



**OSHAcademy**<sup>TM</sup>  
Occupational Safety & Health Training

# Demolition Safety

Demolition work involves many of the same hazards associated with construction work. However, demolition also poses additional hazards. This course includes information on demolition safety and the elements of a demolition safety program, as detailed in 29 CFR 1926, Subpart T Demolition.

This page intentionally blank

# OSHAcademy Course 815 Study Guide

## Demolition Safety

Copyright © 2017 Geigle Safety Group, Inc.

No portion of this text may be reprinted for other than personal use. Any commercial use of this document is strictly forbidden.

Contact OSHAcademy to arrange for use as a training document.

This study guide is designed to be reviewed off-line as a tool for preparation to successfully complete OSHAcademy Course 815.

Read each module, answer the quiz questions, and submit the quiz questions online through the course webpage. You can print the post-quiz response screen which will contain the correct answers to the questions.

The final exam will consist of questions developed from the course content and module quizzes.

We hope you enjoy the course and if you have any questions, feel free to email or call:

OSHAcademy

15220 NW Greenbrier Parkway, Suite 230

Beaverton, Oregon 97006

[www.oshatrain.org](http://www.oshatrain.org)

[instructor@oshatrain.org](mailto:instructor@oshatrain.org)

+1 (888) 668-9079

### Disclaimer

This document does not constitute legal advice. Consult with your own company counsel for advice on compliance with all applicable state and federal regulations. Neither Geigle Safety Group, Inc., nor any of its employees, subcontractors, consultants, committees, or other assignees make any warranty or representation, either express or implied, with respect to the accuracy, completeness, or usefulness of the information contained herein, or assume any liability or responsibility for any use, or the results of such use, of any information or process disclosed in this publication. GEIGLE SAFETY GROUP, INC., DISCLAIMS ALL OTHER WARRANTIES EXPRESS OR IMPLIED INCLUDING, WITHOUT LIMITATION, ANY WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. Taking actions suggested in this document does not guarantee that an employer, employee, operator or contractor will be in compliance with applicable regulations. Ultimately every company is responsible for determining the applicability of the information in this document to its own operations. Each employer's safety management system will be different. Mapping safety and environmental management policies, procedures, or operations using this document does not guarantee compliance regulatory requirements.

Revised: March 13, 2018

This page intentionally blank

**Contents**

Course Introduction ..... 1

Module 1 – Demolition Basics Program Elements..... 2

    Demolition Defined..... 2

    Demolition Safety Program..... 2

    Contractor Preparation ..... 2

    The Safety Report ..... 3

    The Engineering Survey ..... 3

    The Engineering Survey Report ..... 4

    Locating Utilities..... 5

    Training ..... 6

    Module 1 Quiz..... 7

Module 2 – Fire Prevention, Medical Services and Security ..... 8

    Formal Fire Prevention and Protection Plan ..... 8

    Heating devices..... 8

    Smoking..... 9

    Roadways ..... 9

    Storing Materials..... 9

    Control Center..... 9

    Access..... 9

    Water Supply..... 10

    Fire Extinguishers ..... 10

    Alarms ..... 10

    Medical Services, First Aid, and Security ..... 10

Medical Services .....	10
First Aid .....	11
Security .....	11
Module 2 Quiz.....	12
Module 3 – Hazards Associated with Building Demolition.....	13
Hazardous Materials .....	13
Primary Hazards .....	13
Primary Types of Accidents.....	14
Structural Instabilities .....	14
Unsecured Hazard in the Work Area .....	15
Utilities .....	15
Assessing for Hazardous Substances .....	15
Eliminating Hazardous Substances .....	16
Walkways and Access .....	16
Illumination .....	16
Safe Work Practices When Working in Confined Spaces .....	16
Module 3 Quiz.....	18
Module 4 - Demolition of Pre-Stressed Concrete Structures.....	20
“Pre-stressed Concrete” Defined.....	20
Pre-stressed Concrete Structures .....	20
Categories of Pre-Stressed Construction .....	21
Pre-tensioned Members .....	21
Precast Units Stressed Separately .....	22
Monolithic Structures .....	22

Progressively Pre-Stressed Structures .....	22
Module 4 Quiz.....	23
Module 5 – Special Structures Demolition .....	25
Inspection and Planning.....	25
Safe Work Practices .....	25
More Safe Work Practices .....	26
Demolition by Deliberate Collapse .....	27
Using Explosives .....	27
Module 5 Quiz.....	28
Module 6 – Removing Debris and Cleanup .....	30
Dropping Construction Debris .....	30
Removing Walls and Masonry Sections .....	31
Module 6 Quiz.....	33
Module 7 – Controlling Asbestos Exposure .....	35
What is Asbestos?.....	35
Asbestos Health Hazards .....	35
Hazard Location .....	35
Reducing Asbestos Hazards .....	36
Exposure Limits .....	36
Training .....	37
Module 7 Quiz.....	39
Module 8 – Controlling Lead Exposure.....	41
Exposure to Lead.....	41
Permissible Exposure .....	41

Health Effects of Lead Exposure .....	41
Personal Hygiene for Exposure to Lead Dust.....	42
Hazard Controls for Lead .....	43
Respiratory Protection .....	43
Lead Safety Training.....	44
Module 8 Quiz.....	45
Module 9 – Controlling Silica Exposure .....	47
Exposure to Silica .....	47
Silicosis Symptoms .....	47
How Silica is Generated .....	47
Visible and Respirable Dust .....	48
Exposure Limits .....	48
Collecting an Air Sample .....	49
Controlling Exposure.....	49
More Best Practices .....	50
Training .....	50
Module 9 Quiz.....	52
Endnotes .....	53

## Course Introduction

From 2009 to 2013, OSHA issued nearly 1,000 citations for violations of OSHA's construction demolition standards.

The American National Standards Institute (ANSI) in its ANSI A10.6-1983 - Safety Requirements For Demolition Operations states:

*"No employee shall be permitted in any area that can be adversely affected when demolition operations are being performed. Only those employees necessary for the performance of the operations shall be permitted in these areas."*

"Demolition workers face many hazards and their lives should not be sacrificed because of deliberate neglect of demolition fundamentals," said Assistant Secretary of Labor for Occupational Safety and Health Dr. David Michaels. "Employers must ensure that all workers involved in a demolition project are fully aware of hazards and safety precautions before work begins and as it progresses."

Demolition work involves many of the same hazards associated with construction work. However, demolition also poses additional hazards due to unknown factors such as: deviations from the structure's original design, approved or unapproved modifications that altered the original design, materials hidden within structural members, and unknown strengths or weaknesses of damaged materials.

To counter these unknowns, all personnel involved in a demolition project need to be fully aware of these types of hazards and the safety precautions available to control these hazards. This Safety & Health course includes information on demolition safety and the elements of a demolition safety program, as detailed in 29 CFR 1926, Subpart T – Demolition.

Watch this interesting [video](#) on demolition by the Iowa Department of Transportation.

## Module 1 – Demolition Basics Program Elements

### Demolition Defined

Demolition is the dismantling, razing, destroying or wrecking of any building or structure or any part thereof. The method most widely used in building demolition is called mechanical demolition, which involves the use of specialized equipment such as excavators equipped with tools for crushing concrete and shearing steel.

High-rise structures may be brought down using implosion methods using specialized explosives. Finally, specialized demolition may require the use of hand-held pneumatic, hydraulic and electrical power tools to break up, cut, chip, and drill on smaller projects.

### Demolition Safety Program

To combat the hazards associated with demolition work, it is important that the employer establish an effective Demolition Safety Program. Everyone at a demolition worksite must be fully aware of the hazards they may encounter and the safety precautions they must take to protect themselves and their employees.

### Contractor Preparation

Before the start of every demolition job, the demolition contractor should take a number of steps to safeguard the health and safety of workers at the job site.

These preparatory operations involve the overall planning of the demolition job, including:

- ) the methods to be used to bring the structure down
- ) the equipment necessary to do the job
- ) the measures to be taken to perform the work safely

The contractor should also plan for:

- ) the wrecking of the structure
- ) the equipment to do the work
- ) manpower requirements
- ) the protection of the public

The safety of all workers on the job site should be a prime consideration.

### **The Safety Report**

The development of a safety report specific to the demolition project is critical to planning the project. The safety report should include, but is not limited to, the following components:

- ) an engineering survey completed by a competent person before any demolition work takes place (including the condition of the structure and the possibility of an unplanned collapse)
- ) locating, securing, and/or relocating any nearby utilities
- ) fire prevention and evacuation plan
- ) emergency, first aid and security services
- ) an assessment of health hazards completed before any demolition work takes place.
- ) training requirements

What can happen when the engineering survey and safety report are not adequate? Check out this video on the [Top 10 Demolition Failures](#).

### **The Engineering Survey**

The most common citation issued was for failure to conduct an engineering survey to determine the condition of the structure prior to demolition. This includes determining whether an unplanned collapse of the building or any adjacent structure would injure those working in the vicinity. The demolition contractor must maintain a written copy of this survey.

The engineering survey provides the demolition contractor with the opportunity to evaluate the job in its entirety. The purpose of the engineering survey is to determine the condition of the framing, floors, and walls so that measures can be taken, if necessary, to prevent the premature collapse of any portion of the structure. All the following should be addressed in the survey:

- J **Competent person:** Prior to starting all demolition operations, ensure a competent person conducts an engineering survey of the structure.
- J **Adjacent structures:** Check any adjacent structure(s) or improvements. Photographing existing damage in neighboring structures is also advisable. The contractor should also plan for potential hazards such as fires, cave-ins, and injuries.
- J **Damaged structures:** If the structure has been damaged by fire, flood, explosion, or some other cause, take appropriate measures, including bracing and shoring of walls and floors, to protect workers and any adjacent structures.
- J **Hazardous substances:** Determine if any type of hazardous chemicals, gases, explosives, flammable materials, or similarly dangerous substances have been used in any pipes, tanks, or other equipment on the property. When the presence of any such substances is apparent or suspected, testing and purging must be performed and the hazard eliminated before demolition is started.
- J **Protective equipment:** Determine the safety equipment needs. In demolition operations, PPE may include:
  - o eye, face, head, hand, and foot protection
  - o respiratory protection
  - o hearing protection
  - o personal fall arrest systems (PFAS)
  - o other protective clothing

### The Engineering Survey Report

The engineering survey should result in a formal (written) report that should include each of the following sections:

- ) building characteristics (i.e., construction type & structure size, height, structural hazards, enclosed/confined spaces, wall ties, shoring types and locations)
- ) protection for adjacent structures
- ) methods for demolition
- ) methods to protect the public
- ) protection of utilities (overhead and underground)
- ) protection of above and below-ground tanks
- ) hazardous materials removal
- ) blasting requirements (29 CFR 1926, Subpart U, Blasting Safety Requirements)
- ) training requirements

See this sample of a [Building Demolition Plan](#) that includes a comprehensive engineering survey at Attachment B.

### **Locating Utilities**

One of the most important elements of the pre-job planning is the location of all utility services. Make sure all electric, gas, water, steam, sewer, and other services lines are shut off, capped, or otherwise controlled, at or outside the building before demolition work is started. Other best practices include the following:

- ) Any utility company that is involved should be notified in advance, and its approval or services, if necessary, should be obtained.
- ) If it is necessary to maintain any power, water, or other utilities during demolition, temporarily relocate and/or protect those lines as necessary.
- ) Determine the location of all overhead power sources, as they can prove especially hazardous during any machine demolition.
- ) Inform all workers of the location of any existing or relocated utility service.

## Training

Under the OSH Act, Public Law 91-596, employers have a responsibility to provide a safe workplace for employees. Employers must instruct employees how to recognize and avoid or remove hazards that may cause an injury or illness based on their assigned duties. Certain OSHA construction standards require that employees receive training in specific topics. Employers must provide this safety training in a language and vocabulary their workers can understand.

Employees working on demolition projects may need training in topics including:

- ) asbestos, lead and silica awareness and removal
- ) oxygen/fuel cutting
- ) scaffolding
- ) working at height
- ) material handling
- ) demolition supervisor course
- ) abrasive grinding
- ) powered industrial truck operations
- ) blasting operations
- ) personal protective equipment

## Module 1 Quiz

Use this quiz to self-check your understanding of the module content. You can also go online and take this quiz within the module. The online quiz provides the correct answer once submitted.

- 1. Which of the following is the method most widely used in building demolition?**
  - a. physical demolition
  - b. mechanical demolition
  - c. controlled demolition
  - d. specialized demolition
  
- 2. High-rise structures may be brought down using implosion methods using \_\_\_\_.**
  - a. specialized explosives
  - b. C-4 explosives
  - c. controlled implosion
  - d. specialized equipment
  
- 3. Which of the following is the most common OSHA citation issued for demolition operations?**
  - a. local community coordination efforts
  - b. failure to provide timely reporting
  - c. failure to conduct an engineering survey
  - d. failure to locate utilities
  
- 4. The engineering report should result in a formal report that includes:**
  - a. local community coordination efforts
  - b. building characteristics
  - c. OSHA-approved certification
  - d. accident investigation results
  
- 5. One of the most important elements of the pre-job planning is \_\_\_\_.**
  - a. local community coordination efforts
  - b. the pre-job OSHA inspection
  - c. the coordination with local media
  - d. the location of all utility services

## Module 2 – Fire Prevention, Medical Services and Security

It is extremely important to develop a formal Fire Prevention and Protection plan (FPP) and coordinate medical services prior to beginning a demolition job. The FPP plan should outline the assignments of key personnel in the event of a fire and provide an evacuation plan for workers on the site. Medical services should include coordination with local providers and training in first aid and CPR.

Check out this dramatic [video](#) that emphasizes why it's important to have a construction and demolition fire safety plan.

### Formal Fire Prevention and Protection Plan

Good sense and thorough employee training should be the general rule in all fire prevention planning, as follows:

- ) Evaluate all potential sources of ignition and take the necessary corrective measures.
- ) Ensure a competent person installs all electrical wiring and equipment for providing light, heat, or power. Make sure a competent person inspects electrical wiring and equipment regularly.
- ) Locate equipment powered by an internal combustion engine so the exhausts discharge well away from combustible materials and away from workers.
- ) Maintain a clearance of at least six (6) inches between piping and combustible materials when the exhausts are piped outside the building.
- ) Shut down all internal combustion equipment prior to refueling. Make sure fuel for this equipment is stored in a safe location.
- ) Locate sufficient firefighting equipment near any flammable or combustible liquid storage area.
- ) Use only approved containers and portable tanks for storing and handling flammable and combustible liquids.

### Heating devices

Make sure all workers follow these important safe work practices when using heating devices:

- )] Situate heating devices so that they are not likely to overturn.
- )] Install all heating devices in accordance with their listing, including clearance to combustible material or equipment.
- )] Make sure a competent person maintains temporary heating equipment, when used.

### Smoking

Prohibit smoking at or in the vicinity of hazardous operations or materials. Where smoking is permitted, provide safe receptacles for smoking materials.

### Roadways

Ensure roadways between and around combustible storage piles are at least 15 feet wide and maintained free from accumulation of rubbish, equipment, or other materials.

### Storing Materials

When storing debris or combustible material inside a structure, do not obstruct the storage or adversely affect the means of exit.

### Control Center

Be sure to designate a suitable location at the job site and provide plans, emergency information, and equipment, as needed for coordination.

### Access

It's important to provide access for heavy fire-fighting equipment on the immediate job site at the start of the job and maintain access until the job is completed.

Ensure free access from the street to fire hydrants and to outside connections for standpipes, sprinklers, or other fire extinguishing equipment, whether permanent or temporary, and ensure access is maintained at all times, as follows:

- )] Pedestrian walkways should not be so constructed as to impede access to hydrants.
- )] No material or construction should interfere with access to hydrants, Siamese connections, or fire-extinguishing equipment.

## Water Supply

Make sure an available temporary or permanent water supply is sufficient to operate the fire-fighting equipment properly.

- )] Provide standpipes with outlets on large multi-story buildings to provide for fire protection on upper levels.
- )] Provide a pump if the water pressure is insufficient.

## Fire Extinguishers

It's critical to provide an ample number of fully charged portable fire extinguishers throughout the operation. Equip all motor-driven mobile equipment with an approved fire extinguisher.

## Alarms

Be sure to establish an alarm system (e.g., telephone system, siren, two-way radio, etc.) in such a way that employees on the site and the local fire department can be alerted in case of an emergency.

- )] Conspicuously post the alarm code and reporting instructions.
- )] Make sure the alarm system is serviceable at the job site during the demolition.
- )] Retain fire cutoffs in the buildings undergoing alterations or demolition until operations necessitate their removal.

## Medical Services, First Aid, and Security

### Medical Services

Prior to the start of demolition operations, be sure to establish and coordinate procedures for providing prompt medical attention in case of serious injury.

- )] Locate the nearest hospital, infirmary, clinic, or physician as part of the engineering survey.
- )] Provide the job supervisor with instructions for the most direct route to these facilities.
- )] Make sure proper equipment for prompt transportation of an injured worker is available at the job site.

- J Make sure a communication system to contact any necessary ambulance service is available at the job site. Conspicuously post the telephone numbers of the hospitals, physicians, or ambulances on the job site.
- J In the absence of an infirmary, clinic, hospital, or physician that is reasonably accessible in terms of time and distance to the work site, ensure a person who has a valid certificate in first aid training from the U.S. Bureau of Mines, the American Red Cross, or equivalent training is available at the work site to render first aid.

### First Aid

Ensure a properly stocked first aid kit is available at the job site.

- J The first aid kit should contain approved supplies in a weatherproof container with individual sealed packages for each type of item.
- J The kit should include rubber gloves to prevent the transfer of infectious diseases.
- J Make provisions to provide quick drenching or flushing of the eyes should any person be working around corrosive materials. Eye flushing must be done with water containing no additives.
- J Check the contents of the kit initially before it is sent out on each job and at least weekly to ensure the expended items are replaced.

### Security

This information can prove useful to the job supervisor in the event of any traffic problems, such as the movement of equipment to the job, uncontrolled fires, or other police/fire matters.

- J Make sure the telephone numbers of the local police, ambulance, and fire departments are available and posted at each job site.
- J The police number may also be used to report any vandalism, unlawful entry to the job site, or accidents requiring police assistance.

## Module 2 Quiz

Use this quiz to self-check your understanding of the module content. You can also go online and take this quiz within the module. The online quiz provides the correct answer once submitted.

- 1. During demolition, how much clearance should be provided between piping and combustible materials when the exhausts are piped outside the building?**
  - a. Eight (8) inches
  - b. One (1) foot
  - c. Two (2) inches
  - d. Six (6) inches
  
- 2. On demolition projects, ensure roadways between and around combustible storage piles are at least \_\_\_\_\_.**
  - a. 5 feet wide
  - b. 15 feet wide
  - c. 25 feet wide
  - d. 35 feet wide
  
- 3. What is the solution if water pressure is insufficient to provide adequate water supply for fire protection?**
  - a. Coordinate with local utilities
  - b. Use a 911 system
  - c. Provide a pump
  - d. Request a waiver
  
- 4. What must the job supervisor know in the Medical Services plan?**
  - a. The most direct route to emergency facilities
  - b. The names of local OSHA representatives
  - c. How to perform CPR
  - d. Must have first aid training
  
- 5. How often should the contents of the first aid kit be checked?**
  - a. Daily at the end of each shift
  - b. After each use
  - c. At least monthly
  - d. At least weekly

## Module 3 – Hazards Associated with Building Demolition

### Hazardous Materials

Construction and demolition (C&D) materials consist of the debris generated during the construction, renovation, and demolition of buildings, roads, and bridges. C&D materials often contain bulky, heavy materials that include:

- ) concrete
- ) wood (from buildings)
- ) asphalt (from roads and roofing shingles)
- ) gypsum (the main component of drywall)
- ) metals
- ) bricks
- ) glass
- ) plastics
- ) salvaged building components (doors, windows, and plumbing fixtures)
- ) trees, stumps, earth, and rock from clearing sites

### Primary Hazards

The hazards unique to demolition include all the following:

- ) Changes from the structure's design introduced during construction;
- ) Approved or unapproved modifications that altered the original design;
- ) Materials hidden within structural members, such as lead, asbestos, silica, and other chemicals or heavy metals requiring special material handling;
- ) Unknown strengths or weaknesses of construction materials, such as post-tensioned concrete;

- ) Hazards created by the demolition methods used such as exposure to excessive dust, noise and vibration.

### Primary Types of Accidents

The most common types of accidents that result from the hazards associated with demolition are:

- ) falls from elevated work surfaces
- ) exposure to hazardous air contaminants
- ) being struck by falling or collapsing structures
- ) electrical shock

### Structural Instabilities

It's important that the engineering survey identify framing, floors, walls of the structure and any adjacent structures that might be unstable. Key engineering and work practices controls for the hazards associated with structural instabilities during demolition include:

- ) Shore/brace walls and floors as needed to maintain safe work areas during demolition activities. Watch this [video](#) to see what can happen when walls are not properly braced.
- ) Have a competent person continually inspecting the work area to detect hazards resulting from weakened or deteriorated floors, walls, or loosened material. A competent person is able to recognize existing and predictable hazardous conditions and has the authority to take prompt corrective measures to eliminate the hazardous condition.
- ) Do not allow falling debris/stored materials or heavy equipment to exceed the safe carrying capacity of the floor.
- ) Conduct demolition work from the topmost floors down; do not cut/remove load-supporting members until upper or supported loads have been removed.

### Unsecured Hazard in the Work Area

During demolition, unsecured objects like glass and structural members may fall while workers are under them. Key hazard control strategies for the hazards associated with unsecured hazards in the work area during demolition include:

- ) Use debris netting, sidewalk sheds, canopies, or catch platforms to reduce hazards from falling objects.
- ) Make sure employee entrances to multistory structures are completely protected by sidewalk sheds or canopies, or both, providing protection from the face of the building for a minimum of 8 feet.
- ) Canopies should be at least 2 feet wider than the building entrances or openings capable of sustaining a load of 150 pounds per square foot.

### Utilities

It's important to reduce or eliminate the hazards from utilities that are not properly located and secured. To reduce the hazards associated with utilities:

- ) Verify the location of all other utility lines.
- ) Ensure lines have been shut-off, capped, or otherwise controlled outside the building before beginning work.
- ) Notify utility companies before controlling their utility lines.

### Assessing for Hazardous Substances

During demolition, exposure to hazardous substances is likely. To prevent and reduce the hazards associated with the exposure to hazardous substances, do the following:

- ) Conduct worksite inspections prior to the start of operations to assess for the presence, contents, and condition of tanks and equipment that might contain hazardous chemicals, gases, or flammable materials.
- ) If the condition of tanks or equipment is suspect, avoid disturbing them until after the assessment is done and a plan of action is developed to reduce exposure or eliminate the hazardous substances.

## Eliminating Hazardous Substances

To eliminate the hazardous substances that have been identified prior to and during demolition, do the following:

- J Purge lines, tanks, and equipment containing hazardous chemicals, gases, or flammable materials.
- J Use air monitoring equipment such as a combustible gas indicator, toxic gas monitor, or oxygen monitor to determine if any hazardous conditions remain.
- J When necessary, provide additional controls to protect response and recovery workers (e.g., forced ventilation, respiratory protection, etc.).

## Walkways and Access

To prevent slips, trips and falls, provide and use safe walkways to reach any point without having to walk on exposed beams. Walkways should be at least 18 inches wide and formed by using 2-inch thick wood, with stringers installed as needed for support.

To ensure safe access to the structure, use only inspected and designated stairways, passageways, and ladders, designated as means of access to the structure of a building. Other access ways must be entirely closed at all times.

## Illumination

In a multi-story building, when a stairwell is being used for access or egress, it **must** be properly illuminated by either natural or artificial means, and completely and substantially covered over at a point not less than two floors below the floor on which work is being performed. Access to the floor where the work is in progress **must** be through a properly lighted, protected, and separate passageway.

## Safe Work Practices When Working in Confined Spaces

Demolition contractors often come in contact with confined spaces when demolishing structure at industrial sites. These confined spaces can be generally categorized in two major groups:

1. those with open tops and a depth that restricts the natural movement of air
2. enclosed spaces with very limited openings for entry

Examples of these spaces include storage tanks, vessels, degreasers, pits vaults, casing, and silos.

The hazards encountered when entering and working in confined spaces are capable of causing bodily injury, illness, and death. Accidents occur among workers because of failure to recognize that a confined space is a potential hazard. It should therefore be considered that the most unfavorable situation exists in every case and that the danger of explosion, poisoning, and asphyxiation will be present at the onset of entry.

### Module 3 Quiz

Use this quiz to self-check your understanding of the module content. You can also go online and take this quiz within the module. The online quiz provides the correct answer once submitted.

- 1. Which of the following is a hazard unique to demolition operations?**
  - a. Weather conditions
  - b. Exposure to falling objects
  - c. Being struck by moving vehicles
  - d. Modifications that altered the original design
  
- 2. Which of the following are common accidents during demolition operations?**
  - a. Being struck by high voltage wires
  - b. Hearing loss due to noise
  - c. Falls from elevated work surfaces
  - d. Being struck by moving vehicles
  
- 3. Which of the following is a key engineering control for hazards associated with structural instabilities during demolition?**
  - a. Conduct demolition from bottom floor up
  - b. Shore/brace walls and floors
  - c. Ensure proper hearing protection is used
  - d. Make sure all vehicles have backup warning systems
  
- 4. During demolition, canopies should provide at least \_\_\_\_\_ from the face of the building.**
  - a. 4 feet
  - b. 8 feet
  - c. 6 feet
  - d. 10 feet

- 5. Walkways on demolition projects should be at least \_\_\_\_\_ and formed by using \_\_\_\_\_ wood, with stringers installed as needed for support.**
- a. 18 inches wide, 2-inch thick
  - b. 12 inches wide, 1-inch thick
  - c. 14 inches wide, 2-inch thick
  - d. 16 inches wide, 1-inch thick

## Module 4 - Demolition of Pre-Stressed Concrete Structures

The different forms of construction used in a number of more or less conventional structures built during the last few decades will give rise to a variety of problems when the time comes for them to be demolished.

### “Pre-stressed Concrete” Defined

Pre-stressed concrete is defined as concrete in which there has been introduced internal stresses of such magnitude and distribution that the stresses resulting from given external loadings are counteracted to a desired degree. In reinforced concrete members, the pre-stress is commonly introduced by tensioning the steel reinforcement.

This internal stress is induced into the member by either of the following two pre-stressing methods:

- ) **Pre-tensioning:** In pre-tensioning, the tendons are first stressed to a given level and then the concrete is cast around them. The tendons may be composed of wires, bars or strands.
- ) **Post-Tensioning:** In post-tensioning, the concrete member is first cast with one or more post-tensioning ducts or tubes for future insertion of tendons. Once the concrete is sufficiently strong, the tendons are stressed by jacking against the concrete. When the desired prestress level is reached, the tendons are locked under stress by means of end anchorages or clamps. Subsequently, the duct is filled with grout to protect the steel from corrosion and give the added safeguard of bond.

Read the [WisDot Bridge Manual, Chapter 19 – Prestressed Concrete](#) for a detailed discussion.

Also, check out this slide show by [Parag Pal on Pre-tensioning and Post-Tensioning Concrete](#).

### Pre-stressed Concrete Structures

The most important aspect of demolishing a pre-stressed concrete structure takes place during the engineering survey. During the survey, a qualified person should determine if the structure to be demolished contains any pre-stressed members.

It is the responsibility of the demolition contractor to inform all workers on the demolition job site of the presence of pre-stressed concrete members within the structure. They should also instruct them in the safe work practice which must be followed to perform the demolition safely. Workers should be informed of the hazards of deviating from the prescribed procedures and the importance of following their supervisor's instruction.

## Categories of Pre-Stressed Construction

There are four main categories of pre-stressed members. The category or categories should be determined before attempting demolition, bearing in mind that any pre-stressed structure may contain elements of more than one category.

**Category 1:** Members are pre-stressed before the application of the superimposed loads, and all cables or tendons are fully bonded in the concrete or grouted within ducts.

**Category 2:** Like Category 1, but the tendons are left ungrouted. This type of construction can sometimes be recognized from the access points that may have been provided for inspection of the cables and anchors. More recently, unbonded tendons have been used in the construction of beams, slabs, and other members; these tendons are protected by grease and surrounded by plastic sheathing, instead of the usual metal duct.

**Category 3:** Members are pre-stressed progressively as building construction proceeds and the dead load increases, using bonded tendons as in Category 1.

**Category 4:** Like Category 3, but using unbonded tendons as in Category 2.

Examples of construction using members of Categories 3 or 4 are relatively rare. However, they may be found, for example, in the podium of a tall building or some types of bridges. They require particular care in demolition.

## Pre-tensioned Members

Pre-tensioned members usually do not have any end anchors, the wires being embedded or bonded within the length of the member.

- ) Demolish simple pre-tensioned beams and slabs of spans up to about 23 feet (7 meters) in a manner similar to ordinary reinforced concrete.
- ) Lift and lower pre-tensioned beams and slabs to the ground as complete units after the removing composite concrete covering to tops and ends of the units.
- ) Turn the members on their sides to facilitate breaking up.
- ) Lift the structure from points near the ends of the units or from lifting point positions.
- ) Whenever possible, reuse lifting eyes if they are in good condition.
- ) When units are too large to be removed, consider temporary supporting arrangements.

### **Precast Units Stressed Separately**

Before breaking up precast units stressed separately from the main frames of the structure, they should be lowered to the ground, if possible. It is advisable to seek the counsel of a professional engineer before carrying out this work, especially where there are ungrouted tendons. In general, this is true because grouting is not always 100% efficient.

- ) After lowering, the units can be turned on their side with the ends up on blocks after any composite concrete is removed. This may suffice to break the unit and release the prestress; if not, erect a sand bag screen, timbers, or a blast mat as a screen around the ends.
- ) Clear the area of any personnel.
- ) Remember the end blocks may be heavily reinforced and difficult to break up.

### **Monolithic Structures**

A monolithic structure is something carved or cast from a single piece of a material. Usually (and literally, from the translation of monolith being "one stone") the material is stone, but it could equally be applied to a structure cut from a single block of metal, or cast in metal in a single piece. Most domed structures, like sports stadiums, are considered monolithic.

The advice of the professional engineer experienced in pre-stressed work should be sought before any attempt is made to expose the tendons or anchorages of structures in which two or more members have been stressed together.

- ) It will usually be necessary to provide temporary supports so that the tendons and the anchorage can be cautiously exposed.
- ) Do not indiscriminately attempt to expose and destress the tendons and anchorages.

### **Progressively Pre-Stressed Structures**

In the case of progressively pre-stressed structures, it is essential to obtain the advice of a professional engineer, and to demolish the structure in strict accordance with the engineer's method of demolition. The stored energy in this type of structure is large. In some cases, the inherent properties of the stressed section may delay failure for some time, but the presence of these large pre-stressing forces may cause sudden and complete collapse with little warning.

## Module 4 Quiz

Use this quiz to self-check your understanding of the module content. You can also go online and take this quiz within the module. The online quiz provides the correct answer once submitted.

- 1. In which of the pre-stressing methods are the tendons first stressed to a given level and then the concrete is cast around them?**
  - a. Pre-tensioning
  - b. Post-tensioning
  - c. Pre-conditioning
  - d. Post-conditioning
  
- 2. In which of the pre-stressing methods is the concrete member first cast with one or more ducts or tubes for future insertion of tendons?**
  - a. Pre-tensioning
  - b. Post-tensioning
  - c. Pre-conditioning
  - d. Post-conditioning
  
- 3. The most important aspect of demolishing a pre-stressed concrete structure takes place during the \_\_\_\_.**
  - a. post-tensioning operations
  - b. safety inspection
  - c. engineering survey
  - d. pre-job meeting
  
- 4. In which of the following pre-stressed construction categories are members pre-stressed before the application of superimposed loads?**
  - a. Category 2
  - b. Category 3
  - c. Category 1
  - d. Category 4

- 5. Workers may demolish simple pre-tensioned beams and slabs of spans up to about \_\_\_\_\_ in a manner similar to ordinary reinforced concrete.**
- a. 10 feet (3 meters)
  - b. 10 feet (3 meters)
  - c. 15 feet (4.6 meters)
  - d. 23 feet (7 meters)

## Module 5 – Special Structures Demolition

### Inspection and Planning

[OSHA’s Technical Manual \(OTM\) Section V: Chapter 1](#) designates the following as special structures:

- ) chimneys
- ) stacks
- ) silos
- ) cooling towers

When preparing to demolish any chimney, stack, silo, or cooling tower, the first step must be a careful, detailed inspection of the structure by an experienced person. If possible, architectural/engineering drawings should be consulted. Particular attention should be paid to the condition of the chimney or stack.

- ) Workers should be on the lookout for any structural defects such as weak or acid-laden mortar joints, and any cracks or openings.
- ) The interior brickwork in some sections of industrial chimney shafts can be extremely weak.
- ) If a stack has been banded with steel straps, these bands must be removed only as the work progresses from the top down. Sectioning of the chimney by water should be considered.

Watch this [video](#) showing the demolition of three towers and a chimney at the Richborough Power Station.

### Safe Work Practices

- ) When hand demolition is required, it should be carried out from a working platform.
- ) Experienced personnel must install a self-supporting tubular scaffold, suspended platform, or knee-braced scaffolding around the chimney. Particular attention should be paid to the design, support, and tie-in (braces) of the scaffold.

- J A competent person should be present at all times during the erection of the scaffold.
- J It is essential that there be adequate working clearance between the chimney and the work platform.
- J Access to the top of the scaffold should be provided by means of portable walkways.
- J The platforms should be decked solid and the area from the work platform to the wall should be bridged with a minimum of two-inch thick lumber.
- J A back rail 42 inches above the platform, with a midrail covered with canvas or mesh, should be installed around the perimeter of the platform to prevent injury to workers below. Debris netting may be installed below the platform.

Now watch this [video](#) of the most dangerous scaffolding in the world in India. You won't believe it!

#### More Safe Work Practices

- J When working on the work platform, all personnel should wear hard hats, long-sleeve shirts, eye and face protection (such as goggles and face shields), respirators, and safety belts, as required.
- J Care should be taken to assign the proper number of workers to the task. Too many people on a small work platform can lead to accidents.
- J An alternative to the use of a self-supporting tubular steel scaffold is to "climb" the structure with a creeping bracket scaffold. A competent person should inspect the masonry and decide about the safety of this alternative. The masonry of the chimney must be in good enough condition to support the bracket scaffold.
- J Rope off or barricade the area around the chimney. Post appropriate warning signs and do not permit unauthorized entry.
- J Keep a worker (i.e., a supervisor, operating engineer, another worker, or a "safety person") on the ground to communicate with workers above.
- J Pay attention to weather conditions when working on a chimney. Do not work during inclement weather such as during lightning or high wind situations.

- )] Wet down the work site as needed to control dust.
- )] Excess canvas or plywood attachments can form a wind-sail that could collapse the scaffold.

[See what happens to a scaffold on a windy day in March 2015 in Portland Oregon, USA.](#)

### Demolition by Deliberate Collapse

Another method of demolishing a building, chimney or stack is by deliberate collapse. Deliberate collapse requires extensive planning and experienced personnel, and should be used only when conditions are favorable.

- )] There must be a clear space for the fall of the structure of at least 45 degrees on each side of the intended fall line and 1½ times the total height of the chimney.
- )] Considerable vibration may be set up when the chimney falls, so there should be no sewers or underground services on the line of the fall.
- )] Post lookouts on the site and arrange for warning signals.
- )] Keep the public and other workers at the job site well back from the fall area.

Collapse of buildings and special structures don't always go as planned: check out this [Top 10 Las Vegas Casino Implosions](#) video.

### Using Explosives

The use of explosives is one way of setting off deliberate collapse. This type of demolition should be undertaken only by qualified persons.

- )] The entire work area must be cleared of non-essential personnel before any explosives are placed.
- )] Though the use of explosives is a convenient method of bringing down a chimney or stack, there is a considerable amount of vibration produced, and caution should be taken if there is any likelihood of damage.

Check out this short [GoPro video](#) on building demolition.

## Module 5 Quiz

Use this quiz to self-check your understanding of the module content. You can also go online and take this quiz within the module. The online quiz provides the correct answer once submitted.

- 1. When preparing to demolish any chimney, stack, silo, or cooling tower, the first step must be \_\_\_\_.**
  - a. to expose tendons for distressing
  - b. a careful, detailed inspection of the structure
  - c. band the stack with steel straps
  - d. sectioning of the chimney by water
  
- 2. When demolishing chimneys, it is very important to be on the lookout for structural defects because \_\_\_\_.**
  - a. tendons can become easily distressed
  - b. the steel bands on the stack can break
  - c. section of the chimney can be loose
  - d. the brickwork can be extremely weak
  
- 3. When demolishing chimneys special structures how high should scaffold back rails be?**
  - a. About 35 inches above the platform
  - b. At least 55 inches above the platform
  - c. 42 inches above the platform
  - d. 35-43 inches above the platform
  
- 4. When performing deliberate collapse of special structures, be sure to clear space for the fall of the structure at least \_\_\_\_ on each side of the intended fall.**
  - a. 90 degrees
  - b. 45 degrees
  - c. 30 degrees
  - d. 15 degrees

- 5. When performing deliberate collapse of chimneys or stacks, how long should the intended fall line be?**
- a. 1 1/2 times the total height of the chimney or stack
  - b. Twice the total height of the chimney or stack
  - c. 2 times the total height of the chimney or stack
  - d. At least the total height of the chimney or stack

## Module 6 – Removing Debris and Cleanup

Debris collection and removal tasks include picking up, clearing, separating, and removing debris. Most of these tasks are typically performed using heavy equipment; however, some manual effort can be necessary at every stage.

The foreman should determine when debris is to be removed, halt all demolition during debris removal, and make sure the area is clear of cleanup workers before continuing demolition.

- ) Make sure openings cut in a floor for the disposal of materials are no larger than 25 percent of the aggregate of the total floor area, unless the lateral supports of the removed flooring remain in place.
- ) Shore up floors weakened or otherwise made unsafe to safely carry the intended imposed load from demolition operations.
- ) If debris is dropped inside the shaft, it can be removed through an opening in the chimney at grade level.
- ) Keep the opening at grade level relatively small in order not to weaken the structure. Consult with a professional engineer if a larger opening is desired.
- ) When removing debris by hand, use an overhead canopy of adequate strength. If machines are used for removal of debris, use proper overhead protection for the operator.
- ) Do not allow excessive debris to accumulate inside or outside the shaft of the chimney as the excess weight of the debris can impose pressure on the wall of the structure and might cause the shaft to collapse.

### Dropping Construction Debris

It's important that drop chutes are designed and constructed of strong enough materials to eliminate failure due to impact of materials and debris. When drop chutes are in operation, make sure a competent person is always assigned to control the operation of the chute gate, and the backing and loading of trucks.

- ) Never allow material to be dropped to any point lying outside the exterior walls of the structure unless it is effectively protected.

- )] Plank off solid floor openings within 10 feet of any wall being demolished, except when employees are kept out of the area below.
- )] Make sure that the waste and debris stored on any floor does not exceed the allowable floor load.
- )] Enclose material chutes at greater than a 45-degree angle from the horizontal unless openings are equipped with closures at or about floor level for the insertion of materials.
- )] Chute openings should be 48 inches or less in height measured along the wall of the chute. Openings at all floors below the top floor must be closed when the chute is not in use.
- )] Provide 42-inch high guardrails/barricades at least 6 feet back from the projected edge of the opening above where debris is dumped manually through floors without chutes.
- )] Where debris is dumped using mechanical equipment or wheel barrows, provide 4-inch wide by 6-inch high toeboards/bumpers.
- )] Block off storage spaces to which material is dumped unless the openings are used for the removal of materials and kept closed when material is not being removed.
- )] Barricade and mark all debris-dropping areas. Post warning signs on each side of the debris opening at each floor level.
- )] Ensure debris is not removed in lower areas until all debris-handling ceases in areas above.
- )] Install a substantial gate in each chute at or near the discharge end. Make sure the discharge gate closed off when not in use.

### **Removing Walls and Masonry Sections**

To prevent injury to employees engaged in removing walls and masonry sections, follow these best practices:

- )] Demolition of exterior walls and floors must begin at the top of the structure and proceed downward.

- ) Do not allow masonry walls to fall on the floors of a building in masses that would exceed the safe carrying capacities of the floors.
- ) Do not allow wall sections, one story in height or higher, to stand alone without lateral bracing, unless the wall was originally designed and constructed to stand without lateral support, and is safe enough to be self-supporting.
- ) Leave all walls in a stable condition at the end of each work shift.
- ) Employees must not work on the top of a wall when weather conditions create a hazard.
- ) Do not cut or remove structural or load-supporting members on any floor until all stories above the floor have been removed.
- ) In buildings of "skeleton-steel" construction, the steel framing may be left in place during the demolition of masonry. Where this is done, clear all steel beams, girders, and similar structural supports of all loose material as the masonry demolition progresses downward.
- ) Provide walkways or ladders to enable workers to safely reach or leave any scaffold or wall.
- ) Do not demolish walls that serve as retaining walls to support earth or adjoining structures, until the supporting earth has been properly braced or until adjoining structures have been properly underpinned.
- ) Do not use walls which serve as retaining walls against which debris will be piled unless they are capable of supporting the imposed load.
- ) Dismantle steel construction column length by column length, and tier by tier.

Watch this [video](#) of a building wall collapse as a worker attempts to pull bricks down. Saved him some time, but it was pretty dangerous!

## Module 6 Quiz

Use this quiz to self-check your understanding of the module content. You can also go online and take this quiz within the module. The online quiz provides the correct answer once submitted.

- 1. What can happen if excessive debris accumulates inside or outside the shaft of the chimney?**
  - a. The chimney wall may collapse due to pressure on the shaft
  - b. The shaft may collapse due to pressure on structure walls
  - c. Debris may accidentally be pushed into the shaft
  - d. The debris may fall over the side of the structure
  
- 2. When demolishing special structures, plank off solid floor openings within \_\_\_\_\_, except when employees are kept out of the area below.**
  - a. 10 feet of any wall being demolished
  - b. 3 feet of any wall being demolished
  - c. 20 feet of any wall being demolished
  - d. 5 feet of any wall being demolished
  
- 3. Where demolition debris is dumped using mechanical equipment or wheel barrows, provide \_\_\_\_\_ toeboards/bumpers.**
  - a. 4-inch wide by 4-inch high
  - b. 3-inch wide by 1-foot high
  - c. 4-inch wide by 6-inch high
  - d. 3-inch wide by 6-inch high
  
- 4. What is important to remember when removing wall sections, one story in height or higher?**
  - a. Walls must be designed so that they can stand alone without bracing
  - b. Walls must be braced regardless of their ability to stand alone
  - c. Walls must not be braced unless a competent person determines the need
  - d. Walls must not stand alone without lateral bracing unless properly designed

- 5. When removing walls and masonry sections, do not cut or remove structural or load-supporting members on any floor until \_\_\_\_\_.**
- a. the floor being removed is inspected and braced
  - b. all stories above the floor have been removed
  - c. at least one story above the floor has been removed
  - d. all stories above the floor have been properly braced

## Module 7 – Controlling Asbestos Exposure

Workers are likely to be exposed to asbestos during demolition operations. Heavy exposures tend to occur in the construction industry and in ship repair, particularly during the removal of asbestos materials due to renovation, repairs, or demolition. This exposure creates a very real danger to the safety and health of workers.

Watch this short [video](#) on the hazards created during a demolition project due to asbestos.

### What is Asbestos?

Asbestos is the name given to six naturally occurring incombustible minerals that are resistant to heat and corrosion.

Asbestos minerals formed millions of years ago when heat, pressure, or chemical activity changed the physical and chemical characteristics of pre-existing rock. Unlike other minerals, which consist of tightly bound crystals, asbestos minerals are characterized by the presence of densely packed bundles of fibers.

On July 12, 1989, the U.S. EPA issued a final rule banning some, but not all, asbestos-containing products. For additional information, please visit the [U.S. EPA: Asbestos page](#).

### Asbestos Health Hazards

Asbestos is well recognized as a health hazard and its use is now highly regulated by both OSHA and EPA. Asbestos fibers associated with these health risks are too small to be seen with the naked eye. Breathing asbestos fibers can cause a buildup of scar-like tissue in the lungs called asbestosis and result in loss of lung function that often progresses to disability and death.

Asbestos also causes cancer of the lung and other diseases such as mesothelioma of the pleura which is a fatal malignant tumor of the membrane lining the cavity of the lung or stomach. Epidemiologic evidence has increasingly shown that all asbestos fiber types cause mesothelioma in humans.

### Hazard Location

The hazard may occur during renovating or demolishing buildings or ships; cleanup from those activities; contact with deteriorating asbestos-containing materials; and during cleanup after natural disasters. Asbestos has been used in products, such as insulation for pipes (steam lines for example), floor tiles, building materials, and in vehicle brakes and clutches.

Some materials are presumed to contain asbestos if installed before 1981. Examples of these materials, as well as other presumed asbestos-containing materials, are:

- ) thermal system insulation
- ) roofing and siding shingles
- ) vinyl floor tiles
- ) plaster, cement, putties and caulk
- ) ceiling tiles and spray-on coatings
- ) industrial pipe wrapping
- ) heat-resistant textiles
- ) automobile brake linings and clutch pads

### Reducing Asbestos Hazards

Airborne levels of asbestos are never to exceed legal worker exposure limits. There is really no "safe" level of asbestos exposure for any type of asbestos fiber. Asbestos exposures as short in duration as a few days have caused mesothelioma in humans. Every occupational exposure to asbestos can cause injury of disease; every occupational exposure to asbestos contributes to the risk of getting an asbestos-related disease.

- ) Where there is exposure, employers are required to further protect workers by establishing regulated areas, controlling certain work practices and instituting engineering controls to reduce the airborne levels.
- ) The employer is required to ensure exposure is reduced by using administrative controls and provide for the wearing of personal protective equipment.
- ) Medical monitoring of workers is also required when legal limits and exposure times are exceeded.

### Exposure Limits

**Time-weighted average limit (TWA):** The employer must ensure that no employee is exposed to an airborne concentration of asbestos in excess of 0.1 fiber per cubic centimeter of air as an eight (8) hour time-weighted average (TWA).

**Excursion limit:** The employer must ensure that no employee is exposed to an airborne concentration of asbestos in excess of 1.0 fiber per cubic centimeter of air (1 f/cc) as averaged over a sampling period of thirty (30) minutes.

## Training

Employers should conduct initial and annual training for all employees who are likely to be exposed to asbestos in excess of Permissible Exposure Limits (PELs) and all employees who perform Class I through IV asbestos operations.

The training program must be conducted in a manner that the employee is able to understand. Employees must be informed of the following:

- ) methods of recognizing asbestos
- ) health effects associated with asbestos exposure
- ) relationship between smoking and asbestos in producing lung cancer
- ) nature of operations that could result in exposure to asbestos
- ) importance of necessary protective controls to minimize exposure including, as applicable:
  - o engineering controls
  - o work practices
  - o respirators
  - o housekeeping procedures
  - o hygiene facilities
  - o protective clothing
  - o decontamination procedures
  - o emergency procedures
  - o waste disposal procedures

- any necessary instruction in the use of these controls and procedures where Class III and IV work will be or is performed (the contents of [EPA 20T-2003, "Managing Asbestos In-Place"](#) July 1990 or its equivalent in content)
- ) purpose, proper use, fitting instructions, and limitations of respirators as required by 29 CFR 1910.134

Check out this [video](#) on the history of asbestos by Brent Coon and Associates.

## Module 7 Quiz

Use this quiz to self-check your understanding of the module content. You can also go online and take this quiz within the module. The online quiz provides the correct answer once submitted.

- 1. What is the name given to a group of naturally occurring minerals that are resistant to heat and corrosion?**
  - a. Silica
  - b. Asbestos
  - c. Graphite
  - d. Lead
  
- 2. Breathing asbestos fibers can cause a buildup of scar-like tissue in the lungs called \_\_\_\_\_.**
  - a. asbestosis
  - b. asbestos silicosis
  - c. graphiosis asbestos
  - d. asbestos poisoning
  
- 3. What may occur if workers are exposed to asbestos in duration as short as a few days?**
  - a. Asbestos
  - b. Acute asbestos
  - c. Mesothelioma
  - d. Short-term asbestos poisoning
  
- 4. Which of the following is required by OSHA where there is exposure to asbestos?**
  - a. Asbestos hazard controls
  - b. Immediate employee testing
  - c. The use of PPE as a first line of defense
  - d. Establishment of regulated areas
  
- 5. The employer must ensure that no employee is exposed to an airborne concentration of asbestos in excess of \_\_\_\_\_ as an eight (8) hour time-weighted average (TWA).**
  - a. 0.1 fiber per cubic centimeter of air (.1f/cc)
  - b. 0.5 fiber per cubic centimeter of air (.5f/cc)
  - c. 1.0 fiber per cubic centimeter of air (1f/cc)
  - d. 1.5 fiber per cubic centimeter of air (1.5f/cc)



## Module 8 – Controlling Lead Exposure

Inorganic lead is a malleable, blue-gray, heavy metal that occurs naturally in the Earth's crust. Lead was one of the first metals used by humans and, consequently, the cause of the first recorded occupational disease (lead colic in a 4th century BC metal worker).

Lead was used extensively as a corrosion inhibitor and pigment in paints, but concerns over its toxicity led to the ban of the use of lead in paint for residential and public buildings.

### Exposure to Lead

Lead enters the body primarily through inhalation and ingestion, and passes through the lungs into the blood where it can harm many of the body's organ systems. While inorganic lead does not readily enter the body through the skin, it can enter the body through accidental ingestion (eating, drinking, and smoking) via contaminated hands, clothing, and surfaces.

Lead poisoning may occur in workers during abrasive blasting, sanding, cutting, burning, or welding of bridges and other steel structures such as water and fuel storage tanks coated with lead-containing paints. Workers who may be exposed to lead include abrasive blasters, inspectors, iron workers (welders and cutters), painters, and laborers.

### Permissible Exposure

**Action level:** The action level is the degree of employee exposure, without regard to the use of respirators, to an airborne concentration of lead of 30 micrograms per cubic meter of air (30 ug/m<sup>3</sup>) calculated as an 8-hour time-weighted average (TWA). Employers must determine if their employees performing manual demolition may be exposed to lead at or above the action level.

**Permissible exposure limit (PEL):** Employers must make sure that employees are not exposed to lead at concentrations greater than fifty micrograms per cubic meter of air (50 ug/m<sup>3</sup>) averaged over an 8-hour period.

If employees are exposed to lead for more than 8 hours in any work day, the permissible exposure limit, as a time weighted average (TWA) for that day, must be reduced according to the following formula:

$$\text{Maximum permissible limit (in ug/m}^3\text{)} = 400 \text{ divided by hours worked in the day.}$$

### Health Effects of Lead Exposure

The frequency and severity of medical symptoms increase with the concentration of lead in the blood. Workers with blood lead levels (BLLs) of 80 µg/dl (micrograms/deciliter) or greater have

symptoms or signs of acute lead poisoning, although in some individuals, symptoms may be so mild that they are overlooked.

Common symptoms of acute lead poisoning are loss of appetite, nausea, vomiting, stomach cramps, constipation, difficulty in sleeping, fatigue, moodiness, headache, joint or muscle aches, anemia, and decreased sexual drive.

Severe health effects of acute lead exposure include damage to the nervous system, including wrist or foot drop, tremors, and convulsions or seizures. Acute lead poisoning from uncontrolled occupational exposures has resulted in fatalities.

Chronic lead poisoning may result after lead has accumulated in the body over time, mostly in the bone. Long after exposure has ceased, some physiological event such as illness or pregnancy may release this stored lead from the bone and produce adverse health effects such as impaired hemoglobin synthesis, alteration in the central and peripheral nervous systems, hypertension, effects on male and female reproductive systems, and damage to the developing fetus. These health effects may occur at BLLs below 50 µg/dl.

Check out this [video](#) on why lead poisoning may be cause your health problems by Dr. Mark Hyman, MD.

### Personal Hygiene for Exposure to Lead Dust

Personal hygiene is an important element of any program for protecting workers from exposure to lead dust. OSHA requires employers to provide adequate washing facilities at the worksite so that workers can remove lead particles that accumulate on the skin and hair. Showers should also be available.

- ) **Washing:** All workers exposed to lead should wash their hands and faces before eating, drinking, or smoking.
- ) **Tobacco:** Tobacco products (cigarettes, cigars, chewing tobacco, etc.) and food items should not be permitted in the work area. Contaminated work clothes should be removed before eating.
- ) **Personal Clothing:** Workers should change into work clothes at the worksite. Work clothes include disposable or washable coveralls. Street clothes should be stored separately from work clothes in a clean area provided by the employer. Separate lockers or storage facilities should be provided so that clean clothing is not contaminated by work clothing and shoes. Workers should change back into their street clothes after washing or showering and before leaving the worksite to prevent the accumulation of

lead dust in the workers' cars and homes and thereby protect family members from exposure to lead. Read [OSHA's Quick Card](#) on personal clothing best practices.

- ) **Protective clothing:** Employers should arrange for the laundering of protective clothing; or, if disposable protective clothing is used, the employer should maintain an adequate supply at the worksite and arrange for its safe disposal according to applicable Federal and State regulations.
- ) **Vehicles:** Trucks, cars and other vehicles should be parked where they will not be contaminated with lead.

### Hazard Controls for Lead

Effective source control measures (such as containment or local exhaust ventilation) should be implemented to minimize worker exposure to lead. NIOSH prefers such measures as the primary means of protecting workers, but source control at construction sites is often ineffective, and airborne lead concentrations may be high or may vary unpredictably.

### Respiratory Protection

Respiratory protection is also necessary for certain operations such as blasting, sweeping, vacuuming, and for other jobs as determined at the worksite by an industrial hygienist or other qualified professional. However, respirators are the least preferred method of controlling lead exposure, and they should not be used as the only means of preventing or minimizing exposures. The use of respirators should supplement the continued use of engineering controls and good work practices.

When respirators are used, the employer must establish a comprehensive respiratory protection program. Important elements of the OSHA respiratory protection standard are:

1. an evaluation of the worker's ability to perform the work while wearing a respirator;
2. regular training of personnel;
3. periodic environmental monitoring; and
4. respirator fit testing, maintenance, inspection, cleaning, and storage.

The program should be evaluated regularly by the employer. Without a complete respiratory protection program, workers will not receive the protection anticipated.

Respirators should be selected by the person who is in charge of the program and knowledgeable about the workplace and the limitations associated with each type of respirator. Because exposures to lead during construction may vary substantially throughout a workshift and between days, the highest anticipated exposure should be used to determine the appropriate respirator for each job.

### Lead Safety Training

Workers should receive training that includes the following:

- ) information about the potential adverse health effects of lead exposure
- ) information about the early recognition of lead intoxication
- ) information in material safety data sheets for new paints or coatings that contain lead or other hazardous materials [29 CFR 1926.59]
- ) instruction about heeding signs that mark the boundaries of lead-contaminated work areas
- ) discussion of the importance of personal hygiene practices in reducing lead exposure
- ) instruction about the use and care of appropriate protective equipment (including protective clothing and respiratory protection)
- ) information about specific work practices for working safely with lead-containing paints

Check out this [video](#) about lead in the construction industry. It's a little long (20 minutes), but has a lot of great information.

## Module 8 Quiz

Use this quiz to self-check your understanding of the module content. You can also go online and take this quiz within the module. The online quiz provides the correct answer once submitted.

- 1. This corrosion inhibitor and pigment in paints is banned in paint for residential and public buildings.**
  - a. Asbestos
  - b. Lead
  - c. Silica
  - d. Graphite
  
- 2. Employers must make sure that employees are not exposed to lead at concentrations greater than \_\_\_\_\_ averaged over an 8-hour period.**
  - a. five micrograms per cubic meter of air (5 ug/m<sup>3</sup>)
  - b. twenty-five micrograms per cubic meter of air (25 ug/m<sup>3</sup>)
  - c. one hundred and fifty micrograms per cubic meter of air (150 ug/m<sup>3</sup>)
  - d. fifty micrograms per cubic meter of air (50 ug/m<sup>3</sup>)
  
- 3. Exposure to which of the following substances may cause damage to the nervous system, including wrist or foot drop, tremors, and convulsions or seizures.**
  - a. Asbestos
  - b. Lead
  - c. Silica
  - d. Aluminum
  
- 4. Which of the following is considered effective primary source control measures to minimize worker exposure to lead?**
  - a. Personal protective equipment
  - b. Respirators
  - c. Wearing gloves
  - d. Containment or local exhaust ventilation

- 5. Which of the following are considered the least effective control measure to minimize worker exposure to lead?**
- a. Respirators
  - b. Containment or local exhaust ventilation
  - c. Personal protective equipment
  - d. Wearing gloves

## Module 9 – Controlling Silica Exposure

### Exposure to Silica

Exposure to fine particles of silica has been shown to cause silicosis, a serious and sometimes fatal lung disease. Construction employees who inhale fine particles of silica may be at risk of developing this disease.

### Silicosis Symptoms

Silicosis is classified into three types: chronic/classic, accelerated, and acute.

**Chronic/classic silicosis**, the most common, occurs after 15-20 years of moderate to low exposures to respirable crystalline silica. Symptoms associated with chronic silicosis may or may not be obvious: therefore, workers need to have a chest x-ray to determine if there is lung damage. As the disease progresses, the worker may experience shortness of breath upon exercising and have clinical signs of poor oxygen/carbon dioxide exchange. In the later stages, the worker may experience fatigue, extreme shortness of breath, chest pain, or respiratory failure.

**Accelerated silicosis** can occur after 5-10 years of high exposures to respirable crystalline silica. Symptoms include severe shortness of breath, weakness, and weight loss. The onset of symptoms takes longer than in acute silicosis.

**Acute silicosis** occurs after a few months or as long as two years following exposures to extremely high concentrations of respirable crystalline silica. Symptoms of acute silicosis include severe disabling shortness of breath, weakness, and weight loss, which often leads to death.

Check out this [video](#) on Silicosis and Crystalline Silica.

### How Silica is Generated

Silica dust can be generated when materials such as ceramics, concrete, masonry, rock and sand are mixed, blasted, chipped, cut, crushed, drilled, dumped, ground, mixed or driven upon.

Employees at construction sites may be exposed to silica dust during general housekeeping activities such as sweeping, emptying vacuum cleaners and using compressed air for cleaning. Silica exposures may also occur whenever silica-containing dusts are disturbed, such as during material handling. The small particles generated during these activities easily become suspended in the air and, when inhaled, penetrate deep into employees' lungs.

## Visible and Respirable Dust

Visible dust contains large particles that are easy to see. The tiny, respirable-sized particles (those that can get into the deep lung) containing silica pose the greatest hazard and are not visible.

Most dust-generating construction activities produce a mixture of visible and respirable particles.

- ) Use visible dust as a general guide for improving dust suppression efforts. If you see visible dust being generated, emissions of respirable silica are probably too high.
- ) Measures that control tool-generated dust at the source usually reduce all types of particle emissions, including respirable particles.
- ) Do not rely only on visible dust to assess the extent of the silica hazard. There may be airborne respirable dust present that is not visible to the naked eye.

***General Rule: If dust containing silica is visible in the air, it's almost always more than the permissible limit.***

## Exposure Limits

When employees perform tasks listed in [OSHA Standard 1926.1153, Table 1](#) for more than four hours, they may be required to use respiratory protection. Click on the link above for more specific information.

Depending on the degree of exposure, the silica standard for construction requires employers to:

- ) Measure the amount of silica that workers are exposed to if it may be at or above an action level of 25  $\mu\text{g}/\text{m}^3$  (micrograms of silica per cubic meter of air), averaged over an 8-hour day;
- ) Protect workers from respirable crystalline silica exposures above the Permissible Exposure Limit (PEL) of 50  $\mu\text{g}/\text{m}^3$ , averaged over an 8-hour day;
- ) Limit workers' access to areas where they could be exposed above the PEL; and
- ) Use dust controls to protect workers from silica exposures above the PEL.

Where exposure exceeds the action level, the employer must assess exposure either through a performance option or monitoring. Where the most recent exposure monitoring indicates that employee exposures are at or above the action level but at or below the PEL, the employer must repeat monitoring within six months.

### Collecting an Air Sample

A trained specialist, such as a certified industrial hygienist, will use a device called a cyclone assembly and a sampling pump to trap tiny respirable silica particles from the air in the work environment.

- ) The cyclone assembly and sampling pump will be placed on an employee, who will wear the device throughout the work shift for up to 8 hours.
- ) All employees may be fitted with the sampling device or just a select few who are closest to the silica source may be fitted. The industrial hygienist can help you determine what will be most appropriate.
- ) The hygienist will return at the end of the sampling period to de-activate the sampling pump and remove the filters to be sent for analysis.

Watch this short [video](#) by Galson Laboratories on dust and/or silica sampling.

### Controlling Exposure

To control exposure to silica dust and fibers, avoid dry sweeping and the use of compressed air on concrete. Both these activities can stir up large amounts of dust. Use a vacuum with high efficiency filters when possible. When these activities cannot be avoided, respirators must be worn.

Best practices to help protect employees against exposures to silica include:

- ) Replace crystalline silica materials with safer substitutes, whenever possible.
- ) Provide engineering or administrative controls, where feasible, such as local exhaust ventilation and blasting cabinets. Where necessary to reduce exposures below the PEL, use protective equipment or other protective measures.
- ) Use all available work practices to control dust exposures, such as water sprays.

- ) Wear only a N95 NIOSH-certified respirator, if respirator protection is required. Do not alter the respirator. Do not wear a tight-fitting respirator with a beard or mustache that prevents a good seal between the respirator and the face.

For a more detailed discussion of controlling exposure to respirable silica, see [OSHA Standard 1926.1153, Respirable crystalline silica](#), and [OSHA Publication 3902-07R 2017, Small Entity Compliance Guide for the Respirable Crystalline Silica Standard for Construction](#).

Check out this short [video](#) on controlling silica in construction.

### More Best Practices

- ) Wear only a Type CE abrasive-blast supplied-air respirator for abrasive blasting.
- ) Wear disposable or washable work clothes and shower if facilities are available. Vacuum the dust from your clothes and change into clean clothing before leaving the work site.
- ) Participate in training, exposure monitoring, and health screening and surveillance programs to monitor any adverse health effects caused by crystalline silica exposures.
- ) Be aware of the operations and the job tasks creating crystalline silica exposures in your workplace environment and know how to protect yourself.
- ) Be aware of the health hazards related to exposures to crystalline silica. Smoking adds to the lung damage caused by silica exposures.
- ) Do not eat, drink, smoke, or apply cosmetics in areas where crystalline silica dust is present. Wash your hands and face outside of dusty areas before performing any of these activities.
- ) Remember: If it's silica, it's not just dust.

### Training

It's important for the employer to train all employees who might have exposure to silica while performing demolition operations. Make sure employee training includes:

- ) methods and observations to detect the presence of silica
- ) when and where the physical and health hazards associated with silica exist

) steps necessary to eliminate the hazards or at least protect themselves from silica exposure in the workplace

Check out this IOSH [video](#): No Time to Lose Campaign about the consequences of exposure to harmful substances in the workplace.

## Module 9 Quiz

Use this quiz to self-check your understanding of the module content. You can also go online and take this quiz within the module. The online quiz provides the correct answer once submitted.

- 1. This dust can be generated when materials such as concrete and masonry, blasted, ground, mixed or driven upon.**
  - a. Lead
  - b. Silica
  - c. Asbestos
  - d. Barium
  
- 2. The employer must ensure that no employee is exposed to an airborne concentration of silica dust in excess of \_\_\_\_.**
  - a. 100. f/c<sup>3</sup> as an eight (8) hour time-weighted average (TWA)
  - b. 10. f/c<sup>3</sup> as an eight (8) hour time-weighted average (TWA)
  - c. 1.0 f/c<sup>3</sup> as an eight (8) hour time-weighted average (TWA)
  - d. 0.1 f/c<sup>3</sup> as an eight (8) hour time-weighted average (TWA)
  
- 3. To control exposure to silica dust and fibers during demolition, \_\_\_\_.**
  - a. perform dry sweeping with an approved broom
  - b. use a single-strap dust mask
  - c. avoid dry sweeping and using compressed air on concrete
  - d. do not use local exhaust ventilation
  
- 4. If respiratory protection is required during demolition, wear only a \_\_\_\_.**
  - a. tight-fitting respirator over a beard or mustache
  - b. N95 NIOSH-certified respirator
  - c. suitably altered full-face respirator
  - d. Type 3 air-supplied respirator
  
- 5. What should demolition workers who have been exposed to silica fibers and dust do before leaving the work site?**
  - a. Vacuum the dust from work clothes and change into clean clothing
  - b. Shake off the dust from clothing prior to leaving the worksite
  - c. Vacuum the dust from work clothes prior to leaving work
  - d. Change into clean clothing and take work clothes home for washing

## Endnotes

1. 29 CFR Part 1926, Subpart T – Demolition, OSHA. Derived from:  
<https://www.osha.gov/doc/topics/demolition/index.html>
2. Demolition, from Wikipedia, the free encyclopedia. Retrieved from:  
<http://en.wikipedia.org/wiki/Demolition>
3. Construction and Demolition Materials, Environmental Protection Agency. Retrieved from:  
<http://www.epa.gov/wastes/nonhaz/industrial/cd/>
4. Construction and Demolition Waste Manual, City of New York City. Retrieved from:  
[www.nyc.gov/html/ddc/downloads/pdf/waste.pdf](http://www.nyc.gov/html/ddc/downloads/pdf/waste.pdf)
5. Construction, Demolition and Abatement, City of New York, Environmental Protection. Retrieved from:  
[http://www.nyc.gov/html/dep/html/construction\\_demolition\\_abatement/index.shtml](http://www.nyc.gov/html/dep/html/construction_demolition_abatement/index.shtml)
6. Silica in Construction Training Kit, Washington State Dept. of Labor and Industries. Retrieved from:  
<http://www.lni.wa.gov/SAFETY/TRAININGPREVENTION/TRAININGKITS/SILICAINCONSTRUCTION/DEFAULT.ASP>
7. A Guide to Working Safely with Silica, US Dept. of Labor, NIOSH. Retrieved from:  
<http://www.msha.gov/S&HINFO/SILICO/SILICAX.pdf>
8. “Crystalline Silica Exposure” – Health Hazard Information for Construction Employees, OSHA. Retrieved from: <https://www.osha.gov/Publications/3177-2002-English.html>
9. Safety and Health Topics – Lead, OSHA. Retrieved from:  
<https://www.osha.gov/SLTC/lead/index.html>
10. Safety and Health Topics – Asbestos, OSHA. Retrieved from:  
<https://www.osha.gov/SLTC/asbestos/index.html>