA, NFPA and California Specialized Training Institute's Hazardous Materials Technician and Specialist Programs.

Emergency actions consist of the following issues:

Immediately recognize the incident as clandestine laboratory-related and be aware of the level of threat that it presents. Your actions should include, at the minimum:
*Immediate area is alerted to the situation at hand;
*Protective actions should be implemented immediately;
And
*Personnel who became exposed on the initial response should be decontaminated and all personnel should regroup while the scene is assessed further.

Emergency response and management of clandestine laboratories is a multidisciplinary function that is challenging and could lead to long-term consequences to public safety personnel, the public and the environment.

Tips on the safe response to, and scene mitigation of suspected Clandestine Laboratories:

1. Do Not handle unknown chemicals or explosives

2. Chemicals can be "processed" in any type of container. Soda bottles, drink cups, blenders, tin cans, pots, pans, coffee makers and etc.

3. If chemicals, containers and/or biological incubators appear to be out of place, back out until you gather the information you need.

4. Do not turn electricity on or off, do not open or close doors (cabinets, refrigerators, and container).

5. Do not use your radio or cell phone until you are a safe distance away.

6. Once suspected as a lab, control the scene as a crime scene until proven otherwise.

7. Be alert for reporting parties who are suspects and suspects who are still in the area.

8. Have a list of resources for this type of incident and call for assistance early.

9. Remember that crystallized explosives can detonate with the slightest of contact.

Additional information can be found at the Attorney General's Office, including regulations, statistics, contacts and other resources.
Go to: http://ag.ca.gov/bne/clanlab.php

Summary

Recognizing that an incident is or may be involve illicit or clandestine laboratories is critical for the protection of Technicians at scene. Recognition will aid in understanding what dangers are or could be present, how fast, and to what extent, additional resources will be needed and if entry will be made. If entry is made, knowing there is a potential for improvised explosive devices, possible criminal suspects, and dangerous chemicals/objects used in illegal manufacturing processes, will affect the entry process and alert responders to potential evidence.

10

Chapter Ten

Chapter 10: Weather Considerations

Overview: The effects of weather on a hazardous materials incident can be dramatic and can catch responders unprepared. A basic understanding of daily weather patterns, as well as irregular weather events that may occur, will help responders better manage a hazmat incident.

Time Allocated: 1 Hour

Method of Instruction: Interactive Lecture

Terminal Learning Objective:
At the conclusion of this section the participant will be able to list the most important elements of weather which can change the hazard and response procedures at a hazmat incident and discuss how they affect an emergency response effort.

Enabling Objectives:
A. List the three weather values which can influence a hazmat incident
B. Describe how each of these elements can influence a hazmat incident
C. List detection and quantification methods for the three values

Instructional Resources Required:

1. Student Notebook
2. Projection system for PowerPoint (or similar program)
3. Dry erase, paper chart and or chalk board with appropriate markers

Instructor to Student Ratio: 1:40

References:
1. FIRESCOPE Field Operations Guide
2. CSTI Hazardous Materials Technician (4 Week Course)
3. NFPA 472, Competence of Responders to Hazardous Materials Incidents
4 Columbia Weather Systems White Paper
5. Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities, NIOSH/OSHA/USCG/EPA, US Department of Health and Human Services

Practical Exercise: None

Evaluation Strategy: Participants will complete a written examination at the conclusion of the class.

Weather Considerations

The information contained in this chapter is intended to provide an overview and understanding of weather and its effect on a hazardous materials incident. Weather is in a constant state of change due to many factors and in many cases can be forecasted to understand what changes may be occurring and to correlate this information as we develop response strategies.

The effects of weather can in some instances create additional challenges and conversely, they can also work in our favor; it is important that we consider these changing conditions to maximize our effectiveness.

In the early phases of developing an incident action plan we must gather current and projected weather conditions and apply this information to what we know about the physical properties of the chemical. Accurate weather information is needed to predict how chemicals will behave under current atmospheric conditions. We will discuss some of the elements of weather information which are important values as they may have a direct impact on the incident.

Weather Resources

There are several resources available to the hazardous materials team to obtain current weather including cell phone apps, portable weather stations, internet and the National Weather Service. Of these options weather obtained at the scene is among the most accurate as it is real time data. Some portable weather stations transmit weather information directly to the hazardous materials team and are linked with computer data bases. Information such as temperature, humidity wind speed and direction are essential for predicting plume modeling for downwind protective actions. These systems can monitor weather conditions and average information such as wind speed and direction over a period. Other factors affecting weather information is where you are physically located while gathering data such as temperatures. If the hazardous material release is occurring in a facility which is surrounded by black asphalt and your temperature readings are taken on a grassy area the actual temperature at the release site can be significantly higher than the value that you obtained. Whenever practical it is preferred to gather this data on a similar surface to be more accurate.

Weather Patterns

In many cases weather patterns are predictable for geographical areas based upon factors such as topography and prevailing weather conditions. Some examples of this are up slope winds in early hours which change direction in the afternoon to down slope winds, many coastal areas are affected by early morning and late evening FOG. Responders who live and work in these types of areas are aware of these types of weather patterns and can anticipate these normal changes.

Weather Values

When we refer to values about weather, we are talking about specific data that is important for us to take into consideration. The following values are examples of weather data that may either positively or negatively influence the incident.

- TEMPERATURE
- WIND
- MOISTURE

Temperature

Temperature is among the most significant weather factors that may influence a hazardous materials incident. Temperature may drive some of your tactical objectives especially when we consider extreme high and low temperatures. Responder safety must always be weighed when placing personnel in chemical protective clothing. If the current temperature is well above 100 degrees and the temperature is predicted to drop significantly after sundown one of your options is to weigh the risk/gain to wait for more favorable temperature conditions to make an entry. Extreme cold temperatures can create conditions exposing response personnel to hypothermia which can be equally as dangerous as hyperthermia. OSHA/ NIOSH Heat Index cell phone app. uses actual air temperature and relative humidity for Occupational Exposure to Heat and Hot Environments.

If we look at the effect of temperature on chemicals, we can relate this to observations we have made during previous modules. We have studied the effects of volatility and understand the relationship of temperature to volatility. As temperature increases volatility increases as well and remember it is the vapors that are produced which can potentially ignite. You may have a static scene that slowly becomes more dangerous as the heat from the sun warms the chemical and produces dangerous vapors, we must predict these effects and not allow them to catch us by surprise. The following volatility relationship chart illustrates the effects of temperature on volatility.

Figure 10.1: As volatility increases:

Vapor pressure (VP)		Increases
Evaporation rate (ER)		Increases
Vapor content (VC)		Increases
Vapor travel (VT)		Increases

Figure 10.2: As volatility increases:

Boiling point (BP)		Decreases
Melting point (MP)		Decreases
Freezing point (FRP)		Decreases
Heat output (HO)		Decreases
Viscosity (V)		Decreases

Wind

Wind speed and direction should be obtained in an open area to gather more accurate values for plume modeling predictions and protective actions. Windsocks provide a visual indicator of wind direction, and provide a rough idea of velocity. If a windsock is not available a piece of fire line tape placed on an antenna will provide this visual reminder to ensure that the team remains in an upwind position. Wind direction can change slowly over time or suddenly and if not monitored it could result in placing the team in harm's way if downwind from the release. Some geographical areas are prone to swirling winds where close attention to wind direction must be closely monitored by an assigned responder.

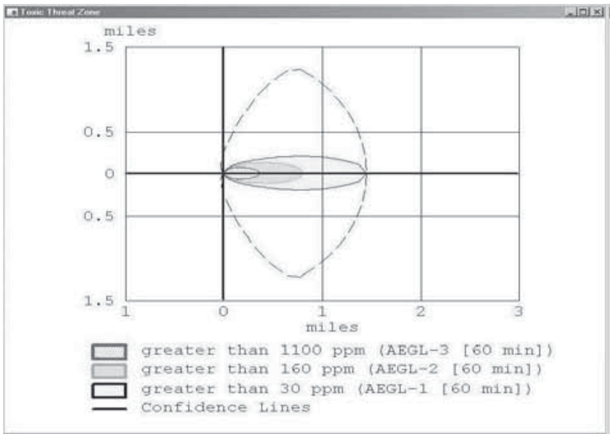
Wind speed is another value that can have a significant effect on protective actions. Conversely, these downwind zones with a strong wind are further however the width becomes narrow.

Humidity

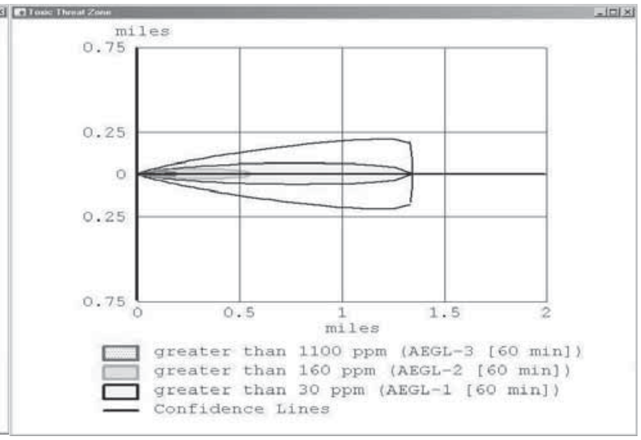
Moisture content in air information is referenced as Humidity. The moisture can be described as the wetness or conversely dryness of the air which either condition may influence either positively or negatively a hazardous materials incident. Humidity values are reported in percent (%) commonly referred to as *relative humidity*. 100% humidity is fully saturated air. Moisture in the air can present as clouds, fog, and/or rain and should be considered when gathering weather data.

The moisture in the air could potentially have a positive or negative impact on the chemical release. Additionally, moist air and cloud cover can minimize the pre-heating of chemicals and reduce the chance of vapor production and/or fire. Conversely, moist air can significantly have a negative impact on a water reactive chemical resulting in fire. Rain can create a challenging effect on a release allowing for the chemical to spread and all these potential outcomes must be considered when we gather information and develop an action plan.

Exhibit 10.3: Plume models with differing wind speeds factored in



Ammonia plume with 1 mph wind



Ammonia plume with 30 mph wind

Summary

It is important to consider many factors when we gather weather values. As discussed, the weather can create positive conditions as well as create challenges. All the information that you gather ultimately leads to the development of incident objectives and action planning. We must continue to monitor for changes and use all available resources to predict weather and anticipate changing conditions. CAMEO/ALOHA software uses ongoing weather measurements to estimate how a toxic cloud might disperse after a chemical release. During an emergency there needs to be clear communication between sources of data, decision-makers, and team members on scene. Automated, digital data transmission is an emerging technology that can free up critical manpower and provide multiple users with precise on-scene data.

11

Chapter Eleven

Chapter 11: **Hazardous Materials Response and The Hazmat Incident Command System**

Overview: This chapter introduces the participant to SEMS, NIMS and reviews the Incident Command System related to hazardous materials response

Time Allocated: 60-120 Minutes (Class Dependent)

Method of Instruction: Interactive Lecture

Terminal Learning Objective:

The participant will be able to list the positions, duties and responsibilities of the Command Staff and General Staff within a Hazardous Materials Response ICS

Enabling Objectives:

A. Describe SEMS and NIMS
B. List the responsibilities of the Command Staff and General Staff
C. Describe the major components of the Incident Command System
D. Describe the ICS positions for a hazardous materials incident

Instructional Resources Required:

1. Student Notebook
2. Computer system for visual aids and supporting documents
3. Projection system for PowerPoint (or similar program)
4. Dry erase, paper chart and or chalk board with appropriate markers

Instructional Resources Recommended:
1. One copy ICS HM 120 or Field Operations Guide

Instructor to Student Ratio: 1:40

References:

1. FIRESCOPE Field Operations Guide
3. Title 8 CCR 5192/1910.120
6. CSTI Hazardous Materials Technician (4 Week Course)
7. NFPA 472, Competence of Responders to Hazardous Materials Incidents (2008 Ed)

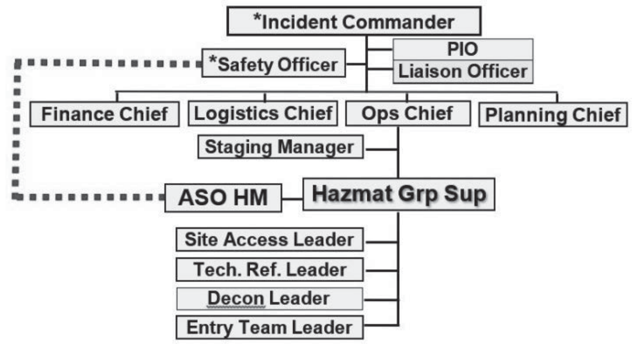
Practical Exercise: None

Evaluation Strategy: Complete a written examination at the conclusion of the class.

The Incident Command System: NIMS and SEMS

Hazardous Materials Incident Management and Organization

The ICS standardized terminology, flexibility and modular organization provides a comprehensive command and control structure for single and multi-agency response. A thorough working knowledge of the Incident Command System (ICS) is necessary for efficient and safe hazardous materials incident operations.



ICS is an essential component of SEMS for proper incident organization, tactical and strategic planning, resource management, and safety. Within the State of California, the Standardized Emergency Management System, SEMS, was adopted by the California Office of Emergency Services to coordinate communication and operations among all incident response organizations, including fire, law enforcement, public utilities, and private industry response groups. In this chapter the fundamentals of complying with NIMS utilizing SEMS and standardized ICS will be discussed in the context of responding to hazardous materials and WMD incidents of all magnitudes.

The standardized ICS and was adopted by Federal Emergency Management Agency. It is required by Presidential Homeland Security Directives 5 and 8, and local, state, and federal response agencies must utilize the National Incident Management System. ICS is an essential required component of NIMS.

(SEMS) State of California, Standardized Emergency Management System

The Standardized Emergency Management System (SEMS) standardizes the principles and methods of emergency response in California. SB 1841 enacted January 1993, Section 8607 of the California Government Code, requires all California state and local response agencies to use the SEMS, tying compliance to state financial assistance for Preparation, Mitigation, and Recovery. SEMS incorporates the FIRESCOPE (see ICS) Standardized Incident Command System (ICS) and multi-agency coordination system (MACS), mutual aid agreements (sec. 8561), and the operational area concept (sec. 8559) for state wide incident management.

California, emergency response agencies benefit from a number of established mutual aid systems and components for agencies and regions to acquire assistance during major disasters. FIRESCOPE provides the California Disaster and Civil Defense Master Mutual Aid Agreement,

(SEMS) State of California, Standardized Emergency Management System, Cont.

(MMAA) and MACS with the system identification of resources by ***kind*** and ***type***, such as hazmat team type I.
SEMS requires emergency response organizations, affiliated utilities and special districts **"**develop a plan providing for the effective mobilization of resources and facilities, both public and private, to cope with any type of disaster**"**; providing provides a well-organized all-risk system for managing disasters.

SEMS has integrated Operational Areas (county OES) and OES Regions specific mutual aid systems to ensure that resources will be obtained in a timely and organized manner. Additionally, the system ensures interoperability of individual agency EOPs and EOCs with those of the Operational Areas and Regions that will be accessed for assistance.

The SEMS activation sequence to the level needed begins with Field Response, to Local Government, to the Operational Area, to the State Region and then the State. An Area Plan may require immediate activation at any level. Major components of SEMS include: ICS, Multi-agency Coordination System, MMAA and Operational Area Concept. SEMS management functions are Management/Command, Operations, Planning/Intelligence, and Finance Administration. NIMS is utilized when California requires interstate and/or federal assets. SEMS allows a smooth transition to NIMS as described below.

(NIMS) National Incident Management System

Retaining the SEMS concept, NIMS is the national all-risk template enabling all government, private-sector, and nongovernmental organizations to work together during incidents requiring multi region and interstate resources. Homeland Security Presidential Directives (HSPD) 5 and 8 to standardized national response. On February 28, 2003, HSPD-5 directed the Secretary of Homeland Security to develop and administer a National Incident Management System, (NIMS).

NIMS incorporates FIRESCOPE ICS and MACS for a comprehensive, national approach to incident management that is applicable at all jurisdictional levels and across functional disciplines. The flexibility of ICS permits incident management of a magnitude requiring an interstate response and/or that will have an interstate impact; incident management can transition from the initial response to the level needed with efficient communication, resource organization and acquisition, coordinated tactical and strategic planning, and rapid dissemination of incident information to the public as appropriate.

NIMS enhances the Public Information System, with the Joint Information System and Center to insure incident information flows across jurisdictional and functional boundaries. The NIMS communication asset further supports Multi-Area Command System or Unified Command scale incidents.

ICS

The FIrefighting REsources of Southern California Organized for Potential Emergencies, **FIRESCOPE,** established by fire protection agencies in 1970 after several disastrous fires in Southern California and the need for a new approach to the problem of managing rapidly moving wildfires. The FIRESCOPE interagency task force worked cooperatively with local, state and federal agencies. FIRESCOPE developed the Standardized Incident Command System (ICS) based on best practices and key principles: Common Terminology, Modular Functional Organization, Management by Objectives, and Incident Action Plans. 14 essential features were developed, some of which are: Command and Control, Unified Command, Unity of Command, Flexible Modular Organization, Span of Control, Incident Facilities and Accountability.

Unified Command is necessary when multi-agencies or jurisdictions have responsibility for the incident, to coordinate effective information flow between agencies and to establish a common set of objectives and strategies. Under Unified Command, each response agency with jurisdictional authority will provide a representative to remain at the command post and have the authority to speak for and commit agency resources. Other agencies that do not have statutory responsibility for an incident access the command structure through the Liaison Officer. Hazardous materials incidents are managed using a unified command because fire, law enforcement, and public health will all have some statutory functional responsibility for incident mitigation.

Organization of the Incident Command System is based on a structure that is identified by common terminology. There is a position title for each position within the ICS which only applies to a specific incident and is not related to that person's title outside of the response command structure. Example: a fire captain may be assigned Operations Chief, during which time the fire chief is identified as Ops Chief for the incident. The position title identifies the position responsibility, authority, and position in the chain of command. The position identifiers are as follows:

- Incident Commander – Command
- Command Staff – Officers
- Sections – Chiefs
- Branches – Directors
- Groups – Supervisors
- Teams/Units – Leaders
- Areas – Managers

Incident Command System Benefits

- Flexibility – Activating or deactivating modular functions as needed
- Clear Accountability and Coordination of Resources
- Common Terminology
- Span of Control – the number of organizational elements that may be directly managed by one person. Span of control may vary from three to seven, **a ratio of one to five reporting elements is recommended**. Example: One Decon Unit Leader to seven personnel
- Management by Objectives
- Action Planning

Modular Development

The Incident Commander (IC) activates command components of the organization as needed. Organization components not delegated are the responsibility of the supervising rank above it. Example: The IC is responsible for general staff positions such as Operations if not delegated.

- **Initial Response Organization**

Initial response operational period and resources are managed by the Incident Commander, who will handle all command and general staff responsibilities until delegated. NOTE: IC & SO are mandated positions.

- **Multi-Division/Group Organization**

The Incident Commander establishes command of the general staff positions and at the request of each general staff position, divisions and groups as needed.

- **Multi-Branch Organization**

Branches are established to maintain Section Chief Span of Control, not to exceed one supervisor to seven resources. Example: A Hazardous Materials Branch may be established to supervise up to seven Hazmat Groups on a geographically large incident involving multiple hazmat incidents.

Hazardous Materials Operational Position Descriptions – Introduction

OSHA requires the use of the Incident Command System during Hazardous Materials Incidents
Title 8 CCR 5192 (q)(3)(A), it states: "The senior emergency response official who has ultimate site control responsibility shall confirm that the Incident Command System (ICS) is in place and the position of Incident Commander (IC) instituted." Title 8 and 29 CFR 1910.120 (q)(3)(i) require an IC and a Safety Officer 29 CFR 1910.120 *(q)(3)(vii)* shall be appointed for all hazardous materials incidents.

The Hazardous Materials Group Supervisor directs all resources that have direct involvement with the hazardous material operations within the control zones. The hazardous materials command element is designed to provide organizational structure necessary for supervision and Control of functions at hazardous materials incidents that exceed the initial response assets. This provides controlling the tactical operations and movement of personnel and equipment a greater degree of safety and reduce the spread of contaminants.

The Hazardous Materials Group supervises four functional elements: Technical Reference Leader, Entry Team Leader, Decontamination Unit Leader, and Site Access Control Leader. Supervision of these elements requires a high degree of control and close supervision.

- The Entry Leader supervises all personnel operating in the exclusion zone.

- The Decontamination Unit Leader supervises all operations in the contamination reduction zone (except Safe Refuge Area Manager). The Decon Unit Leader ensures all civilians, response personnel, and equipment have been decontaminated before leaving the incident.

- The Site Access Control Leader controls all movement of personnel and equipment between the control zones. The Site Access Control Leader is responsible for isolating the exclusion and contamination reduction zones and ensuring that civilians and incident personnel use proper access routes. The Site Access Control Leader is responsible for the care and movement of people in the safe refuge area.

    - The Refuge Area Manager (located in the Exclusion Zone) is responsible for preventing the spread of contamination, evaluating and prioritizing victims for decontamination and medical treatment. The Refuge Area Manager coordinates with the Entry Team Leader and Decon Unit Leader to facilitate prioritization and movement of victims to the Safe Refuge Area. Ref ICS-361-6 lesson

    - The Safe Refuge Area Manager is appointed by and reports to the Site Access Control Leader to assist with the control and management of victims not requiring immediate medical attention for debrief and observation for residual contamination. Ref ICS-361-7 lesson

- The Technical Specialist-Hazardous Materials Reference (Tech-Ref), may consist of multiple individuals to form a Unit lead by a Leader. The Tech-Ref Unit is responsible for providing technical hazardous materials information and assistance to the Hazardous Materials Group and the Planning Section using various sources such as computer databases, technical information agencies, facility representatives, and product specialists. The Tech-Ref Unit provides product information, identification, verification, physical properties, and hazardous characteristics using various reference sources, hazard categorization tests or by any other means available.

The Assistant Safety Officer-Hazardous Materials is hazardous materials trained, must be present at the hazard site. The Incident Safety Officer will have overall incident safety concerns, with the Assistant Safety Officer-Hazardous Materials working directly with the Hazardous Materials Group Supervisor. (Refer to Chapter 20 for additional information on the ASO/HazMat's specific role)

All tactical operations outside of the hazmat control zones such as evacuation, isolation, medical, traffic control, etc., will be managed by other non-hazmat ICS positions.

Assisting Agencies in Hazardous Materials Incidents

Law Enforcement - The local law enforcement agency will respond to most hazardous materials incidents. Depending on incident factors, law enforcement may be a partner in Unified Command or may participate as an assisting agency. Some functional responsibilities that may be handled by law enforcement are:

- Isolate the incident area.
- Manage crowd and traffic control.
- Manage public protective actions such as evacuation.
- Provide scene management for on-highway incidents.
- Manage criminal investigations.
- SWAT Issues.
- Explosives mitigation.

Environmental Health Agencies - In most cases the local or state environmental health agency will be at the scene as a partner in Unified Command. Some functional responsibilities that may be handled by environmental health agencies are:

- Establish the criteria for cleanup and disposal of the hazardous materials.
- Declare a site safe for entry by the public, under the authority of the county health officer.
- Monitor the environment.
- Supervise the cleanup of the site.
- Enforce various environmental laws and acts.
- Approve funding for the cleanup.

Incident Documentation/ICS Forms

Standard ICS forms are useful tools in managing an incident. Not only do they help in tracking equipment, making assignments, identifying objectives, and ensuring safety, they also serve as valuable documentation for future reference.

One of the most important ICS forms at a hazardous materials incident is the ICS 208, Site Safety and Control Plan. Cal OSHA and Federal OSHA regulations require the development of a site safety plan at a hazardous materials incident.

The ICS 208 is a comprehensive site safety plan template. The site safety plan is not required to affect an emergency rescue; however, the rescue must be documented and what safety measures were taken for the rescue.

Some of the standard ICS forms that are commonly used at hazardous materials incidents are listed as follows:

- ICS 201 – Incident Briefing Form
- ICS 202 – Incident Objectives
- ICS 205 – Communication Plan
- ICS 206 – Medical Plan
- ICS 208 – Site Safety and Control Plan
- ICS 214 – Unit Log

Other forms have been developed by hazmat teams for medical monitoring, suit time log, etc. Although these forms can be quite useful for special purposes, it is recommended that standard ICS forms be used whenever possible for consistency and easy recognition.

Hazardous Materials Team Typing

Hazmat Team Typing definitions provides the means to order appropriate response assets. Through FIRESCOPE, California initiated the process of Hazardous Materials Team Typing. FEMA uses the FIRESCOPE template as the basis of their program. The California Office of Emergency Service manages the HazMat Team Typing System in California.

The California Team Typing Program can be located at:
http://www.firescope.org/specialist-groups/hazmat/hazmat-sel.pdf

http://www.caloes.ca.gov/cal-oes-divisions/fire-rescue/hazardous-materials/team-typing-information

The FEMA team typing program is located under the Resource Management Program at:
http://www.fema.gov/emergency/nims/ResourceMngmnt.shtm

Initial Response ICS

The first due emergency responder must give a size-up, establish command and identify the IC. The incident should be named by a location identifier, whether by the IC or the communications center. Safety, Isolation and Notifications are the first tactical operations for a hazardous materials incident. The IC, with or after the scene size-up report, should establish a staging area and safe traffic pattern for incoming resources. A Safety Officer must be assigned as soon as possible and always before tactical operations begin. The Safety Officer (Assistant Safety Officer – Hazardous Materials, ASO-HM) overseeing the hazardous materials zones must be hazmat qualified.

Transfer of command should be face-to-face to include a comprehensive summary of collected intelligence, actions taken and planned. Notification of the transfer of command should be made to all of the responders should be made responders at scene and en route.

Summary:
In 1993 California mandated the use of the state Standardized Emergency Management System (SEMS).
California SEMS serves to consolidate the efforts of allied organizations such as public utilities, environmental health departments, and health care providers with first responder organizations. California and the Federal DHS require responders to comply with SEMS and NIMS.
SEMS and NIMS require management and tactical positions possess certification and qualification competencies for incident responsibilities. The standardized Incident Command System (ICS), developed by FIRESCOPE, is integral to both SEMS and NIMS as an all risk management system.
ICS is organized with key principles: Common Terminology, Modular Functional Organization, Management by Objective, and Incident Action Plan. A few of the 14 key features of ICS are Unified Command, Unity of Command, Span of Control, and unified Incident Action Plans.
Initial responders using ICS integrate directly into SEMS and NIMS facilitating efficient and rapid incident management. Significant hazardous materials (hazmat) and terrorist incidents require a large number of personnel, multiple agencies, equipment, and incident resources.
Functional hazmat ICS positions and responsibilities provide command and control which are essential for safe and efficient operations. The first arriving responder should establish command and an Incident Commander (S.I.N.)
Transfer of command should be face-to-face and include a comprehensive summary of intelligence, events and actions taken. OSHA requires both an IC and a Safety Officer appointed.

Glossary of Terms

29 CFR Part 1910.120 — 29 of the Code of Federal Regulations, Part 1910.120 is the Hazardous Waste Operations and Emergency Response reference document as required by SARA. This document covers employees involved in certain hazardous waste operations and any emergency response to incidents involving hazardous situations. Federal OSHA enforces this code.

Access Control Point — The point of entry and exit from the control zones. Regulates access to and from the work areas.

CHEMTREC — Chemical Transportation Emergency Center. A public service of the American Chemistry Council (formerly the Chemical Manufacturers Association).

Compatibility — The matching of personal protective equipment to the hazardous materials involved in order to provide the best protection for the worker.

Contamination Reduction Corridor (CRC) — That area within the contamination reduction zone where the actual decontamination is to take place. Exit from the exclusion zone is through the contamination reduction corridor (CRC). The CRC will become contaminated as people and equipment pass through to the decontamination stations.

Contamination Control Line (CCL) — The established line around the contamination reduction zone that separates the contamination reduction zone from the support zone.

Contamination Reduction Zone (CRZ) — That area between the exclusion zone and the support zone. This zone contains the personnel decontamination station. This zone may require a lesser degree of personnel protection than the exclusion zone. This area separates the contaminated area from the clean area and acts as a buffer to reduce contamination of the clean area.

Control Zones	The geographical areas within the control lines set up at a hazardous materials incident. The three zones most commonly used are the exclusion zone, contamination reduction zone, and support zone.
Decontamination (Decon)	That action required to physically remove or chemically change the contaminants from personnel and equipment.
Environmental	Atmospheric, hydrologic, and geologic media (air, water, and soil).
Exclusion Zone	That area immediately around the spill. That area where contamination does or could occur. The innermost of the three zones of a hazardous materials site. Special protection is required for all personnel while in this zone.
Evacuation	The removal of potentially endangered but not yet exposed persons from an area threatened by a hazardous materials incident. Entry into the evacuation area should not require special protective equipment.
Hazardous Categorization Test (HAZ CAT)	A field analysis to determine the hazardous characteristics of an unknown material.
Hazardous Material	Any material that is explosive, flammable, poisonous, corrosive, reactive, or radioactive, or any combination, and requires special care in handling because of the hazards it poses to public health, safety, and/or the environment.
Hazardous Materials Incident	Uncontrolled, unlicensed release of hazardous materials during storage or use from a fixed facility or during transport outside a fixed facility that may impact the public health, safety, and/or environment.
Mitigate	Any action employed to contain, reduce, or eliminate the harmful effects of a spill or release of a hazardous substance.

Personal Protective Equipment (PPE)
That equipment and clothing required to shield or isolate personnel from the chemical, physical, and biologic hazards that may be encountered at a hazardous materials incident.

Refuge Area
An area identified within the exclusion zone, if needed, for the assemblage of contaminated individuals in order to reduce the risk of further contamination or injury. The refuge area may provide for gross decontamination and triage.

Rescue
The removal of victims from an area determined to be contaminated or otherwise hazardous. Rescue shall be performed by emergency personnel using appropriate personal protective equipment.

Safe Refuge Area (SRA)
An area within the contamination reduction zone for the assemblage of individuals who are witnesses to the hazardous materials incident or who were on site at the time of the spill. This assemblage will provide for the separation of contaminated persons from uncontaminated persons.

Site
That area within the contamination reduction control line at a hazardous materials incident.

Site Safety Plan
An emergency response plan describing the general safety procedures to be followed at an incident involving hazardous materials. This plan should be prepared in accordance with 29 CFR 1910.120 and the U.S. Environmental Protection Agency's "Standard Operating Safety Guides for Environmental Incidents (1984)."

Support Zone
The clean area outside of the contamination control line. Equipment and personnel are not expected to become contaminated in this area. Special protective clothing is not required. This is the area where resources are assembled to support the hazardous materials operation.

Chapter Twelve

Chapter 12: Hazardous Materials Triage

Overview: This chapter is intended to provide an overview of events, problems, and resources that must be evaluated in hazmat triage. It will assist responders in developing a system or matrix they can use to triage hazardous materials incidents.

Time Allocated: 30 Minutes

Method of Instruction: Lecture

Terminal Learning Objective: At the conclusion of this Section the participant will be able to describe the process of triage and list the elements of a decision matrix.

Enabling Objectives:

A. Define the process of Triage
B. List the elements found in a HazMat Triage Decision Matrix

Instructional Resources Required:

1. Student Notebook
2. Projection system for PowerPoint (or other similar program)
3. Alternate: Overhead projection with Overhead Slides
4. Dry erase, paper chart and or chalk board with appropriate markers

Instructional Resources Recommended: None

Instructor to Student Ratio: 1:40

References: 29 CFR 1910 (q) (iii) (b)

Practical Exercise: Varies based on Instructor and student need(s).

Evaluation Strategy**:** Participants will complete a written examination at the conclusion of the class.

Hazmat Triage

When Emergency Medical Personnel arrive at the scene of a **M**ass **C**asualty **I**ncident (With dozens of injured people needing attention), they must have a method for sorting the injured by need. That method will prioritize the patients, allowing the greatest number of injured people to get the appropriate care with the resources present. This method is called Triage. It is an organized process of prioritizing and applying resources where they will do the most good. Triage also can apply to Hazardous Materials Emergency Response.

To effectively utilize hazmat triage, response personnel must understand the triggering event, the problems caused by the triggering event, and the resources available to deal with these problems.

This chapter provides only an overview of events, problems, and resources that must be evaluated in hazmat triage. It is up to each individual to be familiar with the triage process used in their jurisdiction.

Triggering Events

When the word *triage* is used in EMS calls, it means that the victims outnumber the personnel or resources available on scene, and they must be sorted and prioritized for treatment. Theoretically, even a relatively small hazmat incident could generate the same condition. An overturned tanker with leaking product, a small fire, and an injured driver present, response personnel will be faced with several situations at once, which must be prioritized. A single engine company arriving first on scene, for example, must triage the situation to determine which problem they will attend to first.

Thus, triggering events should be considered those that are disastrous by nature. Those disasters could be man-made (Deliberate release, Traffic Collision, Civil unrest, etc.), natural (Earthquake, Flooding, Hurricanes, etc.), or any combination thereof.

Problems

Although every incident presents its own inherent problems, the following are some of the situations that response personnel may be faced with:

- Unsafe conditions that further delay mitigation efforts or put response personnel at additional risk;
- Injuries to response personnel;
- Structural collapse that delays rescue and prevents access to other problems;

Problems, Cont.

- Breakdowns in communication (from equipment failures, dead spots affecting transmissions, incompatible frequencies between mutual aid agencies, etc.);
- Damaged or insufficient equipment;
- Infrastructure failure (Collapsed overpasses, damaged roads, etc.)
- Interference from the media

Resource Availability

Once their own resources have been exhausted, response personnel must know what they can count on from mutual aid agreements with other jurisdictions, and individual agreements with private companies. These pre-incident plans must take into account the fact that a widespread disaster (Such as an earthquake or flood) will cause significant delays in obtaining those resources.

1) Personnel. Are there enough people to perform the job safely and effectively? Do the personnel available have the right training and experience for the tasks that must be performed? Only trained hazmat teams should attempt to mitigate most hazardous materials incidents. Where rescue is needed, it may be necessary to opt for defensive control measures versus mitigation. Response personnel will only be able to work for a specific duration, particularly in chemical protective clothing, before they must be relieved by fresh crews. Are relief personnel available?

2) Equipment. Is the appropriate equipment in sufficient quantities available? If not, where can it be obtained? How long will it take to obtain it? Does the pre-plan (If it exists at all) address these issues?

The Decision-Making Process

It is up to each jurisdiction to develop its own protocols. However, a “Decision Matrix” of some kind can prove helpful in evaluating such factors as direct life hazards, chemical hazards, resources required and availability, and the mitigation actions needed.

To evaluate the chemical hazards, response personnel must look at the information known, and consider future potential threats such as penetrative capability on PPE, volatility, and other factors that the Technical-Reference Specialist will need to thoroughly evaluate.

Direct life hazards involve people in the direct area of the release. Can these victims extricate themselves to a safe refuge area or must they be rescued? Is this going to be a rescue or a body recovery operation?

The Decision-Making Process, continued

Extended life hazards refer to exposed populations downwind or downstream from the release. How many people are impacted? What protective actions are required/recommended?

Exposure hazards deal with the spread of the incident. Is there a risk of the incident escalating due to multiple chemicals mixing or vapors reaching a source of ignition? What can be done to quickly and effectively prevent these conditions? Can the chemicals reach areas where victims are trapped?

Mitigation needed is another aspect requiring consideration Will the incident mitigate itself without the need for intervention? Can the problem be handled by first responders using defensive actions, such as damming, diking, or diverting?

Summary

Hazmat triage can require tough decision making. The factors influencing the prioritizing strategy are numerous and complicated. Understanding the trigger events, the problems associated with those events, and the resources available are critical to a successful operation. Having an established “decision matrix” or triage plan can help response personnel through the decision-making process.

Table 12.1:
Generic Decision Matrix

Incident	Chemical(s) involved	√ Direct Life Hazard	√ Extended Life Hazard	Resources Required	Mitigation Time in Hours	Action
						FRO HM Team
						FRO HM Team
						FRO HM Team
						FRO HM Team
						FRO HM Team
						FRO HM Team
						FRO HM Team
						FRO HM Team
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CHAPTER
13

Chapter Thirteen

Chapter 13: Laws and Regulations

Overview: This chapter is an overview of the legal system, laws, regulations, policies, and procedures which govern the manner in which Hazardous Materials Technicians function within their level of training..

Time Allocated: 1 Hour

Method of Instruction: Interactive Lecture

Terminal Learning Objective:

Upon completion of this chapter the student will be understand basic precepts of laws, regulations, and the necessary legal framework to comply with Federal, State, and local agency policy.

Enabling Objectives:

A. List the types of laws and regulations encountered by HazMat team members
B. Define the difference between Criminal & Case Laws, Regulations, and Consensus Standards
C. Describe the importance of important case law, such as Whirlpool Vs Marshall
D. Demonstrate a working knowledge of immunities and defenses
E. Explain the criteria for a local business (HMMP) plan

Instructional Resources Required:

1. Student Notebook
2. AV-Media Projection system for PowerPoint (or other similar program)
3. Alternate: Overhead projection with Overhead Slides
4. Dry erase, paper chart and or chalk board with appropriate markers

Instructional Resources Recommended: None

Instructor to Student Ratio: 1:40

Practical Exercise: None

Evaluation Strategy:

Participants will complete a written examination at the conclusion of the class.

References:

1. California Peace Officers Standards and Training (P.O.S.T.) Learning Domains 05 & 08 (January, 2019)
2. Whirlpool V Marshall (445 US-1, 1980)
3. Public Law 91-596
4. CA SB 198 (IIPP, 1990)
5. NFPA 471
6. NFPA 472
7. NFPA 1500
8. California Health and Safety Code Chapters 6.5 - 6.95
9. Title 18, 5192 CCR
10. 29 CFR 1910

Legal Considerations

Laws and Regulations

Emergency response personnel must become familiar with the laws and regulations that govern how they do their jobs. Laws and regulations are tools that response personnel can use to gain compliance, get information for planning, recover expenses and persecute criminals.

A **law** is a “Statute” written by a legislative body. It may be the result of an initiative raised by an interest group of citizens. A law is a specific statement of what is to be done, not necessarily how it will be accomplished. Laws are generally written by persons who don’t possess technical expertise in how to implement the requirements of the law.

A **regulation** is a document detailing procedures for implementing, complying with and enforcing the law. Regulations are generally written by the agency charged with implementing and/or enforcing the law. They are the place for fire service personnel to look for information as to how compliance is achieved.

Federal Statutes

There are a number of federal statutes dealing with hazardous materials. Responders may face potential liabilities for the failure to comply with those statutes and regulations. A select number of important Federal statute include:

- Resource Conservation and Recovery Act (RCRA)
- Toxic Substances Control Act (TSCA)
- Comprehensive Environmental Response, Compensation & Liabilities Act (CERCLA)
- Superfund Amendments and Reauthorization Act (SARA)
- Federal Insecticide, Fungicide & Rodenticide Act (FIFRA)
- Temporary Flight Restrictions (Federal Aviation Regulations Section 91.137)

State Laws and Regulations

The Williams-Steiger act of 1973 served to make California a "contract" or "State Plan" state. This means California has developed environmental laws and regulations that *meet or exceed* what the federal government requires. Many of the laws and regulations relating to hazardous materials are found in the California Health & Safety Code. A good resource for questions on state laws and regulations is the Department of Toxic Substances Control (part of Cal/EPA).

- California Health & Safety Code
    - Chapter 6.5 - Hazardous Waste Control Law
    - Chapter 6.6 - Safe Drinking Water & Toxics Enforcement Act
    - Chapter 6.7 - Underground Storage Tanks
    - Chapter 6.8 - Hazardous Substances Account or State Superfund
    - Chapter 6.95 - Hazardous Materials Disclosure Act
    - Section 25507
    - Section 25507.10
- California Vehicle Code
- California Code of Regulations (CCR)
    - Title 8, Section 5192 - Workplace Standards (Cal OSHA)
    - Title 13 - Transportation
    - Title 19, Sections 2510-2560 - Hazardous Substances Emergency Response Training
    - Title 22 - Hazardous Waste Control

Other Codes and Ordinances

There are many resources available to assist the hazardous materials Technician in determining the regulatory requirements. Being aware of these regulations can assist you in gaining information for pre-incident plans and determining what system(s) should be in place for dealing with hazardous materials. Listed below are the primary resources pertinent to hazardous materials.

Other Codes and Ordinances, Cont.
- The Uniform Fire Code
- Uniform Building Code
- NFPA 704
- Hazard identification system
- SARA, Title III
- Emergency planning, community right to know and emergency notification
- California Health and Safety Code, Chapter 6.95
- Hazardous Materials Disclosure Act
- Locally adopted ordinances

Pre-Incident Planning

An emergency scene, by nature, is often chaotic. Many times, lack of information available at the scene adds to the chaos. A plan of action must be quickly developed and implemented to mitigate the incident. The planning process requires that hazardous materials response personnel gather information, examine the facts and probabilities, and determine resources needed to mitigate the incident. Pre-incident planning gives responders the opportunity to develop a plan to handle potential hazardous materials emergencies in a calm atmosphere.

Site Surveys

The site survey is also an opportunity for response personnel to develop a professional working relationship with key personnel at the facility. Response personnel should take the opportunity find out what kind of assistance and/or information they can provide when emergency does occur.

Hazardous Materials Management Plans (HMMPs)

HMMPs are developed and maintained by personnel at the fixed facility. A copy of the HMMP must be given to the agency having emergency response authority. The HMMP is required for facilities that store materials in excess:

1) 200 cubic feet of gas,
2) 500 pounds of a solid,
Or
3) 55 gallons of a liquid.

Hazardous Materials Management Plans (HMMPs), Cont.

HMMPs are required by the 1988 Uniform Fire Code and Chapter 6.95, Section 25500, et. seq., of the California Health and Safety Code. This section is often referred to as the Waters' Bills, AB 2185/2187 (1985/86). HMMPs and Business plans became mandatory following the Fricker Pesticide fire in Orange County, CA., in 1985.

State and Local Hazardous Materials Emergency Planning

Requirements for state and local hazardous materials emergency planning can be found in the California Health and Safety Code (Chapter 6.95), the California Code of Regulations (Title 19), and the U.S. Environmental Protection Agency (SARA Title III) regulations.

Local Hazardous Materials Emergency Planning

The administering agency of each jurisdiction is required to develop and submit a Hazardous Materials Area Plan to State OES for review. Most "administering agencies" in California are fire agencies.

The development of an area plan allows emergency response personnel the opportunity to conduct an area-wide hazard analysis, identify and assess available resources, establish the roles of various agencies, and develop SOPs and action plans. This is best accomplished by conducting full, functional exercises, involving all the agencies that are identified in the area plan.

California Hazardous Materials Incident Contingency Plan

The California Hazardous Materials Incident Contingency Plan (HMICP) was originally published in November of 1982, as mandated in Sections 8574.16 - 8574.18 CCR.
The California HMICP serves as valuable resource to emergency response personnel. However, response personnel should be aware that the HMICP is intended as a reference document, not an operational tool. It should be used with an agency or jurisdiction specific plan.

Liabilities and Immunities

Every hazardous materials incident has the potential for far-reaching legal effects. The extent to which emergency response personnel become involved depends directly upon their knowledge of the regulatory framework that governs all aspects of an incident. This framework provides them with guidelines and responsibilities, as well as opportunities for training and equipment to perform their job. Response personnel are not only in the position of having to comply with the regulations, but also to regulate others.

Liability Under SARA Title III

Title III of the Superfund Amendments & Reauthorization Act (SARA) gives the right to sue under any of the following conditions:

- Not having a chemical disaster plan in place as of October 17, 1988
- Failure to exercise the plan annually

Liability Under SARA Title III, continued

- Failure to update the plan
- Failure to follow the plan during emergency
- Failure to utilize the chemical information that is collected

Immunities for Emergency Response Personnel

Health and Safety Code, Chapter 6.9, Section 25400, both lessens liabilities and increases immunities for emergency response personnel. It provides *qualified* immunity from liability. In other words, it protects emergency response personnel from liability for any injury or property damage, caused by an act or omission, as long as the employee was working within the course and scope of employment, and the act or omission was performed in good faith and without gross negligence.

California Government Code 8657, under the Emergency Services Act, states that volunteers shall have the same degree of responsibility for their actions and enjoy the same immunities as officers and employees of the state and its political subdivisions. It also implies that public employees have immunities.

Summary

Emergency response personnel are required to develop hazardous materials emergency plans under state and federal regulations. Failure to develop a hazardous materials emergency plan, exercise it, update it, and follow the plan during an emergency, can result in personal and agency liability under SARA Title III and CCR Title 8. All agencies that will be involved in the hazardous materials response should also be involved in the development of local plans to ensure universal “buy in.” Once the plan is developed, it is important to exercise the plan and make adjustments as necessary.

Summary, Cont.

Local hazardous materials response plans should clearly spell out roles and responsibilities of the various response agencies. Emergency response personnel must become familiar with the plan in order to understand how they fit into the big picture. A good response plan can be the difference between a well managed incident and a disaster.

Emergency response personnel must also be aware that, while they do have some legal immunities, their actions at a hazardous materials incident can result in law suits against them or their agencies. The importance of consulting city or county attorneys on matters of law or liabilities cannot be overstated. It is vital to establish good standard operating procedures, train personnel, and document, document, document.

INFORMATION SHEET: LEGAL INFORMATION

Criminal and Civil Liability

Liability may be divided into two categories: criminal or civil. *Criminal liability* involves the commission of a crime (an "unlawful act") as defined in criminal laws such as the Penal Codes, the Vehicle Codes and the Health & Safety Codes. Penalties for criminal liability involve jail or prison terms and/or extensive fines. *Civil liability* is the accountability of an individual under civil law such as the Civil Codes, Government Codes and the Health & Safety Codes. The purpose of civil action is to recover any losses incurred by injured parties and to create behavioral changes in defendants. Civil courts can award compensation for damages, and can divide and assign a degree of responsibility for the damages incurred in cases involving multiple defendants.

Types of Civil Liability

Liability can be thought of simply as "accountability for one's actions." There are three major categories of liability that have the greatest impact on emergency responders at hazardous materials incidents:

- A **Common Law Nuisance** is any activity which substantially and unreasonably interferes with the use and enjoyment of property (private nuisance), or has an impact on the public's health and safety (public nuisance).

- **Common Law Negligence (Tort Laws)**. A "tort" can be defined as any wrongful act that is done willfully or negligently, causing damage or injury. It does not involve a breach of contract.

- **Strict (Statutory) Liability**, which is covered in both civil and criminal codes, is the accountability imposed directly through federal, state and local statutes and ordinances.

Negligence

Negligence is the failure to exercise prudent judgment in carrying out an action where an injury or damage may result. It is particularly important for emergency response agencies to recognize that negligence may be applied both to actions taken at the scene of an emergency and to actions taken prior to emergency response. For example, an agency can be held liable for negligence in the hiring, retaining, training, supervising or assigning of an employee. It is considered gross negligence when an individual acts in an outrageous manner, whether or not he/she was working within the scope of employment.

Negligence, Cont.

All three of the following elements must be satisfied before a tort of negligence can be applied in a civil suit. It must be shown that:

- The defendant had a "duty to act" and failed to do so. Response personnel have a duty to act in an emergency situation.

- The defendant failed to conform to the standard of care imposed by the law of negligence.

- There was an actual loss or damage suffered by the plaintiff as a result of the defendant's negligent conduct.

There are various legal terms to describe liability with respect to negligence:

- **Vicarious Liability** is responsibility for the acts of another person. Employers are legally responsible for the actions of their employees. For example, if an agency is negligent in the training of an employee and damages were caused by the employee while working within the scope of his/her employment, the agency could be held financially liable. This applies to both agencies and individual supervisors.

- **Respondeat Superior** is Latin for "*let the master answer.*" It means that the employer is financially responsible if an employee either fails to provide care or was negligent (used imprudent judgment) while working within the scope of his/her employment. If, however, the employee is negligent while acting beyond his/her scope of employment, this protection is no longer valid, and the employee can be personally sued as an individual.

- **Joint & Several Liability**, or "*deep pocket liability,*" is designed to protect the victim by emphasizing the victim's injury or damage, rather than the degree of negligence of the defendant(s). It allows a victim to sue and recover damages from all wrongdoers when multiple parties are involved. If there are several defendants and one or more are unable to pay their portion of the award, that portion is spread out among the remaining defendants.

- Under **Landowner Liability**, property owners (of both real and personal property) have a moral and legal responsibility to ensure that their property is not a safety hazard to others. For example, an agency can be held liable if an injury or damage resulted from a broken piece of equipment if the problem was known and the agency could not show good faith in attempting to resolve the problem. Individual employees can also be held liable if they knew about the problem and failed to report it (or cannot show proof that it was reported).

Penalties or Damages

The penalties for negligence can be assessed against a defendant or their agencies as follows:

- Compensatory damages to pay restitution for loss of wages or expenses, and for repair/replacement of property
- General damages to pay restitution for general pain and suffering.
- Punitive damages as a punishment for outrageous conduct (gross negligence). Punitive negligence must be paid by the individual or employee who committed the gross negligence.

Guidelines to Minimize Liability

- Review your agency's loss claim history.
- Review similar agencies' loss claim histories.
- Review your policies, procedures and plan for inadequacies, out-datedness, vagueness or restrictiveness. Make sure they say what you want them to say.
- Utilize recognized training programs. Document all training.
- Establish criteria for performance standards. Enforce these performance standards for all personnel.
- Ensure that every specialty officer is thoroughly trained and aware of legal considerations.
- Require thorough incident and investigation reports. Document all response activities.
- Prepare or update your response plans or Standard Operating Procedures (SOPs) to meet current standards and regulatory requirements.
- Obtain and maintain all necessary equipment to conduct response and recovery operations. Document your actions.
- Review business or facility risk management plans for compliance with regulations.
- Require complete facility inspection records and issue citations, or seek judicial instruction, when hazards are seen.

<u>Environmental Crimes Summary</u>
Hazardous Waste Control Laws

25189.5 (b) HS	Illegal disposal of hazardous waste. May be either a misdemeanor or felony offense. Imprisonment: 16, 24 or 36 months Mandatory fine: $5,000 - $100,000
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25189.5 (c) HS	Illegal transportation of hazardous waste to an unpermitted facility. May be either a misdemeanor or felony offense. Imprisonment: 16, 24 or 36 months Mandatory fine: $5,000 - $100,000
25189.5 (d) HS	Knowingly treating or storing hazardous waste at an unpermitted facility. May be either a misdemeanor or felony offense. Imprisonment: 16, 24 or 36 months Mandatory fine: $5,000 - $100,000
25189.5 (e) HS	Commission of any acts under section 25189.5 that cause gross bodily injury or substantial probability of death. May be either a misdemeanor or felony offense. Add 36 months and up to $250,000/day
25189.6 (a) HS	Knowingly, with reckless regard for risk; treating, handling, transporting, disposing or storing hazardous waste in a manner which causes unreasonable risk of fire, explosion, serious injury or death. May be either a misdemeanor or felony offense. Imprisonment: 16, 24 or 36 months Mandatory fine: $5,000 - $250,000
25189.6 (b) HS	Knowingly placing another in imminent danger of death or serious bodily injury while violating section 25189.6 (a). May be either a misdemeanor or felony offense. Imprisonment: 3, 6 or 9 years Mandatory fine: $5,000 - $250,000
25189.7 (b) HS	Illegal burning of hazardous waste at an unpermitted facility. May be either a misdemeanor or felony offense. Imprisonment: 16, 24 or 36 months Mandatory fine: $5,000 - $100,000
25189.7 (c) HS	Commission of any acts under section 25189.7 that causes gross bodily injury or substantial probability of death. Add 36 months and up to $250,000/day

25190 HS — Violation of any code section, regulation or permit.
Penalty for first offense (misdemeanor): $1,000
Penalty for second offense (felony): $5,000 - $25,000

Note: for sections 25191 (a) below, the first offense is a misdemeanor with fines of $2,000 - $25,000 per day. The second offense is a felony with penalties of 16, 20 or 24 months imprisonment and a mandatory fine of $2,000 - $50,000. Items identified with an asterisk (*) may have other special provisions.

25191 (a) (1) HS — Knowingly falsifying documents.

25191 (a) (2) HS — Knowingly possessing altered or concealed compliance documents. *

25191 (a) (3) HS — Knowingly destroying, altering or concealing compliance documents. *

25191 (a) (4) HS — Knowingly withholding of information regarding “real and substantial danger” after receiving a request for such information by any agency. *

25191 (a) HS — Various subsections - Various manifest violations.

25191 (c) HS — Knowing transporting hazardous waste in an uncertified vehicle or container, or handling hazardous waste without a manifest in possession, or transporting hazardous waste without having registration in driver’s possession.
This is a misdemeanor offense.
Imprisonment: 6 months
Fines: $500/day.

Failures to Report

25180.7 HS — The knowing and intentional failure of a designated government employee to disclose to the Board of Supervisors and local health officer the release or threatened release of hazardous waste likely to cause substantial injury to public health or safety.
May be either a misdemeanor or felony offense.
Imprisonment: up to 3 years, and/or Fines: $5,000 - $25,000
Additional penalty: mandatory loss of job

Medical Waste Management Act

25097 (b) HS — Storing, treating, disposing (or causing) in violation of chapter (penalties dependent on class of operation; range from fines to county jail; 2nd offense <u>within 3 years</u> is felony) - strict liability.

25097 (d) HS — Knowingly storing, treating, disposing (or causing) in violation of chapter (F prison and/or fine $5K - $25K)

25097 (e) HS — Unregistered haulers are regulated under hazardous waste laws.

Water Code

13387 (b) WC — Negligently discharging pollutants under the Federal Water Pollution Control Act to navigable water without a permit
Imprisonment: 1 year
Fines: $5,000 - $25,000/day

13387 (c) WC — Knowingly discharging pollutants under the Federal Water Pollution Control Act to navigable waters without a permit
(F no longer than 3 years, $5K - $50K/day; 2nd offense: no longer than 6 years, no more than $100K/day of violation)

13387 (d) WC — Knowingly discharging pollutants under the Federal Water Pollution Control Act to navigable waters without a permit, and knowingly placing another person in imminent danger of death or gross bodily injury.
(F no more than 15 years, no more than $250K/day; if an “organization” is responsible, no more than $1,000,000; 2nd offense: all penalties double)

13387 (e) WC — Knowingly including false statements in any document filed with water board, or falsifying or tampering with monitoring devices required under the water code.
(F not more than 2 years, $25K; 2nd offense: 4 years or $25K/day)

13271 (c) WC — Failing to notify of discharge of hazardous substance or sewage to waters of state.
(strict liability) (M 1 year, $20K)

Fish and Game Code

5650 FG	Depositing or permitting to pass into, or placing where it can pass into waters of state: various things, best one for me is "deleterious to fish, plant or bird life." (depending on substance, 6 months or 1 year and $1,000 or $2,000)
5650.1 FG	Civil penalty for 5650 FG of up to $25,000 per violation.
12011 FG	Penalty for 5650 (a) or (b) of 6 months; $1,000 plus $10/gallon of discharge or costs of cleanup and damage to natural resources.

Vehicle Code

23112 VC	Depositing a substance (other than clear water or feathers from live birds) on highway - strict liability. No jail. Fine: $1,000 plus pick up litter for at least 8 hours.
23112.5 VC	Failing to notify CHP after dumping, spilling or causing release of hazardous material or waste upon highway - strict liability. (M mandatory minimum fine $2,000)
34506 (b) VC	Failing to comply with CHP adopted rules and regulations regarding hazardous materials transportation - strict liability. (M $1,000)
27903 VC	Failing to display appropriate placards and markings. (...any vehicle transporting any explosive, blasting agent, flammable liquid, flammable solid, oxidizing material, corrosive compressed gas, poison, radioactive material, or other hazardous materials, of such type and in such quantities as to require the display of placards or markings on the vehicle exterior... ...shall display such placards and markings in the manner and under conditions prescribed by such regulations of the United States Department of Transportation. (Caution: Depending on the type of material, this may not apply if less than 1,000 pounds of hazardous material are present.)

Penal Code

370 PC	Causing a public nuisance - anything injurious to health, offensive to the senses or an obstruction to the free use of property so as to interfere with the comfortable enjoyment of life or property by the community of any considerable number of people - strict liability. (M $1,000)
374.8 (b) PC	Any person who knowingly causes any hazardous substance to be deposited into or upon any road, street, highway, alley or railroad right-of-way, or upon the land of another, without the permission of the owner, or into the waters of this state. Subsection (c) defines "hazardous substance." Imprisonment: 16 months, 2 or 3 years Fines: $50 - $10,000
387 PC	Corporations or managers failing to inform CAL-OSHA <u>and</u> warn affected employees in writing of actual knowledge of a serious concealed danger. Several definitions and conditions apply. Imprisonment: 16 months, 2 or 3 years Fines: $25,000; if corporation is defendant, up to $1,000,000
409.5	Gives peace officers the authority to close areas during emergencies. (More information can be found in Chapter 4 on Protective Actions.)
4476 HS	Placing garbage, sewage, etc. upon property general publicly accessible (M)

Air Pollution Offenses

42400 HS	Violating codes, orders, permit rules or regulations - strict liability. (M $1,000)
42400.1 HS	Negligently emitting air contaminants, operation of source. (M $10,000)
42400.2 HS	Knowingly emitting air contaminants, operation of source. (M $25,000)

Food and Agriculture Code

12996 (a) FA	Violating codes or regulations relating to pesticides - strict liability (M $500 - $5K; 2nd offense: M $1K - $10K)
12996 (b) FA	Intentionally violating codes or regulations relating to pesticides - strict liability (W $5K - $50K)

Radiation Control Laws

25865 (a) HS	Violating chapter, rules, regulations or orders in effect pursuant to chapter (M $1,000)
25865 (b) (1) HS	Knowingly disposing (or causing) any radioactive material regulated by chapter at unlicensed facility; if disposal is found to have caused substantial danger to public health or safety. Penalty: 16, 24 or 26 months and/or $100K/day of violation.
25865 (b) (2) HS	Knowingly disposing (or causing) any radioactive material regulated by chapter at unlicensed facility; if disposal is found to have caused gross bodily injury or substantial probability of death. Penalty: 3, 5, 7 years and/or $250K/day of violation.
25865 (c) (1) HS	Knowingly transporting to an unlicensed facility (or causing) any radioactive material regulated by chapter; if transportation is found to have caused substantial danger to public health or safety. Penalty: 16, 24 or 26 months and/or $100K/day of violation.
25865 (c) (2) HS	Knowingly transporting to unlicensed facility (or causing) any radioactive material regulated by chapter; if transportation is found to have caused gross bodily injury or substantial probability of death. Penalty: 3, 5, 7 years and/or $250K/day of violation.

14

Chapter Fourteen

Chapter 14: Hazardous Materials Storage

Overview: This chapter is an overview of how Hazardous Materials Technicians deal with, and recognize the different types of storage facilities and containers in which Hazardous Materials are stored. Response to locations where large quantities of Hazardous Materials are stored is a common encounter for those on HazMat teams.

Time Allocated: 1- 4 Hours, class dependent

Method of Instruction: Interactive Lecture

Terminal Learning Objective:

Upon completion of this chapter the student will understand basic concepts of the types of storage, locations of storage, and methods of containment used to store Hazardous Materials.

Enabling Objectives:

A. List the locations where Storage of Hazardous Materials occur
B. Demonstrate a working knowledge of the categories of storage
C. Demonstrate a working knowledge of the basic mitigation techniques used by Hazardous Materials Technicians in the field to deal with storage related HazMat emergencies.
D. Describe the difference between types of liquid, solid, and gas (vapor) storage tanks and containers

Instructional Resources Required:

1. Student Notebook
2. AV-Media Projection system for PowerPoint (or other similar program)
3. Alternate: Overhead projection with Overhead Slides
4. Dry erase, paper chart and or chalk board with appropriate markers

Instructional Resources Recommended: None

Instructor to Student Ratio: 1:40

Practical Exercise: None

Evaluation Strategy: Participants will complete a written examination at the conclusion of the class.

References: NFPA Standard 472, Uniform Building code, and Uniform Fire code

Bulk Packaging

The type of container that is unique to fixed facilities is fixed storage tanks. Storage tanks can range in size from 200 gallons to hundreds of thousands of gallons.
There are two categories of storage tanks:
Underground storage tanks and Aboveground tanks. Both types of tanks have their own sets of regulations.

Uniform Building Code (UBC) sets regulations for the construction and installation of hazardous materials storage tanks, and associated plumbing and hardware can be found.
Uniform Fire Code (UFC) sets regulations for fire protection, prevention, and mitigation in facilities where Hazardous Materials are found. (EX: Section 80.301(d) of the Uniform Fire Code requires signage of aboveground storage tanks as specified in UFC Standard 79-3 (NFPA 704)).
Occupational Safety and Health Administration (OSHA) regulations were adopted for the protection of workers, emergency responders, and the public.

OSHA requires that appropriate warning be in place when hazardous materials are stored or used. This information can be in the form of labels, tags, signs, placards, process sheets, batch tickets, operating procedures, etc. Other requirements for hazardous materials storage tanks may include secondary containment systems, dikes, monitoring devices, remote shutoff switches, and warning systems. The presence of any of these systems associated with storage tanks should serve to warn responders of the presence of hazardous materials.

Aboveground Stationary Storage Tanks

All tanks, whether they are designed for fixed applications or transportation use (e.g., cargo tanks and railroad tank cars), have to deal with the same laws of physics. They have to handle changes in pressure, vacuum, etc. In general, aboveground fixed storage tanks have many of the same types of fitting and design features found on tanks used for transportation. However, due to size and configuration, they may pose unique challenges to emergency responders. It is important for hazardous materials response personnel to become familiar with the fittings and design features found on aboveground tanks so that they can recognize the various types of tanks and understand how they will react in emergency situations. The type of storage tank can give response personnel some clues as to the type of material inside and the tactics that will be necessary to control the incident.

Refer to the attached digital document, “Silhouettes of Rail, Cargo, and Storage Tanks” for pictorial depictions, descriptions, and technical data on the types of storage containers likely to be encountered in an emergency response or site inspection.

Vertical Atmospheric Fixed-Roof Tanks

Vertical atmospheric fixed-roof tanks are wider then they are tall, and have either a flat roof or an inverted cone shaped roof.
Many of these roofs are designed with weak roof-to-shell attachments so they will fail when internal pressure becomes too high (such as in case of a fire or explosion). These tanks usually contain flammable, combustible, and corrosive liquids.

Floating Roof Tanks

A floating roof tank is a very large tank with a roof that floats on the liquid inside the tank. The floating roof is designed to move up and down on top of the liquid, thereby limiting the vapor space and reducing the chance of a fire. These tanks are designed to store flammable and combustible liquids that readily vaporize.

Covered Floating Roof Tanks

A covered floating roof tank has a fixed roof with an inner floating roof. These tanks can be identified by large vent openings around the top of the tank. They are designed to contain flammable and combustible liquids. Overflow can be a problem with these tanks.

Vertical Low-Pressure Fixed-Roof Tanks

Vertical low-pressure fixed-roof tanks (sometimes called *dome roof tanks*) are easy to distinguish from other tanks in that they are generally taller than they are wide and have a dome top. The dome top is designed to accommodates changes in vapor pressure and operate at pressures not to exceed 15 psig. These tanks are used for flammable and combustible liquids as well as other types of hazardous materials.

Horizontal Aboveground Low-Pressure Storage Tanks

Horizontal aboveground low-pressure storage tanks are aboveground tanks that lay horizontally. Potential problems with these tanks include possible failure of supports during a fire and possible inadequate venting. These tanks can contain corrosive liquids, oxidizers, and flammable or combustible materials, such as gasoline, naphtha, or fuel oil.

Pressure Horizontal Tank

Pressure horizontal tanks are easy to identify by their rounded ends. They are usually mounted horizontally on concrete foundation walls or legs and are painted white or another highly reflective color. These tanks can contain LPG, anhydrous ammonia, chlorine, sulfur dioxide, or hydrogen chloride. They may have built-in protection systems, such as water deluge systems.

Spherical Tanks

Spherical tanks are easily recognized by their ball-like shape. These tanks contain high pressure gases and are painted white or another reflective color to reflect heat. A pressure relief valve at the top of the tank indicates that it probably contains pressurized gases, such as methane or propane. If there is no pressure relief valve and the tank appears to be heavily insulated, it may indicate that it is being use to store cryogenic liquids, such as hydrogen, nitrogen, or oxygen.

Some of these tanks (covered spherical tanks) have a layer of sheet metal surrounding the lower half. They look similar to vertical tanks with rounded roofs. A large pressure relief valve on top of the tank indicates contents under pressure. These tanks often contain LPG or cryogenic liquids.

Cryogenic Liquid Tanks

Cryogenic liquid tanks are taller than they are wide and have dome tops like a vertical low-pressure fixed-roof tank. A distinguishing characteristic, however, is that they rest on legs rather than directly on the ground. These tanks are actually a tank within a tank. The interior tank contains the liquid and may be less than half the size of the outside tank. The outside tank covers and protects the insulation between the tanks. These tanks are used to store cryogenic liquids, such as liquefied oxygen and nitrogen.

Underground Storage Tanks (UST)

Any tank with greater than 10% of its surface area underground is considered an underground tank. Tanks that are completely underground have some advantages in that they are protected from fire and mechanical damage. The disadvantage of underground tanks is that they cannot be visually inspected for leaks and thus can develop leaks that may go undetected. Being underground, they are more subject to corrosion. Most UST's are double walled. However, single walled tanks are permitted if they are fiberglass reinforced plastic, or lined steel with cathodic protection (commercial or retail facilities require an emergency shut-off). These tanks usually contain gasoline, fuel oil, diesel and waste oil.

Bulk Storage Facilities

Emergency response personnel must be able to identify and utilize safety features within bulk storage facilities. Safety requirements pertinent to large storage tanks and bulk storage facilities can be found in the Uniform Fire Code and/or other locally adopted codes. Listed below are some of the safety features that can be found at bulk storage facilities:

Table 14.1: Matrix of Storage Tank features

Feature	Detail
Tank Spacing	Tanks should be spaced an adequate distance to provide a margin of safety when tanks are involved in an incident. Requirements for tank spacing can be found in UFC.
Drainage Control and Diking	The area surrounding a tank shall be provided with drainage or shall be diked to prevent accidental discharge of liquid from endangering adjacent tanks or adjoining property or from reaching waterways. (See Article 79 of the UFC.)
Venting Systems	Tanks shall be adequately vented to prevent failure due to either vacuum or pressure from filling, emptying, or atmospheric temperature changes. (See Article 79 of the UFC.)
Monitoring and Detection Systems	Monitoring and detection devices may be used in conjunction with warning systems or automatic shutoffs. Requirements for monitoring and detection systems may be adopted locally.
Fire Protection Systems	Fire protection requirements for bulk storage facilities include foam systems for storage tanks, automatic sprinkler systems, and access for fire protection. Requirements for fire protection systems can be found in Article 79 of the UFC.
Transfer Options	Requirements for transfer operations can be found in Article 79 of the UFC. Requirements include static protection, shutoff control, signage, fencing, electrical equipment, location, and fire protection.

Fixed Facility Systems

The UFC and locally adopted codes and ordinances are good resources for determining which systems are required or recommended based on the hazards present. These systems are designed to help prevent hazardous materials incidents and to lessen the impact when incidents do occur. Hazardous materials response personnel should be familiar with the codes and ordinances, as well as the protection systems found within their jurisdictions.

The following tables describe a partial list of the systems in use today. Emergency response personnel should make an effort to become familiar with the systems at facilities in their area. The scene of an emergency is not the place to learn how these systems work. The more emergency response personnel know about a facility going in, the better off they will be during an emergency.

Table 14.2: Examples of systems that may be found in fixed facilities:

System	Detail
Containers and tanks	Must meet nationally recognized design and construction standards.
Piping, valves, and fittings	Must be made of compatible materials, properly designed, and durable to withstand pressure, seismic and structural stresses. Some materials may require double wall piping.
Signage	NFPA 704 placarding, stenciling of product name, and no smoking signs may be required. Signage should be durable, unobstructed, and properly colored.
Security	Must safeguard from tampering and vandalism.
Ignition sources	No smoking permitted. Intrinsically safe switches and appliances may be required.
Shelf storage	Substantial construction, seismic bracing and facing (UBC), lip or guard on shelf is required.
Spill control, drainage, and containment	Spillage control measures for hazardous material and fire protection water, or drain to a safe location. Can be recessed floors, liquid tight raise sill, or open grate trench which connects to drainage system. Drainage systems should drain to treatment, storage, or neutralization system. Monitoring method may be required.
Ventilation	Indoor storage shall be provided with mechanical exhaust ventilation.
Separation from incompatible hazardous materials	Must provide 20 feet separation, partition > 18 inches above and to the sides of stored material, or store in segregated cabinets.
Hazardous materials storage cabinets	Must be metal construction and compatible with material stored. (Can be treated or coated with compatible material.) Must be labeled: "Keep Fire Away." Compressed gas storage cabinets must be designed in accordance with UFC 80.303.
Fire extinguishing systems	Sprinklers, halon, carbon dioxide, dry powder, etc.

Explosion venting or suppression	Lightweight walls, lightly fastened hatch covers, lightly fastened outwardly opening doors in exterior walls.
Standby power	Required when ventilation, treatment, temperature control, alarm, detection, and other systems are required.
Limit controls	Liquid-level limit controls required on tanks > 500 gallons to prevent overfill. Redundant temperature limit controls. Pressure relief devices which vent to external scrubber or treatment system.
Manual alarm	Manual alarms at each interior exit door to sound a local alarm.
Supervision	Central, proprietary, or remote station, or shall initiate audible or visual signal at site.
Emergency vehicle access	Accessible from roadways < 150' from storage areas.
Toxic gas storage	Cylinders to be stored in gas cabinets, exhausted enclosures, and separate gas storage rooms. Independent exhaust required. Exhaust system must be able to handle accidental release from largest single tank/cylinder by dilution, absorption, neutralizing, or burning. Gas cabinets require negative pressure, self-closing ports and doors. Separate gas rooms designed to negative pressure and exhaust to treatment system. Treatment system to process all released gas to 0.5 IDLH at point of discharge.
Gas detection	Detection system to be continuous and detect at or below PEL. Must initiate both local alarm and to constantly attended control station. Detection system may not be required when physiological warning properties (smell, taste, etc.) are below the PEL for the gas.
Local gas shut off	Manual activation controls which are "fail safe to close" design.
Automatic shut off	Can be activated by gas detection, manually from remote location, failure of emergency power, seismic activity, failure of primary containment, activation of alarm, or excess flow valve.
Enunciator panel	Determine location and type of alarm.

Nonbulk and Intermediate Bulk Packaging

Nonbulk Packaging

Most hazardous materials incidents do not involve railroad tank cars, pipelines, cargo tanks, or storage tanks. A vast majority involve the class of container that is categorized as *nonbulk packaging*. This section will serve as an overview of the various types of containers and the materials they may have within. Techniques for dealing with leaking containers are covered in other chapters.

The term *package* means a container and its contents. Packaging may be singular or plural and means anything that contains a material. Nonbulk packaging is defined by D.O.T. as any packaging meeting one of the following criteria:

- Liquid - internal volume of not greater than 119 gallons (450 liters);
- Solid - capacity of 882 pounds (400 kilograms) or less; or
- Compressed Gas - water capacity of 1000 pounds (453.6 kilograms) or less.

Examples of nonbulk packaging include bags, bottles, boxes, cylinders, drums, jerricans, and wooden barrels. Nonbulk packaging may be a single package or combination packaging consisting of one or more inner packages inside an outer packaging (e.g., glass bottles inside a fiberboard box). Nonbulk packaging may palletized or overpacked for transport by various transport vehicles.

Performance-Oriented Packaging

On December 21, 1990, the Research and Special Programs Administration of the Department of Transportation (DOT) released Docket HM-181, which comprehensively revised the hazardous materials regulations with respect to hazard communication, classification, and packaging requirements based on the United Nations (UN) Recommendations on the Transport of Dangerous Goods. The adoption of regulations spelled out in HM-181 brought the United States more in line with international regulations.

Under the performance packaging provision of HM-181, packaging can now be built to meet performance criteria rather than being built to detailed DOT design specifications. It is based on how well the package will perform under conditions normally incident to transportation. The performance criteria should accommodate technical innovations by industry and serve to simplify and reduce regulations.

Hazardous materials are assigned a packing group for packing purposes. These groups are found in 49 CFR. Classes 1, 2, 7, combustible liquids, and ORM-D materials do not have packing groups. Packing group numbers indicate the degree of danger presented by a material:

Table 14.3: Packing groups

Packing Group	Degree of Danger
I	Great
II	Medium
III	Minor

Manufacturers of hazardous materials packaging are required to design, construct, and test the packaging (49 CFR Part 178).
The shipper must follow the instructions from the manufacturer to ensure that the material is properly packed and conforms to all requirements.

Performance tests must be performed at least once a year. Records of the results must be maintained for a year. The tests include a drop test, a leak-proofness test, a hydrostatic pressure test, a stack test, a chemical compatibility test, and a vibration test.

Types of Packaging

The following is a description of some of the basic types nonbulk packaging that emergency response personnel are likely to encounter at hazardous materials incidents.

This section will provide a brief overview of several types of Non-Bulk and Intermediate Bulk Packaging, including:

- ✓ Bags
- ✓ Portable Bins
- ✓ Drums
- ✓ Boxes
- ✓ Ton Containers
- ✓ Wooden Barrels
- ✓ Cylinders
- ✓ Bottles
- ✓ Portable Tanks
- ✓ Jerricans
- ✓ Multicell Packaging
- ✓Radioactive

Packaging

- ✓ Carboys
- ✓ Bulk Bags

Bags

Bags are flexible packages made of paper, cloth, burlap, plastic, or a combination of these materials. Bags are mainly used for solid materials. They typically hold up to 100 pounds of material. Examples of hazardous materials found in bags include caustics, fertilizers, and pesticides.

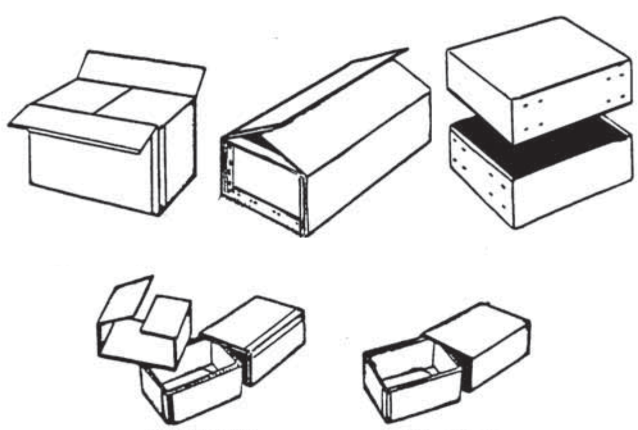
Bottles

Bottles, ("Jugs" or "Jars") are used for both liquids and solids. Bottles can be made of glass, plastic, metal, or ceramic. They range in size from a few ounces to twenty gallons. They are usually packed in some type of outside packaging, such as a wood or fiberboard box, for transport. Examples of hazardous materials found in bottles include flammable and combustible liquids, corrosives, poisons, oxidizers, radioactives, and explosives. Just about any class of material may be found in bottles.

Protected Bottle **Plastic Bottle** **Glass Bottle**

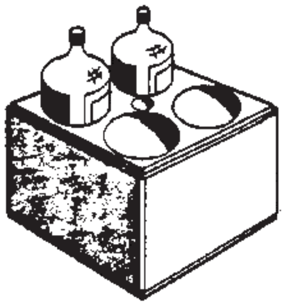
Boxes

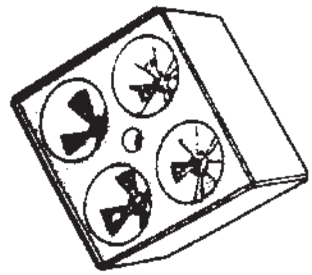
Boxes are rigid packaging having faces that completely enclose the contents. They are commonly used as outside packaging for other nonbulk packages, including aerosol containers, bottles, and cans. Boxes may be made out of fiberboard, wood, metal, plywood, reconstituted wood, plastic, or other materials. Fiberboard boxes may contain up to 65 pounds of material, while wooden boxes may contain up to 550 pounds. Some boxes have inner packages that hold from one to nine gallons of materials such as battery acid, laboratory chemicals, household chemicals, or paints. Boxes may contain an inner package surrounded by absorbent and/or cushioning materials.



Multi-cell Packaging

Multi-cell packaging consists of a form-fitting, expanded polystyrene box encasing one or more bottles. The polystyrene box may be shipped with the two parts banded together or packed inside another box. Examples of materials shipped in this type container include hydrochloric acid, sulfuric acid, solvents, and other chemicals.

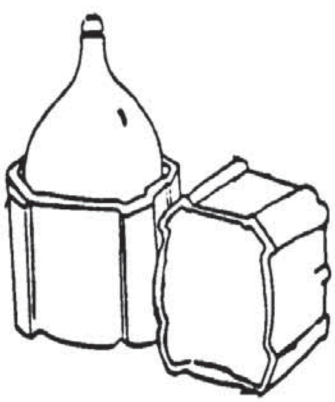


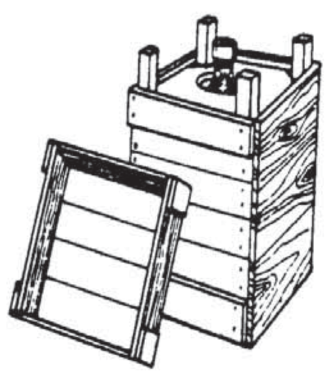


Base Element **Lid Element**

Carboys

Carboys are glass or plastic bottles that may be encased in an outer packaging, such as a wooden crate, expanded polystyrene boxes, or plywood drums. Carboys may contain over 20 gallons of product. Materials shipped in carboys include sulfuric acid, hydrochloric acid, ammonium hydride, and water.





Carboy in Expanded Polystyrene Box **Carboy in Wooden Crate**

Cylinders

Cylinders normally contain liquefied, nonliquefied, or dissolved gases, or mixtures thereof, but may also contain liquids or solids. Some cylinders will contain gas only, while others contain aerosols (a mixture of compressed gas and other materials like hair spray, spray paint, or whipping cream). Cylinders range in size from small aerosol cans to large insulated cryogenic cylinders that are approximately two feet in diameter and five feet tall. Cylinders may be shipped with or without an outer packaging. Service pressures range from a few psi to 5000 psi.

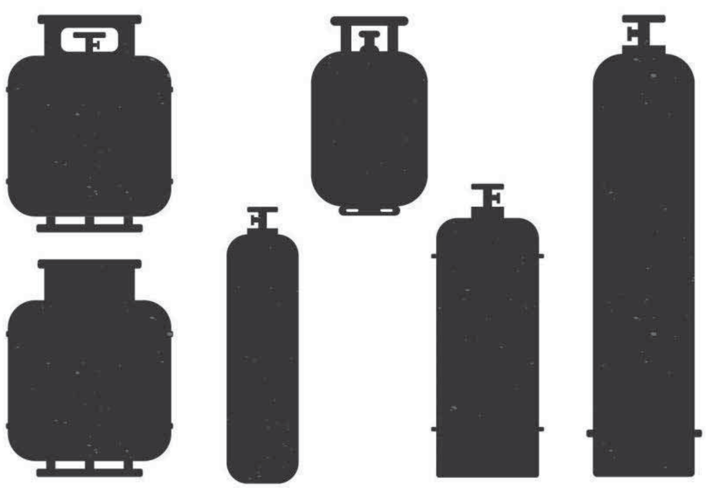
All cylinders have a round cross section with a valve arrangement at one end. Some cylinders have a seal in place of a valve and are used with equipment having a valve arrangement. The majority of cylinders, other than those used for consumer commodities, have a pressure relief device.

There are three basic types of cylinders:

- aerosol containers
- uninsulated cylinders
- cryogenic (insulated) cylinders

Uninsulated Cylinders

Uninsulated cylinders are typically made of steel. However, some (like SCBA bottles) are made of aluminum or fiberglass-wrapped aluminum. They have rounded shoulders on top and screw-on caps or cylinder rings to protect valves. Uninsulated cylinders are typically up to ten inches in diameter and five feet tall. Examples of materials shipped in uninsulated cylinders include acetylene, gaseous nitrogen, LPG, poisonous gases, and oxygen.



Uninsulated cylinders

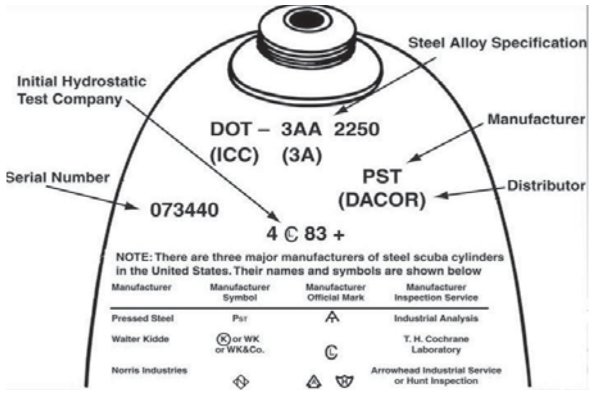


Exhibit 14.4: Illustration of cylinder markings

Specifications for cylinder markings are found in 49 CFR 178.35. The markings on each cylinder should be stamped plainly and permanently on the shoulder, top, head, or neck as follows:

- The DOT mark starts with “DOT,” followed by specification number, followed by service pressure. In the example above, (DOT-3BN400), 3BN is the specification number, and 400 is the service test pressure (400 psi). On older cylinders, you may find an ICC mark in place of the DOT mark. The ICC mark is the same basic format, but begins with ICC.

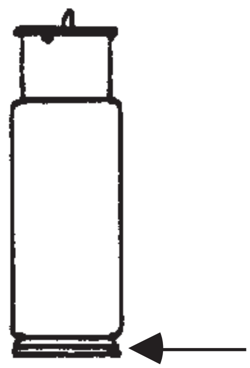
- A serial number and identifying symbol (letters) are located just below or immediately following the DOT mark. The identifying symbol must be registered with the Associate Administrator for Hazardous Materials Safety. Duplications are not authorized. An alternate method of marking the cylinder in the illustration above would be DOT-3BN400-134243-XYZ.

- The size of cylinder markings must be at least 1/4" high if space permits.

- The inspector’s official mark is placed near the serial number with the date of test (such as May 30 or 5-30) so that dates of subsequent tests can be added.

Cryogenic (Insulated) Cylinders

Cylinders for cryogenic liquids consist of an insulated metal cylinder contained within an outer protective metal jacket. The area between the cylinder and the jacket is under vacuum. These cylinders are designed for a specific range of service pressures and temperatures. Cryogenic cylinders have a small protective ring at the top to protect the valves and a foot ring (a slight narrowing of the cylinder) just above the bottom to allow for handling with a special hand truck. These cylinders can be up to two feet in diameter and five feet tall. Materials found in these cylinders are cryogenic liquids such as argon, helium, nitrogen, and oxygen.



Drums

Drums used for solids, liquids and sludges are usually cylindrical packages made of metal, plastic, fiberboard, plywood, or other suitable material. Drums are sometimes called buckets, cans, or pails. Typical drum capacities range from 5 gallons to 55 gallons. Metal and plastic drums can be up to 23 inches in diameter and 34 inches high. Fiber drums range from 8 inches in diameter and 4 inches high to 24 inches in diameter and 43 inches high. The most common salvage drums (or overpack drums) used to hold damaged or leaking nonbulk packaging for repacking or disposal are 85 gallons.

Drums may have either removable or non-removable heads, referred to as “open head” and “tight (or closed) head” respectively. Removable heads are attached to a drum by a separate ring or built-in lugs. Some fiber and plastic drums have spin-on heads
The common 55-gallon, closed head metal drum is approximately 23 inches in diameter and 34 inches high. The heads are joined to the body by folding the sheets together in a “chime.” The chime is a metal ring around the top and bottom of the sidewall. The sides have two or more ridges, called “rolling hoops,” for strength. A tight-head drum usually contains two openings (one 2 inches in diameter and one 3/4 inches in diameter) closed with plugs called “bungs.” A thin metal or plastic “tamper-proof seal” or “weather cap” is sometimes crimped over the bung plugs. Drums containing certain materials, such as hydrogen peroxide, have closures (bungs) in the head design to vent pressure.

Exhibit 14.6:

Illustration of DOT 1A2

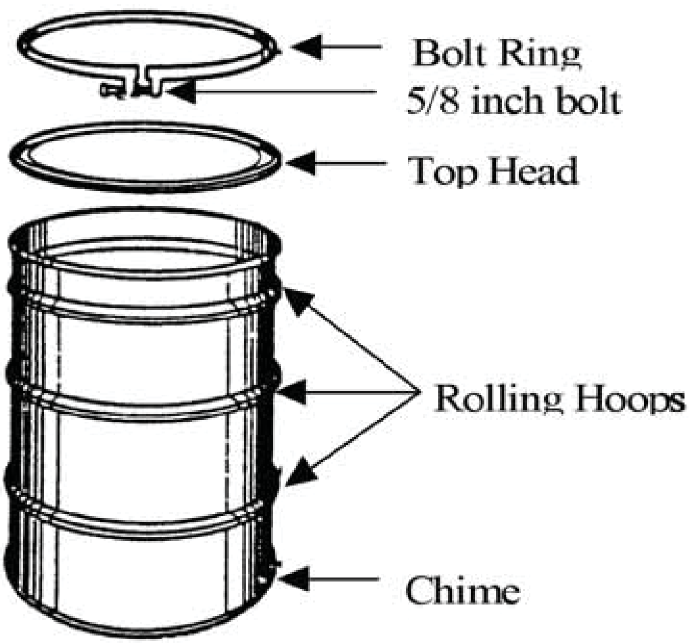
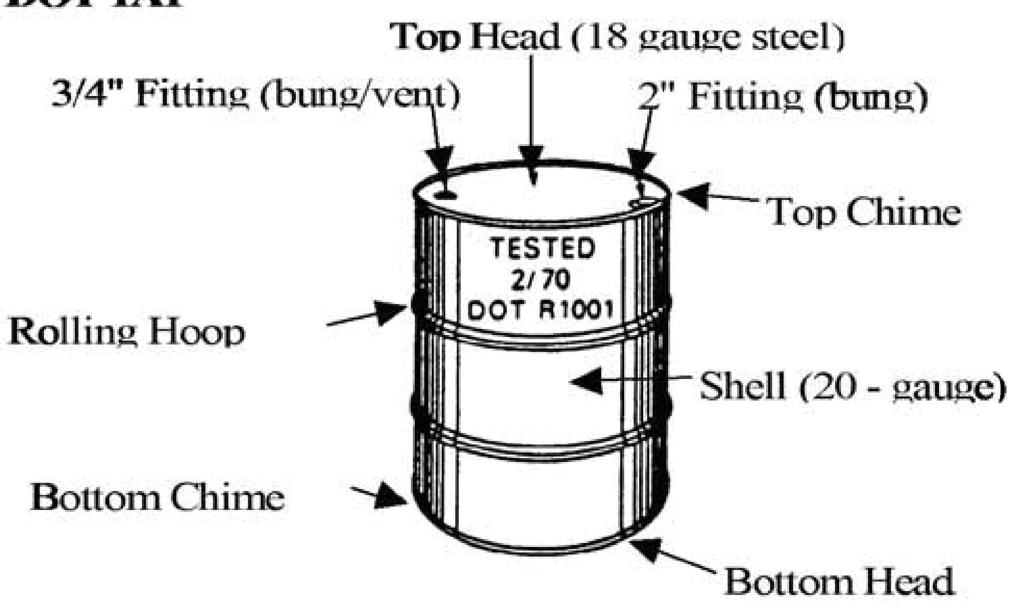
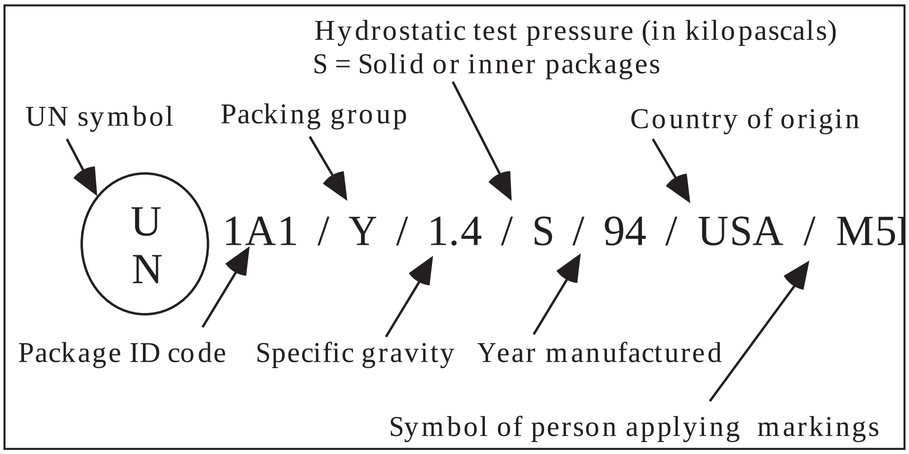


Illustration of DOT 1A1 **Tight-head 20/18 gauge 55**



Packaging Manufacturers' Marking Requirements 178.503

The package manufacturer is required to use the UN standard marking systems on each nonbulk package intended for use in transportation of hazardous materials (with the exception of cylinders and Class 7 packaging). An example of UN markings is as follows:



The packaging identification code indicates the type of packaging, materials of construction, and category of packaging. Package identification codes are as follows:

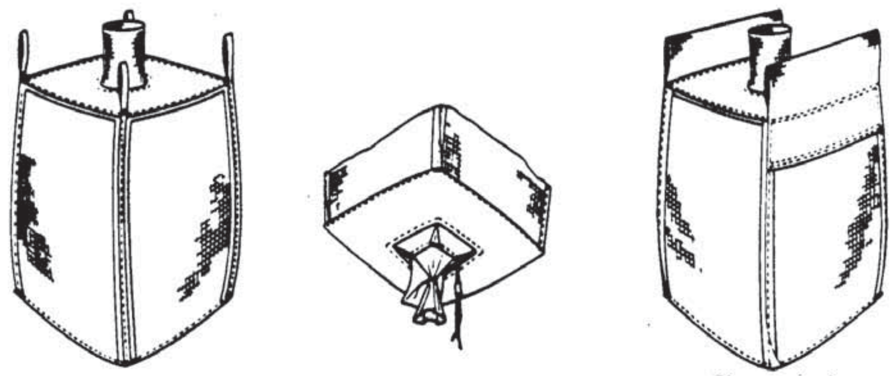
Shipper Marking and Labeling Requirements

Each person who offers a hazardous material for transportation must mark each package, freight container, and the transport vehicle as prescribed in 49 CFR, Part 172.300. Additionally, when required, each *carrier* shall mark each package, freight container, and the transport vehicle, as prescribed in the same section. Packaging with a rated capacity of 119 gallons or less must be marked with the proper shipping name and the identification number, proceeded by *UN* or *NA* as appropriate. There are some exceptions. "Inhalation Hazard" must be marked on *any package* containing materials that meet the criteria for a "Poison-Inhalation Hazard" material.

Labels are applied to the outside of packages containing hazardous materials. They identify the primary and secondary hazards specific to the material and may give information about handling precautions as well. Column 6 of the Hazardous Material Table (49 CFR, Part 172.101) contains a listing of label(s) required for each hazardous material. If column 6 says "none," no label is required. A package containing a hazardous material that meets more than one hazard class must be labeled for the additional hazard class(es).

Portable Bins

Portable bins are used to transport bulk solids. They are approximately four feet square and six feet high and may contain up to 7700 pounds of material. Most portable bins are loaded through the top and unloaded from the side or bottom. Dump type portable bins are loaded on flat bed trucks and are used to transport ammonium nitrate fertilizer to agricultural areas. Farm chemicals are an example of the materials carried in portable bins.

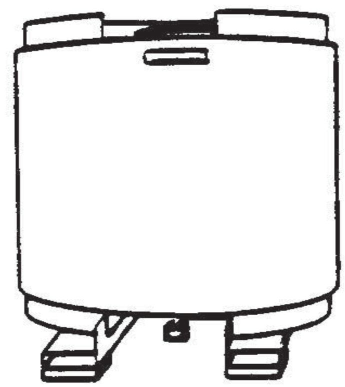


Portable Tanks

The portable tanks described in this section include pressure and nonpressure portable tanks. (Intermodal tank containers will be covered in a later chapter.) Portable tanks are larger than nonbulk containers and generally smaller than cargo tanks. They are generally transported to various sites by truck or other transport vehicle. The specifications for portable tanks are found in DOT Specification 51 (49 CFR, Part 178, Subpart H). Portable tanks must have a pressure relief device; protective housings for all valves, fittings, accessories, safety devices; and mountings to provide a secure base during transit. Each tank is required to have a name plate that includes manufacturer's name, serial number, DOT specification number, tank capacity, and design pressure. The name plate is good source of tank related information for emergency response personnel.

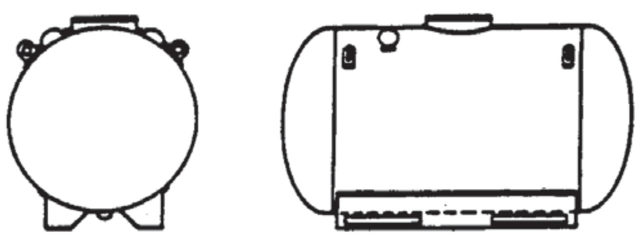
Nonpressure Portable Tanks

Nonpressure portable tanks are used to transport liquids and solids. These tanks have rectangular, oval, or circular cross sections. They have capacities that generally do not exceed 6300 gallons. Although referred to as nonpressure tanks, they may have internal pressures up to 100 psi. Examples of materials shipped in nonpressure tanks include food grade commodities, liquid fertilizers, resins, sodium cyanide, and water treatment chemicals.



Pressure Portable Tanks

Pressure portable tanks transport liquefied compressed gases and liquids. The tanks have circular cross sections and may be quite large. Service pressures can range from 100 to 500 psi. Materials that are shipped in portable pressure tanks include anhydrous ammonia, bromine, and LPG.



Ton Containers

Ton containers are cylindrical pressure containers used to transport various gases. They are approximately three feet in diameter and eight feet long with concave or convex heads. They are called ton containers because they hold one ton of chlorine. (Ton containers are commonly used for chlorine.) The valves on this container are found on one end under a protective cap. Ton containers are generally transported on specifically designed flatcars and flatbed trailers with specifically designed racks and securing devices. Other materials commonly shipped in ton containers include phosgene and sulfur dioxide.

Packaging for Radioactive Materials

49 CFR 173.24 contains general requirements that must be met for *all packages used to ship hazardous materials*. In general, they say that all packages must be designed and constructed so that under conditions normally incident to transportation, there will be no release of the hazardous material and the effectiveness of the packaging will not be reduced. The type of packaging used for a *radioactive materials shipment* is dependent upon general requirements found in CFR 173 Subpart I and the requirements for the specific shipping category.

Limited Quantity Materials

Limited quantity materials are those whose surface radiation exposure is extremely low (near background radiation). Typical shipments include medical diagnostic kits, smoke detectors, and luminous watch dials.

These materials are subject only to the general packaging requirements under 49 CFR 173.24 They must be shipped in a strong, tight container. The contents must be compatible with the packaging material. The container must be secure enough to have no significant release of contents in conditions normally incident to transportation. The mixture of materials may not reduce the effectiveness of the packaging through spontaneous increase in heat or pressure or through an explosion.

Type A Packaging

Materials that require Type A packaging include radiopharmaceuticals, research sources, and industrial sources. Packages containing UN Class 7 (radioactive) materials must meet all general design requirements in CFR 173 Subpart I and shall be designed to prevent loss of contents and maintain shielding under normal conditions of transport. They must be designed to be easily handled and properly secured during transport. The external surface, as far as practicable, may be easily decontaminated. The smallest outside dimension must be four inches or greater. It must be designed to maintain shielding efficiently. It must be leak-tight under normal transportation conditions. The decay heat generated within the package shall not cause the package to deteriorate. Liquid radioactive material must be packaged in leak-resistant and corrosion-resistant inner containment. For authorized Type A packages, refer to 49 CFR 173.415.

The container must pass several tests, including a water spray test (for 1 hour to simulate rainfall of 2 inches per hour), a free drop (free fall onto a flat hard surface with distance specified according to packaging weight), a compression test (5 times the weight of the package for at least 24 hours), and a penetration test (impact from dropping a 13-pound bar [1-1/4 inch in diameter] vertically from a height of 3.3 feet). Each shipper of a Type A package is required to maintain on file a complete certification and supporting safety analysis that the construction methods, packaging design, and materials of construction are in compliance with the specifications.

Type B Packaging Requirements

Shipments that require Type B packaging include radiography sources, larger research and industrial sources, and spent nuclear fuel. The Type B package must meet all Type A criteria plus provide adequate protection for serious accident conditions with limited loss of shielding and no loss of containment as demonstrated in test conditions and requirements prescribed in Title 10, CFR, Part 71. For authorized Type B packages, refer to 49 CFR 173.416.

Type B tests include water immersion (50 feet under water for not less than 8 hours), a free drop (from 30 feet onto a flat unyielding surface), a puncture test (a free drop of 40 inches onto a 6-inch diameter cylindrical steel bar), and a thermal test (30 minutes at 1475˚F).

Low Specific Activity (LSA) Materials

Low specific activity (LSA) materials present a low risk of responders. They generally fall into one of three groups:

- Materials in natural form with a low level of specific activity.
- Materials with a high level of specific activity that are uniformly distributed throughout an inactive material (such as cement), resulting in a low radioactive concentration overall. (These loads are sometimes referred to as "rocks and garbage.")
- Nonradioactive materials externally contaminated with a low-level radioactive substance.

LSA materials are specifically listed or calculated per 49 CFR 173.403.

Protective Overpacks

Protective overpacks containing inner packages of radioactive materials are rigid packages with either cylindrical or box-like configurations.

Cylindrical overpacks are made of laminated or solid wood and may be covered with steel. These overpacks may have stiffener rings around the sides. They may weigh up to 6000 pounds when loaded.

The box-like overpack consists of nested plywood boxes enclosed in a solid wooden box that is further reinforced with steel bars. These overpacks are painted with a paint that swells and forms a protective char when exposed to fire. They vary in size and may weigh up to 3000 pounds

Casks

Casks are used to transport certain radioactive materials. Casks are rigid metal packages that can range in size up to ten feet in diameter and fifty feet long. Some casks have reinforcing rings and/or cooling fins.

Summary

Many of the procedures for bulk storage containers at fixed facilities will be the same as for other types of incidents. There are, however, several advantages when dealing with a bulk storage container emergency at a fixed facility including:

- On-scene expertise
- Built-in safety systems
- Hazardous Materials Management Plans
- Pre-incident plans
- MSDSs

Emergency response personnel must identify facilities within their response area that contain bulk storage tanks which pose a hazmat problem and develop pre-incident plans for those occupancies. Pre-incident planning is the key to handling bulk storage container hazmat emergencies at fixed facilities.

15

Chapter Fifteen

Chapter 15: Hazardous Materials Transportation

Summary: This chapter is intended to familiarize students with essential concepts and awareness of the transportation of hazardous materials. As many jurisdictions throughout California do not deal with large quantities of bulk Railroad transportation, this may be considered an optional topic of instruction, dependent on the group represented.

Time Allocated: 60-180 Minutes, program dependent

Method of Instruction: Lecture

Terminal Learning Objective:

At the conclusion of this section the participant will be able to describe the principle components of Railcars, dangers that might be encountered by Technicians in the field, and basic tactics that may be utilized in the mitigation of releases encountered.

Enabling Objectives:

A. Define the types of Rail Cars likely to be encountered
B. List the elements of safe operation near Rail cars
C. Identify specific hazards likely to be encountered when dealing with Rail cars.
D. Demonstrate a working knowledge of the key points in the Association of American Railroads Guidebook.

Instructional Resources Required (If class presentation is utilized):

1. Student Notebook
2. Projection system for PowerPoint (or other similar program)
3. Alternate: Overhead projection with Overhead Slides
4. Dry erase, paper chart and or chalk board with appropriate markers

Instructional Resources Recommended: AAR Guidebook, digital version, 2017, and 49 CFR

Instructor to Student Ratio: 1:40

References: AAR Guidebook, digital version, 2017

Evaluation Strategy:

Participants will complete written examination at the conclusion of the class.

PLEASE REFER TO THE DIGITAL STUDENT REFERRENCE DOCUMENTS, FOR ADDITIONAL INFORMATION. IN PARTICULAR, FROM THE ASSOCIATION OF AMERICAN RAILROADS, USED WITH THE PERMISSION OF:

UNION PACIFIC

CSTI WISHES TO THANK THE ONGOING SUPPORT, AND COMMITMENT TO EXCELLENCE OFFERED BY UPRR AND ITS MEMBERS.

CLASS PRESENTATIONS NOTES:

Highway Transportation of Hazardous Materials

Many ground-based shipments involve hazardous materials, and most hazardous materials are carried in specification cargo tanks. Specification cargo tanks are different from other highway carriers in that they are regulated and must conform to certain specifications. Hazardous materials technicians need a basic understanding of the features and design characteristics for each type of cargo tank.

Until September 1, 1993, cargo tanks were built to either MC specs — MC 306, MC 307, MC 312, — or new DOT specifications — DOT 406, DOT 407, DOT 412. Cargo Tanks built after September 1, 1993, were built to the current DOT 406, DOT 407, DOT 412 specifications. While cargo tanks could not be built to MC 306, MC 307, or MC 312 specs after August 31, 1993, many of these (and older spec) cargo tanks will remain in service for several years. Specifications for cargo tanks can be found in CFR 49 Part 178 Subpart J – Specifications for Containers for Motor Vehicle Transportation.

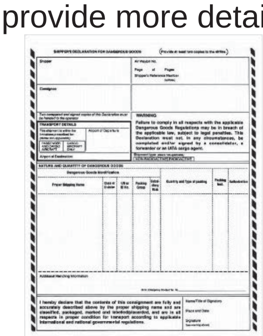
Where applicable, this program identifies cargo tanks by the type of service provided — nonpressure, low-pressure, pressure, corrosive liquid, and cryogenic liquid. However, it also contains references to specification numbers, such as MC 306.

Some data suggests that gasoline accounts for more than half of all hazardous materials ground shipments Often shipments of gasoline are made on a regular schedule between tank farms and service stations. Gasoline is almost always transported in specification, nonpressure cargo tanks, which are discussed in detail later in this unit.

In addition, every community has its own unique shipping needs and capabilities. Knowledge of the types of products commonly shipped into or out of your community will help you prepare for an incident.

Shipping Papers and Other Documentation

Ground based shipping papers, ("Bills of lading"), provide one of the first available and more accurate sources of information about the materials involved in a highway incident. While placards may indicate the presence of hazardous materials and their primary hazards, shipping papers provide more detailed information about the materials.


SHIPPER'S DECLARATION FOR DANGEROUS GOODS

WARNING

Failure to comply in all respects with the applicable Dangerous Goods Regulations may be in breach of the applicable law, subject to legal penalties. This Declaration must not, in any circumstances, be completed and/or signed by a consolidator, a forwarder or an IATA cargo agent.

TRANSPORT DETAILS

NATURE AND QUANTITY OF DANGEROUS GOODS

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 labelled/placarded, and are in all respects in proper condition for transport according to applicable international and national governmental regulations.

Even when hazardous materials are transported in small quantities not requiring placards, the shipping papers identify:

- The shipper, who can provide complete information about the contents
- The consignee, who should have information on the product
- The carrier, who should have complete information about the vehicle
- The name of the hazardous material
- The quantities involved
- Basic hazard and response information
- A phone number for 24-hour access to emergency response information

As with any mode of transportation, shipping papers must accompany each shipment of hazardous materials.

Division 9 of the California Vehicle Code, and 49 CFR dictate that Commercial Vehicles carrying Hazardous Materials upon a Highway must have their shipping papers (Bill Of Lading) immediately accessible.
When the Vehicle's Driver is not inside the Cab, the Bill Of Lading can only be placed in the storage pouch inside the driver's side door, or upon the driver's seat, in the absence of the driver. However, if involved in an accident, the driver should take the shipping papers with him or her when leaving the vehicle.

In addition, the carrier may be able to provide you with material safety data sheets (MSDSs) for the contents. In fact, it is becoming fairly common for MSDSs to be included with shipping papers. If not available on the scene, you can obtain an MSDS directly from the manufacturer of the material or from the shipper once you have identified the shipment and its contents.

Finally, cargo tanks are required to carry vehicle registration and inspection information on the tank trailer.

When documentation such as shipping papers and MSDSs are not accessible, you must look for other methods to identify the materials involved. In many cases, the trucking company dispatcher can provide some information, particularly if you can provide him or her with the tractor or trailer number. Internet data bases (WISER, etc.) can be of great help in obtaining technical-reference data, once the load has been identified.

Cargo Tank Markings

Cargo tanks may display a number of markings that can be used to gain valuable information about the tank itself and about its contents. Knowledge of a cargo tank that is involved in an emergency situation — its construction, fittings, capacity, etc. — will help you identify potential problems and possible solutions. Knowledge of the tank's contents will help you make educated decisions about rescue, evacuation, and control.

Compressed gases (flammable and nonflammable) and cryogenic liquids have their proper shipping names (e.g., liquefied petroleum gas) or common technical names (e.g., LPG) marked on both sides and both ends of the cargo tank.
Hydrogen peroxide is the only liquid (noncryogenic) that must also be transported in a cargo tank marked with its name. In addition, cargo tanks are frequently marked with a brand name or the name of a shipper or product manufacturer

Other sections of this workbook will provide information on Tank construction, identification, and evaluation.

Specification Plates

All specification cargo tanks are required to carry a DOT specification/certification plate. This plate must be permanently attached in a location readily accessible for inspection on the left side of the vehicle near the front of the cargo tank. (On tanks constructed prior to July 1, 1985, this plate is mounted on the *right* side near the front.) Insulated cargo tanks, such as cryogenic liquid cargo tanks and some corrosive liquid cargo tanks, may have two specification plates.
One plate is located on the left side near the front, but because it is welded to the tank under the jacket and insulation, it is hidden from sight (unless the jacket and insulation have been torn away).
The second plate is located either on the outside of the jacket near the front left side or inside the cabinet at the operator's station (on cryogenic liquid cargo tanks).

Specification plates for tanks being constructed under current regulations are required to contain the following information:

- Cargo tank motor vehicle manufacturer
- Cargo tank motor vehicle certification date (if different from the cargo tank certification date)
- Cargo tank manufacturer
- Cargo tank date of manufacture (month and year)
- Maximum weight of lading (in pounds)
- Maximum loading rate in GPM, at maximum loading pressure in psig
- Maximum unloading rate in GPM, at maximum unloading pressure in psig
- Lining material (if applicable)
- Heating system design pressure (if applicable)
- Heating system design temperature (if applicable)

On cargo tanks that are older but still in service, the specification plates may contain slightly different information.

MANUFACTURED BY MFG. COMPANY
MFG. SERIAL__MFG. DATE
DOT SPEC.
ORIGINAL TEST DATE
CERTIFICATION DATE
DESIGN PRESSURE___________PSIG
TEST PRESSURE___________PSIG
HEAD MAT'L___SHELL MAT'L
WELD MAT'L___LINING MAT'L
NOMINAL COMP'T. CAP. (FRONT TO REAR)
U.S. GALS.
MAX. PROD. LOAD____________LBS.
MAX. TEMP.___°F
LOADING LIMITS
UNLOADING LIMITS

Exhibit 15.1: Specification Plate for Nonpressure, Low-Pressure, and Corrosive Liquid Cargo Tanks

The DOT spec, listed near the top of the plate shown in Figure 2, identifies the specs to which the tank was built. For example, MC 306 would indicate that the tank is a nonpressure cargo tank. Specification designations represent the following.
Tanks may be designed to higher working pressures than indicated above, but would have to be specifically engineered to the American Society of Mechanical Engineers (ASME) standards for the higher pressures.

DESIGNATION	SPECIFICATION TYPE	WORKING PRESSURES	
		Minimum	Maximum
DOT 406, MC 306	Nonpressure Cargo Tank	2.65 psig	4 psig
DOT 407, MC 307	Low-Pressure Cargo Tank	25 psig	35 psig
DOT 412, MC 312	Corrosive Liquid Cargo Tank	5 psig	15 psig
MC 331, MC 330	Pressure Cargo Tank	100 psig	500 psig
MC 338	Cryogenic Liquid Cargo Tank	2.53 psig	500 psig

The letters immediately following the DOT specification indicate the type of material used to build the tank. For example, MC 306 AL would indicate that the tank is an MC 306 (nonpressure cargo tank) constructed of aluminum. Material abbreviations represent the following:

ABBREVIATION	MATERIAL
AL	Aluminum
CS	Carbon Steel
SS	Stainless Steel
MS	Mild Steel

The material of construction may be particularly relevant in emergency response situations because it indicates relative tank strength and how the tank is likely to react under certain conditions. However, all metals lose their tensile strength (resistance to rupture under tension) at temperatures above 1200°F. While the destructive temperature varies with different alloys, the alloys used most in cargo tanks sustain irreparable damage at 1300°F to 1500°F. You should become concerned when a tank is likely to be subjected to these temperatures for more than 30 minutes.

The following definitions will help you interpret spec plate information.

Design Pressure - indicates the working or maximum allowable pressure for the particular tank (not the pressure above which the tank is likely to fail)
Head, Shell, and Weld Material - indicates the thickness or strength of the materials used.

Lining Material - indicates the type of material, if any, that the cargo tank is lined with; if blank, the tank is not lined.

Nominal Compartment Capacity - indicates the maximum capacity — in gallons — that each compartment will hold (in consecutive order, from front to rear); if the tank is not compartmented, the total number of gallons that the tank will hold may appear here.

Maximum Product Load - indicates — in pounds — the maximum product load and, on corrosive carriers, the maximum weight *per gallon* that the tank will hold; this generally appears as follows:

Max. Product Load..56,250 lbs. @ 7.5 lbs. per gal.

Maximum Temperature - indicates the maximum temperature at which the tank will safely carry the material without a failure; though not always required, this is usually provided, even on non-insulated cargo tanks.

Manufactured By__________________Mfg. Company Mfg. Serial No.______________________________ DOT Spec.__________________________________ Vessel Mt'l Spec. Water Cap. Lbs.______________________________ Original Test Date_____________________________

Exhibit 15.3: Specification Plate for Pressure and Cryogenic Liquid Cargo Tanks

While the information contained on spec plates can be very useful, being close enough to a cargo tank to read its spec plate may jeopardize your safety. Until you can be sure that the situation is stable, you should not approach an involved cargo tank.

Cargo Tank Construction

Typically, cargo tanks are round or elliptical cylinders with flat or rounded ends, called heads. They may or may not be compartmented. Most are equipped with fittings and safety features that accommodate the properties of the commodities that they will be used to transport.

Welding, damage repair, and modifications/alterations to spec cargo tanks must be performed in accordance with DOT regulations. This work must be performed at approved repair facilities that hold the National Board of Pressure Vessels “R” stamp or an ASME “U” stamp.

The Tank Itself

Each tank shell is constructed from sheets of metal formed into circular sections. The heads are constructed from sheets of metal formed into either circular or elliptical shapes, depending on the tank design. The circular sections and the heads are then joined, either by semiautomatic or manual welding, to form the tank. The tank is then equipped with fittings and safety features appropriate for the specific commodities that it will be used to transport.

Materials of Construction

As noted earlier, most highway cargo tanks are constructed of aluminum, quenched and tempered steel, mild steel (nonquenched and tempered), carbon steel, or stainless steel. Aluminum is relatively soft, and bends, tears, and is punctured more easily than the other metals. It begins to melt at roughly 1200°F. However, because aluminum is relatively soft, it is better able than other metals to withstand stress (such as from a collision) without fracturing. And, when exposed to flame, aluminum tanks tend to melt down above the liquid level — creating an open tank fire — making extinguishment easier and eliminating the possibility of a tank explosion. Aluminum tanks rarely rupture or explode. In addition, aluminum has a high strength-to-weight ratio and resists corrosion from the atmosphere, though it can be corroded by acids and alkalis.

Quenched and tempered steel is very strong and hard, but slightly more susceptible to cracking and eventual catastrophic failure than nonquenched and tempered steel. It is also more likely to be corroded by acidic and alkaline commodities.

Mild steel is basically unaltered steel from the factory. It is harder than aluminum but softer — and more ductile — than quenched and tempered steel, carbon steel, or stainless steel.
While other steels contain carbon, carbon steel contains a higher percentage of carbon and derives its strength and hardness from the carbon. (Properties of other steels — *alloy* steels — are a result of iron and other elements being incorporated into the steel, though alloy steels contain some carbon as well. Different alloys are created to produce steels with specific desired properties.) Carbon steel is harder and stronger than aluminum or mild steel.

Stainless steel contains nickel, which makes it harder but also more brittle than mild steel. When stainless steel is heated, it loses its strength about twice as fast as mild steel; stainless steel begins to sustain damage at temperatures above 1200°F, and significant loss of strength begins to occur at 1500°F to 1600°F.

Understanding the properties of the materials used to construct an involved cargo tank is critical to assessing the situation and determining possible outcomes.

Capacity Limitations

Cargo tank dimensions and capacities are determined by several factors, such as carrier requirements, state and local laws, and the weight/density of the intended lading. Safety considerations — such as minimum road clearances and center of gravity — also play a key role in determining cargo tank capacities. Currently, most cargo tank capacities do not exceed 9200 gallons.

Multiple Compartments

Cargo tanks may be divided into compartments, and each compartment may have a different capacity and carry a different commodity. In some cases, compartments within the same tank may even meet different specs.

Compartmented cargo tanks generally have no more than five or six compartments. For the most part, compartments with capacities in excess of 2500 gallons must have manholes, and some compartments have more than one manhole. The number of discharge valves is usually equal to the number of compartments in the tank. Nonpressure, low-pressure, and corrosive liquid cargo tanks may have void sections between the compartments.

Frames

Most cargo tank trailers are of frameless construction, with the tank itself acting as the frame to absorb the stresses placed upon it. On cargo tank motor vehicles, the tank may be mounted on either the flatbed portion of a truck or to a set of frame rails that form a portion of the truck itself.

Features

Various features are added to a tank to accommodate the specific commodities that it will transport. These features include:

- Insulation
- Thermal protection
- Jackets
- Linings and claddings

Insulation

Insulation is a material used to safeguard the contents of the tank from outside temperatures. Fiberglass and polyurethane foams are common types of insulating materials, with fiberglass being the most common. Perlite (foam beads) is used on cryogenic liquid cargo tanks. You will probably not see the insulation because it is normally held in place and protected by a jacket.

Thermal Protection

Thermal protection, not to be confused with insulation, is a sprayed-on coating designed to keep tank metal temperatures below the point where structural failure could occur. It protects the tank surface from flame impingement when subjected to torch or pool fires. It is not used on most cargo tanks, but may be used on pressure cargo tanks transporting liquefied petroleum gas. Thermal protection may be concealed by a jacket.

Jackets

A jacket is a thin outer covering that holds insulation in place and protects the insulation from weather. In addition, undamaged jackets may serve as heat shields from radiated heat. Jackets are generally made out of a thin layer of stainless steel.

Jacketed cargo tanks can be identified by one or more of the following indicators:

- Bright or shiny metal flashing — a shroud or cover — covering tank mountings
- Flat appearance of ends or flat sections on sides of the tank
- Rough appearance of visible welds, including lap welds; jacket welds are generally narrower than tank welds

Linings and Claddings

The interiors of some cargo tanks are lined or clad with materials to protect the tank from the corrosive or reactive effects of the contents or to maintain the purity of the contents.

A *lining* is a covering applied in strips or sections and glued to the inside of a tank after the tank is constructed. Rubber is the most commonly used lining in cargo tanks used to transport corrosive materials. Other commodities may require other linings, such as glass, lead, or polyurethane.

Claddings are coverings that are applied to the base metal before a plate is formed. Nickel is the primary material used as cladding.

Cargo Tank Fittings

There are a number of different cargo tank fittings that allow cargo tanks to be loaded and offloaded and to safely transport various commodities. The physical and chemical properties of the material to be transported determine which cargo tank fittings are needed and, therefore, how a cargo tank is built. In this chapter, we will look at cargo tank fittings in general, followed by a closer look at each type of cargo tank and fittings specific to various tanks.

This section discusses typical cargo tank fittings for nonpressure, low-pressure, pressure, corrosive liquid, and cryogenic liquid cargo tanks. We will discuss fittings specific to each type of tank later in this chapter. The fittings discussed are representative of the fittings most commonly used on specification cargo tanks constructed today. This list is not all-inclusive; the variety of fittings is far too great to cover here. Furthermore, there are exceptions to nearly every description and fitting listed. These descriptions provide a base of knowledge on which to build; hands-on examination of various fittings is essential in order to understand their design and operation.

Cargo Tank Fittings, Cont.

Although varied in design, when fittings leak, they tend to do so in similar areas; for example, around flanges, through worn or defective gaskets, and through safety vents that do not reseat.

Manholes

Manholes are large openings on the tops of cargo tanks — or on the back head on most pressure cargo tanks — that allow access to the interior of the tank for inspection, cleaning, and making repairs. There are numerous styles of manhole covers, but all must provide a secure closure to prevent product loss; be capable of withstanding specified internal pressures; have safety devices that prevent the covers from opening due to internal pressure; and, on corrosive liquid cargo tanks, have gaskets that can withstand the effects of the product to be transported.

For most nonpressure, low-pressure, and corrosive liquid cargo tanks, manholes are required on every compartment with a capacity in excess of 2500 gallons. On DOT 406 cargo tanks, each compartment with a capacity in excess of 400 gallons must have its own manhole. On pressure cargo tanks, only those compartments having capacities in excess of 3500 gallons are required to have manholes. Some cargo tanks have more than one manhole per compartment.

Often other fittings are located in the area of the manhole or are mounted on the manhole cover. Some cargo tanks have fill holes for loading and offloading on the manhole cover. Manholes and surrounding fittings are protected by overturn protection devices. These devices either run the length of the cargo tank or surround just the manhole.

Loading/Offloading Piping and Valves

Most nonpressure and low-pressure cargo tanks are bottom-loaded (loaded and offloaded from the bottom of the tank), while most corrosive liquid (and some low-pressure) cargo tanks are top-loaded (loaded and offloaded from the top of the tank). Bottom offloading is easier and faster than top offloading, so cargo tank manufacturers are working to design tanks and bottom-loading/offloading features that are as safe as top-loading tanks. As this area develops, more corrosive liquid cargo tanks may be built for bottom-loading and offloading.

Bottom-loading tanks have internal valves or “emergency valves” that are designed to remain closed in emergency situations. Because the valves are internal — seated within the tank, flange, or sump — they remain intact and prevent product from being released if the piping is torn away. In addition, these product discharge valves have automatic heat-activated closures that melt and close the valves under fire conditions, as well as a secondary means of closure that is remote from filling and discharge openings. Remote closures are usually located on the left front corner of the tank.

All bottom-loading/offloading piping is protected by a shear section that is designed to break away if struck.
The shear section will break under the strain of impact and leave the emergency valve head, seat, and its attachment to the tank intact and capable of retaining the product.

Under normal conditions, loading/offloading valves are operated by mechanical, hydraulic, or pneumatic means.

On bottom-loading tanks, a leak at the flange between the tank and loading/offloading valve is often caused by loose flange bolts or nuts. If the leak continues after the bolts/nuts have been tightened, the leak may be the result of a worn or defective gasket. Worn and defective gaskets should be replaced only by industry specialists.

Liquid leaking from the end of an offloading pipe may indicate that the internal valve is not properly seated or is broken. It is not uncommon for internal valves to be wedged open by debris or other foreign material that has fallen into the tank.

If the leak continues after you open and reclose the valve, the internal valve is probably broken and must be replaced by an industry specialist.

Liquid or vapor leaking from around a top-mounted valve is often caused by a valve that is not completely closed or is not properly seated. Generally, these leaks can be stopped by closing or tightening the valve. If the leak is caused by a defective seat or threads on the valve, it must be handled by an industry specialist.

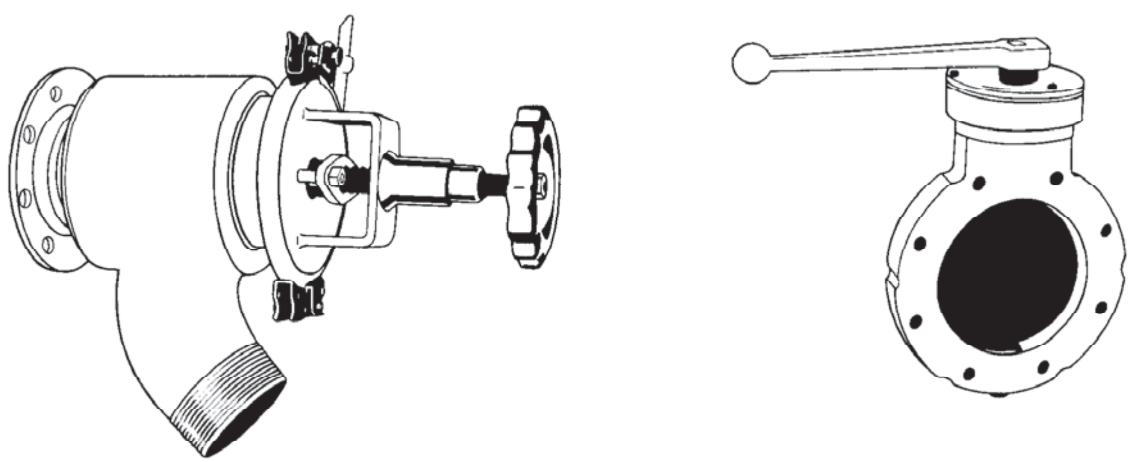


Figure 15.4: Discharge Valves Placed on the End of Product Discharge Piping,

Typical for Nonpressure and Low-Pressure Cargo Tanks

Venting and Safety Relief Devices

With the exception of tanks carrying poisonous materials, most cargo tanks are built with fittings that allow venting under normal conditions as well as venting, or pressure/vacuum relief, when the tank is under stress. These fittings include:

- Breather vents
- Loading and offloading vents (vapor recovery vents)
- Safety relief devices

Breather vents allow normal venting of vapors. They are designed to open at predetermined settings to relieve pressure or a vacuum. Breather vents reclose when internal tank pressure has been restored below the predetermined setting.

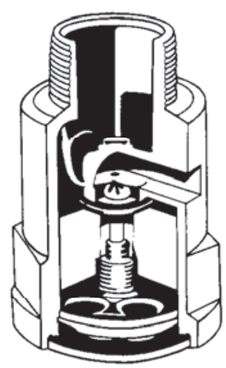


Figure 15.5: Breather Vent

Safety relief devices include both safety vents and safety relief valves. They are designed to relieve tank pressure or vacuum at predetermined limits. Tank size and number of compartments, in addition to prescribed cargo tank specifications, dictate how many safety relief devices a tank must have — generally, one per compartment.

Safety vents are typically used on nonpressure, low-pressure, and corrosive liquid cargo tanks; they are not used on pressure or cryogenic liquid cargo tanks. When used, they are sometimes mounted on the manhole cover plate or are part of a fusible cap. Safety Vents are designed to fail (open) at 100% of the tanks test pressure There are two common types:

- Fusible plugs
- Frangible disks

Fusible plugs, which melt at predetermined temperatures, and frangible disks, which burst at predetermined pressures, do not reclose even when normal temperatures and pressures have been restored. Regulations now prohibit the installation of non-reclosing pressure relief devices on newer cargo tanks (built after August 31, 1990) that will be used to transport hazardous materials, except that frangible disks may still be used in conjunction with one or more reclosing safety relief devices.

Since they do not reclose, melted and ruptured safety vents are common causes of leaks from cargo tanks. Once they have melted or ruptured, safety vents must be replaced.

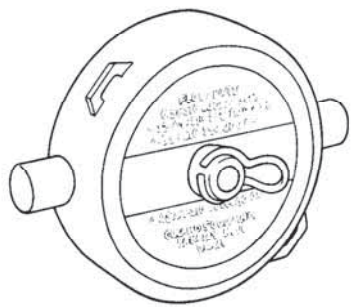


Figure 15.6: Fusible Cap

Safety Relief Valves (SRV) are used on pressure and cryogenic liquid cargo tanks, as well as on nonpressure, low-pressure, and corrosive liquid cargo tanks. They allow for emergency venting, often referred to as pressure-actuated venting (PAV). These devices are spring-loaded and are designed to open when pressure inside the tank reaches a predetermined limit. Safety relief valves reseat themselves when normal pressure has been restored.

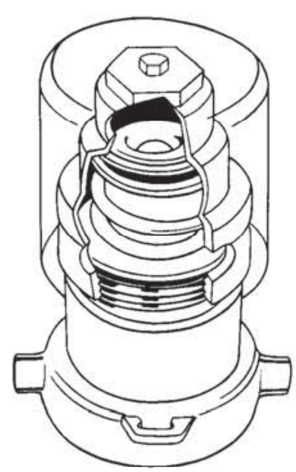


Figure 15.7: Pressure-Actuated Vent (Safety Relief Valve)

The DOT requires that venting and safety relief devices not leak, regardless of the position of the vehicle (e.g., after a rollover). However, breather vents often leak when a tank is overturned, screw-on fusible caps sometimes blow out when pressure surges as a tank rolls over, and frangible disks may burst when tank contents surge during normal transit.
And, as mentioned earlier, fusible and frangible disks will continue to vent, and may leak, even after normal pressure and temperature have been restored. Safety Vents are designed to open at 75% of the tanks test pressure. There are rare exceptions to the 75% rule, which require DOT authorization.

In addition, liquid or vapor leaking from a safety relief valve could indicate that the relief valve spring is defective. On nonpressure cargo tanks, it may be appropriate for you to replace the safety relief device if one is available to you. However, leaks caused by defective valves on low-pressure and pressure cargo tanks should be handled by industry specialists.

Miscellaneous Fittings

Cargo tanks may have various other fittings and devices to allow for the safe transit, loading, and offloading of the tank.

Types of Cargo Tanks

The truck driver, trucking company dispatcher, and shipping papers can often provide you with solid, accurate information about the contents of a cargo tank that has been involved in an emergency situation. However, when these resources are not readily accessible, or you receive conflicting or questionable information, you may have to begin making decisions based on the type of cargo tank involved. The type of cargo tank used to transport a hazardous material — its shape, size, materials of construction, fittings, linings, and other features — is determined by the physical properties of the commodity to be transported. So, when you know something about the features of an involved cargo tank, you will have an idea of how the tank will react under various conditions and you will be able to make *general assumptions* about the characteristics of its contents.

There are five basic types of specification cargo tanks in use today: nonpressure, low-pressure, pressure, corrosive liquid, and cryogenic liquid cargo tanks. Silhouette identification — identification based on the overall shape of the cargo tank — is frequently used in the initial stages of response to identify the type of involved cargo tank. The following illustrations and general cargo tank descriptions provide additional information and can be used in conjunction with other information to begin developing response plans. Remember, however, that tank shapes and features vary to accommodate the physical and chemical properties of the specific commodities they were designed to transport, and jacketed cargo tanks may be difficult or impossible to identify based solely on tank shape.

In addition, nonpressure and low-pressure cargo tanks often have such similar design features that the only way to distinguish between them is through their spec plates or other documentation.

Nonpressure Cargo Tanks

Nonpressure cargo tanks are in wide use across the country — they represent 57% of the nation's total fleet, make over 100,000 deliveries per day, and are used for hazardous materials shipments more than any other cargo tank. These are the cargo tanks used for the transportation of flammable liquids, such as gasoline, diesel fuel, jet fuel, and kerosene, as well as for combustible and poison liquids. Because they are so closely associated with the transportation of gasoline and other fuels, you may have to remind yourself that they are used to transport a tremendous variety of other hazardous materials. They can hold up to 12,000 gallons of product and are built to withstand only very low-pressures — 5 psi, with the SRV set to 3-4 psi.

Over 90% of these tanks are constructed of aluminum, though regulations also allow stainless steel or mild steel to be used in their construction. The aluminum tanks are very thin-skinned, usually 3/16 inch thick, and are more susceptible to tears and punctures than steel tanks. However, aluminum tanks are also less likely to fracture under stress, and they melt rather than explode when exposed to flame.

Many of the larger nonpressure cargo tanks are compartmented. Every compartment with a capacity in excess of 2500 gallons must have its own manhole (On the new DOT 406 cargo tanks, each compartment with a capacity in excess of 400 gallons must have its own manhole). Large compartments may have more than one manhole, so count the number of discharge valves, stationed beneath the tank, to determine the number of compartments. Overturn protection running the length of the tank protects the manholes from damage should the tank overturn.

These cargo tanks are unique in that product sometimes remains in the bottom piping while the tank is in transit. The product is emptied from these lines once the first delivery has been made. Discharge piping is protected by a "shear section" (or a guard) that prevents the internal valve from being broken and releasing the tank's contents in an accident. If the first delivery has not yet been made, however, 30 to 40 gallons (depending on tank size and number of compartments) may be spilled from the bottom piping.

Nonpressure cargo tanks generally have flat heads and elliptical cross-sections, though some, such as those used to haul crude oil, have round cross-sections. These tanks sometimes have external — visible — stiffening rings. In addition, they are often permanently marked with the owner's name and/or the type of material being transported.

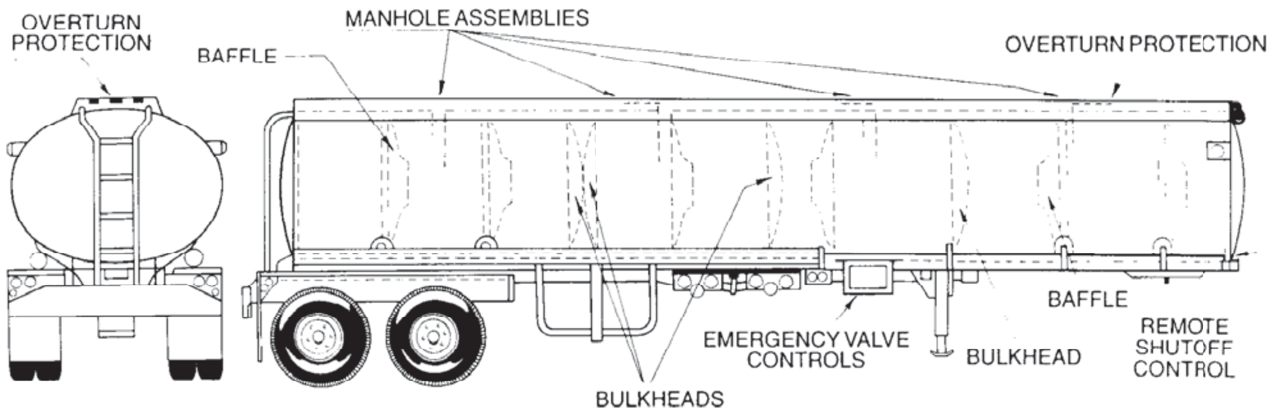


Figure 15.8: Nonpressure Cargo Tank (MC 306/DOT 406)

The walls between the compartments and the baffles provide structural support, but are often damaged in rollover situations. When walls are damaged, product may flow between compartments, changing weight distribution and making uprighting and recovery operations difficult.

Nonpressure Cargo Tank Fittings

Nonpressure cargo tanks have bottom-loading and offloading valves. The loading and offloading valves are down line from the internal valve so that the internal valve must be open to permit loading and off loading from the tank. Fittings for vacuum and pressure relief are found on top of the tank on or near the manhole cover. Pressure relief devices are set to relatively low-pressures (1 to 5 psi). An overflow sensor is also found on top of nonpressure cargo tanks on or near the manhole cover. All fittings on top of the tank are protected by overturn protection.

Loading/offloading vents, also called vapor recovery vents, are high-capacity vents that allow tanks to be vented while being bottom-loaded or offloaded with the dome covers closed. They must be opened manually by mechanical, hydraulic, or pneumatic means. Many times, the lines that lead to the pneumatically and hydraulically operated vents have fusible plugs that, if melted, cause the vents to close.

Mechanically operated vapor recovery vents, typical on nonpressure cargo tanks, open whenever the internal valves are opened. This makes product transfer through the discharge valves very difficult on overturned tanks; the vapor recovery vents must be plugged or disabled to prevent them from leaking product as the discharge valves are opened. Mechanically operated vents also have fusible elements — either nuts or links — that, if melted, cause the vents (as well as the internal valves) to close.

These vents are installed in the dome cover or on top of the tank itself.

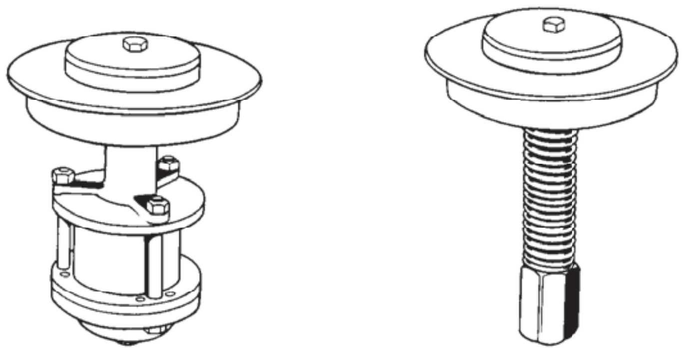


Figure 15.9: Loading/Offloading (Vapor Recovery) Vents

Liquid leaking from around a vapor recovery line often indicates that a vapor recovery vent is open or that the tank is overloaded. Close the vent, if open. Overloaded tanks should be partially offloaded by the tank owner or the shipper.

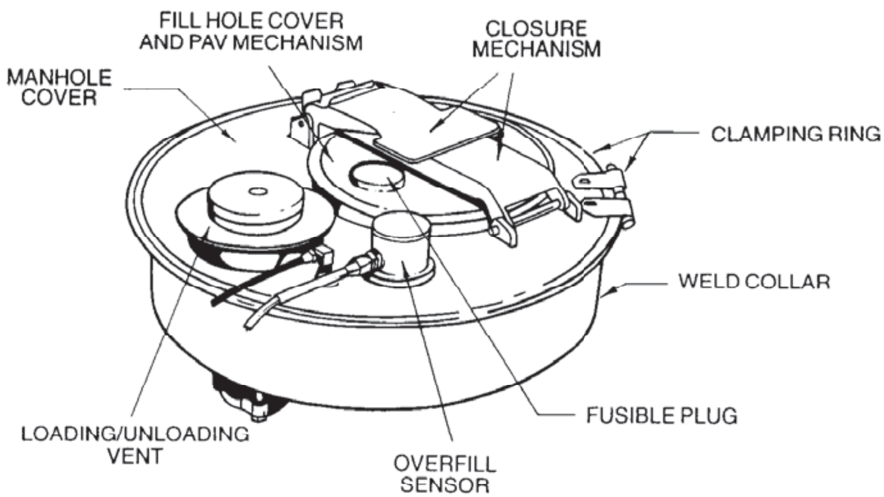


Figure 15.10: Typical Manhole Assembly for Nonpressure Cargo Tanks

Leaks can develop in the area of the manhole when the manhole clamp ring becomes loose or the gasket becomes worn or is defective. If a loose clamp ring is the cause of the leak, tighten it. If a worn or defective gasket is the cause of the leak, it must be replaced by an industry specialist.

Similarly, if liquid or vapor is leaking from around the fill hole cover, check for zero pressure, then open and reclose the cover *only if the tank is in its upright position*, or tighten the wing nuts or apply a dome cover clamp. If the fill hole cover has a worn or defective gasket, it must be replaced by an industry specialist.

Low-Pressure Cargo Tanks

Low-pressure cargo tanks comprise approximately 21% of the fleet of cargo tanks in service today. They are used to transport flammable and combustible liquids, mild corrosives, some Class B poisons, and a wide variety of other liquids. They have a minimum design pressure of not less than 25 psig and, typically, not more than 35 psig, though some may be built to tolerate pressures as high as 150 psig. Many of these tanks are insulated to protect temperature-sensitive commodities. The insulation is covered by a jacket — usually made of stainless steel — that is riveted over the shell of the tank.

Tank construction is generally stainless steel, but regulations also permit the use of mild steel or aluminum. Stainless steel is harder — but also more brittle — than mild steel or aluminum. (Stainless steel contains nickel; mild steel is basically steel as it comes from the factory, without additional treatment.) When stainless steel is heated, it loses its strength about twice as fast as mild steel; stainless steel quickly loses its integrity at about 125°F - 130°F above its design temperature.

(Most cargo tank specification plates have a maximum temperature stamped on them — usually 250°F. This is *not* the design temperature for the stainless steel used to construct the tank. Stainless steel begins to sustain damage at temperatures above 1200°F, and significant loss of strength begins to occur at 1500° to 1600°F.)

These tanks are generally not compartmented, though when they are, every compartment with a capacity in excess of 2500 gallons must have a manhole. (On the new DOT 407 cargo tanks, each compartment with a capacity in excess of 400 gallons must have its own manhole.) On single-compartment tanks, the manhole is usually located on the top center of the tank and is surrounded by overturn protection. Manholes on compartmented tanks are usually located as close to the center of the tank as the compartment configuration will allow; they are also surrounded by overturn protection. The overturn protection on compartmented tanks may extend from the front of the tank to the back.

These tanks are circular in cross-section, though from behind, some appear to be horseshoe-shaped. Their heads are convex (dish-shaped), but a jacket (when present) makes the heads appear flat. Tanks may slant noticeably downward toward unloading piping either at the center or rear of the tank. Some of these tanks have external — visible — stiffening rings.

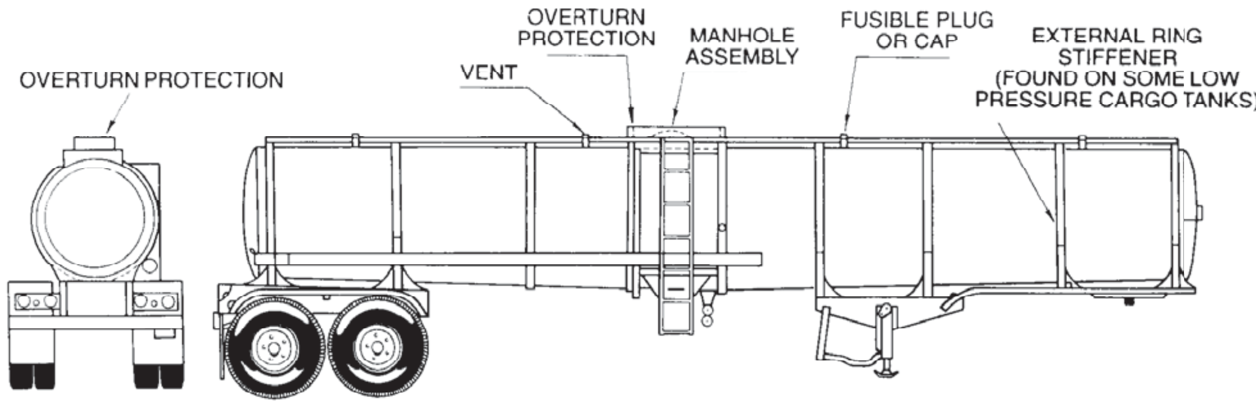


Figure 15.11: Low-Pressure Cargo Tank (MC 307/DOT 407)

Low-Pressure Cargo Tank Fittings

Low-pressure cargo tanks usually have bottom-loading/off-loading valves. Loading/offloading valves are down line from the internal valves (similar to nonpressure tanks). Fittings for vacuum and pressure relief are found on top of the tank on or near the manhole cover. Figure 12 illustrates a manhole cover with no fitting. On many low-pressure cargo tanks, there will be one or more fittings on the manhole cover. Low-pressure cargo tanks may be equipped with an air fitting used to pressurize the tank for off-loading. The airline fitting is usually found on top of the tank. Many low-pressure cargo tanks are equipped with thermometers that indicate product temperature and pressure gauges that indicate internal tank pressure.

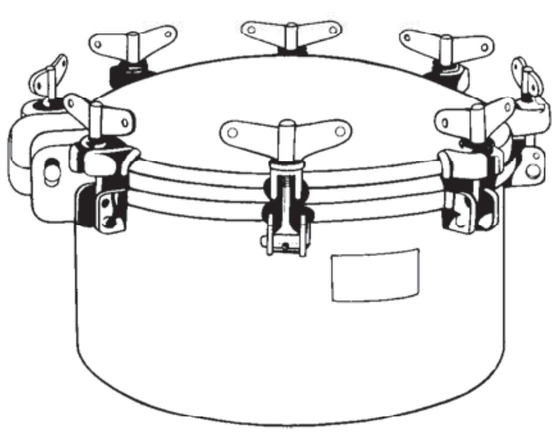


Figure 15.12: Typical Manhole Assembly for Low-Pressure Cargo Tanks

Pressure Cargo Tanks

Pressure cargo tanks comprise approximately 10% of the cargo tank fleet in service today. They are high-pressure tanks used for the transportation of liquefied petroleum gas (LPG), anhydrous ammonia, and other gases that have been liquefied through compression. Their contents must remain under pressure to maintain their liquid state. Design pressures for these tanks range from 100 psig to 500 psig, but most have design pressures of 250 psig (for nonquenched and tempered tanks) or 265 psig (for quenched and tempered tanks). Smaller pressure tanks are commonly used for the distribution of anhydrous ammonia fertilizer, or to refill propane and butane tanks or cylinders used by households and businesses.

Most pressure cargo tanks are constructed of steel — quenched and tempered or nonquenched and tempered. Regulations also permit the use of stainless steel or aluminum for these tanks, though few pressure tanks are made of these metals. Quenched and tempered steel is very hard and brittle, with very high tensile strength. Like other metals, quenched and tempered steel becomes soft and loses its tensile strength when exposed to high temperatures. Nonquenched and tempered steel has no special attributes. Heads and shells are quite thick, with a minimum thickness of 0.1875 inches; it is not uncommon to see heads as thick as 0.250 inches and shells as thick as 0.375 inches. In addition, these tanks are post-weld heat treated, which strengthens the tank.

In order to withstand the high internal pressures necessary to maintain the liquid state of the contents, pressure tanks are built with circular cross-sections and rounded heads. This shape helps distinguish pressure cargo tanks from other cargo tanks. In addition, the upper two-thirds of these tanks must be painted white or another reflective color or must be covered by a nontarnishing jacket.

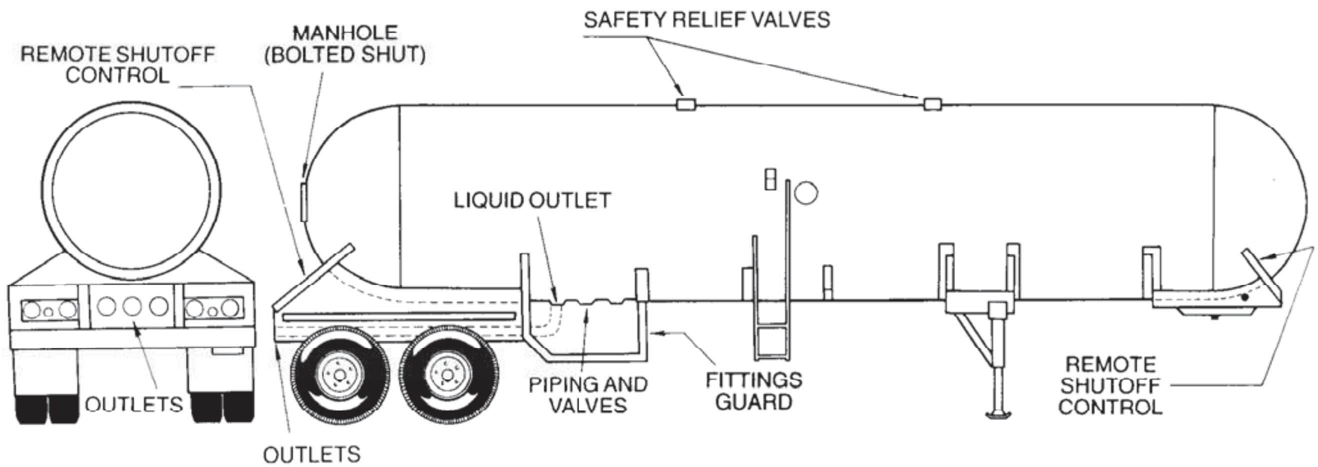


Figure 15.13: Pressure Cargo Tank (MC 330/ MC 331)

Pressure Cargo Tank Fittings

Most pressure cargo tanks are equipped with thermometers that indicate product temperature and pressure gauges that indicate internal tank pressure. Pressure cargo tanks are usually also equipped with gauging devices used to determine the volume of product in the tank. (Low-pressure cargo tanks rarely have gauging devices.) Safety relief valves are recessed into the tank to protect them from damage in the event of a rollover (see Figure 14). The manhole covers are usually bolted on at the end of the tank.

On pressure cargo tanks, product discharge valves are internally seated and equipped with automatic heat-activated valve closures and remote emergency controls. Pressure cargo tanks having capacities in excess of 3500 gallons must have remote closures at two diagonal corners of the tank. Those with capacities of 3500 gallons or less are required to have only one remote closure, located on the side of the tank furthest from the hose connection. The location of the hose connection on pressure cargo tanks is not regulated, but curb-side (right) and back end are the typical locations. Piping and valves are also protected by guards, but the discharge valves are equipped with excess flow shutoff valves rather than shear sections.

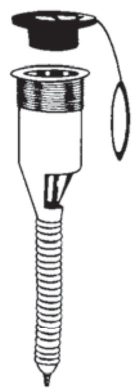


Figure 15.14: Safety Relief Valve, Typical on Pressure Cargo Tanks

Corrosive Liquid Cargo Tanks

Corrosive liquid cargo tanks make up approximately 12% of the nation’s cargo tank fleet. They are designed to transport corrosive liquids, which are usually heavier than other liquids (some weighing in excess of 17 pounds per gallon), and other high-density liquids.

Most corrosive liquid cargo tanks are made of mild steel, though stainless steel or aluminum may be used. Again, mild steel is basically steel as it comes from the factory, without any additional treatment; it tends to be harder than aluminum but softer — and less brittle — than stainless steel.

These tanks are generally built as single-compartment tanks, with overturn protection and a single manhole and fittings at the back of the tank. If compartmented, each compartment with a capacity in excess of 2500 gallons must have its own manhole. (On the new DOT 412 cargo tanks, each compartment with a capacity in excess of 400 gallons must have its own manhole.) To protect the tank metal, some corrosive liquid cargo tanks are lined with rubber, glass, or another lining material. Many of these tanks are insulated and jacketed — the jacket concealing some of its identifying characteristics.

While corrosive liquid cargo tanks have the same basic configuration as low-pressure cargo tanks — circular cross sections with dish-shaped heads — those that are not jacketed can look quite different. The diameter of the tank itself is usually much smaller than other cargo tanks. This keeps the weight of the shipment down and limits the amount of product that can be loaded. In addition, most have exterior stiffening rings that run vertically around the tank for added strength.

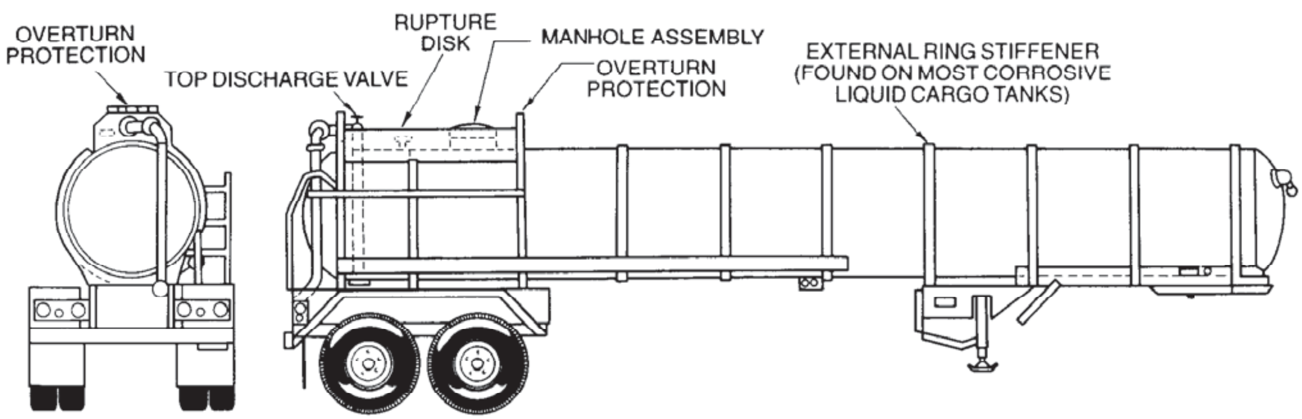


Figure 15.15: Corrosive Liquid Cargo Tank (MC 312/DOT 412)

Corrosive Liquid Cargo Tank Fittings

Many corrosive liquid cargo tanks are top-loading tanks. However, bottom-loading corrosive liquid tanks are now being manufactured. Top-loading cargo tanks have overturn protection around the valves, and all piping protruding from this protection has a shear section. Top-loading tanks do not usually have internal valves. Fittings for pressure relief and venting are found on top of the tank. Corrosive liquid cargo tanks used as vacuum trucks have bottom-loading/offloading valves usually located at the back end of the tank.

Cryogenic Liquid Cargo Tanks

Cryogenic liquid cargo tanks make up a very small portion of the nation's cargo tank fleet. They are specially designed to carry gases that have been liquefied through temperature reduction. The contents must remain extremely cold (-130°F or lower) to maintain a liquid state. Specifications to build these tanks were first used October 1, 1984; cryogenic tanks built prior to this date may not conform to the following description. Nonspec cryogenic liquid cargo tanks can be identified by spec plates that indicate the exemption to which the tank was built; the spec plates read "DOT-E-****," with the asterisks replaced by numbers. Use this exemption number to obtain details from the shipper or carrier on tank construction, valves, and plumbing before attempting to offload the product or manipulate any fittings.

Spec cryogenic liquid cargo tanks are usually made of steel and are heavily insulated and then jacketed with a thin aluminum jacket. Because contents are under pressure, these tanks are classified as pressure cargo tanks. For purposes of emergency response, they should be handled like pressure cargo tanks.

Although these cargo tanks are heavily insulated, some of the lading will vaporize as the material is slowly warmed by the temperatures outside the container. When this occurs, pressure builds up inside the tank and the relief valve is activated, discharging vapor from the tank. This is usually *not* indicative of a problem, though it often causes concern from citizens.

Any cryogenic liquid cargo tank exposed to flame, radiant heat, or other unusually high temperatures is subject to catastrophic failure if measures to cool the tank are not implemented. Generally, this requires that the source of heat be eliminated since the tank's heavy insulation renders cooling streams of water ineffective. In fact, you must use extreme caution when using water around a venting cryogenic liquid cargo tank — water can freeze almost instantly if exposed to the extremely cold temperatures of a cryogenic liquid, possibly blocking the safety relief valve and causing overpressurization of the tank.

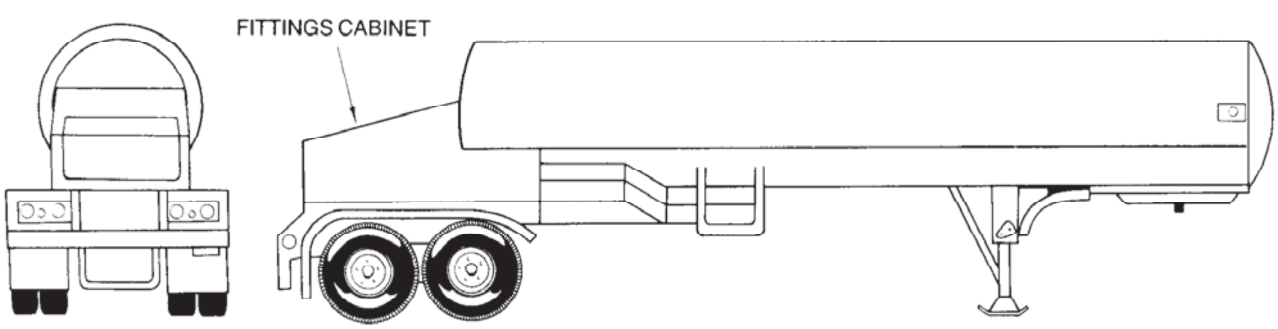


Figure 15.16: Cryogenic Liquid Cargo Tank (MC 338)

Cryogenic Liquid Cargo Tank Fittings

Fittings for loading/offloading, pressure relief, and venting are usually located within a cabinet (see Figure 18) or “station” at the center or rear of the tank. This cabinet protects the piping, valves, and pumps if the carrier overturns. Because the fittings are located in a cabinet, this cargo tank has “clean” lines, unlike other cargo tanks.

Multipurpose Cargo Tanks

Some specification cargo tanks, called multipurpose cargo tanks, are built with features that allow them to be used for the transportation of more than one type of commodity. For example, one cargo tank can be used (at different times) as both a low-pressure cargo tank and a corrosive liquid cargo tank if it meets the specs (has the appropriate fittings, etc.) for both types of tanks. Common multipurpose tank configurations include nonpressure/low-pressure (MC 306/307) and low-pressure/corrosive liquid (MC 307/312).

In addition to a specification plate, these tanks have a second — “multipurpose” — plate that identifies the specification under which the tank is being operated. This plate is mounted near the spec plate, which remains in place and visible. The multipurpose plate that is visible represents the specs currently met by the cargo tank. The plates are color-coded, as are the fittings that are added to make the tank meet the corresponding specs.

Non-Specification Cargo Tanks

Pneumatically Offloaded Hoppers

Dry bulk hopper tanks, or “pneumatic” trailers, carry dry materials, such as fertilizers, oxidizers, and plastics. When carrying hazardous materials, they should be appropriately placarded.

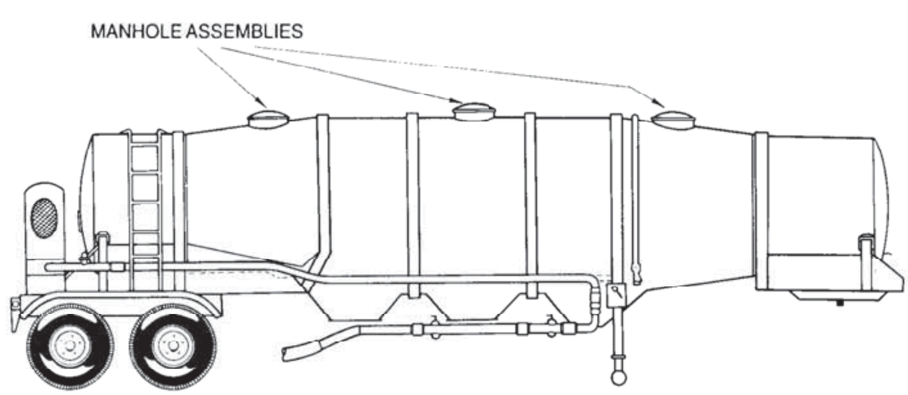


Figure 15.17: Pneumatically Offloaded Hopper

These tanks carry very heavy loads, and centrifugal force is the cause of many overturned pneumatic trailers. When responding to an incident involving pneumatically offloaded hoppers, take extra care to ground and bond all equipment, as static electricity is a common hazard associated with these cargo tanks.

Molten Sulfur Cargo Tanks

Molten sulfur was added to the list of regulated hazardous materials on January 2, 1989. This product is carried in cargo tanks constructed of mild steel or aluminum. The tank is covered with insulation, with outer panels made of stainless steel to retain the heat of the product. Steam coils are mounted inside the shell to ensure that the sulfur remains molten until it is offloaded.

These tanks are not currently regulated, but they are required to be stenciled on the sides and ends with the words “Molten Sulfur.”

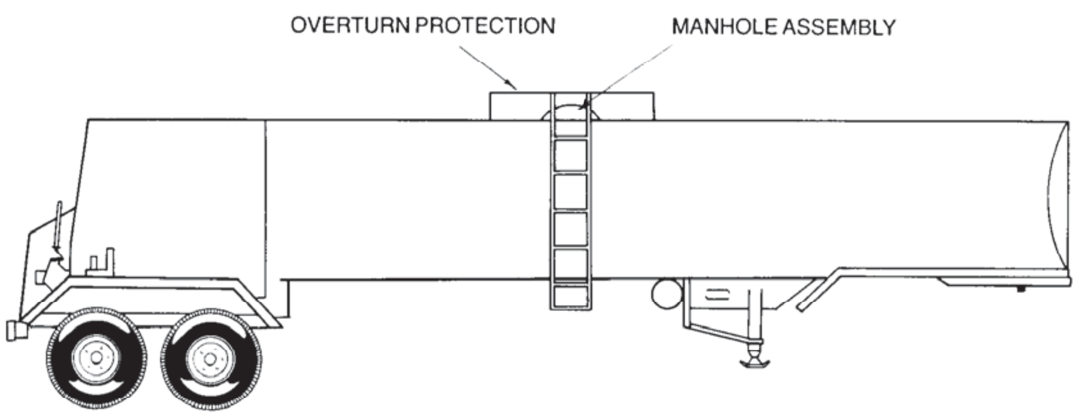


Figure 15.18: Molten Sulfur Cargo Tank

The primary hazard represented by molten sulfur cargo tanks is the extreme heat of the product. When spills occur, it is not unusual for the sulfur to run down between the tank and jacket and ignite the insulation.

Asphalt Trailers

Asphalt trailers are used to transport asphalt cutback — a mixture of asphalt and a flammable or combustible liquid that thins the asphalt so it can be spray-applied. If the flash point of this mixture is below 200°F, it is regulated as a combustible material; with a flash point below 100°F, it is regulated as a flammable liquid. If asphalt is not cut and its flash point is above 200°F, it is not regulated. Regulations require that tanks used for asphalt cutback classified as flammable or combustible liquids be "equivalent" to spec tanks, but certification of these tanks is not required.

These tanks are usually constructed of aluminum alloy or mild steel. They are heavily insulated and covered with a jacket of either aluminum or stainless steel. While there are no steam coils in these tanks (as there are in molten sulfur trailers), some asphalt tanks have burner tubes and may carry propane bottles to fuel the burners.

Asphalt trailers are similar in appearance to nonpressure and low-pressure cargo tanks.

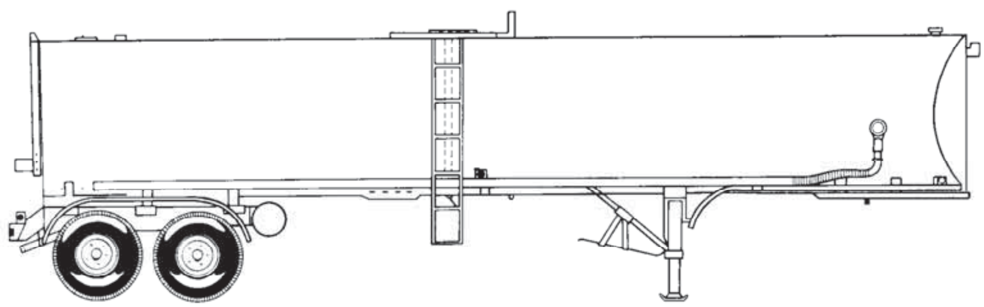


Figure 15.19: Asphalt Trailer

MANUFACTURED BY WEST-MARK CERES, CALIFORNIA
V.I.N.________ D.O.T.________
MFG.________ TEST________ CERT.________
DESIGN____P.S.I.G./____IN. HG. TEST____P.S.I.G./____IN. HG.
MAX. TEMP.______°F MATERIAL : SHELL________
HEAD________ WELD________ LINING________
NOM. CAP. BY COMPT. (FRONT TO REAR) U.S. GAL. #1.______
#2.______ #3.______ #4.______ #5.______ #6.______
MAX. LOAD ______lbs. MAX. PRODUCT WT.___lbs./Gal.
LOADING LIMIT________G.P.M. AT________P.S.I.G.
UNLOADING LIMIT________G.P.M. AT________P.S.I.G.
G.A.W.R.___AT______lbs. EACH WITH________TIRES
________RIMS AT_____P.S.I. COLD________
GROSS VEHICLE WEIGHT RATING________lbs.
THIS VEHICLE CONFORMS TO ALL APPLICABLE FEDERAL MOTOR VEHICLE SAFETY STANDARDS IN EFFECT ON THE DATE OF MANUFACTURE.

Figure 15.20: Manufacture Plate

Alternate Transportation Incidents

AIRCRAFT INCIDENTS

This section will introduce you to the common aircraft construction features and systems.

Aircraft Construction Materials

Most aircraft are extensively constructed of aluminum, usually in the form of Duraluminum, an aluminum alloy. It is used in sheets for skin surfaces and pressed sections, such as the framework, channels, spars, plates, and in castings for bulkheads and fittings.

Aluminum construction has some important disadvantages. It melts at low temperatures (1200˚F). Since jet fuel burns at over 1500˚F, well above the melting temperature of aluminum, the fuselage begins to fail within 90 to 120 seconds of direct flame contact.

Magnesium is also widely used in aircraft construction. Some of the areas where magnesium is used include flooring, landing gear, wheels, rims, some engine parts (such as crankcase sections and cover plates), and the construction of the fuselage for some helicopters.
Titanium has similar properties to magnesium. It is used to reinforce skin surfaces in the engine areas to protect from exhaust heat. These materials are as strong as steel, but half the weight.
However, they burn furiously and are difficult to extinguish.

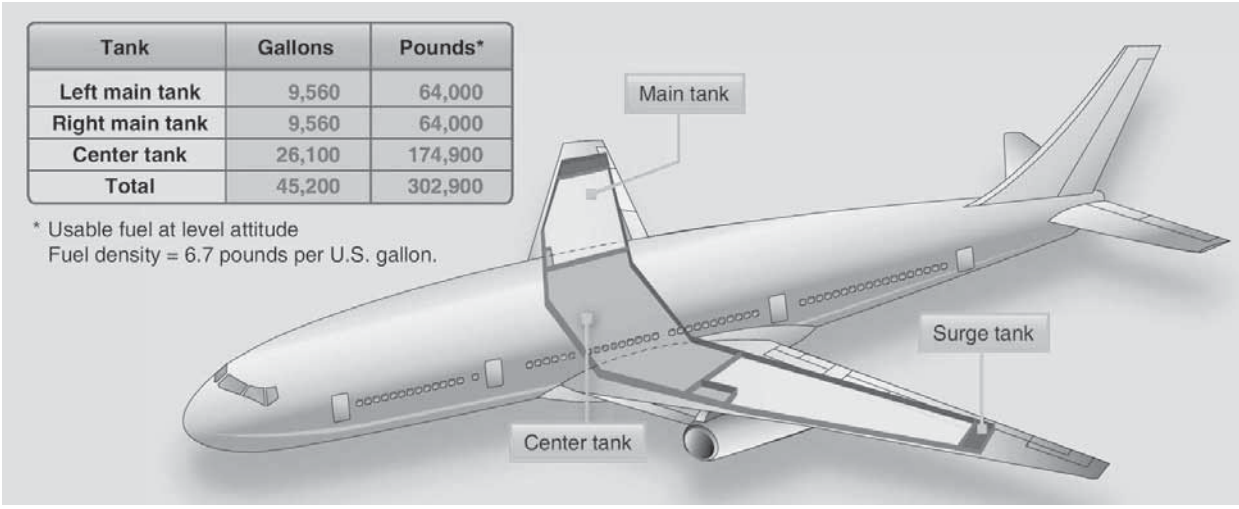
Carbon graphite composite materials are now being use in most operational aircraft in varying amounts and locations. When burning, these materials release fibers that are a health hazard. Another material that can pose a health hazard to responders is depleted uranium. It is used for counterweights on some aircraft and is coated for protection.

Aircraft Fuels and Fluids

Most Aircraft fuels are fractionalized kerosene mixtures. Other fuel mixtures utilized include hydrazine, ammonia, hydrogen, and aniline. These mixtures are usually used in jet-assisted takeoff systems. Many of these mixtures are extremely poisonous and can cause frostbite to exposed skin.

Generally, the fuel carried on aircraft represents the greatest quantity of hazardous materials. As much as 30,000 to 60,000 gallons of fuel are carried on aircraft. For example, a 767 carries up to 24,000 gallons of Jet-A. Anticipate that fuel will be stored in the wings and portions of the fuselage of most aircraft.

Exhibit 14.1: Location of Aircraft Fuel Tanks



Hydraulic fluids also present a hazard to responders on aircraft emergencies. Hydraulic fluids have a flash point of 440˚F and are mostly purple or blue in color. One such fluid is named “Skydrol.” Hydraulic fluids are usually under pressure at 1500 psi. With this type of pressure, accidentally cutting into a line while performing a rescue can have serious consequences.

Other hazardous materials found on aircraft include:
1) De-icing fluids (Commonly mixtures of 85% alcohol and 15% glycerin)
There are usually approximately 100 gallons of liquid in the deicing system (depending on the size of the aircraft).
And
2) Oxygen. Oxygen is found in most commercial and military aircraft. In commercial aircraft, the oxygen is stored in gas form. In military aircraft, especially fighters, the oxygen is in liquid form.

Hazardous Materials Regulations

Passenger aircraft are permitted only a minimum of hazardous cargo in the baggage area. Only certain hazardous cargo can be carried on board and they must be indicated on the air bill. Shipping by air is regulated under 49 CFR and details of packaging, air bill contents and types of hazmat which can be shipped are found in 49 CFR 173.27 (and other sections). Most of the shipments are small packages of radioactive and biological materials.

There are many large carriers of hazardous materials including Federal Express, United Parcel, Emery Air Express, etc. Packages must be properly labeled in accordance with 49 CFR, Parts 172, 173, and 178. They must also be identified by a red border if shipped in “unit loads.” Each unit load must include a halon extinguisher.

Some cargoes are shipped on palletized "overpacks" covered by netting and red-marked containers. Usually, the hazardous cargo is the last loaded on the aircraft and is located near or just inside the cargo doors. The pilot and airline office will also have a stowage plan showing the location of the cargo carried on the aircraft.

Shipping Papers

Each hazardous materials shipment will have a corresponding shipping paper called the "air bill." (May be referred to as the shipper's "Declaration of Dangerous Goods.")
The air bill is distinctly identified by a red border. Air bills are kept in the flight deck area (cockpit) in the possession of the pilot or other officer. There should also be a copy kept at the airline office of departure.

Military Aircraft

Large transports, like C-5s and C-17s, can also carry many passengers along with the cargo. Ammunition carried on military aircraft can pose a major hazard. The military prefers to respond and assume command on any incidents involving its aircraft. Always notify the military when its aircraft are involved in an incident.

Airport Safety Considerations

Emergency responders should become familiar with the airports within their response area. When responding to incidents, it is important to get to the location of the problem as quickly as possible. Responders should be familiar with the layout of runways, the runway numbering and lighting systems, roads, gates, fences, and buildings.

A secondary form of communication used at airports is the use of light signals from the tower. Response personnel should always contact the tower by radio prior to responding on runway areas. The tower will advise of the safest route of travel. It's essential to get clear instructions and to get clarification if unsure. Driving across an active runway is extremely dangerous.

When working around runways, emergency responders should be aware of the hazards posed by aircraft preparing for takeoff. These include high-velocity jet wake turbulence, high-frequency noise, high-temperature jet wakes, and possible radiation from operating radar.

Aircraft Fuels and Fluids

There are several types of fuels used in aircraft. The following table gives just a brief overview as to the different types of fuels. Note that the flash points listed below may vary depending on the particular fuel mixture.

Type	Flash Point	Description
Jet-A	110˚F to 125˚F	Closely fractionalized kerosene
Jet-B	-16˚F to 30˚F	
Av Gas	-36˚F	High octane gasoline
JP-4	-10˚F to 30˚F	65% gas and 35% light petroleum distillate
JP-5	95˚F to 145˚F	Specially refined kerosene
JP-6	100˚F	Higher kerosene cut than JP-4

Runway Lighting

Listed below is the typical runway lighting system:

Blue - Outlines taxi strips, ramps, and dispersal areas
White - Outlines the sides of runways and are placed 200' apart
Green - (AKA Threshold lights) mark the end the runway
Red - Marks obstructions such as parked aircraft, buildings, or other structures
Amber - Marks the departure end of the runway and are spaced 200' apart

Tower Light Signals

The controller in the tower has a light gun used to signal traffic in the runway area. The controller will direct a light beam at vehicle traffic. Vehicle operators must be aware of what each light signal means:

Flashing green light - Clearance to proceed across or down the runway
Steady red light- Stop immediately and do not proceed
Flashing white light- Return to fire station or starting point

MARITIME INCIDENTS

Vessels can be classified into several main types, including dry bulk carriers, general cargo vessels, car carriers, container ships, passenger ships, and liquid carriers. Each of these vessels has its own inherent problems.

The regulations and requirements for all U.S. ships are spelled out in 49 CFR. *Safety of Life at Sea (S.O.L.A.S.)* sets requirements for foreign flagships. The Coast Guard acts as the enforcing agency for these regulations in U.S. waters.

Shipping Papers

The regulations for shipping papers on a vessel can be found in 49 CFR 176.24. There are several types of shipping papers associated with maritime shipments including: A bill of lading and a Dangerous Cargo Manifest being the most common. It is important to remember that shipping papers may *not* be accurate if the vessel is loading or unloading at the dock.

The bill of lading for vessels is found and kept in the carrier's shipping office. Most often, the captain or master will also have a copy on the bridge. The bill of lading is a list of *all* the cargo carried on the vessel.

The dangerous cargo manifest is a list of all the hazardous materials carried on a vessel. Only hazardous cargo can be listed on the dangerous cargo manifest. The captain or master of the ship has responsibility for the dangerous cargo manifest. It is kept in a designated holder, which is located on or near the bridge or pilothouse. It must be clearly visible and easily accessible. Some ships also have a "fire plan" that can help identify the firefighting capabilities.

Responsible Authorities

The local fire department is the responsible party for containment when ships are at dock. The local fire department has incident command authority for incidents involving ships moored at facilities and for the facilities themselves.
The U.S. Coast Guard has incident command authority for incidents involving vessels under way or at anchor. The Coast Guard may ask the local agency to assist through a unified command. The Coast Guard can also tow the vessel into a facility and turn responsibility of the vessel over to the local fire department. The "Captain of the Port" might also share in the responsibility for port safety, security, and marine issues.

The US Coast Guard has three national strike teams activated through the National Response Center: The Pacific, Gulf, and the Atlantic strike team.

General Guidelines for Maritime Involved responses

Several agencies can assist with logistical needs during a maritime emergency. The military can provide scene security, firefighting personnel and equipment, demolition experts, surface crafts and helicopters. The Army Corps of Engineers has vessels designed to remove debris from channels. The hazardous materials branch of the National Oceanic and Aeronautics Administration (N.O.A.A.) can give scientific advice to minimize the effects of the incident. It can plot the spread of pollutants in the atmosphere and marine environment.

Response personnel should try to get as much information as possible while still en route. The Coast Guard should be contacted to find out if the vessel is docked or inbound and for any information available regarding conditions on scene.

An immediate size-up should be provided upon arrival. Response personnel should establish a command post, isolate the area, and request any additional resources that might be needed. They should determine if a rescue is needed and if it's safe to perform a rescue at that point.

As soon as possible, response personnel should determine the full extent of the situation. What type of incident is this: Fire, a hazmat release, etc.? Are there explosives or other hazardous materials present, and how will they react under the conditions? What extinguishing agents or mitigation supplies are appropriate for the materials involved? This is not a criminal investigation, but an investigation to determine the most expedient and efficient way to mitigate the HazMat emergency.

Understanding the extent and location of the incident is also important in the decision-making process. Location may have a significant impact on the problem itself and the mitigation options available. What is the direction of travel or spread? Are there any exposures? What impact will the weather have on the incident?

Response personnel must also gather information about the ship itself. What kind of vessel is this? Does it pose any particular hazards? What condition is it in? What is the status of the cargo? What is the status of the ship's own fire protection and safety systems? Are there other water supplies available in the area?

Once these elements have all been addressed, a plan of action can be established. Small fires with minimal risk permit the use of an interior attack. An interior attack may also be necessary to control a fire until a rescue can be accomplished. Depending on the extent of the fire and the resources available, an interior attack may be sufficient to handle the incident.

When it's not possible to directly attack the fire, an exterior attack should be implemented. This is a defensive approach, with an emphasis on exposure protection. On occasion, it may be necessary to intentionally ground or sink the ship. Ships are normally towed out to sea before sunk. This operation may require the use of explosives. These operations will require authorization from Owners, shippers, and other management that is considerably above you in the chain-of-command.

Vessel Types

Dry bulk carriers carry solid materials that are poured into the cargo hold. Typical cargoes include sawdust, wood chips, scrap metal, grain, ore, and coal. This type of vessel is a huge container with large holds and large hatch openings. One problem that may be encountered on this type of vessel is that the cargo may absorb moisture, ultimately affecting vessel stability. Some cargoes, such as coal, may build up heat and cause a fire.

General cargo vessels, also known as "freighters," carry dry cargo in the form of smaller parcels. Generally, the cargo is packed in crates, barrels, drums, boxes, etc. General cargo vessels are less common in the United States than in foreign countries. Each hold will have a crane or boom to load the cargo. The large variety of hazardous cargo that can be found on board a single vessel can present problems to emergency responders.

Car carriers have up to 18 decks and carry thousands of cars. The cars have only small amounts of fuel in their tanks. However, when dealing with thousands of vehicles, the small amounts of fuel could cause big problems.

Container carrying vessels are becoming more popular and efficient because Containers can be moved from ship to train to truck with minimal handling. The reduced handling of products has obvious cost-saving advantages. These ships carry cargo in steel or aluminum containers.
There are two standard sizes of containers: 8' x 8' x 20' and 8' x 8' x 40'. Different types of containers include tank containers, refrigerated containers, and car containers. Containers can be stacked eight to ten high. The greatest disadvantage is the potential access problem if there's a leak in one of the containers in the middle of the load. Many of these ships are computerized with crews of only five to ten assigned to a ship.

A **passenger ship** is a vessel that usually holds twelve or more passengers. If a vessel holds six or more and is in navigable waters (oceans or waterways joined to the ocean), it is inspected by the Coast Guard. These ships may have large amounts of fuel and alcoholic beverages on board.

Tank ship or liquid carriers can carry extremely large quantities of hazardous materials. Most of these vessels carry petroleum products. Other products carried include anhydrous ammonia, molasses, etc. They range in capacity from small tankers (16,000 tons) to super tankers (50,000 to 70,000 tons) to large carriers (100,000 to 200,000 tons) to ultra large carriers (250,000 tons or more). The Exxon Valdez was considered a large crude carrier.

Other special-purpose or multipurpose vessels you may encounter include military vessels, barge carrying ships, research vessels, tugboats, and barges. They share the same types of hazards found in other vessels. All have fairly large amounts of fuel (mostly diesel). Most have several decks, making access difficult. Virtually all types of hazardous materials can be found on these vessels.

Vessel Nomenclature

The following are some basic terms that response personnel should be familiar with when it comes to the structure of the vessel or the personnel on board:

Term	Definition
Bow	The forward most end (Pointed)
Stern	The rearward most end (Blunt)
Deck	The floor
Overhead	The ceiling
Bulkhead	The wall
Hatch	A Doorway
Hole	As in Porthole; A Window
House	The deckhouse where the crew live and work
Bridge	The location from which the vessel is operated
Hold	Where Cargo is secured/placed
Forecastle (“Foke-Sul”)	The forward portion, below deck, forward of the foremast
Captain	The Commanding Officer of the Ship
Chief Mate or “Mate”	The second in command
Chief Engineer or “Chief”	The person in charge of the engine room

PIPELINE INCIDENTS

As a hazardous materials technician, you will be expected to know the safety measures that must be taken to prevent further loss of life and property in case a pipeline incident does occur.

Pipeline Characteristics

Approximately 500 billion-ton miles of crude oil and petroleum products are carried annually in U.S. pipelines. These products are sometimes pumped under high pressures in "cycles." For example, 200,000 gallons of unleaded gasoline may be pumped through a pipeline, followed by 500,000 gallons of diesel fuel. These products are pumped through the pipelines with no separation between cycles. Sensors in the pipeline detect where one product cycle ends and a new cycle begins, so there is very little mixing between the cycles. However, on a pipeline incident, a pipeline leak may start out as a diesel spill and then change to unleaded gasoline as the cycle changes. This can drastically change the hazards involved in the incident.

Approximately 15 trillion cubic feet of natural gas is also transported by pipelines. Other gases include anhydrous ammonia, nitrogen, and chlorine.

Pipeline Construction

Pipeline construction material is dictated in 49 CFR, sections 192 and 195. Since 1970, steel has been the standard material for most petroleum product pipelines. However, natural gas lines may also be made of cast iron, plastic, or copper. The pipe can be of various diameters, depending on the product being carried. Once installed, pipelines are tested only as needed.

Pipeline Markers

Pipeline companies must place and maintain line markers over each buried pipeline. They must be located at each public road crossing, at each railroad crossing, and in sufficient numbers along the remainder of the buried pipeline to accurately identify the pipe's location. The marker must contain the word "Warning," followed by the identity of the hazardous product being transported. It must also include the name of the pipeline company and a 24-hour telephone number for the company.

Types of Pipelines

Pipelines distribute *liquid* commodities through gathering mains (which bring the liquid from its source to the refinery) and transmission mains (which bring the liquid product from the refinery to the storage facilities where they are stored for distribution to the consumer).

Gas pipelines distribute their commodities through gathering mains (which bring the gas from its source to the facility where it can be purified) and transmission mains (which move the gas from the facility through to storage facilities for distribution). Smaller distribution lines carry the gas to the consumer.

Mitigating the Incident

Under the requirements of 49 CFR, section 192.615, all fire jurisdictions must have an emergency plan to deal with a pipeline accident in their areas. To best handle a pipeline incident, each jurisdiction should develop their own SOPs and accurate preplans. Preplans should include exact location, size, and type of pipelines in the given area.

Summary

The degree to which you need to be familiar with these systems depends on how prevalent these systems are within your jurisdiction or surrounding jurisdictions to which you might respond for mutual aid.

Hazardous materials response team members must understand aircraft construction, systems, and operations in order to function safely and effectively at aircraft incidents involving hazardous materials. Many aircraft design features and operations can be very hazardous and present special problems to the responder. Utilize the air bill and other information to identify materials and determine your actions.

The hazardous materials technician must understand vessel construction, systems, and operations in order to effectively and safely function at maritime incidents.

The key to successful mitigation of a hazardous materials incident involving pipelines is in the time taken to properly preplan. Part of this preplanning must include knowing the locations of the pipelines in your jurisdiction and knowing what companies operate these pipelines. Familiarizing yourself with their capabilities ahead of time can greatly assist you during an incident.

List of Known Hazardous Liquids Transported by Pipelines in California

Product Description	Flash Point (^oF)	Explosive Limits % in Air	DOT ID	DOT Guide No.
Anhydrous Ammonia		16 - 25	1005	15
Crude Oil	20 to 90	varies by type	1270	27
Gas Oils (typical)	150 +	6.0 - 13.5	1071	22
Heavy Gas Oil	167	4.8 - 32.5	1071	22
Hydro Heated Gas Oil	160	4.8 - 32.5	1071	22
Light Cycle Oil	150	0.7 - 5.0	1071	22
Light Gas Oil	115	4.8 - 32.5	1202	27
Raw Gas Oil	150	4.8 - 32.5	1071	22
Decant Oil	171	0.7 - 5.0	1071	22
Cutter Stock	125	0.7 - 5.0	1993	27
Diesel Fuel	140	0.7 - 5.5	1993	27
Distillate Fuels	150 to 230	0.7 - 5.0	1299	27
Fuel Oil	110	0.7 - 5.0	1993	27
Gasoline	-45	1.4 - 7.6	1203	27
Jet Fuels				
Jet A	110 to 150	.07 - 5.0	1863	27
Turbine Fuel	100 to 140	.07 - 5.0	1863	27
JP-4	-10 to +30	1.3 - 8.0	1863	27
JP-5	95 to 145	0.6 - 3.7	1863	27
Liquefied Natural Gas		5.0 - 15.0	1972	22
Liquid Petroleum Gas			1075	22
Butane (C_4H_{10})		1.8 - 8.4	1011	22
Propane (C_4H_8)		2.1 - 9.5	1978	22
Marine Diesel Fuel	180	0.7 - 5	1993	27
Naphtha	0	0.9 - 6.0	2553	27
Natural Gas		5.0 - 15.0	1971	17
Natural Gas Liquids	-7 to -76	1.8 - 13.0	1972	22
Pressure Distillate	70	0.7 - 5.0	1294	27
Styrene	88	0.9 - 6.8	UN2055	27
Toluene	40	1.2 - 7.1	1294	27

CHAPTER

16

Chapter Sixteen

Chapter 16: Damage Assessment

Summary: This chapter is an overview of how to evaluate containers involving hazardous materials that have been damaged or compromised by an external force. It will discuss basic metallurgy as it applies to damage assessment, forms of damage, materials used in tank manufacturing and methods to predict and/or prevent catastrophic failure of a container.

Time Allocated: 2 Hours

Method of Instruction: Interactive Lecture

Terminal Learning Objective:

Upon completion of this chapter the student will be able to identify different types of damage, the various metals that are used in tank construction and how to make safe decisions for incident mitigation.

Enabling Objectives:

A. Describe basic metallurgy and how metals are treated to meet performance standards
B. Define various types of damage inflicted on containers
C. State the different types of metal used in tank construction
D. List the steps necessary to perform a thorough damage assessment
E. Be able to provide direction for control options

Instructional Resources Required:

1. Student Notebook
2. Projection system for Powerpoint
3. Alternate: Overhead projection system with overhead slides
4. Dry erase, paper chart and or chalk board with appropriate markers

Instructional Resources Recommended: None

Instructor to Student Ratio: 1:40

Practical Exercise: None

Evaluation Strategy:

Participants will complete a forty question examination at the conclusion of the class

Damage Assessment

Emergency responders must conduct a thorough assessment of an incident to plan a course of action. They must account for the hazards of both the container and commodity to minimize risk to life, environment or property. Hazardous materials are packaged and transported in containers with a wide array of shapes, sizes, construction material and structural features. Hazardous Materials Technicians and Specialists must understand metallurgy, container construction and the mechanism for container failure to make decisions for safe mitigation of an incident.

When performing damage assessment, there are three items that need to be considered.

- Type and mechanism of Damage
- Construction materials used to build containers
- Stressors that cause container failure

Container Information

The Code of Federal Regulations 49 CFR 100-177 define packaging requirements for chemical transport. Part 178-199 define the requirements for container construction. These regulations describe the required minimum plate thickness, maximum allowable working pressure (MAWP), design bursting pressure, materials, insulation, safety valve pressures, and a variety of other construction details. Responders must be aware of these features to determine an effective mitigation option.

METAL PROPERTIES AND TREATMENT

Commodities must be transported in containers designed for their specific use. Containers must be compatible with the product, be able to hold the pressure and weight of the product and maintain integrity, absorb energy and must be built with durability in the event of an accident.

One of the factors that determine strength and durability of metal is its difference between ductility and brittleness.

Ductility, or malleability, is the ability of a metal to be formed or shaped by pounding, or drawing, or by bending and stretching without cracking. It signifies that the metal will bend when exposed to force and thin when elongated. Ductility is a great determinant of the total strength of a container. High ductility equals high strength. High ductility also equals high malleability and less metal fatigue. When a ductile container cracks, the cracks tend to be small.

Brittleness or hardness is a property of metal that resists bending or stretching. Non-ductile metals have good overall strength and hardness. They will crack and fracture rapidly. Cracks will run linearly and cause the container to fail.

Elasticity is a property where metal can be manipulated and return to it's original shape. An example is a spring that can be compressed then released with-out causing damage to the metal. Metals with good elasticity will endure damage from bending and denting.

Plasticity is the property when metal is manipulated then retains its shape.

Yield point is where metal will transition from elasticity to plastic deformation. Metals will fail if they are manipulated beyond their yield point.

Elongation is the ability of a metal to expand while maintaining its integrity. As metal is stretched or thinned beyond its yield point it can no longer absorb the stress and will fail. Highly ductile materials tend to elongate well and thin when exposed to these forces. Nonductile materials, on the other hand, do not will crack and fracture.

Tensile strength is the ability of a material to withstand tension and elongation forces. Materials with high tensile strength are not malleable, nor do they elongate well. Their advantage is in total strength, but they are brittle and susceptible to cracking.

Toughness is the ability to absorb energy during plastic deformation and is measured by the area under the stress-strain. Mild, stainless, and carbon steels have good toughness above their transition temperatures. Above 80˚F, all three are ductile and tough. Therefore, the likelihood of a catastrophic failure is greatly diminished.

Treating Metals

Metals are crystalline structures. As the crystals are heated they form in alignment. This allows them to be manipulated and shaped. When the metal cools the crystals are in a haphazard formation and the metal will retain its shape.

Annealing is the most common form of metal treatment used. The process requires that the metal be heated to a specific temperature at a specified rate. This allows the metal to be shaped and formed. The material is then allowed to cool slowly. This produces a stronger, uniform metal.

Annealing is a controlled process that aligns crystals to produce their greatest strength. Uncontrolled heating and cooling, such as a tank that is exposed to fire or a chemical reaction inside a container can cause a loss of strength performed in the annealing process.

Tempering is a process where metal is heated at a controlled rate to a pre-determined temperature and then cooled at a determined rate. This process will increase or decrease the metals ductility. Metals are tempered with variations based on the container needs. It is important to understand that the faster the metal is cooled the harder and more brittle the metal will be. If the metal is cooled at a slower rate it will be more ductile.

Non-quenched and tempered (NQT) metals are heated and cooled at pre-determined rates to produce the desired balance between ductile and brittle properties. NQT metal will endure denting and bending in an accident better than quenched material.

Quenched and tempered (QT) metals are heated at a controlled rate to a pre-determined temperature then rapidly cooled in water or salt-based medium such as sodium nitrate. The outside of the metal cools rapidly and is very hard while the inside tends to cool at a slower rate. This gives the metal an overall greater engineered strength. It allows larger containers to hold more product in a lighter weight tank. The tensile strength of these containers can be as high as 81,000 psi. Quenched and tempered (QT) tanks are more susceptible to cracking and fracturing in an accident. Crews should consider off-loading the product before moving these containers.

Alloys are used to enhance the properties of metal. Metals with high amounts of carbon will be hard and brittle while medals mixed with alloys such as nickel, chromium, copper or zinc will be more ductile. High strength low alloy steel (HSLA) has good strength and toughness. It is also very hard that makes it more susceptible to cracking and fracturing in an accident. Metals mixed with alloys are more ductile, tougher and tend to be more resilient against denting.

TYPES OF CONTAINER DAMAG

There are numerous types of damage that may occur to a container during a collision or accident They include:

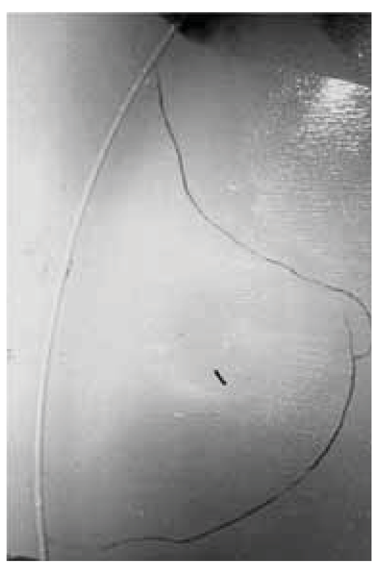
- cracks
- dents
- scores
- gouges
- punctures
- tears
- corrosion
- cold work
- rail burns
- road burns

Cracks

A crack is a narrow split or break in the container which may or may not penetrate through the metal. Cracking is the major mechanism causing catastrophic failures. Crack propagation can be very rapid in “brittle” steel and, conversely, relatively slow in ductile steels. Cracks are typically associated with dents and occur in tension areas from sharp bends. When assessing damage, it is important to evaluate cracks on the outside as well as the inside of the container. (Figure 18.1 and 18.2) Cracks will grow relatively more rapid in hard metals and slower in ductile metals. Therefore, it is crucial to consider reducing pressure and or off-loading product in containers made with harder metals such as HSLA and QT steel. And when sharp bends or thinning are noticed in the tank shell.

Figure 8.1: Crack in the Outer Tank Shell

Figure 18.2 Cracks in the Inner Tank Shell



Dents

Dents are a deformation of the container. They are caused by impact from a blunt object. Dents have an outward and inward deformation. The internal curvature is under compression. While the outward curvature thins and cracks the metal. This is one of the most common areas for tank failure.

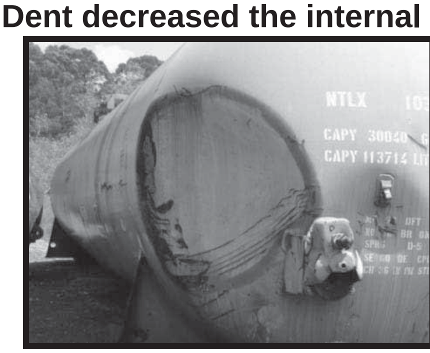
The sharper the radius of a bend the greater chance of cracking or fracturing the metal. It is important to evaluate both the internal and external radius of a dent. A Dent Gauge can be used to estimate the significance of a bend. (Figure 18.3)

Figure 18.3 A dent gauge is used to measure the radius of a dent

Because of advancements in alloys and metal treatment, newer tanks can endure sharper bends than older tanks. Tanks built prior to 1967 should be off-loaded prior to movement if the radius is 4” or less. Tanks built after 1967 have an acceptable minimum radius of 2” as a guideline for off-loading. Note that the owner and manufacturer of the tank should be consulted prior to up righting or moving the container.

When a tank is dented it decreases the internal configuration of the container and will increase pressure if the tank does not vent. Tanks are usually filled with 5% - 10% outage to allow for expansion when the product is warmed by an increase in ambient temperature. Significant denting as shown in figure 18.4 can eventually lead to hydrostatic failure. Figure 18.4 Containers with significant denting should be checked for increased pressure and evaluate the amount of product in the tank.

Figure 18.4 Dent decreased the internal configuration

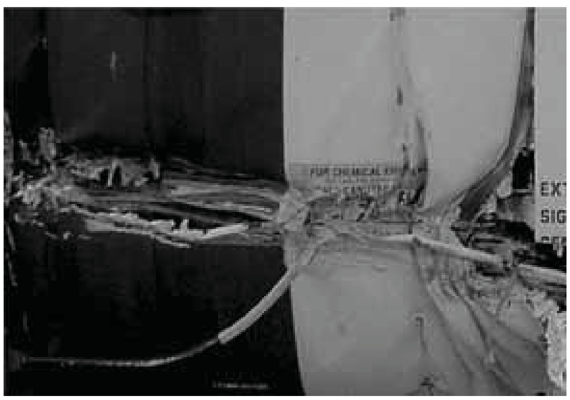


Scores and Gouges

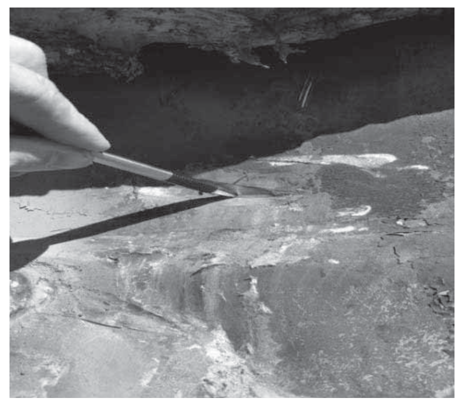
A score is made by a relatively blunt object that will displace metal. It is noticeable by ridges formed by the displaced metal. A gouge is made by a sharper object that will remove metal. Both scores and gouges weaken the tank by thinning the tank shell. Ductile containers are more susceptible to damage from abrasion that causes scores and gouges. It is imperative that the depth of the score or gouge as well as the pressure of the tank be evaluated when making decisions to move or offload containers. (Figure 18.5)

Figure 18.5: Score vs. Gouge

Score Displaces Metal



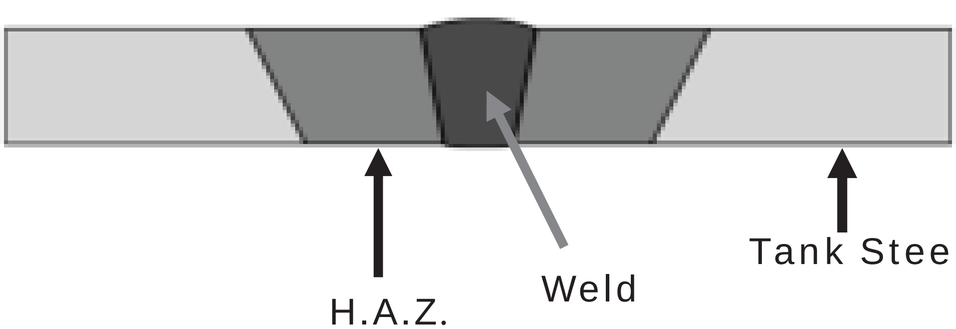
Gouge Removes Metal



Heat Affected Zone

One of the more significant scores or gouges is that which runs across the heat affected zone of a weld. When metal is welded it endures heating and cooling that changes strength done during the annealing process. While the bead of the weld is thicker and very strong. The area either side of the weld loses its durability. This can be a failure point in a damaged container. (Figure 18.6)

Figure 18.6: Heat Affected Zone Either Side of a Weld



Punctures

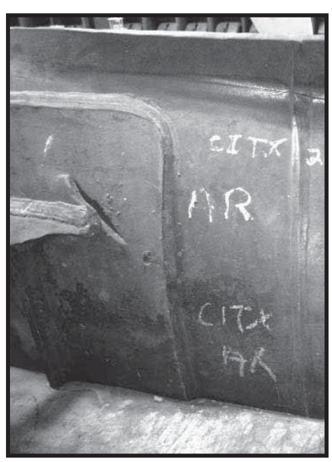
Punctures are breaches of the container caused by sharp or non-blunt objects. The object causes the material to rapidly thin, fracture, crack, and separate. Most punctures occur in mild steel or aluminum containers. Punctures may also occur in HLSA or tempered steel but require much greater energy levels. (Figure 18.7)

Figure 18.7: Puncture

Tear

Tears result when dents, cracks, or punctures are accompanied by shearing forces. This lateral movement of the material causes the container to separate. They can also be caused by over pressurization that thins metal to its failure point. The high energy required to cause a tear usually results in container deformation and extremely sharp edges. Most tears occur in soft metals. Hardened metals tend to crack and fail before tearing occurs. Figure 18.8

Figure 18.8: Tear



Corrosion

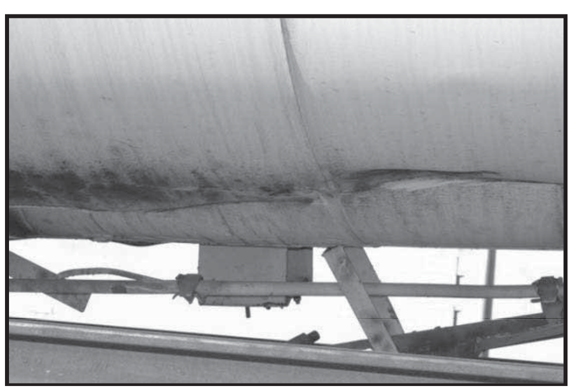
Corrosion is the result of a chemical oxidation process. It decreases the wall thickness either from the inside or outside of the container by eating away at the material. There may be no external visual clues to this damage, but if there is, it is likely to be discoloration, scaling, flaking, or minute leaks. These containers are susceptible to catastrophic failure if the container is moved. (Figure 18.9)

Figure 18.9: Corrosion

Cold Work

Cold work is the stretching or deformation of metal at ambient temperatures. Because the metal has been bent and deformed without the benefit of heating it increases the chance of cracking and failure. Forms of cold work include wheel burns, rail burns and road burns. A wheel burn is the deformity of the metal by a train wheel or tire rim. A Rail burn is similar to wheel burn except it is caused by a rail. Road burns produce scores and gouges as a container slides along an abrasive surface or highway. It is important to evaluate curvature of bends, dents and depth of scores and gouges caused from cold work. Figure 18-10

Figure 18.10: Wheel Burn



CONTAINER METALS

Aluminum containers are very light and take impact stresses well. For the most part, they do not react with hydrocarbons, hydrocarbon derivatives, or with many acids. Some aluminum tanks will have a lining to protect the metal. Aluminum containers are classed in three series: 40s, 50s, and 60s. The following summarizes their differences:

- 40 series — Softest alloys, ductile but not strong
- 50 series — Combine the best qualities of the 40s and 60s; not as ductile as the 40s, but as strong as the 60s
- 60 series — Hardest alloys, strong but not very ductile

Aluminum containers also dent easily and are more susceptible to failure from scores and gouges. They hold only a fair amount of pressure, and don't plug very well because the metal is too pliable.

Carbon Steel (CS) — High Tensile Strength has good ductility, toughness and ultimately high strength. It tends to absorb more energy before cracking. Carbon steel is best suited for railroad tank cars, pressure tanks and non-bulk containers.

Carbon Steel (CS) — High-Strength, Low-Alloy (HSLA) is steel made with high carbon content. One way to enhance strength, ductility and toughness is through adding alloys to the metal. These alloys may include nickel, manganese or chromium. HSLA steel has fewer alloys making it less ductile and more brittle. These containers have better resistance from scores and gouges. They will crack and fracture before yielding to bends and dents. This metal is used for high pressure containers requiring high strength.

Mild steel (MS) is also known as open-hearthed and blue-annealed steel. Mild steel has less carbon content and more alloys. It has good ductile properties and will endure denting, scores and gouges. Mild steel will be more durable in an accident. Common containers include bulk and non-bulk containers.

Austenitic Stainless (SS) is an alloy of iron with either chromium or nickel added. This makes it very resistant to corrosion. It is strong, does not fracture, and is abrasion-resistant. Stainless steel tanks are commonly used for food, cryogenic transportation, hazardous waste, corrosives.

CONTAINER BREACH EVENTS

Breach Events occur when, container can no longer adapt to stress and will fail. Breach events include:

- Disintegration
- Runaway cracking
- Punctures
- Splits and tears

Disintegration results from any process or mechanism that degrades the tank. Rust is an example of disintegration.

Runaway cracking occurs in closed, pressurized containers. It is more prevalent in hard brittle containers such as HSLA and quenched tanks. Runaway cracking can occur in any container that undergoes heating, chemical reaction, or other pressurization. Cracks can grow very quickly and without warning. It is important to evaluate and predict tank failure from cracks.

Punctures are usually created by mechanical stressors that result in a total breach of the container.

Splits typically occur as the result of internal forces, such as pressure, polymerization, and decomposition.

Tears are usually the result of external forces that shear, compress, or separate the container

Stress events are the mechanism that ultimately cause failure to a container. Stress is most commonly caused by:

- Chemical reactions
- Mechanical forces
- Thermal events

Chemical stress can be from chemicals that are incompatible with the container can cause disintegration and thinning of the tank wall. Chemical stress can also be from heat or pressure caused by other chemicals, polymerization, decomposition or the environment.

Mechanical stress is caused by blunt impact, compression or elongation, pressure or tearing. Some of these forces result in denting that decreases internal configuration of the tank and subsequently increased pressure within the tank.

Thermal stress can be caused by flame impingement, chemical reactions and radiant heat. Thermal stressors involve heat or the absence of heat. Heating or cooling of a container and its contents can occur through:

- Compression
- Conduction
- Convection
- Decomposition
- Flame impingement
- Polymerization

High temperature conditions can be created by direct or indirect methods. An example of direct heating is flame impingement. Flame impingement can result in rapid container failure by heating, melting, tearing, cracking, or thinning the container walls.
Indirect methods involve heat produced by material processing (compression and expansion), chemical reactions (polymerization and decomposition), or collateral heating (convection, radiation, and conduction). These processes result in an increase in internal pressure exhibited by bulging of the container, partial container failure, or catastrophic container failure.

Containers can also be affected by cold temperatures as well. As metal becomes colder it will increase brittleness. This can be caused by ambient temperatures or by the chemical itself. As gasses escape from a tank they expand and cause frosting around the release point. Cryogenic liquids are intrinsically cold.

Pressure is common denominator of both the type of breach and stress. The most important vital sign of any closed container that has or has the potential to be compromised is the pressure inside the tank. Pressure cannot be evaluated simply by visual inspection such as that of a dent or gouge. Responders must evaluate the pressure gauge on the tank or apply an external gauge. Terminology that is commonly used is "Gauging the tank." Information regarding tank operating pressure, test pressure and safety relief valves can be found in a variety of locations such as a specification plate or stenciled on the side of a railroad tank car. It may be necessary to consult the owner or tank manufacturer regarding appropriate tank pressures.

RELEASE EVENTS

An important tactical priority when responding to a hazardous materials incident is to isolate the area. Hazardous Material Technicians are responsible to establish a perimeter and control zones for the incident. They are also asked to provide direction for sheltering in place or evacuation. Responders must understand the mechanism for product release and dispersal to make these decisions.

Once a container is breached, the product is free to escape. Release events are measured by the speed in which they occur. As a rule, the more energetic the release the farther the product will travel. Release events include:

- Detonation
- Violent rupture
- Rapid relief
- Spill or leak

Detonation is an instantaneous chemical reaction that occurs at a rate of less than 1/100th of a second. It may be the result of explosive decomposition, polymerization, or other causes. There is ***no*** reaction time with this type of release.

Violent rupture is associated with chemical reactions or pressure releases occurring at the rate of less than one second. This type of release is associated with runaway cracking and over-pressurization of closed containers. There is ***no*** reaction time with this type of release either.

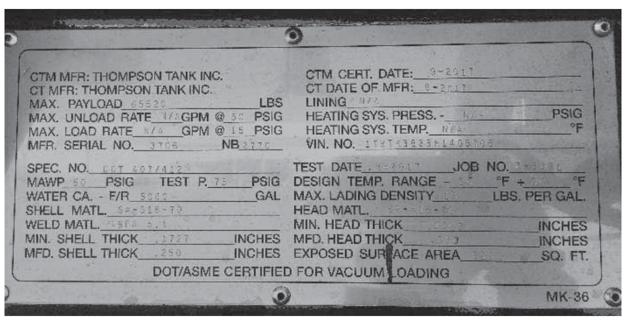
Rapid relief ranges from more than a second to several minutes. The rate of the relief is determined by the size of the opening, the type of container, the container contents, and the pressure developed with the vessel.

Spills or leaks are relatively slow releases. They typically occur over minutes to days. They are nonviolent releases from low-pressure containers, usually from breaches or damaged fittings.

EVALUATING THE CONTAINER

The specification plate is the best place to start when evaluating a container. It will have the tank specification, build date, tank capacity and the type of metal that the tank is made of. It will list tank operating pressure, tank test pressure and safety relieve device activation pressure. (Figure 18-11) Another source of information regarding material of construction is the "Certificate of Construction," which is in the possession of the tank car owner. The tank steel specification is also stamped on both heads of the tank.

Figure 18-11: Tank Specification Plate



The next step is to inspect exterior and interior of the tank for structural damage and the stability of its contents. It may be necessary to remove the jacket, insulation and / or thermal protection to visualize the tank wall. A frequently overlooked but very important part of the tank inspection is the evaluation of the interior. It is impossible to visualize the interior of a container at the time of the accident. Responders must evaluate the metal and deformity to anticipate cracks, fissures and tank wall thinning. There are two closely related mechanisms for catastrophic failure. They are cracking and thinning of the tank shell. Cracks are typically more severe in hard, brittle material. Scores and gouges are more prevalent in ductile materials.

As stated before, temperature and pressure are the most important vital sign when assessing a closed container; this is part of the interior evaluation.

The final part of the assessment is to evaluate the danger of moving the container. Some containers may be up-righted and moved without off-loading. Other circumstances make it necessary to reduce the pressure and / or transfer the product before moving. The course of action will depend on the type and severity of damage and estimating the probability of catastrophic failure.

Summary

Damage assessment is the most important step in planning a course of action. It is necessary to determine the safe location of control zones to protect the public and responders. It is a factor in the selection of the appropriate safety equipment for entry and decontamination teams. And ultimately the importance of a safe solution is predicated on a thorough and accurate assessment.

CHAPTER
17

Chapter Seventeen

Chapter 17: Offensive Control Options

Summary: This chapter describes methods used by emergency responders to control an accidental chemical spill or release. It incorporates scene safety, safety equipment and basic mitigation techniques.

Time Allocated: 2 Hours

Method of Instruction: Interactive Lecture

Terminal Learning Objective:

Upon completion of this chapter the student will be able to identify various types of chemical releases and incorporate the offensive, defensive or no action options for safe incident resolution.

Enabling Objectives:

A. Identify considerations for incident and scene safety
B. Discus types of containment to include offensive, defensive and no action options
C. Describe methods for containing a spill or release from tanks and containers
D. Learn options to isolate releases by tightening loose valves or fittings
E. Understand considerations for reducing pressure, offloading and transferring product

Instructional Resources Required:

5. Student Notebook
6. Projection system for PowerPoint
7. Alternate: Overhead projection system with overhead slides
8. Dry erase, paper chart and or chalk board with appropriate markers

Instructional Resources Recommended: None

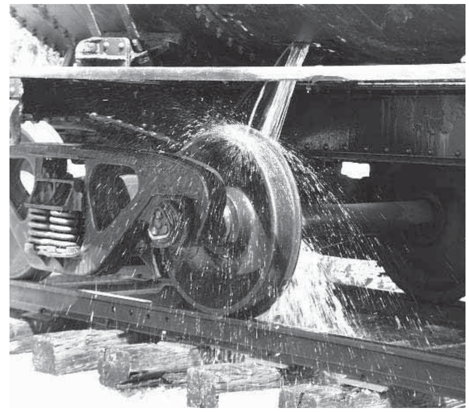
Instructor to Student Ratio: 1:40

Practical Exercise: None

Evaluation Strategy:

Participants will complete a forty (40) question examination at the conclusion of the class.

Offensive Control Options



Hazardous materials technicians are the first level of responder permitted to take offensive actions to contain a material release. Specialized training and protective equipment are required to safely and effectively handle the incident. Offensive control options include repositioning, overpacking, plugging, patching, and catching. A variety of materials and equipment are available for this purpose. However, before any offensive control method is chosen, a thorough risk and damage assessment must be completed.

Hazard - Risk Assessment

A hazard is something that can cause damage or harm to personnel, property or the environment. A risk is the chance we take when working with a hazard. Responders must evaluate the hazards to minimize risks when working with hazardous materials. The overall objective of an emergency response is to favorably change or influence the outcome of the incident. Hazardous materials teams must evaluate the chemical and physical properties, quantity involved, size and type of container, container stress, the proximity to exposures, availability of resources and environmental conditions before selecting a strategy. Actions may include an offensive or defensive strategy or in some cases opt for the no action approach. The method used will be based on information gathered from the size up and damage assessment.

Vehicle and Container Stability

Hazardous materials incidents commonly occur as the result of transportation accident. It is important to consider scene safety and vehicle stability as part of the action plan. This includes stability of vehicles and containers. The weight, pressure, chemical and physical properties should all be considered when stabilizing a vehicle. Liquid commodities will be heavier and require more reinforcement. They also tend to be stable and not move until the unloading process. Liquefied gasses, in some cases, weigh less but pressure inside the container may limit stability options. Boxes and small packages may shift at any time. If one small container shifts or falls over it can cause a domino effect inside the trailer. Caution should be taken every time during the off-loading. Expect tanks and trailers to shift as product is being transferred.

Appropriate steps should be taken to reduce the risk of shifting. Options include:

- Setting brakes
- Chock blocks
- Chains or cables
- Heavy equipment
- Heavy tow vehicles

Container Assessment

Safety is always the highest priority when working with any hazardous material. It is important to approach the container wearing the appropriate personal protective equipment and to use the correct monitoring tools and techniques prior to coming into contact with the vessel or the product. The assessment should begin with a visual inspection of the container. Questions should include; is this a pressure or non-pressure vessel tank, is it a bulk or non-bulk container and what is it made of. Next evaluate the tank for dents, cracks, fissures, scores and gouges. Use appropriate damage assessment techniques to evaluate imminent or sudden tank failure.

Monitors and detectors should be used to further evaluate the commodity itself. A thermal imaging camera can be useful to visualize product level inside a tank or drum. However, the use of a TIC may not be effective with jacketed containers. A temperature gun can also be used to evaluate the temperature of the product. Most chemicals are transported at ambient temperature. Unreasonable elevated temperatures could indicate a chemical reaction, instability of the product or a break-down of inhibitors or stabilizers. Contact the owner of the product to confirm normal temperatures.

Combustible gas indicators, photoionization detectors and radiation survey meters can detect the presence of a release without workers coming in contact with the tanks. Test papers such as pH paper, potassium iodide (KI) paper, peroxide paper and other test strips can be used to evaluate product that may have escaped the vessel.

The last part of the assessment may include obtaining a sample of the product. Use pre-existing holes or openings if possible. Extreme caution should be taken if it is necessary to open a closed container, abandoned or suspicious container. Every effort should be made to gather as much information as possible before moving these containers.

Bulging Containers

Bulging containers are often the result of either chemical or mechanical forces that increase pressure. Chemical forces that can cause bulging include chemical reactions, incompatible or improper mixing, polymerization and the breakdown of inhibitors or stabilizers.

Mechanical forces include crushing, external heating from fire or the sun, and significant denting. Liquid cargo can be overfilled leaving little or no outage or room for expansion as ambient temperatures increase.
Compressed gasses can be filled too quickly causing overfilling and excess pressure. Pressure is the most important vital sign when working with any closed container. Always gauge the tank.

Abandoned or Incorrectly Labeled Containers

Many hazardous materials incidents involve abandoned or unknown containers. Responders must make every effort to find a responsible party to identify the contents. When evaluating abandoned drums consider the construction of the tank. Metal drums are typically used for non-corrosive material. Weeping or degradation of the drum could indicate improper packaging. Poly drums are more indicative of corrosives. Consider the location of the drums. They may be near a processing or manufacturing facility.

Don’t trust labeling. Abandoned drums are often the result of hazardous waste from processes or no longer needed by the end user. As cost becomes a factor in hazardous waste disposal, it is not uncommon for drums to be left in parking lots or unused open fields. The originators of these products rarely comply with DOT or DTSC labeling, use and disposal regulations.

There are specific regulations for hazardous waste disposal. Illegal dumping is a crime. Therefor local law enforcement and CUPA should be notified. These agencies may help with clean up and disposal depending on your jurisdiction.

Commingling

Responders typically focus on the product being transported. There are additional hazardous materials used in the transportation vehicles themselves. Fuel tanks, radiators and refrigeration units should be inspected for leaks. If any of these fluids are accidentally released they can mix with other commodities that can cause additional problems for the incident.

The Code of Federal Regulations (CFR) 49 requires products to be compatible with their container. However, there are less stringent requirements as to where packages are placed in delivery trucks. It is possible for incompatible chemicals to be stored next to each other in transit. Be aware that these products are susceptible to mixing in an accident.

Leaking Containers

Wet spots on the ground around a container are usually evidence that the container is still leaking or has leaked. The wet spot may also be the residual of a rain shower. Emergency response personnel should keep weather conditions in mind. If the container is leaking, response personnel should look for clues that will help to determine what actions are necessary:

- Note the capacity of the container
- Evaluate how much product remains inside
- What direction is the product traveling? Is diking necessary?
- Is this an old or new leak? Coagulation on the ground, rust or corrosion, stain marks are all signs of an old leak
- Vegetation can also be a clue? Green or live vegetation indicate that this might be a new leak.

Control Options

There are three basic options for incident mitigation. Offensive control, defensive control and the no action option. Offensive control includes closing valves, tightening bolts, applying capping and patching kits as well as product transfer operations where technicians must wear specific protective equipment to stop a release. Defensive control includes diking, damming, covering and closing remote valves to contain a release. Responders may not be required to wear specialized PPE for these options as they should not come in contact with the product. The no action option comes in to play when conditions will self-mitigate before action can take place. For example, an ammonia tank may release and dissipate before entry can be made. Sometimes it may be best to let a flammable gas burn until the tank is empty. Or it simply may be too dangerous to approach the product such as the case of an explosive.

All three options may be used in conjunction with each other. In most cases it is best to allow the product to release until a safe solution is determined. Defensive control can be initiated early by diking or damming liquid runoff that might be heading for a storm drain. And finally, offensive measures can be deployed to stop the release at the source. Whichever method or methods are used, a thorough size up and damage assessment must be done before selecting any option.

Vertical and Lateral Control

The EPA distinguishes containment according to the type of control needed. Vertical control measures are required to contain materials that are spreading vertically, either up into the atmosphere or down into the soil, ground water, or wells.
These situations are generally more difficult to contain than those requiring lateral control for surface spreading.

Response personnel should consider the form and physical properties of the chemical in determining which control measures are most appropriate. Gases and volatile liquids will require vertical control to protect against air pollution. Liquids and solids will require control that is more lateral. Chemical and physical properties will also dictate the control method used.

Chemicals may float, sink or dissolve “swim” in water. Some absorbent pads and booms will retrieve hydrocarbons that float on water. Underflow and overflow dams can be used for chemicals that sink or float. While absorbents and adsorbents will be required for products that mix with the water. In many cases involving acids and polar solvents, it will be necessary for vacuum trucks to remove the chemical dissolved in the water. This creates a larger clean-up process.

Sorbent Materials

Sorbent materials are used to absorb or collect a liquid. Some are selective others are non-selective.

Absorbents draw the material into the selected material. An example is vermiculite / kitty litter. Absorbents are very efficient. In some cases, they will absorb more than their own weight. The result is that one can collect a large volume of chemical with a smaller amount of absorbent.

Adsorbents allow the chemical to stick to the outside of the granule. An example of this is sand. Sand is quick, simple and easy to obtain. It does require more product to collect the same amount of chemical.

Selective sorbents pick up specific materials and leave others behind. An example is a hydrocarbon pad. It will float on water and become saturated with the chemical, for instance gasoline, but it will not pick up the water.

Non-selective sorbents will pick up the product and the water.

Pads can be selective or non-selective and are sold individually or on a roll.

Socks, Booms and Pillows are also selective or non-selective and have a variety of sorbent materials inside.

It is important to select the correct sorbent material that is compatible with the chemical hazard.

Offensive Mitigation Options

There are four principal mitigation techniques used with container incidents:

1. Stop the release by plugging, patching, closing valves or tightening bolts.
2. Transfer the commodity to another container at the site of the accident.
3. Reduce the internal pressure without moving the tank, then transfer the commodity.
4. Upright and transport the container.

Options 1, 2, and 4 are based on the conclusion that the risk of catastrophic failure of the container is low.

Catching

Catching is the process of utilizing a capturing device to collect and contain a leak. It can be done prior to plugging or patching or may be done as a supplemental measure if plugging or patching proves not to be completely successful. Large plastic buckets or pails are usually best because they are generally more compatible with various chemicals and have a higher resistance to degradation.

Repositioning a Container

The most common cause of a leak in small containers is a loose bung cap or plug. If the plug cannot be tightened or replaced it may be easiest to simply move the container to the upright position. It may be necessary to use a drum lifter or other device to help lift the container. In the case of a side wall breach the container may be simply rolled to the leak is on top. The container can then be patched and placed in an over-pack drum.

Plugging and Patching

Plugs and patches are typically used for non-pressure or low-pressure containers. However, there are some specialized patching kits that can be used for pressure tanks. The effectiveness of all plugging and patching requires the proper patch kit and application. It requires that the patching material be compatible with the product. Good surface contact between the patch and tank is necessary for a good seal.

When selecting plugging and patching equipment, consideration should be given to the type of container. Pressure tanks require specialized and specific patching kits. Leaks in non-pressure tanks can usually be stopped by a simple plug or gasket material held in place with a tie down strap. The tank construction material is also a factor. Poly drums and tanks are not as rigid. They tend to bend or deform when plugs are inserted, making it difficult to achieve a good seal.

Plugging and Patching, Cont.

Metal drums maintain their integrity when plugs or patches are applied. However, rust or corrosion can cause the container to catastrophically fail when pressure is applied. Jackets, insulation and thermal protection will hide the actual location of a leak. It is important to perform a thorough inspection of the container before applying leak kits.

Plugging devices include mechanical or pneumatic devices that use friction or expansion to create a seal.

- Friction devices include wood or neoprene plugs or wedges that fit tightly into an opening. Screws with grommets can be inserted and stop the leak as the screw is tightened.

- Expansion devices include mechanical or pneumatic plugs. Pneumatic plugs are inserted into an opening then expanded with air to create a seal. Mechanical expanding plugs have a nut and bolt in the center of the plug. As the bolt is tightened it squeezes the center of the plug and causes it to expand laterally to achieve the seal.

Patching involves pneumatic, mechanical or the use of sealing epoxies, foams, or fiberglass patches to adhere to the outer surface of a container to stop the leak. DANGER: Never apply a patching device to a container that is building pressure or having a chemical reaction inside.

- Pneumatic patches are usually strapped around the outside of the container then air is applied to expand and tighten the patch. Airbags and tank bandage systems (Vetter ® Systems) are the most common.

- Mechanical patches include saddle clamps or gasket material that is held in place with tie down or ratchet straps.

- Sealing materials include chemical epoxies or epoxy putties, foams, mastics, fiberglass resins and plug-n-dike ® that fill and harden inside openings in a damaged container.

Capping Kits

Specialized capping kits are designed for railroad tank cars, cargo tanks, ton containers and 150 lb. cylinders that transport high hazard commodities such as chlorine, sulfur dioxide, liquified petroleum gasses and ammonia. These kits include the Chlorine “A”, “B” and “C” kits and the Midland ® capping kit.

The Chlorine “A” kit is specifically designed to contain a release from a 150 lb. compressed gas cylinder. It uses a cap and chain system to contain a release from the valve assembly. It also has drift pins for plugging. It is color coded red for easy identification.

The Chlorine “B” kit is designed to be used on a “Ton Container.” The kit consists of a cap and bridge system to contain a release coming from tank valves. It also has a specific cap to contain a release from a fusible plug. Other equipment in the kit include drift pins for plugging and a side wall patch. It is color coded yellow for easy identification.

The Chlorine “C” kit is intended to be used on chlorine railcars and cargo tanks. It too uses a cap and bridge system to contain leaks from valves. The kit has two different caps. One is designed for liquid and vapor valves while the other cap is designed to be used on the safety relief valve.

The Midland ® capping kit is designed to be used on a variety of railroad tank cars. The kit uses a cap and bridge system for pressure and non-pressure tanks. The kit also comes with hand tools, pressure gauges, gaskets and sealing equipment to stop or slow a release on most tank cars.

Each of these kits require specialized training and knowledge to safely apply the kit. It is important for responders to follow the instructions that come with each kit. It is also recommended that trained technicians review the instructions with the entry team prior to going down range.

Overpacking

Overpacking is done to protect a vessel with hazardous materials, damaged or not, for transportation. The procedure is simply placing one container inside another. There are three methods of placing the target container into the overpack container:

- A forklift or special container-lifting device may be used to lift the target container and place it into the overpack.

- The overpack may be turned upside down and placed over the target container. The overpack can be lifted upright with the target container inside

- Both containers may be turned on their sides. The target container can be slid or rolled using the “V” roll method into the overpack. The target drum should be positioned so that the top is accessible for sampling.

Rules for overpacking:

- Both the inner container and over pack must be labeled according to DOT guidelines for shipping.
- It is recommended that a drum liner be used in conjunction with the overpack drum.
- Damaged drums must be plugged or patched to prevent leaking even though inside the overpack drum.
- Absorbents, pillows or booms should be used to fill the void space between the damaged drum and overpack.

Decision to offload

Containers may need to be offloaded and contents transferred to another container for a variety of reasons. After an accident the vessel may have sustained significant damage that could weaken it. Excessive pressure or weight can cause the container to catastrophically fail while being lifted or moved. Tanks that have degraded from chemical reactions can disintegrate as crews try to move them.

The decision to offload product and transfer it to another container should be based on several considerations:

- Unable to upright due to weight and the potential for tearing or shearing tank material
- Excessive pressure that can cause cracks and fissures to grow causing the tank to fail
- Site location is inaccessible to heavy lifting equipment

Bonding and Grounding

Static electricity is an accumulation of electric charge on an insulated body. Fluid flowing through a hose or pipe during transfer operations will build an electrical charge. If the charge cannot travel to another conductive medium or to the ground it will remain static. Some electrical build ups can reach 40,000 volts which is more than enough to ignite a flammable atmosphere.

Grounding is a procedure done prior to transfer operations that will give any static build up a direct line to the earth. This is done to prevent an unforeseen spark that could ignite a flammable environment.

Bonding is a procedure done to equalize the electrical energy between the receiving tank and the container to be offloaded. During transfer operations the amount of static electrical energy on a damaged container may be different than that of the receiving tank. This is also done to eliminate the possibility of a spark.

Equipment needed for grounding and bonding include:

- Grounding rods 4' – 8' in length. Must be UL or FM approved
- Grounding cables. 12 - gauge cable is preferred. Must be UL or FM approved
- Post driver
- Earth resistance meter

Grounding procedure:

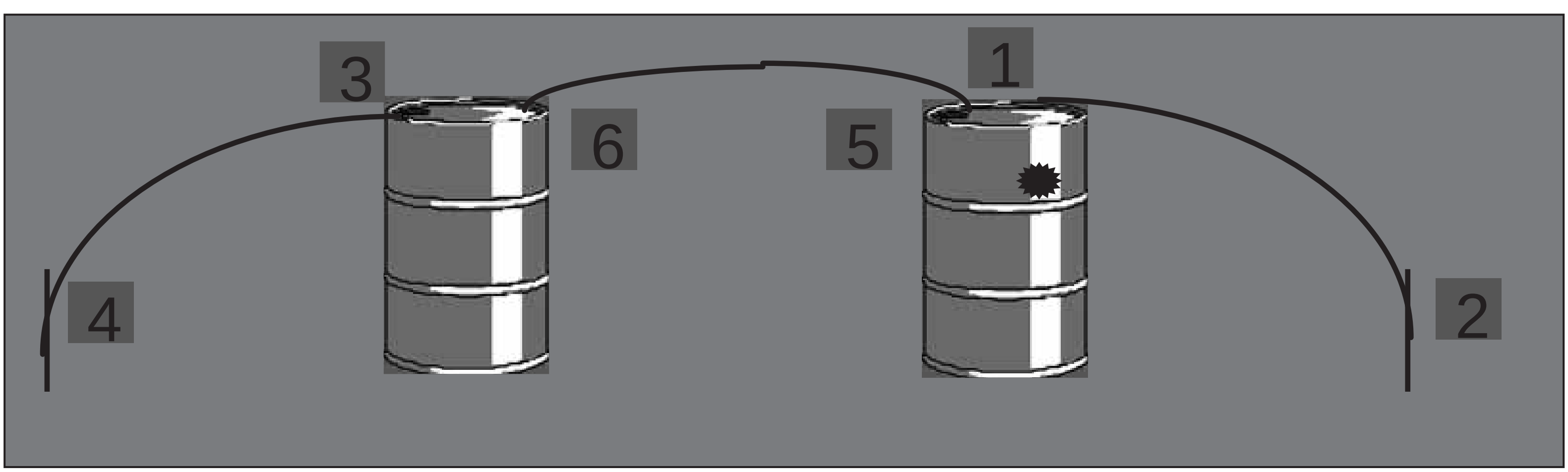
- Grounding rods may be driven vertically into the ground or buried horizontally. Wet sandy soil will provide less resistance than hard dry soil. It may be necessary to place several grounding rods into the soil and connect them sequentially. The method, location or number of rods may vary. The most important part is to test the amount of resistance using an earth resistance meter. NFPA 77 require a temporary ground to be 25 ohm's of resistance or less. However, 1,000 ohm's of resistance is acceptable for emergency responders conducting emergency transfer operations. Note that the less resistance means that electricity will flow better and reduce the chance of sparking.

- Grounding cables should be attached by connecting the first clamp to the damaged container. The other end of the cable then is connected to the grounding rod.

- Transfer trucks should also have a separate ground system set in place using the same procedure.

- The final step in grounding and bonding is to connect the bonding cable from the damaged container to the transfer truck. (Figure 19.1)

Figure 17.1: Grounding and bonding procedure

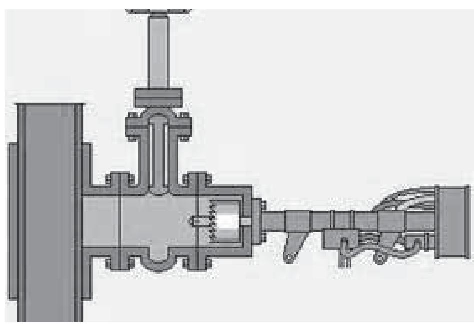


When valves and fittings are inaccessible via conventional methods it may be necessary to access the product directly from the tank. This is accomplished using a procedure called "Hot or Cold Tapping." Either option requires that a trained person drill into the tank with the appropriate equipment to access the product.

Hot tapping is done to offload product from a damaged tank that cannot be offloaded using transfer valves and fittings. It is typically done on pressure tanks, quenched NQT, quenched and tempered QT tanks as well as mild steel tanks.

The procedure is accomplished by welding a special nozzle to the tank. The nozzle must be welded to the tank at the liquid space. A milling machine and drilling assembly is connected to the nozzle. The tank is drilled, and the product is contained inside the milling device. A hose or pump is then connected to the discharge part of the milling machine and product can be offloaded. This procedure can only be performed by trained contractors. (Figure 19.2)

Figure 17.2: Hot Tap



Cold tapping or Stinger is also done to offload product from a damaged tank but is more applicable to non-pressure aluminum and some stainless-steel tanks. Stinger operations can be performed by firefighters and emergency responders; provided that, they have been trained to do so.

The stinger operation begins with safety first. Stinger operations are most commonly performed on MC 406 aluminum tankers that transport gasoline. Therefore, it is important to have control zones established and fire extinguishers or hose lines in place before starting an operation. Responders must account for spillage that may have or has the potential to occur. It is important to note that slow leaks in a tank will leak faster once an opening in the tank is made. As stated earlier, the tank must be grounded and bonded prior to transfer operations. Grounding should be in place before drilling.

When safety measures are in place then drilling can begin. Responders should evaluate the number of compartments to be drilled. Identify bulkheads, baffles and the number of discharges in the tank. Hole placement should ideally be in line with tank discharges.

After the hole is drilled, an expanding plug should be inserted to confine vapors until the transfer hose is ready to be inserted. All compartments should be drilled before proceeding to the offload step. When the transfer truck arrives, offloading hose lines should be in place, grounding and bonding must be completed. Then the vacuum tube can be inserted, and product transfer can begin. (Figure 19.3)

Figure 17.3: Stinger for offloading

Vacuum trucks will typically hold 4,000 to 7,000 gallons. The hazardous waste clean-up company will decide the number of trucks that will be required. They will need to know the estimated total amount of product, including water runoff, absorbents, soil, etc.. They will also need to know if the product is a solid, liquid or gas in order to bring the correct transfer equipment. The product must be identified to ensure chemical compatibility with the transfer truck.

Principle of Product Transfer

Something in – something out. Something out – something in. As solids, liquids or gases leave a container they create a void inside the tank. If that void is not replaced with something else such as air, inert gas or another liquid the tank will implode. Conversely as a receiving tank is filled it will pressurize the air inside the tank unless it is discharged or recovered elsewhere.

Open and Closed Systems

There are two basic transfer systems. An open system allows air to naturally flow into the container being emptied. This is done simply by opening a vapor valve. Then as product flows into a receiving tank the vapor valve is opened that allows vapors to dissipate into the atmosphere. A closed system is one where contents and vapors are contained. The vapor recovery hose will re-circulate back into the tank being emptied or into another recovery device.

There are also two basic methods of product transfer. They are gravity feed and pressure differential. The decision to choose one over the other will depend on the location of the incident, type of container, damage assessment and orientation of valves and fittings after an accident.

Offloading – Gravity Feed

The gravity feed method requires that the receiving tank be lower than the damaged container. Once the transfer process has started the product will flow naturally from the elevated vessel to the receiving tank. The advantage of gravity feed is that no stress is being made on the damaged container. The disadvantages are the difficulty in priming the transfer hose and product will not completely transfer if the receiving tank is not low enough.

Offloading - Pressure Differential

Pressure differential uses pressure or vacuum and can be achieved by several techniques. Vapor compressor, liquid pump or a combination of both. The various options will be selected based on the product to be transferred, the condition of the container and accessibility for equipment. Flammability can also be a deciding factor in the transfer operation used.

Table 17.4: Transfer Method Selection Chart

Transfer Method	Use of Transfer Method When an Increase in Internal Pressure Is . . .	
	Acceptable	**Unacceptable ***
Vapor Compressor	X	
Vapor Compressor and Liquid Pump	X	
Compressed (Inert) Gas	X	
Liquid Pump		X
Internal Vapor Pressure (with or without flaring)		X
* Unacceptable - heavily damaged containers		

Product Transfer Methods

The basic principle for pressure differential transfer operations is simple. The vacuum transfer method draws product from one container and moves it to the other. The positive pressure method uses inert gas or liquid to push contents from the damaged container to the receiving tank. (Figure 19.xxx)

- Vapor compressor draws vapors from the receiving tank and pressurizes the damaged tank.
- Vapor compressor and liquid pump uses a liquid pump to draw the product from the damaged tank and transfer it to the receiving tank. Then a vapor pump uses the vapors from the receiving tank to pressurize the damaged tank.
- Inert gas or air may be used to pressurize the damaged tank for offloading
- Liquid pumps may be used to simply draw product from the damaged container to move it to the receiving tank.

Reducing Pressure

It may be necessary to reduce the pressure in a container. Excess pressure can be caused by a chemical reaction inside the tank, expansion from heat, over filling or flame impingement or by mechanical damage such as denting. Containers may be damaged to the extent that they cannot be moved with excess weight or pressure. A thorough damage assessment may find cracks, scores or gouges that would necessitate offloading contents to a flare, scrubber or transfer to another container. These procedures are performed by specialized contractors. Responders must be aware that these are incident control options and understand basic principles before allowing work to be done.

Venting reduces pressure by opening a vapor valve and releasing the contents directly into the atmosphere. It is the least desirable as contents are unable to be controlled while released. It is also environmentally unsound. However, it is the quickest and easiest method in an emergency or impending catastrophic failure of a container.

Flaring is done to burn vapors of a compressed liquified gas. This concept is similar to a propane bar-b-que. A hose is connected to the tank to be offloaded and the other end of the hose is connected to a “pear burner.” The burner is lit, and vapors burn until the pressure in the tank is reduced to the desired pressure. (Figure 19.4) This is a simple and preferred method as vapors can be controlled. It does however, require specialized equipment not usually carried by emergency response teams.

Figure 17.5: Flaring operation

Pit burn is a method of reducing volume on non-pressurized flammable liquid containers. A pit or containment system is built then lined to prevent contents from leaking into the soil. The liquid product is released into the pit then burned. This is only an option when product transfer to another container would be impossible.

Scrubbers are used to control the release of toxic or corrosive vapors that will not burn. It is also preferred over simple venting but again, requires specialized equipment, responders and training.

Vent and Burn while exciting for responders it's definitely a last resort option. It incorporates the use of explosives to control the release and burning of contents from a tank that is too dangerous to move or offload by any other means.

The evolution requires explosive charges to be placed on the top and bottom of the damaged tank. A containment pit is constructed to catch the released contents. The charge on the top of the tank is detonated first and creates a vent then the second charge at the bottom of the tank allows product to be released into the pit. Contents are then burned.

Up-righting and Transporting

The decision to up-right and transport a container, ether loaded or unloaded is based on several considerations.

- Is it a pressure or non-pressure tank? Are valves and fittings in-tact or damaged? Is the vessel jacketed or non-jacketed? Are the wheels on a stub sill or full frame configuration?
- Are the physical properties a solid, liquid or gas? Are the chemical hazards toxic, reactive, ignitable or corrosive?
- A damage assessment must be performed to evaluate dents, cracks, fissures, scores and gouges and the metallurgy associated with each type of damage.
- External and internal stressors to include pressure, weight and degradation of container metal must be evaluated.
- And last the capability of lifting and towing equipment as well as the equipment operator must be evaluated before moving any damaged container.

Summary

Working with hazardous materials is just that, hazardous. Responders must learn how to do this dangerous job safely. They must practice and train for every possible situation and be able to use the tools and equipment on their apparatus. Evaluating chemical, physical and hazardous properties of the product and release that they are responding to is imperative. Responders must use appropriate monitors and detectors in conjunction with personal protective equipment to work safely in the hazardous environment. All personnel must be proficient in the use and application of plugging, patching, capping tools and equipment to safely mitigate an incident.

CHAPTER
18

Chapter Eighteen

Chapter 18: **The Role of the Assistant Safety Officer-Hazardous Materials**

Summary:

This chapter we will look at the issues pertaining to the Role of the Assistant Safety Officer- Hazardous Materials. The ASO-HazMat not only insures safety is paramount at a HazMat event, they set a role model, demonstrate a wide knowledge base, and their experience can be invaluable to the HazMat group's success.

Time Allocated: 1 Hour

Method of Instruction: Interactive Lecture

Terminal Learning Objective:

At the conclusion of this class the participant will be able to describe the role and responsibilities of the ASO-HazMat.

Enabling Objectives:

A. Explain what a "Positive Safety Attitude is"
B. Explain the importance of a "Positive Safety Atgtitude"
C. Assess what might go wrong during the HazMat response process at scene
D. Develop appropriate personnel management strategies
E. Develop measures that ensure the safety of personnel at a Hazardous Materials incident

Instructional Resources Required:

1. Student Notebook
2. AV-Media Projection system for PowerPoint (or other similar program)
3. Dry erase, paper chart and or chalk board with appropriate markers
4. One copy of the ICS Field Operations Guide (FOG) or similar document

Instructional Resources Recommended:

1. One copy state or federal version of 29 CFR 1910.120 (q)(iii)

Instructor to Student Ratio: 1:40

References:

1. FIRESCOPE Field Operations Guide, Updated 2011
2. Title 8 CCR 5192/1910.120
3. NFPA 472, Competence of Responders to Hazardous Materials Incidents (2008 Edition)
4. Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities, NIOSH/OSHA/USCG/EPA, US Department of Health and Human Services, October 1985

Practical Exercise: N/A

Evaluation Strategy:

Participants will complete a written examination at the conclusion of the class.

The Role of the Assistant Safety Officer – Hazardous Materials

Introduction

State and Federal OSHA laws require the Incident Commander at a hazardous materials incident appoint a safety official. This person is required to be knowledgeable in the operations being implemented at the site, with the specific responsibility to identify and evaluate hazards and to provide direction to the safety of the operations.

For an incident involving an ICS large enough to assign the positions of Safety Officer (or Incident Safety Officer -- ISO) and Assistant Safety Officer (ASO), the ISO has overall responsibility for the incident and the ASO is focused on the safety of the specific operations of the team or group to which he or she is assigned, for example, within the Medical Group or HazMat Group.

The Assistant Safety Officer-Hazardous Materials reports directly to the (Incident) Safety Officer while being the "Boots on the ground" representative working with the Hazardous Materials GROUP .

The Assistant Safety Officer-Hazardous Materials is assigned to the Hazardous Materials Group (or Hazardous Materials Branch if activated). This position is responsible for the overall safety of assigned personnel within the Hazardous Materials Group.

The Assistant Safety Officer-Hazardous Materials coordinates activities directly relating to the Hazardous Materials Group operations as mandated by Title 8 CCR 5192 (q) (29 CFR 1910.120 (q)). This position advises the Hazardous Materials Group Supervisor on all aspects of health and safety and has the authority to stop or prevent unsafe acts. Due to the responsibilities of this position, it is imperative that the individual be safety officer qualified and possess a high degree of knowledge in hazardous substance mitigation operations and procedures. These responsibilities require that personnel assigned to this position have a minimum equivalent training and expertise as mandated by federal, state, and local laws.

Some of the responsibilities of the ASO may include:

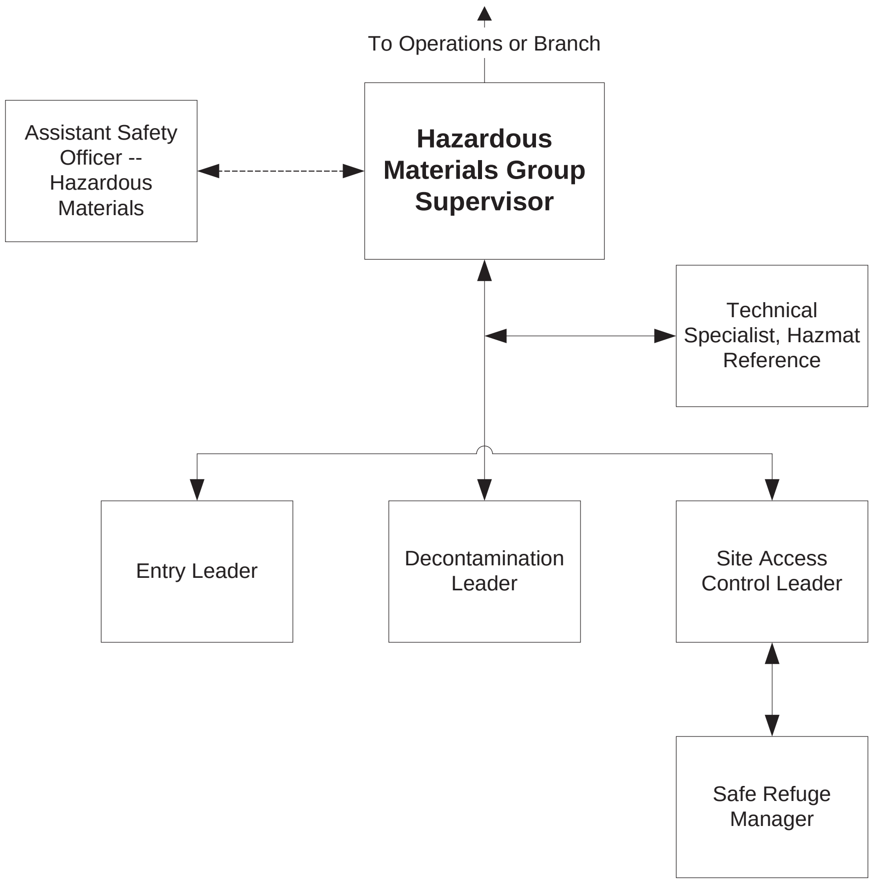
- Assist with the planning and development of the Emergency Response Plan
- Contingency / Emergency Procedures Planning and Implementation (5192 (q) (1) and (2))
- Approve the Site Safety Plan (In the absence of the ISO)

Responsibilities of the ASO-HazMat, Cont.:

- Consult on procedures for handling emergency response 5192(q)(3) – including:
  - Command structure
  - Proper substance, site and condition(s) identification and assessment
  - Identify and evaluate hazards and provide direction with respect to the safety of the operations for the emergency at hand.
  - PPE requirements and selection:
    - SCBA/APR
    - CPC Ensemble
    - Sampling Instruments/Monitoring
    - Maximum exposure limits and toxicology issues
    - Air monitoring strategies, techniques and instrument selection
    - Appropriate staffing, back-up personnel and Buddy system implementation
    - Advance First Aid support and transportation capability
    - IDLH or Imminent Danger authority to suspend, alter or terminate activities for unsafe acts or conditions. Make corrective action recommendations
    - Decontamination techniques, Procedures and Contingencies
    - Entry Procedures and Tactics
    - Tactical and Strategic planning
    - Rescue Considerations
    - Verification of Responder Training
    - Verification that medical surveillance and consultation is appropriate and available

The Assistant Safety Officer-Hazardous Materials is positioned organizationally in the Hazardous Materials Group as illustrated below:

Figure 18.1: ICS Overview showing ASO/HM Position



Major Responsibilities of the Assistant Safety Officer-Hazardous Materials

Following each responsibility are procedures for implementing the responsibility. These are only major responsibilities. Once you have gained additional experience in the position, you may augment this list as necessary.

--Check in and obtain a briefing from the Incident Safety Officer or Incident Commander

*Check in with the Incident Safety Officer or, if there is no Incident Safety Officer, with the Incident Commander. Request a briefing from the Incident Safety Officer or Incident Commander. This briefing should include initial instructions concerning work activities.

*Request a copy of the Incident Action Plan (ICS Form 202) when available. This form provides written incident objectives and organizational information about the incident.

*Start a unit log (ICS Form 214) to record significant events or actions taken during the shift.

--Obtain a briefing from the Hazardous Materials Group Supervisor or Hazardous Materials Branch Director

*Obtain a briefing from the Hazardous Materials Group Supervisor.
This briefing shall include information on the Hazardous Materials Group operational objective, as well as names and contact information for essential personnel with whom the Assistant Safety Officer – Hazardous Materials may need to communicate.

--Participate in preparing and implementing a written Site Safety Plan (ICS Form 208HM)

The ASO – Hazardous Materials will *participate* in preparing and implementing the site safety plan.
This position should not have the responsibility to both prepare *and* approve the plan because there is a greater likelihood of error when the entire responsibility is given to only one individual.

FIRESCOPE recommends that someone from the Operations Section or Hazardous Materials Group complete the site safety plan with assistance approval from the ASO – Hazardous Materials.

The ASO – Hazardous Materials can assist in this process by conducting a site survey, and reviewing documentation of the incident. This might include any maps, aerial photographs, plant diagrams, and product information, if known.

The ASO – Hazardous Materials will also need to review evacuation plans for the incident base, command post, and hazard site.

The ASO – Hazardous Materials should then review the medical plan (ICS Form 206). The medical plan is prepared by the Medical Unit Leader and approved by the Incident Safety Officer.

--Provide for the protection of personnel in the Hazardous Materials Group or Hazardous Materials Branch (if activated) from physical, environmental, and chemical hazards/exposures

The ASO–Hazardous Materials is are responsible to ensure the protection of the Hazardous Materials Group personnel from physical, environmental, and chemical hazards and exposures. The ASO – Hazardous Materials sets a role model for other members of the team by enforcing positive and lawfully justifiable safety practices.

--Ensure required emergency medical services for assigned personnel are in place, and coordinate with the Medical Unit Leader

The ASO – Hazardous Materials must ensure the provision of required Emergency Medical Services *for incident personnel* are in place and coordinate with the Medical Unit Leader.

They should maintain periodic communication with the Medical Unit Leader and review the site safety plan.

The ASO – Hazardous Materials should review the procedures provided for the Team's protection, and ensure that rescue devices and an emergency field decontamination plan are in place.

--Advise the Hazardous Materials Group Supervisor or Hazardous Materials Branch Director (if activated) of deviations from the Site Safety Plan (ICS Form 208) or of any dangerous situations

Once the SSP has been developed and operations are under way, the ASO – Hazardous Materials must conduct frequent, continuous visual inspections to ensure compliance with the SSP. This requires them to maintain an expedient form of communication with the Hazardous Materials Group Supervisor and the Entry Leader and to brief them on known or foreseeable problems and possible mitigation measures as work progresses. In addition to doing visual inspections, the ASO – Hazardous Materials should also monitor radio traffic within the Hazardous Materials Group.

--Alter, suspend, or terminate as appropriate any activity deemed unsafe or involving imminent danger

If unsafe operations are observed, the ASO – Hazardous Materials has full authority to alter, suspend, or terminate that activity. If this is necessary, they must notify the Incident Safety Officer and the Hazardous Materials Group Supervisor of the altered, suspended, or terminated activities. The use of this authority shall be documented as soon as possible on the unit log (ICS 214). Documentation should include a diagram and/or photograph(s), the names of any witnesses, etc.

When altering, suspending, or terminating activities, other activities may be affected. The ASO – Hazardous Materials should make every attempt to contact the supervisor directly responsible for the operation that they modify.

--Ensure medical-related records for the Hazardous Materials Group or Hazardous Materials Branch personnel are maintained

The ASO - Hazardous Materials ensures that medical-related records for the Hazardous Materials Group personnel are maintained. Exposure records should be completed and filed with Documentation Unit. All documents pertaining to medical monitoring, medical treatment, and/or medical needs of the Team are to be checked, collected, and filed by the ASO – Hazardous Materials.

Summary

The Assistant Safety Officer–Hazardous Materials plays a vital role in ensuring the health and safety of the members of the Hazardous Materials Group. This position is responsible to coordinate the activities directly relating to the Hazardous Materials Group. The person assigned to this position has the authority through OSHA law to stop, alter, or suspend any activity deemed unsafe.

Due to this authority and the high level of these responsibilities, it is imperative that the individual assigned to this position (at the minimum) possess:

1. Familiarity with the Operations and procedures utilized by HazMat teams;
2. Familiarity with Emergency Medical procedures & triage;
3. Knowledge of Hazardous Materials mitigation techniques;
4. Knowledge of basic mechanical engineering, piping, machinery likely to be involved, etc.;
5. Knowledge of the Laws, regulations, policies, and procedures pertaining directly to Hazardous Materials response;

And

6. Understanding of fire-ground operations

The ASO – Hazardous Materials makes the incident “happen” by setting an example for other team members. They need to be assured that their skill set brings positive outcome thinking to the Command structure.

“Safety is not an accident…”

INFORMATION SHEET # 18.1

FIRESCOPE – July, 2007 - - ICS-HM-120-112

HAZARDOUS MATERIALS POSITION
DESCRIPTIONS AND FUNCTIONS
ASSISTANT SAFETY OFFICER - HAZARDOUS MATERIALS

Reports to the incident Safety Officer as an Assistant Safety Officer and coordinates with the Hazardous Materials Group Supervisor (or Hazardous Materials Branch Director if activated).

The Assistant Safety Officer-Hazardous Materials coordinates safety related activities directly relating to the Hazardous Materials Group operations as mandated by 29 CFR part 1910.120 and applicable State and local laws. This position advises the Hazardous Materials Group Supervisor (or Hazardous Materials Branch Director) on all aspects of health and safety and has the authority to stop or prevent unsafe acts.

It is mandatory that a Assistant Safety Officer-Hazardous Materials be appointed at all hazardous materials incidents. In a multi-activity incident the Assistant Safety Officer-Hazardous Materials does not act as the Safety Officer for the overall incident.

A. Check-in and obtain briefing from the Incident Safety Officer.

B. Obtain briefing from the Hazardous Materials Group Supervisor.

C. Participate in the preparation of, and implement the Site Safety Plan.

D. Advise the Hazardous Materials Group Supervisor (or Hazardous Materials Branch Director) of deviations from the Site Safety Plan or any dangerous situations.

E. Has authority to alter, suspend, or terminate any activity that may be judged to b e unsafe.

F. Ensure the protection of the Hazardous Materials Group personnel from physical, environmental, and chemical hazards/exposures.

G. Ensure the provision of required emergency medical services for assigned personnel and coordinate with the Medical Unit Leader.

H. Ensure that medical related records for the Hazardous Materials Group personnel are maintained.

I. Maintain Unit Log (ICS Form 214).

CHAPTER 19

Chapter Nineteen

Chapter 19: Introduction to Terrorism and HazMat Teams

Summary:

This chapter we will look at the issues pertaining to the Role of the Assistant Safety Officer- Hazardous Materials. The ASO-HazMat not only insures safety is paramount at a HazMat event, they set a role model, demonstrate a wide knowledge base, and their experience can be invaluable to the HazMat group's success.

Time Allocated: <4 Hours>, class dependent

Method of Instruction: Interactive Lecture

Terminal Learning Objective:

At the conclusion of this class the participant will be able to describe the role and responsibilities of HazMat team member's involvement in the mitigation of a Terrorist-based attack/event**.**

Enabling Objectives:

A. Explain what Terrorism and extremism are;
B. Explain the various laws, definitions, and differences between ordinary criminal Activity, and deliberate Terrorist perpetration;
C. Assess clues and warning signs of possible attacks by Terrorists
D. Develop appropriate personnel safety strategies
E. Develop measures that ensure the safety of personnel and the general public at a possible Terrorist incident

Instructional Resources Required:

1. Student Notebook
2. AV-Media Projection system for PowerPoint (or other similar program)
3. Dry erase, paper chart and or chalk board with appropriate markers
4. One copy of the Ca Penal Code and related legal documents

Instructional Resources Recommended:

1. One copy state or federal version of 29 CFR 1910.120 (q)(iii)

Instructor to Student Ratio: 1:40

Practical Exercise: N/A

Evaluation Strategy: Participants will complete a written examination at the conclusion of the class.

References:

1. Patterns of Global Terrorism, 2002, U. S. Department of State, Office of the Coordinator for Counterterrorism
2. FEMA Fact Sheet: Terrorism, Federal Emergency Management Agency, 2004
3. Field Behavior of NBC Agents, U.S. Army Field Manual FM 3-6, 1986
4. Potential Military Chemical/Biological Agents and Compounds, U.S. Army Field Manual FM 3-9, 1996
5. Chemical Operations, Principles and Fundamentals, U.S. Army Field Manual FM 3-100, 1996
6. Terrorism in the 20th Century: A Narrative Encyclopedia From the Anarchists Through the Weathermen to the Unabomber, Jay Robert Nash, M. Evans & Co., 1998
7. 49 CFR 171-176
8. California Code of Regulations Title 8, CCR 5192 (q)
9. California Penal Code
10. Federal Bureau of Investigation basic Terrorism doctrine and PDD-39
11. California Peace Officers Standards and Training (POST) Learning Domain 43
12. Professional Competence of Responders to Hazardous Materials Incidents, NFPA 472-2016

Public Safety Response to Terrorism -

Tactical Considerations, Incident Recognition and Reporting

One perspective of Terrorism divides it into two basic concepts: First, Terrorism is a violation of basic trusts. It is impossible to predict with any degree of accuracy when or where a terrorist event will occur.
Second, Terrorist events are, by their very nature, intended to effect many people. Chemicals considered for terrorist strikes tend to be super toxic and/or beyond the normal level of experience of hazmat responders.

The FBI Defines Terrorism as: The unlawful use of force or violence against persons or property to intimidate or coerce a government, the civilian population, or any segment thereof, in furtherance of political or social objectives.
The State of California (PC Section 15) defines Crimes as an act or omission, in violation of statutory law, commanding or forbidding, and, to which upon conviction there is punishment.

Whatever the goal of the terrorist, these types of incidents can instantly overwhelm resources and put responders at serious risk. Responders with a solid understanding of recognition, risk assessment and tactical considerations will go a long way in protecting themselves and the communities they are committed to protect.

California specific Penal Laws pertaining to terrorism:

Criminal Threats and Hate Crimes
A. Threatening, Stalking, or Terrorizing

- Criminal Threat (Pen. Code, § 422)
- Stalking (Pen. Code, § 646.9(a), (e)–(h))
- Terrorizing by Destructive Device, Explosive, or Arson (Pen. Code, § 11413)
- Terrorism by Symbol (Pen. Code, § 11411(a) & (b))
- Cross Burning and Religious Symbol Desecration (Pen. Code, § 11411(c))
- Obstructing Religion by Threat (Pen. Code, § 11412)
-

B. Hate Crimes

- Hate Crime: Misdemeanor Interference With Civil Rights by Force (Pen. Code, § 422.6(a))
- Hate Crime: Misdemeanor Interference With Civil Rights by Threat (Pen. Code, § 422.6(a) & (c))
- Hate Crime: Misdemeanor Interference With Civil Rights by Damaging Property (Pen. Code, § 422.6(b))
- Hate Crime: Disability Defined
- Hate Crime Allegation: Felony (Pen. Code, § 422.75(a)–(c))
- Hate Crime Allegation: Misdemeanor (Pen. Code, § 422.7)

Basic Recognition

Basic recognition of specific clues of potential HazMat involvement is a skill that has been taught in the HazMat training curriculum for many years. Some of these clues for HazMat response are as follows and are acquired from nine sources:

1) Information from the dispatcher or call taker
2) Location or Occupancy
3) Initial size-up
4) Container size and shape
5) Markings and colors
6) Identification numbers
7) Container labels
8) Documents and shipping papers
9) Human senses

Not all of these clues will be present at a terrorist incident. However, this method of systematically evaluating your hazards will help the first responder in recognizing that this call differs from a standard HazMat call and will require special consideration to bring the incident to a successful conclusion.

Hazmat Incidents vs. Terrorist Incidents

There are many differences between a hazardous material incident and a terrorism incident.
The primary difference between Criminal Acts and Terrorism is that All Terrorist acts are crimes, but not all crimes are acts of Terrorism.

As a rule, a Hazardous Materials Incident is almost always an accident, whereas a terrorist incident is a deliberate, intentional act. Also, terrorist incidents involving chemical or biological agents will likely be extremely toxic in nature.

For example, sarin nerve agent is 200 times more toxic than chlorine. Sarin is 60 times more toxic than methylisocyanate, (the chemical involved in the Bhopal India, incident that caused 200,000 casualties).

VX nerve agent is 10 times more toxic than Sarin. The detection of a standard Hazmat incident can involve the use of DOT placards, labels and shipping papers, which are mandated by various federal laws. None of these detection methods will be available to the first responder operating at a terrorist incident.

The standard HazMat incident will involve a methodical approach by the HazMat team. This approach will be the result of standard operating procedures, policies and training. The team will use a standard approach that will not be sufficient in terms of personnel or equipment to deal with a terrorist incident.

A terrorist incident involving weapons of mass destruction may create a Mass Casualty Incident.
The Tokyo Subway attack in March, 1995, involved 5,000 casualties; The Nairobi Embassy bombing involved 3,000 casualties.

Terrorism exists globally, and seldom goes unnoticed. The mentalities behind the commission of acts of Terrorism tends to be viewed from one of two legal perspectives:

Domestic Terrorism acts occur within the confines of the border of one specific place, by a number of means, by one or more perpetrators.
Timothy McVeigh and Terry Nichols were responsible for the explosion outside the Alfred P. Murrah Federal Building in Oklahoma City, OK April 19 1995. This act was committed by Americans in the Continental Limits of the USA, making it an act of Domestic Terrorism.

International Terrorism acts occur when the perpetrator(s) cross a border into a neighboring location or country. The Irish Republican Army committed countless acts of violence against within the confines of Northern Ireland for many years. Once they crossed the border into Great Britain and detonated explosives there, their acts became International Terrorism.

Regardless of the type of terrorism, location, or perpetrator, Terrorist attacks should be considered low frequency / high risk events. HazMat Team Members must exercise due caution, adhere to appropriate scene assessment techniques, and utilize the necessary (And available) tools/monitoring devices, etc., at scene.

Types of Incidents

There are many different methods or weapons that can be used by terrorists. Some are easy to obtain and deploy while others could be almost impossible for a terrorist to obtain. In order of probability, we can rank the types of weapons by how easy the components are to obtain, coupled with history.

Most Likely Weapons:

Incendiary
Explosive
Chemical
Biological
Radioactive Material / Radiological Dispersal Device
Nuclear Weapon

Basic Awareness Clues:

The nine clues that we have traditionally used to identify that a first responder is dealing with a hazardous material require the responder to move progressively closer to the hazard, and closer to danger.

When responders are identifying hazardous materials they use the same process, but must now expand their focus to include terrorist incidents. In order to be able to recognize that the incident involves more than a standard hazardous material, the first responders need to become familiar with the types of weapons a terrorist might use in an attack.

The acronym

CBRNE is used to describe the types of weapons used by terrorists.

- **C- Chemical**
- **B- Biological**
- **R- Radiological**
- **N- Nuclear**
- **E- Explosive**

Currently explosives are the number one weapons of choice being used by terrorist.
The largest percent of all terrorist attacks involve explosives.

First responders will need to become familiar with the clues to identify not only hazardous materials incidents but also incidents that involve terrorism.

Information from Dispatcher / Call Taker

The dispatcher or call taker can provide the first clue as to the possibility that a terrorist incident has occurred. This initial information can provide valuable clues concerning the incident. The caller may have information concerning conditions:

- Are their chemicals involved?
- Was there an explosion?
- How many injured persons are there?
- Does the caller smell any strange odors?
- Are there a lot of panicked people running away from the scene?

1) Information from Dispatch
2) Location or Occupancy
3) Initial Size-up
4) Container Size and Shape
5) Markings and Colors
6) Identification Numbers
7) Container labels
8) Documents and Shipping Papers
9) Human Senses

You may be dispatched to a differently reported incident, that turns into a terrorist incident. **The Communications Center can only give you the information that they have.** Unfortunately, many terrorist incidents are initially dispatched as something else; That report may be inadvertent (Witnesses) or deliberately misleading (Suspect made).

Size Up the event

The awareness acronym utilized throughout the Military and Emergency Services, OODA-LOOP has proven to be an effective methodology.

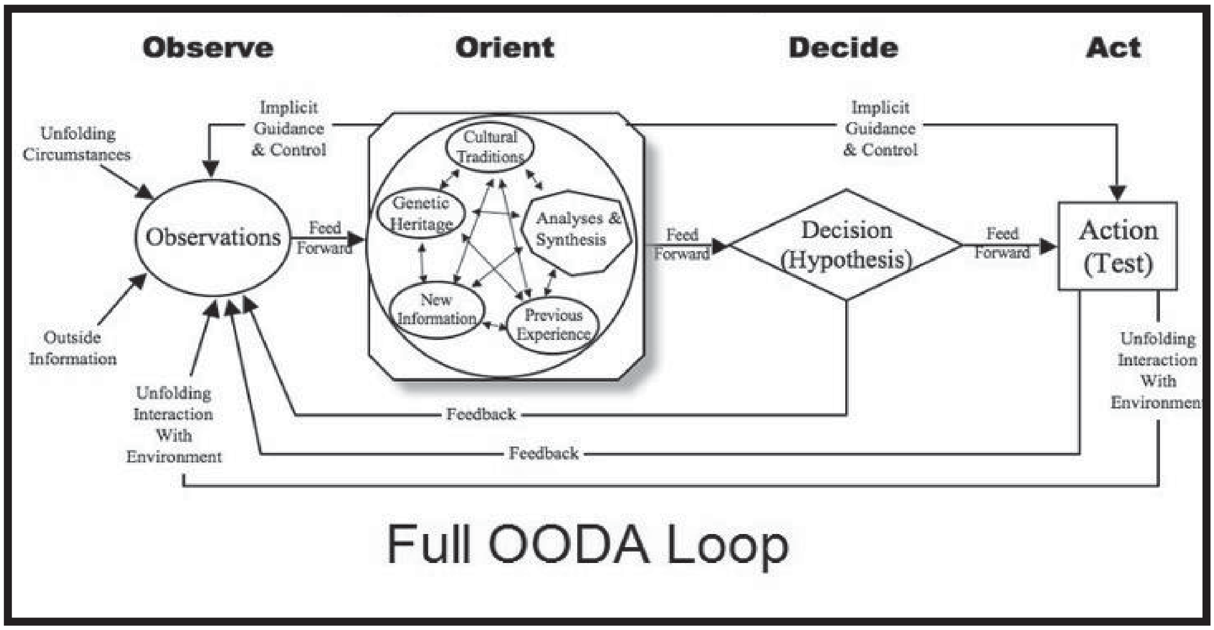


Figure 19.1 The OODA-LOOP

Chemical Incidents

Chemical agents are categorized, generally, as either incapacitating or lethal in nature. Lethal agents may be immediately deadly, or lead to death soon after exposure.

Categories of Chemical Agents likely to be used in a deliberate attack include:

- Nerve Agents (Sarin, Soman,Tabun,VX)
- Blister Agents (Mustard, lewisite)
- Blood Agents (Hydrogen Cyanide)
- Choking Agents (Chlorine, Phosgene)
- Irritating Agents (Mace, Tear Gas, Pepper spray)
- Incapacitating Agents (BZ, Agent-15)

Outward signs that a Chemical Agent has been (In or Outdoors) used may include:

- Explosions that dispense liquids, mists, or gas.
- Explosions that seem only to destroy a package or bomb device.
- Unscheduled and unusual spray being disseminated.
- Abandoned spray devices.
- Numerous dead animals, fish, and birds.
- Lack of insect life.
- Numerous dead animals, fish, and birds.
- Lack of insect life.

Common Chemicals	Effects Resemble
• **Organophosphate Insecticide**	**Nerve Agent**
• **Dimethyl Sulfate (DMS)**	**Blister Agent**
• **Methyl isocyanate**	**Blood or Choking Agent**
• **Anhydrous ammonia**	**Choking Agent**
• **Sevin / Malathion / Parathion**	**Nerve Agent**

Biological Agents

Categories of Biological Agents likely to be used in a deliberate attack include:

- Bacterial (Plague, Anthrax)
- Viral (Viral Hemorrhagic Fevers (VHF), Smallpox)
- Rickettsia (Rocky Mountain Spotted Fever)
- Toxins (Mycotoxins (Trichothecene Mycotoxins), Ricin)

Outward signs of possible Biological Agent attack include:

- Written or verbal threat(s) made prior to attack
- Incubation periods for Biological Agents.
- Vectors? (Insects/Devices)
- Medical community response
  - Pediatric Cases?
  - Veterinary Cases?
  - Outbreak of unusual illness?
- Invisible to human senses
- Sudden appearance of unusual disease(s)
- Animals / Children begin falling victim shortly preceding Adults
- Over-the-Counter medication mass puchases

Radiological Agents

Refer to attached case study of the Goiania, Brazil incident from 1979.
Radiological Dispersion Devices might serve as proxy weapons for Nuclear Munition detonations. The manufacture or theft of a Nuclear weapon is nearly impossible, but the acquisition of radiological materials is possible, and has occurred…Its use is a potential hazard for HazMat Team members.

Nuclear Weapons

Only twice in human history have Nuclear weapons been detonated in anger above ground, both during time of war, and both with long-term and hideous affects to Human beings, the Environment, and Property.

Following the blast and fire damage from a Nuclear detonation, outward warning signs of the aftermath of both Radiological and Nuclear weapons use will involve:

- Tissue destruction that will never heal (The DNA is permanently altered)
- Various types of Cancer related illnesses
- Poisoning of Food and Water supplies
- Depending on the materials disseminated, brilliant colored powders

Explosive Weapons

Explosives remain the most common choice of weapons used. Their components are easily obtained, easily constructed, and allow time for the perpetrator to escape before the detonation occurs.
Fusing/timing mechanisms vary greatly, and their complexity is largely dependent upon the sophistication of the Bomber.

Outward warning signs of Explosive device use include:

- Location/occupancy
- Small/explosion (secondary Device).
- Shockwave with loud Noise.
- Previous warning prior to detonation

Suspicious mail / packages include:

- Excessive postage
- Excessive weight
- Excessive securing materials such as masking tape, string, etc
- Incorrect titles
- Titles but no names
- Misspellings of common words
- Oily stains or discoloration
- No return address

- Rigid Envelope
- Protruding wires or tinfoil
- Foreign mail, airmail and special delivery
- Restrictive markings such as “confidential”
- Hand written or poorly typed addresses

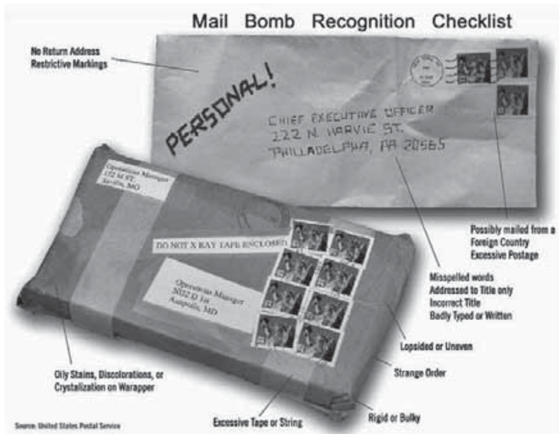


Figure 19.2 Warning Signs of a suspicious package sent through the US Mail.

Reporting Terrorist Incidents

During incidents involving explosives, cellular phones may not work, due to Radio Frequency (RF) blocking by authorities. First-due emergency units should restrict/discontinue radio, cellular and mobile data terminal communications within 150 feet of any suspected explosives. Radio transmitters can create a field of electric energy sufficient enough to trigger electric blasting caps, if they are within close proximity to the suspected explosive device.

Emergency response agencies typically have a SOP that outlines who gets notified for each specific type of emergency.

Allow the FBI to make a determination of a any suspected Terrorist incident as being legitimate in nature. Your goals on a possible Terrorist Incident, as a member of a HazMat team are:

1) Safety of Responders and the public
2) Isolation of the immediate area and establishing zones/perimeters (Treat it like a crime scene, because it most likely is)
3) Notification to the appropriate agencies and organizations in a safe manner

Reporting Terrorist Incidents, continued

4) Leave the scene undisturbed.
   - Leave suspected devices where they are found.
   - They can be marked with a line of barrier tape or string (that is not in contact with the device, but the wall/fixed object adjacent to them).
   - Digital photos may be taken (without flash or other illumination, in the event there is a light-sensitive photo cell on the device). These photos may assist responding Bomb Squad members to evaluate what they are dealing with prior to them taking further recon.

Preplanning your notification process will provide a substantially less chaotic response. Here are some tips for notification when dealing with a terrorist event:

A. Follow your jurisdiction's policies and procedures

B. If a policy or procedure is not written yet, consider the incorporating some Of the following:

   1. Notify your local Law Enforcement and Fire Service

   2. Notify the Office of Emergency Services (OES) at (916) 845-8911

   3. Notify the FBI (Through your Law Enforcement agency)

   4. ____

RESOURCES ONLINE

Terrorism Resources:

California Terrorism Response Plan
An Annex to the State Emergency Plan March 1999 (Updated February 2001)
Available at www.OES.ca.gov

CONPLAN
United States Government Interagency Domestic Terrorism Concept of Operations Plan
Signatories: DOD, DOE, DHHS, EPA, FEMA, FBI and DOJ
http://www.counterterrorismtraining.gov/pubs/05.html

First Responder Awareness, Operational, Incident Commander and Hazmat Technician Terrorism Courses
www.OES.ca.gov California Specialized Training Institute (CSTI)

Emergency Responder Guidelines

Office for Domestic Preparedness www.ojp.usdoj.gov/odp

Glossary of Terms for Nuclear, Biological and Chemical Agents and Defense

Aid for Decontamination of Fire and Rescue Service Protective Clothing and Equipment After Chemical, Biological and Radiological Exposures
National Institute of Standards and Technology
Technology Administration, U.S. Department of Commerce
NIST Special Publication 981
Lawson and Jarboe, 97 pages, May 2002
CODEN: NSPUE2
U.S. Government Printing Office
Washington, D.C.
www.bookstore.gpo.gov
(202)-512-1800

USAMRIID'S Medical Management of Biological Casualties Handbook
Fourth Edition, February 2001
Operational Medicine Department
Attn: MCMR-UIM-O
U.S. Army Medical Research Institute of Infectious Diseases (USAMRIID)
Fort Detrick, Maryland 21702-5011
Pdf and Palm OS electronic version: www.usamriid.army.mil/education/bluebook.html
Resource for all texts: www.usamriid.army.mil/education/instruct.html

Agency for Toxic Substances and Disease Registry (ATSDR)
Chemical Weapon Information Sheets (similar to MSDS)
http://www.atsdr.cdc.gov/

Law Enforcement Officers Guide for Responding to Chemical Terrorist Incidents
U.S. Army Soldier and Bilogical Chemical Command, Homeland Defense Business Unit
January 2003
And
Guidelines for Mass Casualty Decontamination during a Terrorist Chemical Agent Incident
January 2000
www.hld.sbccom.army.mil

Emergency Medical Services Authority
http://www.emsa.ca.gov/

FEMA
http://www.fema.gov/tab_education.shtm

Federal OSHA
http://www.osha.gov/

Internet Bomb Maker
http://www.kurtsaxon.com/

PBS's venture into Terrorism
http://www.pbs.org/avoidingarmageddon/getInvolved/involved_01.html

CHAPTER
20

Chapter Twenty

Chapter 20: Incident Termination

Summary:

Review of a specific event's response and mitigation efforts are essential to an overall successful mission.

Time Allocated: <30 Minjutes>, class dependent

Method of Instruction: Interactive Lecture

Terminal Learning Objective:

At the conclusion of this class the participant will be able to describe the difference between an evaluation and critique

Enabling Objectives:

A. Explain what a critique of events is;
B. Explain what a post-incident analysis is;
C. Explain what an evaluation is;
D. Explain what a de-briefing is.

Instructional Resources Required:

1. Student Notebook
2. AV-Media Projection system for PowerPoint (or other similar program)
3. Dry erase, paper chart and or chalk board with appropriate markers
4. One copy of the Ca Penal Code and related legal documents

Instructional Resources Recommended:

1. One copy state or federal version of 29 CFR 1910.120 (q)(iii)

Instructor to Student Ratio: 1:40

Practical Exercise: N/A

Evaluation Strategy: Participants will complete a written examination at the conclusion of the class.

Hazardous Materials Incident Termination

Major hazardous materials emergencies should be formally terminated using recognized procedures. Proper termination procedures help ensure the personal safety of responders and the public. Proper termination procedures also ensure that a record of events has been established and provide a way to outline lessons learned so that other emergency response personnel may benefit from the experience. The termination process of a hazardous materials incident can be broken down into three phases: incident debriefing, post-incident analysis and critique.

Incident Debriefing

An effective debriefing should inform emergency response personnel of exactly what hazardous materials they were exposed to. The debriefing should identify any equipment damage and unsafe conditions that require immediate attention or isolation for further evaluation. The incident commander shall assign an individual to gather information for the post-incident analysis and critique. A summary of the incident should be completed by each division. Positive aspects of the incident should be emphasized. A debriefing should be held as soon as the emergency phase of the incident is over. The debriefing should last no longer than 45 minutes.

The debriefing should ask the following questions.

- What were responders exposed to?
- What are the signs and symptoms of exposure?
- Was equipment or apparatus exposed?
- Is the equipment and/or apparatus unfit for service?
- How will the contaminated equipment and apparatus be cleaned or disposed of?
- Who is the follow-up contact person?
- What problems need immediate attention?
- What procedures will be followed in the event responders feel they have been exposed to the contaminant or suffer any signs or symptoms after the incident has been terminated?

The debriefing should address safety, equipment, personnel, and legal issues.

Post-Incident Analysis

Post-incident analysis (PIA) is the second phase of incident termination. The PIA is conducted to determine who has a financial responsibility and to establish a clear picture of the incident for further study. Gathering information for a PIA should be the responsibility of one person. This process should start during the debriefing phase. The person conducting the PIA should meet with the incident commander as soon as possible to review key events of the incident and to identify problem areas for follow-up. This person should also collect all documentation from the incident.

A PIA checklist should be used to help the process along. It should include the following:

- Verification of shipping papers/MSDS
- Chemical hazard information
- Computer information
- Information from the poison control center
- Recordings and photographs of the incident
- Records of contamination or exposure to personnel/equipment, suit time log, medical monitoring sheet
- Incident reports, ICS forms, site safety plan, notes, etc.
- Business cards or notes from involved agencies, organizations, company representatives, etc.

The PIA should be conducted as soon as possible, while the information is fresh in the minds of emergency response personnel. A chronological review of the incident should be established. It should encompass the what, when, where, and who of the event. A rough draft of the incident report should be assembled and reviewed by key personnel who were involved in order to verify the available facts. The specific facts the PIA should focus on include command and control, tactical operations, resources, and support services. When the PIA report is completed, it should be forwarded through the proper channels for review. The report is then dispersed to those responsible for appropriate action.

Critique

The third and final part of the termination process is the critique. An effective critique program is a positive way to outline the lessons learned. The critique should identify both strong and weak points of the incident. A good critique will promote trust in the response system as being self-correcting. It will promote cooperation through teamwork.

It also facilitates the continuing development of training skills and techniques, while sharing information between response agencies.

The critique leader acts as the director of the entire performance. The role of the critique leader is to control the flow of the critique, to ensure direct questions receive direct answers, and to ensure that all participants play by the rules. The leader makes sure that no blame is placed on a given individual. The critique leader sees that each operational group presents its observations and keeps notes of important points. The leader must then review the lessons learned from the incident.

All key personnel should be included in the critique, including persons from other agencies or private enterprise. All documents from the incident should be completed and presented at the critique. These documents should have been verified during the PIA process by the individuals who prepared them.

Review

It is important that a hazardous materials incident be terminated formally using specific recognized procedures. This process is broken down into three phases: incident debriefing, post-incident analysis, and critique. The process should include careful documentation of safety procedures, site operations, hazards faced, and lessons learned. This provides a record of resources and events that may affect public health and financial resources. Lastly, it provides the data that may be required to comply with local, state, and federal laws. Although we have discussed this as incident termination, this does not mean that documentation waits until the end of the incident. All forms associated with all ICS positions must be completed in a timely manner as is respective of the position. Remember, too, that everything said or written at a critique can be subpoenaed. Therefore, professionalism must be the only demeanor demonstrated during a critique.

Form Appendix

General Characteristics for Commonly Used Haz Mat Gloves.

Butyl Rubber Gloves

These gloves protect against nitric acid, sulfuric acid, hydrofluoric acid, red fuming nitric acid, and peroxide. Butyl rubber gloves are highly impermeable to gases, chemicals, and water vapor. In addition, they resist abrasion and remain flexible at low temperatures. Poor for gasoline, aromatic, and halogenated hydrocarbons.

Natural Latex or Rubber Gloves

These gloves protect workers hand from most water solutions of acids, alkalis, salts, and ketones. They are not recommended for working with non-water solution hazardous chemicals. They are frequently used to protect against contact with blood or other potentially infectious materials. Thin surgical-style latex gloves offer only limited protection from many chemicals.

Latex gloves have caused allergic reactions in some individuals. Hypoallergenic gloves, glove liners, and powderless gloves are possible alternatives for individuals who are allergic to latex gloves.

Neoprene Gloves

Neoprene gloves provide protection against a broad range of corrosives chemicals. They are resistant to oils, greases, alcohols, resins, alkalis, organic acids, and many solvents. Neoprene has poor resistance to chlorinated aromatic solvents, phenols, and ketones. These gloves have good pliability, finger dexterity, high density, and tear resistance.

Nitrile Gloves (Excellent general use glove)

Nitrile gloves are a good choice if work involves **aromatic petroleum** - Good for solvents, oils, greases, and some acids and bases. and chlorinated solvents such as trichloroethylene and perchloroethylene. Nitrile gloves stand up to heavy use even though they are designed for work where dexterity and sensitivity are required. They are generally resistant to abrasions, punctures, snags, and tears.

Viton gloves are used when dealing with aromatic hydrocarbons such as benzene, toluene and xylene

Silvershield or 4H Gloves

These gloves provide excellent chemical resistance, but are stiff and have poor grip and fit. They are commonly used of HazMat work and are a good choice for universal spill kit gloves.

Cryogenic Resistant Material

For use with cryogenic materials. Designed to prevent frostbite. Note: Never dip gloves directly into liquid nitrogen.

Nomex

For use with pyrophoric materials. • Consider wearing a flame-resistant glove such as a Nomex 'flight' glove with a thin nitrile exam glove underneath.

*Check glove permeation data prior to use

EPA Decontamination Solution Guide

Hazard Suspected:	Solution:
Inorganic Acids Metal Processing Waste Heavy Metal – Mercury, Lead, Cadmium, etc.	Solution A
Pesticides Fungicides Chlorinated Phenols Dioxins, PCP Cyanides Ammonia and other non – acid inorganic wastes	Solution B
Solvents and Organic compounds (PCB's/PBB's)	Solution C or A
Oily, greasy unspecified wastes	Solution C
Inorganic Bases (Alkali and Caustic wastes)	Solution D
WMD/ Nerve agents:	
People	.5% bleach
Equipment	10% bleach

Note: Contamination directly on the skin or clothing Fire Department personnel should remove all of the victim's clothing, and flush with copious amounts of water.
Skin or non-chemical protective clothing – General cleaning, remove previous decon solutions with Solution E.
Plain water will not wash off the simplest of contaminants, use solution E as a minimum.

Solutions A-D should be used only on chemical clothing.

For further Decon Solution recommendations, call CDC/Agency for Toxic substances and Disease; Tech/Ref see web site: http://www.atsdr.cdc.gov/mmg/index.asp#bookmark03

Decontamination Solutions
Mix

Solution A 12.8 oz. Sodium Carbonate (soda ash)
12.8 oz. Trisodium Phosphate (TSP)
Mix the above materials with 2 gallons of water
EPA standard = 5% Na_2CO_3, 5% Na_3PO_4, (same as the above mixture)

Solution B 25.6 oz. Calcium Hypochlorite with 2 gallons of water
Stir with a wooden stick
***Simple Green** can also be used for hydrocarbons & Hydrocarbon based Substances.
EPA standard = 10 % $Ca(ClO)_2$ (same as above mixture)

Solution C 12.8 oz. Trisodium Phosphate (TSP) with 2 gallons of water
EPA standard = 5%Na_3P0_4 (same as the above mixture)

Solution D 1 gallon vinegar with 2 gallons water and stir
EPA standard = (the same as above mixture)

Solution E 4 oz. **Palmolive** liquid dish soap with 2 gallons of water
EPA standard = (the same as above mixture)

HAZMAT CHECKLIST
Initial Actions

Think Safety
• Assess situation.
• Safe approach, upwind/upgrade/upstream.
**Use binoculars from safe distance*
• Identify, isolate and deny entry.
• Update dispatch.
• Exact location, use GPS.
• Request needed assistance and identify a safe approach route.

Scene Management
• Goal is to protect **life, environment and property**.
• Attempt to identify substance using DOT North American Emergency Response Guide. Use binoculars, placards/labels, container shapes/colors, Safety Data Sheets (SDS), shipping papers, etc.
• Quantity and description of material involved.
• Exposures and hazards (Evac. Shelter-in-place) surrounding the site.
• Continually monitor weather.

Organizational Responsibilities
• Establish chain of command / ICS / HazMat Group
• Develop action plan for area security and evacuation.
• Advise all on scene and responding resources of changes in situation.
• Consider EMS/Treatment area for exposure victims. *Notify area hospital of possible haz mat situation.
• Keep dispatcher advised of changes.
• Document all actions taken (ICS 214).
☐ Contacts
☐ Employee exposures

General Guidelines For Isolation Distances
• Minor event (1 drum, 1 bag, etc.) = 150 feet
• Major event (1 drum or more, etc.) = 500
• Residential and light commercial = 330 feet
*Truck or Rail w/explosives “on fire” = 1 mile
• Open areas = 1000 feet
• BLEVE (Boiling Liquid Expanding Vapor Explosion) potential = 2500 feet (one-half mile)
• Stage arriving units 2500 feet upwind.
• Position vehicles headed out.

916-845-8911 - State OES Warning Center 24hr.
1-800-424-9300 - CHEMTREC (Chemical Transportation Emergency Center)
For immediate information about a chemical or to seek assistance from a manufacturer.
1-800-424-8802 - National Response Center- To report spills of oil and Hazardous Material. (U.S. Coast Guard. It is the designated federal point of contact for reporting all oil, chemical, radiological, biological and etiological discharges into the environment).

HAZMAT ICS CHECKLISTS AND FORMS

ICS Position Title: ***INCIDENT COMMANDER***

Major Responsibility: Overall responsibility for management of the incident.

Duty Checklist:

___________ 1. Formally assume command

___________ 2. Evaluate current actions and organization

___________ 3. Assign Incident Safety Officer

___________ 4. Assign Hazmat Group Supervisor

___________ 5. Prepare Incident Action Plan (HM Forms and necessary ICS Forms)

___________ 6. Approve all ordering / releasing of resources

___________ 7. Approve news releases to media through the Information Officer

___________ 8. Ensure pre-entry briefings, safety assessments, and planning meetings are conducted

___________ 9. Conduct post-incident review

Forms checklist:

1. Incident Action Plan

HAZMAT ICS CHECKLIST

ICS Position Title: *HAZMAT GROUP SUPERVISOR*

Major Responsibility: Responsible for managing the activities of the Hazardous Materials Group.

Duty Checklist:

___________ 1. Obtain briefing from the Incident Commander

___________ 1a. Advise IC if additional HazMat Resources are required

___________ 2. Confirm Control Zones and access points have been identified

___________ 3. Coordinate and manage overall activities of Entry, Technical Reference, Decon, Site Access Control, safe Refuse and Medical Unit

___________ 4. Participate in developing Incident Action Plan

___________ 5. Evaluate and recommend public protective actions to the Incident Commander

___________ 6. Ensure *Site Safety Plan* is prepared by Assistant Safety Officer, and a pre-entry safety briefing is conducted

___________ 7. Ensure that proper PPE is selected and used

___________ 8. Ensure current and future weather predictions are obtained

HAZMAT ICS CHECKLIST

ICS Position Title: *ASSISTANT SAFETY OFFICER*

Major Responsibility: Responsible for advising the Hazmat Group Supervisor on health and safety issues, and has the emergency authority to alter, suspend, or terminate, any unsafe acts that present an immediate threat to on-scene personnel.

Duty Checklist:

__________ 1. Obtain briefing from the Incident Safety Officer if assigned

__________ 2. Report to the Incident Safety Officer, but work closely with the Hazmat Group Officer

__________ 2a. Assign Deputy ASO's for large incidents

__________ 3. Prepare *Site Safety Plan – ICS 208HM*

__________ 4. Advise the Hazmat Group Supervisor of any situations that may present a threat to responders

__________ 5. Monitor site safety

__________ 6. Ensure that required (transport capable) EMS is on scene, and coordinate related safety activities with the Hazmat Group Supervisor

Forms checklist:

1. Site Safety Plan – ICS 208HM

HAZMAT ICS CHECKLIST

ICS Position Title: ***TECHNICAL REFERENCE UNIT LEADER***

Major Responsibility: Responsible for providing technical information and assistance to the Hazmat Group Supervisor using various references, resources, and expertise.

Duty Checklist:

___________ 1. Provide technical information about the chemical properties of the hazardous materials involved

___________ 2. Make recommendations regarding public protective actions, PPE, Decon, EMS, and other operational considerations

___________ 3. Provide technical information to assist in the development of the Incident Action Plan and the Site Safety Plan

___________ 4. Assist in interpreting environmental monitoring information

___________ 5. Work with various technical specialists to manage technical information about the incident

___________ 6. Ensure permeation data is checked for; suits, gloves, boots, etc.

___________ 7. Obtain initial weather information and continue to monitor it

___________ 8. Make notification calls as necessary; State Warning Center, Health HazMat, Fish & Wildlife, Schools within ½ mile, Coast Guard, JRIC/NCRIC

Forms checklist:

1. Hazardous Materials Data Sheet

HAZMAT ICS CHECKLIST

ICS Position Title: *DECONTAMINATION UNIT LEADER*

Major Responsibility: Responsible for managing the elements of the Decontamination Unit as required by the Incident Action Plan.

Duty Checklist:

___________ 1. Obtain briefing from the Hazmat Group Supervisor

___________ 2. Establish, identify, and mark the Contamination Reduction Corridor

___________ 3. Maintain control of the movement of personnel and equipment within the Contamination Reduction Zone

___________ 4. Coordinate the transfer of contaminated patients requiring medical attention (after Decon) to the Medical Unit

___________ 5. Coordinate activities with the Entry Team Leader

___________ 6. **Manage** the handling, storage, and transfer of known or suspected contaminated items within the Contamination Reduction Zone

___________ 7. Ensure proper decontamination for the materials involved by consulting with the Technical Reference Unit

___________ 8. Ensure appropriate PPE is utilized by Decon personnel

___________ 9. Ensure samples leaving the Exclusion Zone are Deconned and transferred to Tech./Ref.

___________ 10. Ensure Decon Team is Deconned prior to leaving CRZ

HAZMAT ICS CHECKLIST

ICS Position Title: ***ENTRY UNIT LEADER***

Major Responsibility: Responsible for the management of Entry and Back-up teams operating at the scene.

Duty Checklist:

1. __ Establish Entry & Back-up members.
2. __ Establish communication frequency (frequencies)
3. __ Check with ASO and Tech./Ref on level of PPE.
4. __ Have Entry & Back-up medical evaluation/vitals taken and recorded. Review Vitals.
5. __ Ensures Entry & Back-up briefing is completed.
6. __ Ensure all personal take off all accessories (i.e. badges, buckles, pins, watches, ring etc. that may damage the suit).
7. __ Assemble and check all clothing and equipment needed.
   interior/night entries; ensure entry team has flashlights & Lite sticks
8. __ Check on what type of monitoring equipment needed and make sure it works properly.
9. __ Verify location of:
   - __ a. Exclusion, CRZ, and Support Zone.
   - __ b. Decon Corridor.
   - __ c. Emergency access corridor.
   - __ d. Equipment corridor.
   - __ e. Working radio communication.
10. __ Donn PPE to waist, ensure booties are on boots.
11. __ Donn SCBA back pack and attach suit waist strap.
12. __ Attach radio to SCBA and conduct radio check.
13. __ Donn face piece and but arms in suit attach 3 pairs of gloves.
14. __ Final briefing on assignment, safety and escape instructions. Ensure Entry Team has clear Knowledge of objectives and has necessary tools/equipment.
15. __ Verify both teams' readiness.
16. __ Complete donning of protective clothing (place on air zip up suit).
17. __ Record time zero (from when first on air) and notify IC.
18. __ Entry Team on air, Back-up Team off air (on air if connected to air line)
19. __ Back-up Team should be standing by in the Support Zone w/ Rescue (RIC) Equip.
20. __ When the Entry Team makes entry into the Exclusion Zone record time and notify IC.
21. __ Maintain radio and/or visual contact with Entry Team Leader..
22. __ Record all information from entry team for debriefing and/or mitigation.
23. __ Track and notify entry team of elapsed time.
24. __ When Entry Team exits Exclusion Zone into decon notify IC.
25. __ Decon Leader will take over Entry Team members thorough the decon line.
26. __ Ensure Medical completes medical evaluation/Post-Entry Vitals
27. __ Make sure Entry & Back-up do personal decon (field wash) before leaving site.
28. __ Debrief Entry & Back-up Teams.
29. __ Complete all documentation (exposure reports as necessary) on Incident Termination and Demobilization plan.

HAZMAT ICS CHECKLIST

ICS Position Title: ***SITE ACCESS CONTROL***

Major Responsibility: Responsible for the orderly movement of all people and equipment through appropriate access points at the incident scene.

Duty Checklist:

___________ 1. Obtain briefing from the Hazmat Group Supervisor

___________ 2. Establish Exclusion Zone as priority action

___________ 3. Utilize personnel and equipment (scene tape, traffic cones, etc.) to establish and maintain control of designated access points at scene

___________ 4. Designate a Safe Refuge Area (if needed) for contaminated patients awaiting decontamination

___________ 5. Request additional resource needs through Hazmat Group Supervisor

HAZMAT ICS CHECKLIST

ICS Position Title: *HAZMAT MEDICAL UNIT LEADER*

Major Responsibility: Responsible for providing EMS to response personnel, and conducting pre-entry and post-entry monitoring of Entry and Back-up teams.

Duty Checklist:

__________ 1. Obtain briefing from Hazmat Group Supervisor

__________ 2. Provide pre-entry and post-entry medical monitoring for Entry and Back-up teams

__________ 3. Consult with Technical Reference Unit regarding EMS care for chemical exposures to known or suspected material(s) involved

__________ 4. Evaluate, release or restrict team personnel according to pre-entry exclusion criteria

__________ 5. Establish and maintain Rehab at site

__________ 6. Request additional resources through the Hazmat Group Supervisor

Forms checklist:

1. Medical Monitoring Form(s)

HAZMAT INCIDENT ACTION PLAN

Date:	Incident Commander:	Page 1 of 2

SAFETY
Approach
Position Uphill / Upwind / Upstream
Identify Staging Area
ISOLATION
Use ERG: Establish Perimeter: **Unknown 330’**
Identify isolation & protective action distances
Deny entry / control access
NOTIFICATION
State Warning Center-OES
E.O.C. Activated (if needed)
P.D. (Traffic, Evacuation, Security, etc.)
Additional. units / CUPA/PIO
Outside Agencies (Public Works, Red Cross, Environmental Health Dept, etc.)
COMMAND & MANAGEMENT
Establish Command / ICS
Build Hazmat Organizational Structure
Designate Safety Officer
Designate Hazmat Group Supervisor
IDENTIFICATION & HAZARD ASSESSMENT
Ensure the identification of materials involved (Hazard Class) 1-9
Ensure assessment of all scene hazards
Assess resource status (current / anticipated)
ACTION PLANNING
Identify the problem (Spill? Leak? Fire?)
Identify available resources
Foam / Dike-Dam / Contain / Overpack / Lab Pack / HM Football
“What if we did nothing?” (Consider letting incident run its course)
PROTECTIVE EQUIPMENT
Ensure proper PPE for incident (Hazmat Group Supervisor recommendations)
Assess equipment needs (PPE, SCBA’s, lighting, fuel, rehab, light air, etc.)

HAZMAT INCIDENT ACTION PLAN

	Page 2 of 2
CONTAINMENT & CONTROL	
Non-Intervention Strategy	
Defensive Containment Strategy	
Offensive Control Strategy	
PROTECTIVE ACTIONS	
Shelter-in-Place Strategy (What should they do?)	
Evacuation Strategy (Where will they go?)	
Assess adequacy of resources required	
• Use AGEL 1 ppm as guide for Evac. vs. Shelter-in-place	
DECONTAMINATION	
Type of Decon : Wet or Dry	
Technical - # of pools ________________________	
Emergency Decon (Gross field decon with hose lines, hydrants, engines, etc.	
Mass Decon: (Consult with Hazmat Group Supervisor for layout)	
DISPOSAL	
Contractor required for disposal / cleanup	
Incident site arrangements (Company may have contingency plan for cleanup / disposal)	
DOCUMENTATION	
FD Reports:	
Cost Recovery forms	
FD Hazmat forms & ICS (Incident Action Plan / Site Safety Plan / Hazmat Data Sheets	
Entry Team Tracking Form / Staging Area Manifest)	
ACTION PLAN	
Plan A:	
Plan B:	
Plan C:	

HAZARDOUS MATERIALS DATA SHEET

Tech./Ref. Briefing Form

Date:	Technical Reference (Name):	Page 1 of 3

PRODUCT INFORMATION

Product Name:	NFPA 704: Health [ ]
Synonyms:	Flammability [ ]
UN ID #:	Reactivity [ ]
DOT Hazard Class:	Special Hazards [ ]
ERG Guide #:	Water Reactive: [ ] Yes [ ] No
Quantity of potential release:	Polymerization: [ ] Yes [ ] No

ERG INITIAL ISOLATION DISTANCES

Initial Isolation Distances:	If Material is Highlighted in ERG:					
Spill:	**Small Spills**			**Large Spills**		
Leak:	Isolate	Protect		Isolate	Protect	
Fire:		Day	Night		Day	Night

REFERENCES

References Used:
(3 Minimum)

PHYSICAL PROPERTIES

Color:			
Odor:			
Physical State:			
Boiling Point:			
Specific Gravity:			
Vapor Density:			
Vapor Pressure:			
Water Soluble:			

FLAMMABILITY

LEL:			
UEL:			
Flashpoint:			
Ignition Temp:			
Melting Point:			
Explosion Potential:			

HAZARDOUS MATERIALS DATA SHEET

Sources Used:		Page 2 of 3

TOXICITY			
IDLH:			
TLV / PEL:			
STEL:			
Carc. / Mut. / Teratogen:			
EXPOSURE ROUTES			
Inhalation:			
Ingestion:			
Absorption:			
Injection:			
REACTIVITY			
MSST:			
(Max Safe Storage Temp)			
SADT			
(Self Accel Decomp.Temp)			
Oxidizer:			
Pyrophoric:			
Corrosive:			
pH Potential:			
Incompatibles: (Reacts with)			
RADIOACTIVITY			
Alpha:			
Beta:			
Gamma:			
PERSONAL PROTECTIVE EQUIPMENT			
Entry:			
Decon:			
Decon Recommendations:			
WEATHER INFO			
Temp:	Wind Speed:	Barometric Pressure:	
Wind Direction:	Humidity:		

HAZARDOUS MATERIALS DATA SHEET

Sources Used:		Page 3 of 3

HEALTH EFFECTS

Signs & Symptoms:
(of Exposure)

Target Organs:

FIRST AID

Recommendations:

RECOMMENDATIONS

Based on Hazardous Materials Data Sheet info & level, resources, & capabilities of responders:

Strategy: Non-Intervention:

Defensive Containment:

Offensive Control:

ENTRY TEAM TRACKING FORM

(Pre / Post Entry Medical Monitoring)

Date:	Entry Leader:	Page 1 of 2

PRE-ENTRY MEDICAL MONITORING

Name:	Entry/BU	Temp	BP	Pulse	Resp	Wt

EXCLUSION CRITERIA:PROHIBITIONS FOR ENTRY

The following exclusion criteria is based on NFPA 471:	
Temperature:	> 99.5^0 F (oral) or > 100.5^0 F (core)
	< 97.0^0 F (oral) or < 98.0^0 F (core)
Heart Rate:	>70% of Max heart rate (Max heart rate = 220 – age)
Respirations:	>24 per minute
BP:	> 105 Diastolic
Assess the following:	
History: Recent medical problems (chest pain, dizziness, respiratory problems, etc.)	
Presence of nausea, vomiting, diarrhea, fever, upper respiratory illness within past 72 hrs	
Medications: New prescription medications / over counter meds taken within past 72 hrs	
Other: Alcohol within past 6 hours, pregnancy, altered mental status, skin rashes, sores	
Check AFD Hazmat Personnel Qualifications Roster (List of qualified Tech level personnel)	

ENTRY TEAM STATUS

Entry Personnel:	Gauge psi	On Air Time	Off Air Time	Total Time On Air

ENTRY TEAM TRACKING FORM

Date:		Page 2 of 2

POST ENTRY MEDICAL MONITORING

Benchmarks based on NFPA 471:

Monitor vital signs every 5-10 minutes until member returns to 85% of maximum pulse rate

If vital signs have not returned to within 10% of baseline, perform orthostatic vitals signs

Body weight loss > than 3% or positive orthostatic. *3% mandatory rehab/ 5% IV fluid replacement and transport to hospital*

Greater than 85% maximum pulse after 10 minutes

Temperature > than 101^0 F (oral) or > 102^0 F (core)

Other: signs / symptoms of heat related illness, nausea, vomiting, altered mental status, etc.

POST ENTRY MEDICAL MONITORING

Name:	Temp	BP	Pulse	Resp	Weight

REHAB

Rehab

Post Entry Monitoring

Fluid Replacement

Rest

Cooling

IV Therapy

Transport to Hospital: ____

Comments -

STAGING AREA – UNITS ASSIGNED

Date:	Staging Area Manager:	Page 1 of 1

UNITS

Units Staged:	Assigned Time:	Clear Time:

OTHER AGENCIES

OTHER EQUIPMENT (SPECIFY)

SITE MAP

N

W E

S

<u>Indicate on Map:</u>

☐ Zones ☐ CP ☐ Wind Direction ☐ Spill/HM ☐ Medical/Amb. ☐ For Structures, Indicate Entrance

SITE SAFETY AND CONTROL PLAN ICS 208 HM	1. Incident Name:	2. Date Prepared:	3. Operational Period: Time:

Section I. Site Information

4. Incident Location:

Section II. Organization

5. Incident Commander:	6. HM Group Supervisor:	7. Tech. Specialist - HM Reference:
8. Safety Officer:	9. Entry Leader:	10. Site Access Control Leader:
11. Asst. Safety Officer - HM:	12. Decontamination Leader:	13. Safe Refuge Area Mgr:
14. Environmental Health:	15.	16.

17. Entry Team: (Buddy System) Name:	PPE Level	18. Decontamination Element: Name:	PPE Level
Entry 1		Decon 1	
Entry 2		Decon 2	
Entry 3		Decon 3	
Entry 4		Decon 4	

Section III. Hazard/Risk Analysis

19. Material:	Container type	Qty.	Phys. State	pH	IDLH	F.P.	I.T.	V.P.	V.D.	S.G.	LEL	UEL

Comment:

Section IV. Hazard Monitoring

20. LEL Instrument(s):	21. O_2 Instrument(s):
22. Toxicity/PPM Instrument(s):	23. Radiological Instrument(s):

Comment:

Section V. Decontamination Procedures

24. Standard Decontamination Procedures:	YES:	NO:

Comment:

Section VI. Site Communications

25. Command Frequency:	26. Tactical Frequency:	27. Entry Frequency:

Section VII. Medical Assistance

28. Medical Monitoring:	YES:	NO:	29. Medical Treatment and Transport In-place:	YES:	NO:

Comment:

Section VIII. Site Map

30. Site Map:

Weather ❑ Command Post ❑ Zones ❑ Assembly Areas ❑ Escape Routes ❑ Other ❑

Section IX. Entry Objectives

31. Entry Objectives:

Section X. SOP S and Safe Work Practices

32. Modifications to Documented SOP s or Work Practices:	YES:	NO:

Comment:

Section XI. Emergency Procedures

33. Emergency Procedures:

Section XII. Safety Briefing

34. Asst. Safety Officer - HM Signature:	Safety Briefing Completed (Time):
35. HM Group Supervisor Signature:	36. Incident Commander Signature:

INSTRUCTIONS FOR COMPLETING THE SITE SAFETY AND CONTROL PLAN
ICS 208 HM

A Site Safety and Control Plan must be completed by the Hazardous Materials Group Supervisor and reviewed by all within the Hazardous Materials Group prior to operations commencing within the Exclusion Zone.

Item Number	Item Title	Instructions
1.	**Incident Name/Number**	**Print name and/or incident number.**
2.	**Date and Time**	**Enter date and time prepared.**
3.	**Operational Period**	**Enter the time interval for which the form applies.**
4.	**Incident Location**	**Enter the address and or map coordinates of the incident.**
5 - 16.	**Organization**	**Enter names of all individuals assigned to ICS positions. (Entries 5 & 8 mandatory). Use Boxes 15 and 16 for other functions: i.e. Medical Monitoring.**
17 - 18.	**Entry Team/Decon Element**	**Enter names and level of PPE of Entry & Decon personnel. (Entries 1 - 4 mandatory buddy system and back-up.)**
19.	**Material**	**Enter names and pertinent information of all known chemical products. Enter UNK if material is not known. Include any which apply to chemical properties. (Definitions: ph = Potential for Hydrogen (Corrosivity), IDLH = Immediately Dangerous to Life and Health, F.P. = Flash Point, I.T. = Ignition Temperature, V.P. = Vapor Pressure, V.D. = Vapor Density, S.G. = Specific Gravity, LEL = Lower Explosive Limit, UEL = Upper Explosive Limit)**
20 - 23.	**Hazard Monitoring**	**List the instruments which will be used to monitor for chemical.**
24.	**Decontamination Procedures**	**Check NO if modifications are made to standard decontamination procedures and make appropriate Comments including type of solutions.**
25 - 27.	**Site Communications**	**Enter the radio frequency(ies) which apply.**
28 - 29.	**Medical Assistance**	**Enter comments if NO is checked.**
30.	**Site Map**	**Sketch or attach a site map which defines all locations and layouts of operational zones. (Check boxes are mandatory to be identified.)**
31.	**Entry Objectives**	**List all objectives to be performed by the Entry Team in the Exclusion Zone and any parameters which will alter or stop entry operations.**
32 - 33.	**SOP s, Safe Work Practices, and Emergency Procedures**	**List in Comments if any modifications to SOP s and any emergency procedures which will be affected if an emergency occurs while personnel are within the Exclusion Zone.**
34 - 36.	**Safety Briefing**	**Have the appropriate individual place their signature in the box once the Site Safety and Control Plan is reviewed. Note the time in box 34 when the safety briefing has been completed.**

Residential/Commercial

Natural Gas Response Recommended Procedures:

Dispatcher:

1. Tells RP and occupants to leave structure and meet FD *several* houses/buildings away from affected structure.

Fire Department Arrives:

2. FD meets with RP and obtains information:
   A. Confirm everyone is out.
   B. Size of leak (strong odor or slight).
   C. Possible location of leak.
   D. Construction or recent work done?
3. FD – parks/stages minimum two structure away address -
4. Confirms everyone is out.
5. In full PPE, in pairs have FF's check gas meter for "spinning gauges" if spinning-turn off meter.
6. If meter is spinning and strong odor of gas in area, evacuate surrounding structures.
7. If meter not spinning and no odor of gas, continue investigation around and inside structure with monitors.
8. After meter is turned off, keep everyone away, call Gas Company for response.
9. Wait for Gas Company to arrive before entering structure.
10. Use monitors when entering structure, paying attention to low points, i.e. basements, etc.
11. Ventilate to reduce gas concentration and monitor prior to allowing re-entry.

Aluminum Tanker Off-Loading Stinger Operations Guide

(updated Jan. 2020)
Prepared by
Santa Monica Fire Department

Aluminum Tanker Off-Loading Stinger Operations Checklist

	Task		Notes:
	1. Isolate and Deny Entry 1a. Perform Rescue as necessary.	____	Keep "ALL" people away from tanker. Only a minimum of required personnel should be allowed near the tanker to perform necessary duties.
	2. Foam Hose Lines, Dry Chemical Extinguisher and LEL Monitoring –Throughout incident	____	Staffed foam hose lines and dry chemical extinguishers should be positioned on both sides of the container. Utilize CGI to monitor area. Atmosphere must not be above **10% of the LEL**. Personnel should not be allowed to enter area until vapor suppression is carried out with foam
	3. Don proper PPE	____	Personnel must wear full protective gear. Members on the tanker drilling and sprayer/helper must have SCBA donned.
	4. Shutoff/close Emergency Shutoff Valve and disconnect batteries if safe to do so.	____	Be aware of Vapors
	5. Stop all leaks using best method available; ie; dome clamps, plugs, HazMat Football, tighten lose fittings, etc.	____	If there is a leak in the tanker and the compartment is punctured the leak will increase.
	6. Check spec. plate to ensure that the tank is aluminum before drilling	____	May also use magnet to verify.
	7. Pump off truck/vacuum truck should be clean and of sufficient capacity to handle load of tanker.	____	Pump off truck/vacuum truck should be kept minimum of 50' away.
	8. Stabilize the Tanker	____	The tanker may shift due to weight unbalance while tanker is being unloaded.
	9. Ground /Bond Tankers	____	Grounding rod should be minimum of 3' in ground. **1)** Ground tanker first then to grounding rod. **2)** Ground pumping truck next then to ground. **3)** Bond from tanker to pumping truck that is placed upwind and at safe distance (50' min).
	10. Test ground resistance	____	Clamps placed properly. Indicated reading should be **1000 ohms or less.**
	11. Apply foam to area to suppress vapors	____	Staffed foam lines on both sides of container with monitoring 360 degrees around tank.
	12. Place Ladders	____	Two ladders should be placed against the tank for access and egress; one on each side of the tank.
	13. Send in one person with drilling equipment	____	The driller climbs up first with drill hooked to air bottle and tested. Also takes a rubber mat to be placed on the tank
	14. Sprayer/Helper climbs up next	____	Brings up water sprayer for cooling the area being drilled. Also takes expandable plugs to plug holes.
	15. Safety equipment person stays on ground	____	Assist's with providing equipment to personnel on tanker
	16. Drill holes	____	The holes should be drilled in predetermined order and plugged after each hole is drilled.
	17. Utilize Stinger	____	Hook ground cable to tanker and stinger. Once the holes are drilled, the drill is replaced with the stinger and suction hose making sure all bonding and grounding is complete.
	18. Safety equipment person stays on ground	____	Assist's with providing equipment to personnel on tanker, ensure cables stay attached, check for hose kinks.
	19. Offload Fuel-Bond stinger to truck	____	Fuel removal should be done in the opposite order the holes were drilled. * One person should be assigned to the receiving truck with a radio to coordinate pumping operations.
	20. After the compartment is pumped out, plug the hole in the tank with plug	____	This will limit vapor production. Repeat as needed.
	21. When off-loading is complete, remove all tools and equipment from damaged tank and from around tank.	____	Plumbing of overturned tanker may contain 25-30 gallons of product.
	22. Upright Tanker with wrecker	____	Contact to monitor for safety issues, leaks, etc.
	23. Storm Drain and Runoff	____	Note: Consider sealing storm drains with plastic and/or using absorb.

Aluminum Tanker Off-Loading
Stinger Operations

Five Phase’s

1. Scene & Container Assessment

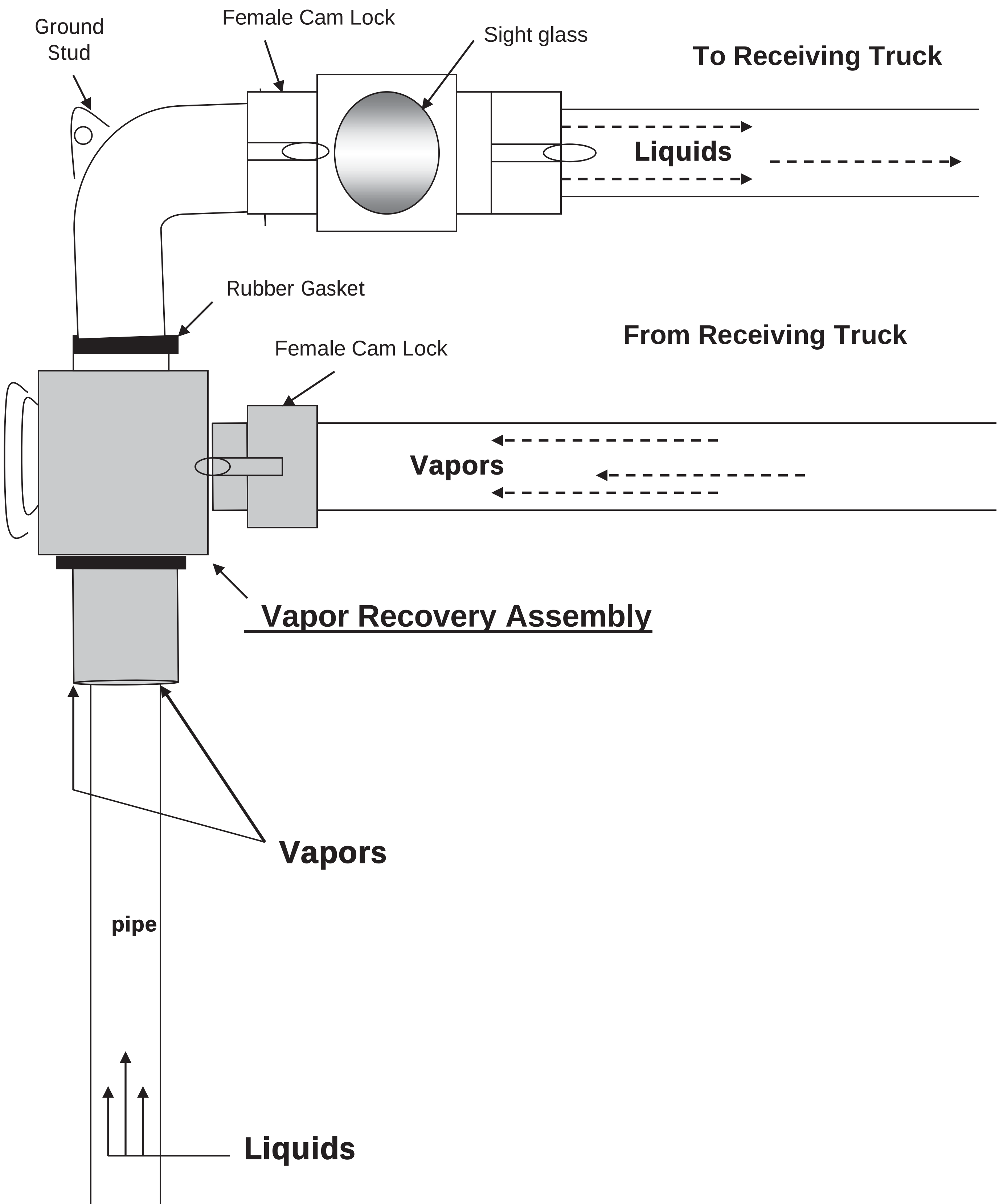
2. Leak Control & Vapor containment; Grounding and Container stabilization

3. Drilling Hot Tapping) & Plugging

4. Stinger Operations (Bonding; Off loading liquid & vapor)

5. Up-righting the container & plumbing drain.

Stinger suction unit



Grounding and Bonding

Grounding and bonding applications are necessary to effectively control the generation or conduction of static electricity. Static electricity occurs as an electric charge on the surface of an insulator (glass, rubber, plastic, etc.) or insulated conductive body (insulated metal). It is generated (meaning made free to act) through the expenditure of mechanical work: such as occurs when liquids are pumped through pipes or hoselines, agitated, or fall freely through the air. The generation of static electricity cannot be prevented absolutely, because it is present everywhere.

In order for static to be a source of ignition, four conditions must be fulfilled: [1]

1) There must first be an effective means of static generation,

2) There must be a means of accumulating the separate charges and maintaining a suitable difference of electrical potential,

3) There must be a spark discharge of adequate energy, and

4) The spark must occur in an ignitable mixture.

Proper grounding and bonding applications must be accomplished before product removal and transfer operations begin. This is necessary for any container, which contains flammable or combustible products (to include: flammable/combustible liquids, gases, solids, and dusts). This would also be necessary for products, which are not normally flammable but may give off flammable gases when contaminated, such as sulfuric acid. Sulfuric acid will give off hydrogen gas when heated or contaminated. Proper grounding and bonding, along with other proper control measures, will greatly minimize the hazards of a flash fire or explosion during any incident mitigation operations.

Definitions

Bonding: the process of connecting various pieces of conductive equipment together to keep them at the same electrical potential. Two pieces of equipment at the same potential eliminates or minimizes the chance of static sparking.

Grounding: is a special form of bonding in which conductive equipment is connected to the ground through an earthing electrode. This is done to minimize potential differences between objects and the ground.

Resistance:

The difficulty an electrical current encounters in passing through an electrical circuit or conductor. This resistance is measured with an ohm meter. *In hydraulics, the resistance to water passing through a pipe or hoseline is called friction loss and is measured in pounds lost in pressure over the length of the pipe or hoseline.* In electricity, resistance can be measured in terms of voltage drop over a part of the circuit but usually is measured in terms of ohms.

Ground Resistance Tester: measures the earth resistance to a ground rod.

Ohm meter: used to measure resistance, ensures continuity.

Procedure

Prior to performing any grounding and bonding procedures, detection and monitoring must be done to determine if the atmosphere is above the action level for the LEL (>10 % of the LEL). If the atmosphere is above the action level, then personnel should not be allowed to enter the area until vapor suppression is carried out by the application of the proper type of foam. Detection and monitoring must be continued throughout the course of the incident. The resistance of the cables to be utilized should be tested prior to use. To test the resistance, connect the ohm meter cables to each clamp of the grounding or bonding cable. The reading should be *0 ohms*. After conducting this test then proceed with the following steps: (the same procedure applies for tank trucks, rail cars, or drums)

Ground Damaged or Leaking Tank

a. Place grounding rod - place as far away as possible but within the reach of the cable.

b. Test ground resistance - tester calibrated, test ground resistance. The reading should be 1000 ohms or less.

c. Clamp Damage Tanker - proper placement so tanker is grounded (non-painted metal).

d. Clamp grounding rod – Good contact

e. Test resistance - test connection after making. The reading should be 1000 ohms or less.

Ground Receiving Tank

a. Place grounding rod - place as far away as possible but within reach of the cable.

b. Test ground resistance - tester calibrated, test ground resistance. The reading should be 1000 ohms or less.

c. Clamp Pump Off/Vacuum Truck - proper placement so tanker is grounded (Non-painted metal).

d. Clamp grounding rod – Good contact

e Test resistance - test connection after making. The reading should be 1000 ohms or less.

Bond between Damaged and Receiving Tanks

a. Clamp placed on Damaged Tank - good contact between tank and clamp.

b. Test resistance - test connection after making. The reading should be 1000 ohms or less.

c. Clamp placed on Receiving Tank - good contact between tank and clamp.

d. Test resistance - test connection after making. The reading should be 1000 ohms or less.

Safety Note:

After grounding and bonding are in place there should be a 5 minute delay before any work begins in order to allow for any static charge to be dissipated.

Any other equipment such as stingers or pumps to be used in transfer operations must also be properly grounded and/or bonded. Nothing should be introduced into a tank until it has been properly bonded and the charge allowed to dissipate.

After the transfer has been completed, the grounding and bonding equipment should be the last equipment to be removed. All domes and hoses should be closed or removed before disconnecting the grounding and bonding equipment.

Transferring –

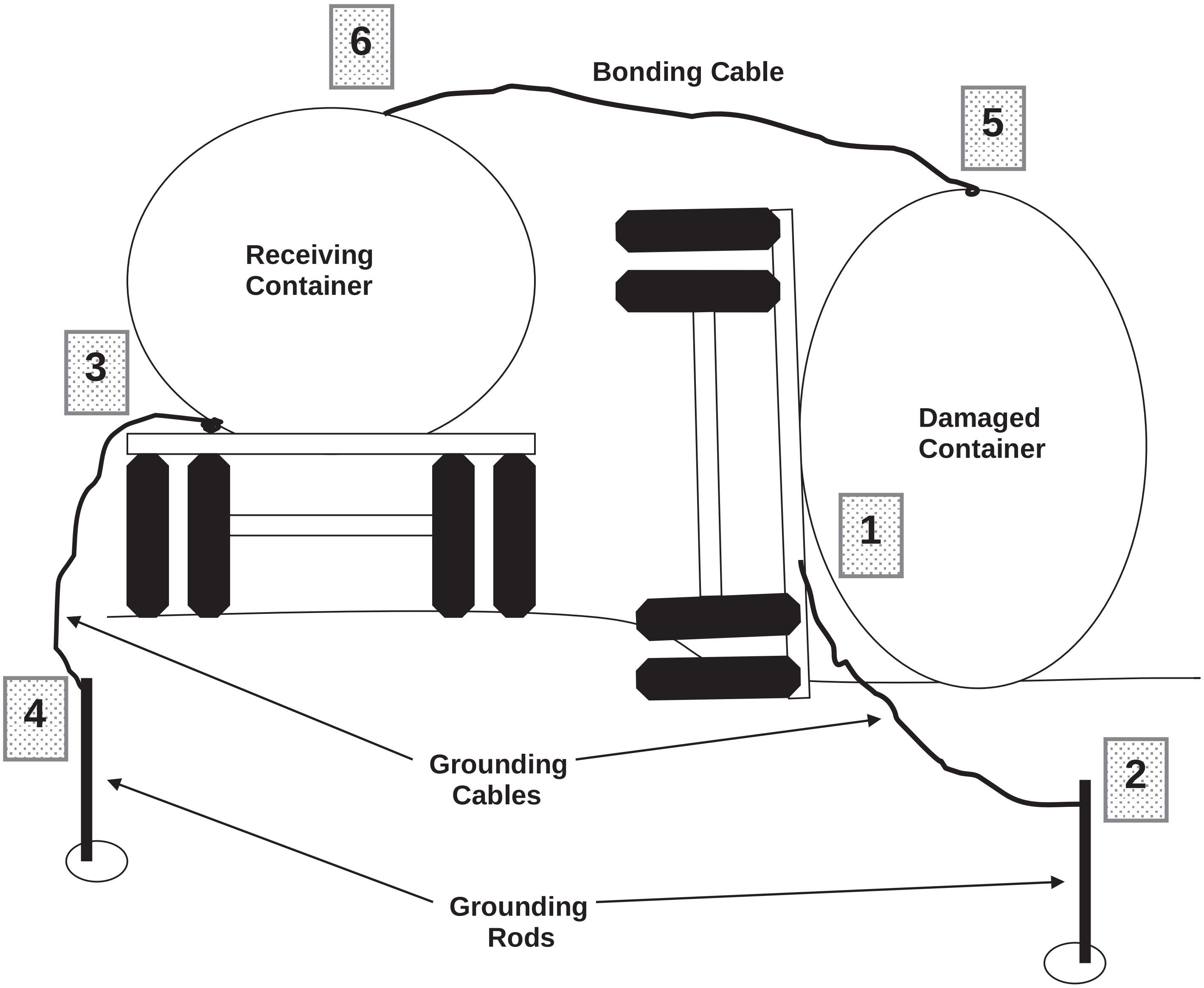
Each different type of container will present unique challenges if in need of transfer. This involves access to the material, controlled removal, and safe introduction into an acceptable container. Access to the material may involve opening valves, bungs, or creating a new access port. Transfer may involve basic mechanical methods such as pouring and the use of hand pumps. Advanced methods, such as power takeoff pumps, vacuum pumps, and air driven portable pumps, are generally employed on bulk containers.

****Specific attention must be given to static electricity, compatibility, vapor suppression and contamination of the product.**

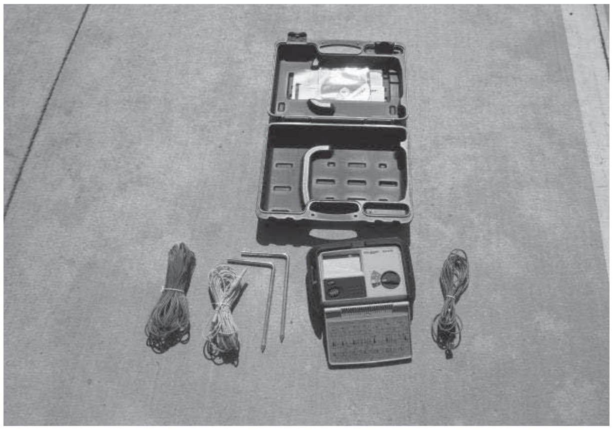
BONDING & GROUNDING CHECKLIST

1.	Ground Damaged Tank		Ground Damaged Tank
	a. Place ground rod	____	a. Place as far away as possible, but within reach of cable.
	b. Test ground resistance	____	b. Ground resistance tester checked and calibrated. Setup and tested according to manufacturer's recommendations. Indicated reading should be 1000 ohms or less.
	c. Clamp Tank	____	c. Proper placement so tank is grounded. Good contact between point and tank.
	d. Test Resistance	____	d. Ohm meter set correctly. Clamps placed properly. Indicated reading should be 1000 ohms or less.
	e. Clamp grounding rod	____	e. Placed low so it is applied in foam and then raised to top of rod.
	f. Test Resistance	____	f. Clamps placed properly. Indicated reading should be 1000 ohms or less.
2.	Ground Receiving Tank		Ground Receiving Tank
	a. Place grounding rod	____	a. Place as far away as possible but within reach of cable
	b. Test ground resistance	____	b. Setup and tested according to manufacturer's recommendations. Indicated reading should be 1000 ohms or less.
	c. Clamp Tank	____	c. Proper placement so tank is grounded. Good contact between point and tank.
	d. Test Resistance	____	d. Clamps placed properly. Indicated reading 1000 ohms or less.
	e. Clamp grounding rod	____	e. Placed low so it is applied in foam and then raised to top of rod (if foaming is necessary).
	f. Test Resistance	____	f. Clamps placed properly. Indicated reading should be 1000 ohms or less.
3.	Bond between Damaged and Receiving Tanks		Bond between Damaged and Receiving Tanks
	a. Clamp damaged tank	____	a. Proper placement so tank is bonded. Good contact between tank and point.
	b. Test Resistance	____	b. Clamps placed properly. Indicated reading should be 1000 ohms or less.
	c. Clamp receiving tank	____	c. Proper placement so tank is bonded. Good contact between tank and point.
	d. Test Resistance	____	d. Clamps placed properly. Indicated reading should be 1000 ohms or less.
4.	Delay before performing transfer		Delay before performing transfer
	***1000 ohms per NFPA 77 2014 ed.**		

Connection Order for Grounding and Bonding Cables



Ground Resistance Tester



Gounding & Bonding Using the Meeger Meter

1. Connect all three cables/wires to Megger Meter (Green/Yellow/Red).
2. Connect/plug-in red and yellow wires to small “L” shaped grounding rods (in kit) and run out entire length away from tanker, **parallel** to each other (yellow is shorter).
3. *Monitor area for flammable vapors.
4. Drive copper grounding rod into ground a minimum of 50” away from overturned/damaged tanker.
5. Hook 50’ cable to tanker (frame, not bolts or parts) and stretch to grounding rod but DO NOT connect yet.
6. Connect the Green wire to the copper grounding rod.
7. Turn Megger to the 3P position and push the test button - (have in the 25volt setting).
8. Reading should be 1000 ohms or less. If greater than 1000 ohms, drive another rod (and another if still <25 ohms) into ground approx. 40 feet from the first, in straight line without coils or bends in wire.
9. Once 1000 ohms or less is achieved, connect cable from tanker to first copper grounding rod.
10. Connect 50’ cable from offloading vehicle to damaged tanker.
11. Use 10’ cable to ground stinger to frame of damaged tanker.

Stabilize the Damaged Container before starting Operations

Stabilizing the container:

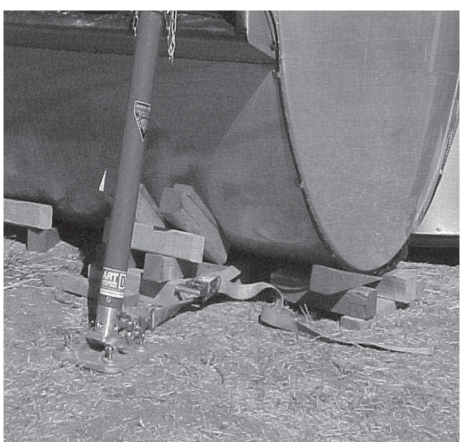
1. Creates a stable surface when work is being done on the top of the container.

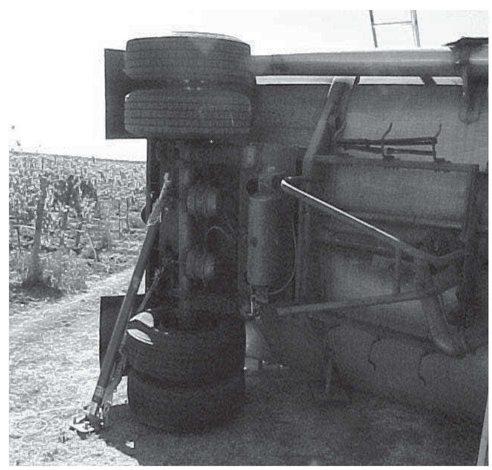
2. Minimizes movement of the container when the product load changes.

3. Must be assessed continuously when work is being done on the top of the container.

Cribbing
- Crib both sides of the container in the position found
- Crib front and/or rear (if needed)
- Assess constantly during drilling and transfer for loose cribbing

Manual or Air Struts
- Apply manual or air struts front and back on both sides (if they are available).
- This can be done with or without cribbing.





OFF-LOADING USING THE DRILLING METHOD

After the vehicle has been stabilized and all bonding and grounding has been completed off-loading procedures can be started.

Staffed foam hose lines should be positioned on both sides of the container and LEL monitoring should be continuous 360° around the tank.

Two ladders should be placed against the tank for access and egress; one on each side of the tank.

The driller climbs up first taking a rubber mat to be placed on the tank to stand on.

The sprayer/helper brings up the water sprayer for cooling down the area being drilled. The helper will also bring up enough expandable 4” pipe plugs and spark resistance tools to plug the holes.

The safety/equipment person on the ground will bring in the drill with the 4 1/8” hole saw (connected to the nitrogen cylinder and tested) to the driller.

The holes will be drilled in the order predetermined and plugged after each hole is drilled.

Once the holes are drilled, the drill is replaced with the stinger and suction hose, making sure all bonding and grounding is complete.

One person should be assigned to the receiving truck with a radio to coordinate pumping operations.

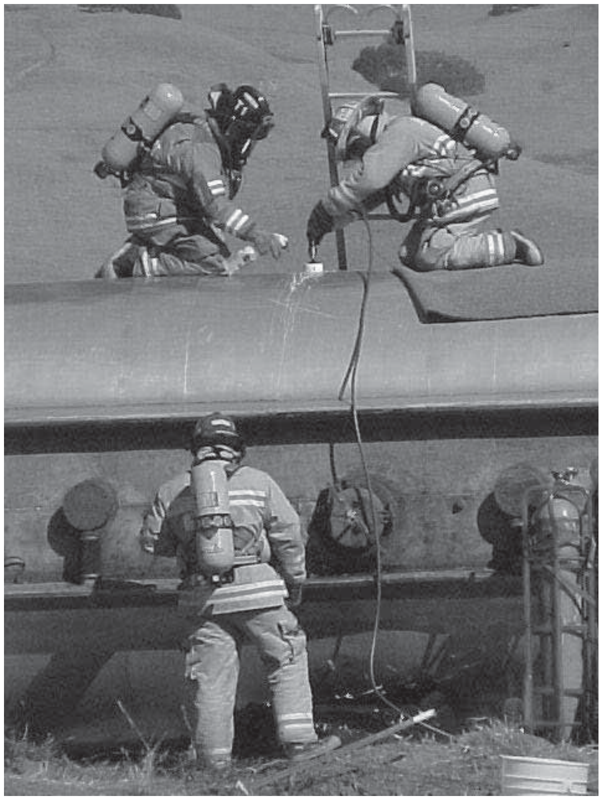
Fuel removal should be done in the opposite order the holes were drilled.

While transferring fuel from the damaged container to the receiving vehicle, cribbing and stabilizing equipment should be checked for adjustment and stability. This is an on-going process throughout the entire operation.
**Note: A Pony Pump may be required to assist fuel transfer.*

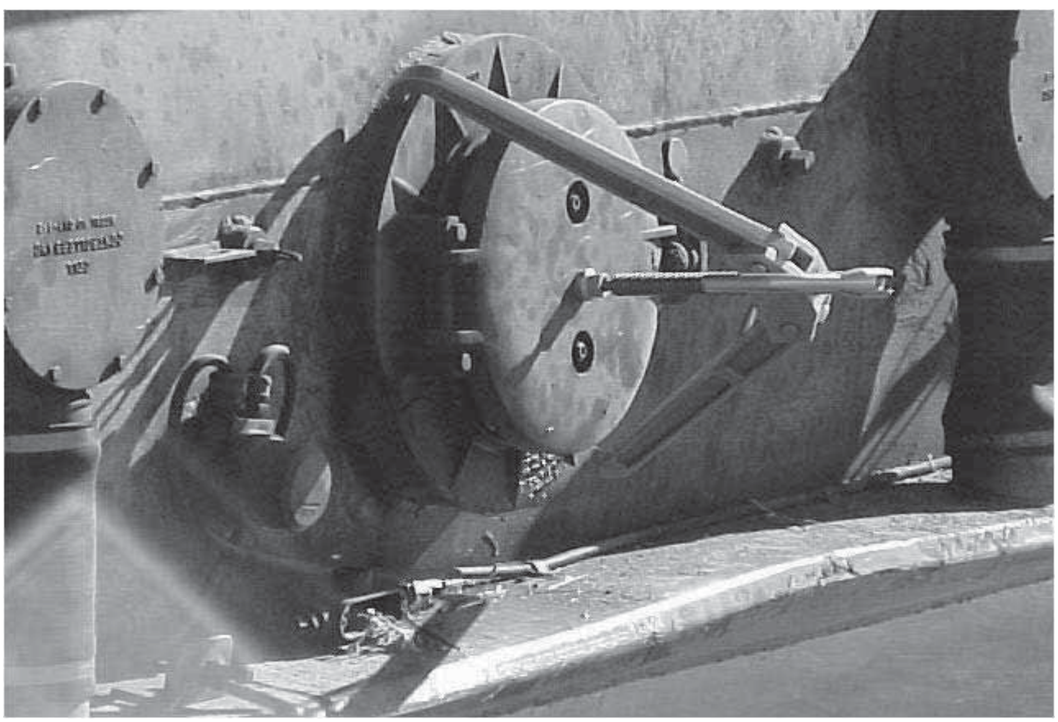
When off-loading is complete, all tools and equipment are removed from damaged tank and from around the tank.

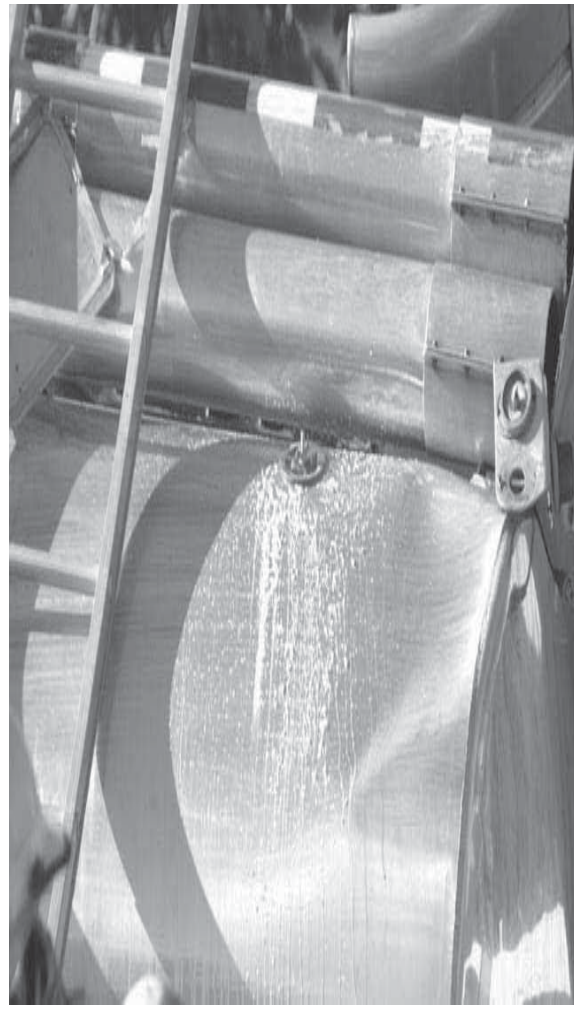
Drilling and Off-Loading Procedures

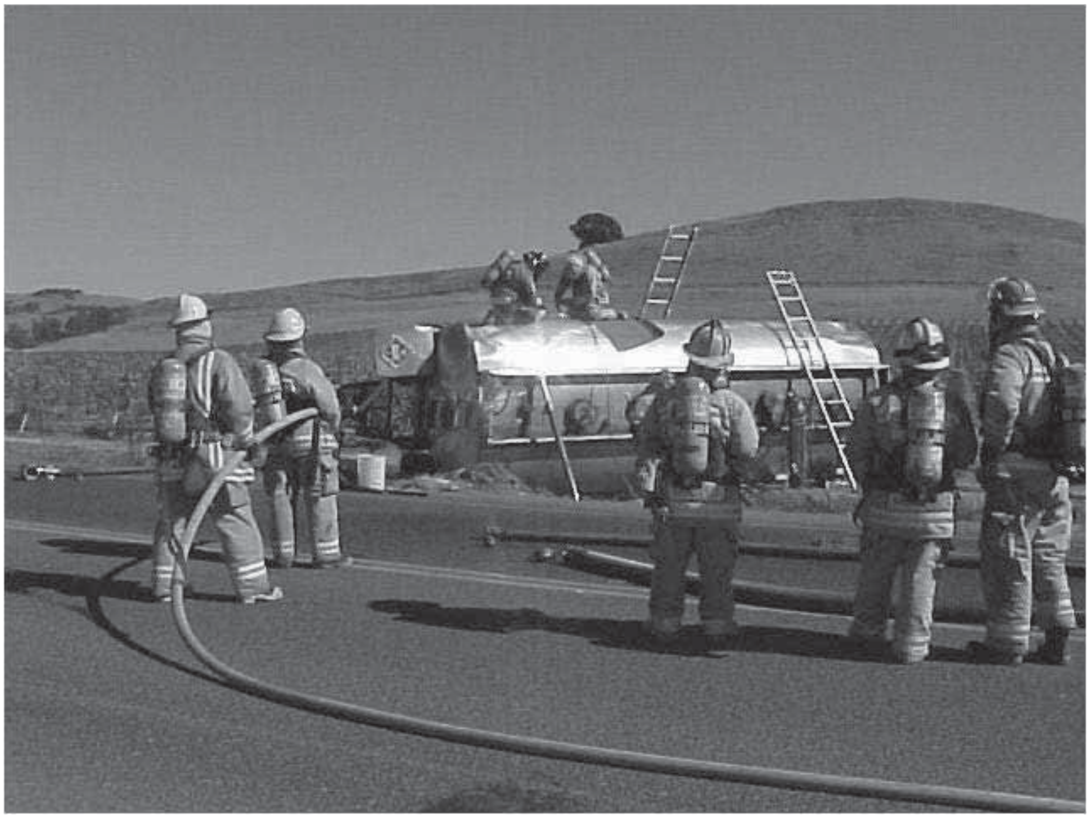
Drilling



Off-Loading







CHEMICAL SUICIDE GUIDANCE

DISPATCHERS ☠ FIRST RESPONDERS ☠ HAZ-MAT TEAMS ☠ MEDICAL PROFESSIONALS

	DETERGENT (HYDROGEN SULFIDE)	HABICHI (CARBON MONOXIDE)	PESTICIDE (BASED ON MALATHION)	CYANIDE (SODIUM & POTASSIUM CYANIDE SALTS INGESTED)	PHOSPHIDE (ALUMINUM OR ZINC PHOSPHIDE INGESTED)	AZIDES (SODIUM AZIDE INGESTED)
Dispatch Triage	Q:Do you feel ok? Q:Warning signs on vehicle/door? Q:Suicide note? Q:Do you smell rotten eggs? Q:Did you see any buckets or containers in the car with yellow liquids? Q:Were you able to read the container labels? Q; Do you see tape over vents, windows, door cracks Q: Wearing goggles or gloves?	Q:Do you feel ok? Q:Warning signs on doors? Q:Suicide note? Q:Did you see a small BBQ or Hibachi? Q: Did you see bags of charcoal? Q: Formic or sulfuric acid containers? Q:Chemical burns around the mouth? Q:Where is this occurring? Bathroom? Bedroom? Small space? Q:Gas cylinders in the area?	Q:Do you feel ok? Q:Warning signs on vehicle or doors? Q:Suicide note? Q:Do you smell a pesticide odor? Q:Skunky or garlic? Q: Pesticide containers? Q: Amber jars? Q: Words "Malathion" Q: Victim shaking, twitching, runny nose, vomiting	Q:Do you feel ok? Q:Warning signs on vehicle or doors? Q:Suicide note? Q: Smell of bitter almonds Q:Did you see any white powders Q:Sodium or potassium cyanide containers Note: Recent trend of CN suicide in courtrooms post guilty verdict	Q:Do you feel ok? Q:Do you have any eye irritation? Q:Warning signs on vehicle or doors? Q:Suicide note? Q: Smell of dead fish? Q:Did you see any gray tablets? Q:Rodent control containers? Q:Pictures of gophers on containers Q:Name: Phostoxin	Q:Do you feel ok? Q:Warning signs on vehicle or doors? Q:Suicide note? Q: Pungent smell? Q:Did you see any white powders? Q:Name: Sodium azide?
First Responder	-Approach from uphill/upwind -Set a 150' perimeter -Eliminate ignition sources -Interview all witnesses -Secure HVAC at building -If H_2S is suspected do no open the vehicle doors, initiate a hazmat call -Use a public address system to - communicate with victim/sirens -If odors are being detected down wind issue a shelter in place order. -Notify area hospitals of possible self-transports-dorm rooms/hotel	- Approach from uphill/upwind -Evacuate building in FFTO -Set a 150' perimeter -Eliminate ignition sources -Secure HVAC -Interview all witnesses -If CO suicide is suspected initiate a hazmat call -Use TIC to evaluate heat signature	- Approach from uphill/upwind -Evacuate building in FFTO -Set a 150' perimeter -Eliminate ignition sources -Secure HVAC -Interview all witnesses -Be careful of spilled pesticides and contaminated vomit -These victims are often alive on arrival -If transported: Emergency decon, transport in open vehicle if possible, wear tyvek with APR, be prepared for contaminated vomit. See below.	- Approach from uphill/upwind -Evacuate building in FFTO -Set a 300' perimeter -Eliminate ignition sources -Secure HVAC -Interview all witnesses -If CN suicide is suspected initiate a hazmat call -Notify area hospitals of possible self transports-dorm rooms/hotel	- Approach from uphill/upwind -Evacuate building in FFTO -Set a 300' perimeter -Eliminate ignition sources -Secure HVAC -Interview all witnesses -If aluminum/zinc phosphide suicide is suspected initiate a hazmat call -Notify area hospitals of possible self transports-dorm rooms/hotel	- Approach from uphill/upwind -Evacuate building in FFTO -Set a 300' perimeter -Eliminate ignition sources -Secure HVAC -Interview all witnesses -If sodium azide suicide is suspected initiate a hazmat & bomb squad call
Haz-Mat Teams	-Recon in FFTO & SCBA -Look for secondary devices -Monitor with 4-gas/H_2S sensor, PID -Ensure perimeter is suitable for wind conditions -Ventilate vehicle for 15 min. -Ensure the vented gases are not impacting other populated areas -Re-monitor vehicle to ensure safe levels of H_2S -Wait for medical examiner to document scene if deceased -Decon body at ME request only -Remove containers in level "B" CPC -Neutralize with fast set concrete -Decontaminate the vehicle -Neutralized acids with concrete can be treated as solid waste according to study data.	-Recon in FFTO & SCBA -Look for secondary devices -Monitor with 4-gas/CO sensor -If high levels of CO still present begin ventilation -Do not use gas powered fans as they will generate more CO -Ensure the vented gases are not impacting other populated areas -Mitigate BBQ/Hibachi -If acids present: check area for spilled acids using pH paper -Wait for medical examiner to document scene if deceased -Neutralize any spilled acids with soda ash -Containerize remaining acids for disposal	-Recon in level "B" CPC -Look for secondary devices -Monitor with 4-gas & PID -Begin ventilation if needed -Do not use gas powered fans as they will generate CO -Ensure the vented gases are not impacting other populated areas -Mitigate any spilled pesticides with absorbent and containerize -Ensure the scene is safe for other personnel to enter in street clothes -Wait for medical examiner to document scene if deceased -If victim is transported ensure they are decontaminated, transported in open air vehicle if possible. Place in a negative pressure room. DO NOT bring the container into the ER.	-Recon in level "B" CPC-flash suit -Look for secondary devices -Monitor with 4-gas, colorimetric tubes/chips, CN specific sensor -Monitor deceased for continued CN gas production, isolate if off gassing. -Begin ventilation if needed -Do not use gas powered fans as they will generate CO -Ensure the vented gases are not impacting other populated areas -Ensure the scene is safe for other personnel to enter in street clothes -Wait for medical examiner to document scene if deceased -If victim is transported ensure they are treated outside or in negative pressure room. DO NOT bring the container into the ER.	-Recon in FFTO & SCBA -Look for secondary devices -Monitor with phosphine sensor, 4-gas, PID*, tubes/chips -Monitor deceased for continued phosphine production -If high levels of phosphine still present begin ventilation and isolate victim -Do not use gas powered fans as they will generate more CO -Ensure the vented gases are not impacting other populated areas -Containerize aluminum/zinc phosphide to prevent moisture absorption -Wait for medical examiner to document scene if deceased -If victim is transported ensure they are treated outside or in negative pressure room. DO NOT bring the container to the ER.	Combination level "B" CPC/flash suit. -Look for secondary devices -Monitor with standard equip but pH paper will be key for acids generated -Monitor deceased for continued hydrazoic acid production (Acetic acid Drager tube) -If acid is present begin ventilation and isolate victim -Do not use gas powered fans as they will generate more CO -Ensure the vented gases are not impacting other populated areas -Containerize sodium azide -Wait for medical examiner to document scene if deceased -If victim is transported ensure they are treated outside or in negative pressure room. DO NOT bring the container to the ER.

Resources utilized: NIOSH Pocket Guide, ATSDR, TOXNET. IDLH = Immediately Dangerous to Life & Health, FFTO = Firefighter Turnouts, OSHA C= Ceiling, SCBA=Self Contained Breathing Apparatus V2015.2

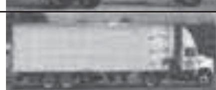
CHEMICAL SUICIDE GUIDANCE

DISPATCHERS ☠ FIRST RESPONDERS ☠ HAZ-MAT TEAMS ☠ MEDICAL PROFESSIONALS

	DETERGENT (HYDROGEN SULFIDE)	HABICHI (CARBON MONOXIDE)	PESTICIDE (BASED ON MALATHION)	CYANIDE (SODIUM & POTASSIUM CYANIDE SALTS INGESTED)	PHOSPHIDE (ALUMINUM OR ZINC PHOSPHIDE INGESTED)	AZIDES (SODIUM AZIDE INGESTED)
Indicators/Red Flags	Warning signs on window, suicide note, rotten egg odor, buckets with yellow liquids, acid & pesticide containers	Warning signs, suicide note, small BBQ, Hibachi grill, formic acid, sulfuric acid	Warning signs, suicide note, pesticide containers, skunk/garlic odor, amber containers	Warning signs, suicide note, Bitter almond odor, sodium or potassium cyanide containers, white powders	Warning signs, suicide note, eye irritation, fishy/garlic smell, gray round pellets, rodent control containers	Warning signs, suicide note, pungent odor, sodium azide container, white crystals,
Chemical Description	Colorless toxic flammable gas with sewer gas odor (Rotten eggs)	Colorless, odorless flammable gas	Deep-brown to yellow liquid with a skunk/garlic like odor.	Colorless toxic flammable gas	Colorless toxic flammable gas	Colorless to white, odorless, crystalline solid. Hydrazoic acid is produced when ingested.
Odor	Rotten egg odor	None	Pungent-skunky	Bitter almonds	Fish or garlic odor	Pungent/obnoxious (Hydrazoic acid)
Odor Threshold Warning Properties	<1 ppm (Good warning properties) (Sense of smell lost at >100 ppm)	None	13.5 mg/m3 (0.99 ppm-Good warning properties)	0.58 ppm (Genetic trait ~40% population can smell HCN)	0.15 ppm (poor warning properties, by the time you smell it you are near toxic levels)	A severe irritant to skin, eyes, and mucous membranes.
Evacuation & Isolation Distance	If the suicide incident occurs indoors consider immediate evacuation of the building, toxic/flammable gases may be carried throughout the structure					
	150 Feet based on study data	150 Feet	150 Feet	150 Feet	150 Feet	150 Feet
Flammability	YES- Flammable range 4 - 40% Eliminate ignition sources *Study data indicates atmosphere will not be flammable in a small car*	YES- Flammable range 12.5 - 74% Eliminate ignition sources *Incomplete combustions will produce toxic but not normally flammable environments*	NO- Combustible carrier (Xylene/Toluene) Flash point at or above 200°F., may be difficult to ignite	YES- Flammable range 5.6 - 40% *Suicide victims may off gas Hydrogen Cyanide gas from the stomach at toxic but not normally flammable levels*	YES- Flammable range 1.79 - ?% *Suicide victims will continually off gas phosphine until the product is fully reacted. Previous incidents: 112 ppm exhaled from victim (2 x IDLH values. Not flammable at this concentration)*	No- Combustible Solid if heated above 572°F, also forms explosive salts on contact with metals
PPF First Responders	First Responders should don Firefighter Turnouts and SCBA for: recon; victim triage/assessment/treatment. Avoid contact with all chemical containers, contamination. Be advised victim vomiting is source of ongoing contamination.					
PPE Hazmat Teams	-Firefighter Turnouts for recon -Level B CPC for chemical handling & neutralization of spent mixture	Firefighter Turnouts	Level B CPC	Combination level "B" CPC/flash suit.	Firefighter turnouts	Level "B" CPC/flash suit Absorption by skin may readily exceed vapor inhalation exposure
Instrumentation	-Low conc. 4-Gas with H2S Sensor -High conc. PID RAE Correction Factor 3.3 Colorimetric tube: H2S 0.2-7% Lead Acetate Paper & PH Paper	4-Gas meter with CO sensor Typically max out at 500 ppm	4-Gas Photo ionization detector M9 paper	Cyanide specific sensor (WMD Instruments) Colorimetric tubes: HCN PH Paper, low ph ~2	Phosphine sensor Phosphine colorimetric tubes/chips 4-Gas Photo ionization detector(Coats lamp)	pH paper for Hydrazoic acid Acetic acid drager tube is cross sensitive
Toxicity	Lethal 800-1000 ppm IDLH 100 PPM, Fed OSHA C20 PPM Extremely lethal method, typically body recovery	Lethal 12,800 ppm @ 3 min IDLH 1200 ppm Fed OSHA PEL 50 ppm Lethal method, typically body recovery	IDLH 250 mg/m3 OSHA PEL 15 mg/m^3 [skin] Xylene=OSHA PEL 100 ppm, IDLH Toluene=OSHA PEL 200 ppm,IDLH 500 Victims often survive event	3500 ppm lethality/1 min. IDLH 50 ppm OSHA PEL 10 ppm [skin] Fatal dose1.5 mg/kg body wt. Extremely lethal - typically body recovery	IDLH 50 ppm NIOSH ST 1 ppm OSHA PEL 0.3 ppm Extremely lethal, may be alive for hours after ingestion	NIOSH REL C 0.1 ppm (as HN_3) [skin] C 0.3 mg/m^3 (as NaN_3) [skin] Lethal method. Rare method but typically body recovery
Deceased Skin Color	Grayish to green	Red	No change	Pink/mauve	Blue or purple	NA
Molecular Weight / RgasD/Vapor Pressure	This is a gas that will mix with air Gas density 1.19 (Air =1)	This is a gas slightly lighter than air Gas density 0.97 (Air=1)	Vapor pressure is very low 0.00004 mm/Hg (Slug, but stinks!)	Vapor pressure 630 mm/Hg Almost a true gas up and around you, slightly lighter than air.	This gas will mix with air, slightly heavier than air. Gas density 1.18 (Air=1)	This will be up and around you 484 mm/Hg
Symptoms	Coma, convulsions, dizziness, headache, lassitude, irritability, insomnia; death Eyes: discomforting to the eyes. Skin: Little effect on the skin.	Headache, nausea, weakness, exhaustion, dizziness, confusion, cyanosis, death	SLUDGE symptoms, blurred vision, nausea, vomiting, abdominal cramps, dizziness, confusion; chest tightness, wheezing	Coma with seizures, apnea and cardiac arrest, with death in minutes, death	Eye irritation - Nausea, vomiting, abdominal pain, diarrhea; thirst; chest tightness, muscle pain, chills; stupor, pulmonary edema; death	Irritation eyes, skin; headache, dizziness, lassitude (weakness, exhaustion), blurred vision; low blood pressure, bradycardia; kidney changes
Emergency Decontamination	Remove clothes emergency decon with water and soap if necessary for solids	Fresh air, gas will dissipate	Must decontaminate prior to transport, soap & water. Be prepared for victim vomiting which will lead to recontamination.	Gas will dissipate, remove clothes Decon with Soap and Water if contaminated,	Fresh air, gas will dissipate. Strip clothes	Remove clothes, dry decon as much as possible. Caution: Azides produce Hydrozoic Acids on contact with water Sol. 42%.
Transport & ER Considerations	Lower Risk- Monitor for Hydrogen Sulfide prior to transport.	Lower Risk-If needed monitor for Carbon Monoxide prior to transport.	High Risk- Victims may vomit in route causing contamination of responders/ambulance. Off gassing from internal contamination may be an issue.	High Risk- Victims may vomit in route causing contamination of responders/ambulance. Off gassing from internal contamination may be an issue.	High Risk- Victims may vomit in route causing contamination of responders/ambulance. Off gassing from internal contamination may be an issue.	High Risk- Victims may vomit in route causing contamination of responders/ambulance. Off gassing from internal contamination may be an issue.
	Victim Clothing- is a source of ongoing contamination. Contaminated clothing should not be taken into the ambulance or ER. Separate clothing from valuables, bag separately and have Hazmat monitor prior to returning to victim. V2015.2					

Industrial Emergency Council (650) 508-9008 www.iectraining.org

Improvised Explosive Device (IED) Safe Standoff Distance Cheat Sheet

	Threat Description		Explosives Mass[1] (TNT equivalent)	Building Evacuation Distance[2]	Outdoor Evacuation Distance[3]
High Explosives (TNT Equivalent)		Pipe Bomb	5 lbs 2.3 kg	70 ft 21 m	850 ft 259 m
		Suicide Belt	10 lbs 4.5 kg	90 ft 27 m	1,080 ft 330 m
		Suicide Vest	20 lbs 9 kg	110 ft 34 m	1,360 ft 415 m
		Briefcase/Suitcase Bomb	50 lbs 23 kg	150 ft 46 m	1,850 ft 564 m
		Compact Sedan	500 lbs 227 kg	320 ft 98 m	1,500 ft 457 m
		Sedan	1,000 lbs 454 kg	400 ft 122 m	1,750 ft 534 m
		Passenger/Cargo Van	4,000 lbs 1,814 kg	640 ft 195 m	2,750 ft 838 m
		Small Moving Van/ Delivery Truck	10,000 lbs 4,536 kg	860 ft 263 m	3,750 ft 1,143 m
		Moving Van/Water Truck	30,000 lbs 13,608 kg	1,240 ft 375 m	6,500 ft 1,982 m
		Semitrailer	60,000 lbs 27,216 kg	1,570 ft 475 m	7,000 ft 2,134 m
	Threat Description		**LPG Mass/Volume[1]**	**Fireball Diameter[4]**	**Safe Distance[5]**
Liquefied Petroleum Gas (LPG - Butane or Propane)		Small LPG Tank	20 lbs/5 gal 9 kg/19 l	40 ft 12 m	160 ft 48 m
		Large LPG Tank	100 lbs/25 gal 45 kg/95 l	69 ft 21 m	276 ft 84 m
		Commercial/Residential LPG Tank	2,000 lbs/500 gal 907 kg/1,893 l	184 ft 56 m	736 ft 224 m
		Small LPG Truck	8,000 lbs/2,000 gal 3,630 kg/7,570 l	292 ft 89 m	1,168 ft 356 m
		Semitanker LPG	40,000 lbs/10,000 gal 18,144 kg/37,850 l	499 ft 152 m	1,996 ft 608 m

[1] Based on the maximum amount of material that could reasonably fit into a container or vehicle. Variations possible.
[2] Governed by the ability of an unreinforced building to withstand severe damage or collapse.
[3] Governed by the greater of fragment throw distance or glass breakage/falling glass hazard distance. These distances can be reduced for personnel wearing ballistic protection. Note that the pipe bomb, suicide belt/vest, and briefcase/suitcase bomb are assumed to have a fragmentation characteristic that requires greater standoff distances than an equal amount of explosives in a vehicle.
[4] Assuming efficient mixing of the flammable gas with ambient air.
[5] Determined by U.S. firefighting practices wherein safe distances are approximately 4 times the flame height. Note that an LPG tank filled with high explosives would require a significantly greater standoff distance than if it were filled with LPG.

Response to a Butane Honey Oil Labs

Response to a BHO-related explosion without fire

- Secondary explosions are possible. Keep the number of exposed personnel to a minimum.
- Ensure HazMat Unit and Law is included in response.
- Secure electrical and gas utilities.
- Natural ventilation methods are preferred over mechanical (i.e., positive pressure) methods whenever possible.
- Establish a two-out team before any personnel makes entry.
- Make entry in full PPE and SCBA on air.
- *Using a four-gas monitor, check for the presence of ignitable gases within Butane's explosive range (1.8–8.4 percent). Butane is heavier than air (2.0-2.4), so monitoring should occur low to the ground – below knees.*
- Extinguish any smoldering fire and secure all possible ignition sources in the affected area.
- Search for and remove victims.
- Treat patients and transport as appropriate.

Response to a BHO-related explosion with fire

- As soon as evidence indicating a butane hash lab is observed, ensure that all responding personnel and the dispatch center are notified.
- Ensure HazMat Unit is included in response.
- Broadcast an emergency alert tone notifying personnel of the hazard (due to possibilities of unexploded Butane cylinders).
- Stop/stage apparatus at first sign of debris field unless life hazard exists.
- As appropriate, conduct a primary search.
- Once the primary search is complete or if the risk-benefit analysis indicates it is unsafe to search, transition to defensive operations.
- Secondary search should include surrounding area for victims.
- Offensive operations may occur in nearby residences or attached exposures, if evidence of structural compromise is absent.
- Ensure law enforcement is notified for crime scene investigation.

Hazardous Materials Team Orientation Checklist

Name____
Last First

Assignment____________________
Platoon Assignment

Objective/Topic	Date Completed	Signature (Haz Mat Captain)
Overall Equipment Placement/ Use & Awning Deployment		
In-Suit Communication Equipment		
HM Unit Command Area: 1. HM Forms 2. Computer Programs 3. Fax/Cell Phones/Radios 4. Reference Books & Guides	____ ____ ____ ____ ____	____ ____ ____ ____ ____
Montiors/Operation: 1. 4-5 Gas 2. Tubes & Chips 3. Radiological 4. Halon Detector 5. CO Monitor 6. Bio 7. Mercury Spill Kit 8. Weather Station 9. WMD – A. ______________ B. ______________ C. M8/9 & M256	____ ____ ____ ____ ____ ____ ____ ____ ____ ____ ____	____ ____ ____ ____ ____ ____ ____ ____ ____ ____ ____
Decon Equip. – Location & Inventory		
Power – Generator & Shorelines		

Lab Area: HazCat & Reagents		
Suits – Types & Uses 1. Donning & Doffing 2. Rescue Sked		
Edwards & Crowell / Pipe Repair Kit / Drum Kit / Bonding & Grounding		
Handling Common HM Alarms: 1. Paint Spills 2. Abandoned oil & paint cans 3. Abandoned Drums 4. Unknown Powder Calls		
When to Make Notifications: 1. Health Haz Mat 2. Agriculture 3. Cal OES/State Warning Center 4. Code Enforcement 5. Waste Water		
HM Unit Operations: 1. Driving/Cab Area 2. Daily Check 3. Weekly Check		
Utility Equip. & Operation: 1. Lift Gate 4. Drum Dolly 5. 55 gallon Vacuum 6. Combustible Liq. Pump		
HM Inc. Layout: 1. Tarps & Weights to hold down tarps 2. Chairs 3. Perimeter tape 4. Rehab-H2O, Medical Equip.		

Haz Mat Group Positions *(Students must perform a minimum of 3 positions)*

Student Name: ____
Department/Agency_________________________ Begin Date:__________ End Date:__________

Position	Date Performed	Duties Performed	Comments
Incident Commander			
Haz Mat Group Supervisor			
Entry Team Leader			
Decon Leader			
Assistant Safety Officer			
Decon/Entry Team Member			
Tech./Ref.			
Site Access			
Safe Refuge			
Medical Monitoring			
Scribe-214			

Score 1-5

Scenario #

Instructor Names:____