UNIVERSITY OF WISCONSIN OSHKOSH

Safety and Health in Wind Energy

Strategies for Small Wind Energy Businesses
Targeted Topic Training

Participant Booklet

Developed by the University of Wisconsin Oshkosh,
Center for Career Development and Employability Training

In cooperation with the Occupational Safety and Health Administration
and funded by a Susan B. Harwood Grant

2011

UNIVERSITY OF WISCONSIN OSHKOSH

Center for Career Development and Employability Training (CCDET)

The vision of CCDET is to be the provider of choice for innovative training and support services to Wisconsin public agencies.

This curriculum was developed by The University of Wisconsin Oshkosh, Center for Career Development and Employability Training, Oshkosh Wisconsin. It was fully funded with federal funds from the Occupational Safety and Health Administration, U.S. Department of Labor, in the amount of $200,785, under grant number SH-21009-10-60-F-55. These materials do not necessarily reflect the views or policies of the U.S. Department of Labor, nor does mention of trade names, commercial products or organizations imply endorsement by the U.S. government.

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INTRODUCTION

This *Safety and Health in Wind Energy* training program is sponsored by a grant made available through the Susan Harwood Training Grant Program. This grant program is administered by the United States Department of Labor, Occupational Safety and Health Administration (OSHA).

The purpose of the Susan Harwood Training Grant Program is to provide training and education programs that will help employers and workers recognize, avoid and prevent safety and health hazards in their workplaces.

This particular training program was developed by the University of Wisconsin Oshkosh's Center for Career Development and Employability Training (CCDET). Recognized as a leader in regional and state training for more than two decades, CCDET offers creative solutions and support services to federal, state and local organizations. CCDET creates new approaches and modify existing strategies, providing training and support services to meet the unique needs of agencies and organizations, both large and small.

The purpose of the *Safety and Health in Wind Energy* training program is to address hazards related to the installation, maintenance and demolition of wind turbines. During this program, you will gain the knowledge and basic skills to:

- Identify the ten critical processes used in constructing, maintaining and demolishing wind turbines, particularly as they relate to your worksite.
- Identify the general safety and health hazards associated with these ten processes.
- Perform a job hazard analysis of the processes used at your worksite to identify specific hazards.
- Recognize regulatory standards and requirements pertaining to the hazards you find at your worksite.

- Identify ways to control and eliminate the hazards you find at your worksite as a means of preventing injuries and deaths.
- Recognize obstacles to using safe work practices at your worksite and identify suggestions for addressing them.

The content in this training program will reflect the needs and characteristics of small businesses and their workers in the wind energy industry. You will receive a variety of resources and tools so you can take the content from this program and use it on the job in two ways. First you can use the materials yourself to practice your own job in a safe manner. Second, you can use the materials to teach others at your worksite the important principles of working in a safe manner.

The following people deserve recognition and thanks for their assistance in reviewing this program and providing suggestions for improvement.

Dan Epstein, CEO
Renewegy, L L.C.
Oshkosh, Wisconsin

Jenny Heinzen, Wind Energy Instructor
Lakeshore Technical College
Cleveland, Wisconsin

Andrew Herr, Lead Technician
Seventh Generation Energy Systems
Madison, Wisconsin

Douglas Larson, President
Orion Construction Group, L.L.C.
Appleton, Wisconsin

Greg Vosters, Project Manager
Orion Construction Group, L.L.C.
Appleton, Wisconsin

Thanks to the following students from Lakeshore Technical College in Cleveland, Wisconsin for their participation in the filming.

Demonstration of Harnesses

Lin Phonthongsy
Troy Erickson

Outdoor Climbs

Joshua Goede—Ladder Climber
Todd Sturz—Peg Climber

Indoor Climb

Aaron VandenBloomer—Climber
Kyle Guthrie—Photographer

Struck-By Demonstration

Aaron VandenBloomer—Climber
Joshua Goede—Ground Worker

MODULE 1
INTRODUCTION TO THE TEN CRITICAL PROCESSES

The Purpose of this Module

In this module, you will get an overview of the course, and you will learn the ten critical processes involved in installing, maintaining and decommissioning wind turbines.

Objectives

When we are done with this module, you will be able to:

- State the course goals.
- Identify the ten critical processes involved in installing, maintaining and decommissioning wind turbines.

WELCOME

Welcome to the *Safety and Health in Wind* Energy *training* program. Today's class will teach you the basics of safety and health as you work on your wind energy projects. You will probably discover that you already use many safety practices on your job. That's great! This class will reinforce the good practices you already use and perhaps teach you some new ones. There are six main goals for today's class.

- Identify the ten critical processes used in constructing, maintaining and demolishing wind turbines, particularly as they relate to your worksite.
- Identify the general safety and health hazards associated with the above ten processes.
- Perform a job hazard analysis of the processes you use at your worksite to identify specific hazards.
- Recognize regulatory standards and requirements pertaining to the hazards you find at your worksite.
- Identify ways to control and eliminate the hazards you find at your worksite as a way to protect you from injury or death.
- Recognize obstacles to using safe work practices at your worksite and find ways to address them.

? **Did you know . . .** one in every five workplace fatalities is a construction worker?

THE TEN CRITICAL PROCESSES

The American Society of Safety Engineers has identified ten processes related to the building, maintaining and demolition of wind turbines. These processes should be considered when you identify safety procedures for your worksite. How many of these processes do you use on your job?

1. Working at heights
2. Mechanical assembly of large components
3. Working around electricity
4. Working in exposed environments

Photo courtesy of Jenny Heinzen, Lakeshore Technical College

Photo courtesy of Orion, L.L.C.

5. Wind turbine assembly and erection
6. Wind turbine component offloading
7. Tower assembly

8. Nacelle placement
9. Rotor assembly and placement
10. Mechanical completion and commissioning

Photo courtesy of Orion, L.L.C.

MODULE 2
THE JOB HAZARD ANALYSIS

The Purpose of this Module

In this module, you will learn about the employer's responsibilities and the employee's rights under OSHA for a safe working environment. An important method for ensuring a safe working environment is the job hazard analysis. In this module, you will be introduced to the job hazard analysis and a job hazard analysis form. You will practice by choosing a process you commonly perform at your work and prepare a job hazard analysis for it.

Objectives

When we are done with this module, you will be able to:

- Recognize the employer's responsibilities under OSHA to provide a safe working environment.
- Recognize the employee's rights under OSHA to work in a safe environment.
- Describe the purpose of the job hazard analysis.
- Recognize the important components of a job hazard analysis.
- Perform a job hazard analysis on one of your work processes.

WORKER RIGHTS UNDER THE OSH ACT

The law encourages workers to be active players in their workplace's safety and health effort. It gives employees the right to:

1. Review copies of appropriate standards, rules, regulations, and requirements that the employer is required to have available at the workplace.
2. Request information from the employer on safety and health hazards in the workplace, appropriate precautions to take, and procedures to follow if the employee is involved in an accident or is exposed to toxic substances.
3. Gain access to relevant employee exposure and medical records.
4. Request an OSHA inspection if they believe hazardous conditions or violations of standards exist in the workplace.
5. Accompany an OSHA compliance officer during the inspection tour, or have an authorized employee representative do so.
6. Respond to questions from the OSHA compliance officer.
7. Observe any monitoring or measuring of hazardous materials and see the resulting records, as specified under the OSH Act and required by OSHA standards.
8. Review or have an authorized representative review the employer's Log of Work-Related Occupational Injuries and Illnesses (OSHA 300) at a reasonable time and in a reasonable manner.
9. Object to the timeframe set by OSHA for the employer to correct a violation by writing to the OSHA area director within 15 working days from the date the employer receives the citation.
10. Submit a written request to the National Institute for Occupational Safety and Health for information on whether any substance in the workplace has potentially toxic effects in the concentration being used, and, if requested, have their names withheld from the employer.
11. Be notified if the employer applies for a variance from an OSHA standard, and have an opportunity to testify at a variance hearing and appeal the final decision;
12. Have their names withheld from their employer, by request to OSHA, if they sign and file a written complaint.
13. Be advised of OSHA actions regarding a complaint, and request an informal review of any decision not to inspect the site or issue a citation.
14. File a complaint if punished or discriminated against for acting as a "whistleblower" under the OSH Act or 13 other federal statutes for which OSHA has jurisdiction, or for refusing to work when faced with imminent danger of death or serious injury and there is insufficient time for OSHA to inspect.

For more information, go to http://www.osha.gov/Publications/3021.html

EMPLOYER RESPONSIBILITIES UNDER THE OSH ACT

Employers have certain responsibilities under the Occupational Safety and Health Act of 1970. The following list is a summary of the most important ones:

1. Provide a workplace free from serious recognized hazards and comply with standards, rules and regulations issued under the OSHA Act.
2. Examine workplace conditions to make sure they conform to applicable OSHA standards.
3. Make sure employees have and use safe tools and equipment and properly maintain this equipment.
4. Use color codes, posters, labels or signs to warn employees of potential hazards.
5. Establish or update operating procedures and communicate them so that employees follow safety and health requirements.
6. Provide medical examinations and training when required by OSHA standards.
7. Post, at a prominent location within the workplace, the OSHA poster (or the state-plan equivalent) informing employees of their rights and responsibilities.
8. Report to the nearest OSHA office within 8 hours any fatal accident or one that results in the hospitalization of three or more employees.
9. Keep records of work-related injuries and illnesses. (Note: Employers with 10 or fewer employees and employers in certain low-hazard industries are exempt from this requirement.)
10. Provide employees, former employees and their representatives access to the Log of Work-Related Injuries and Illnesses (OSHA Form 300).
11. Provide access to employee medical records and exposure records to employees or their authorized representatives.
12. Provide to the OSHA compliance officer the names of authorized employee representatives who may be asked to accompany the compliance officer during an inspection.
13. Not discriminate against employees who exercise their rights under the Act.
14. Post OSHA citations at or near the work area involved. Each citation must remain posted until the violation has been corrected, or for three working days, whichever is longer. Post abatement verification documents or tags.
15. Correct cited violations by the deadline set in the OSHA citation and submit required abatement verification documentation

For more information, go to http://www.osha.gov/as/opa/worker/employer-responsibility.html

THE JOB HAZARD ANALYSIS

An effective way to assess risk on the job is to perform a job hazard analysis.

What is a job hazard analysis?

Steps for Performing a Job Hazard Analysis

1. Identify a work process.
2. List every step involved in performing that work process.
3. For each step, ask, "What are the hazards or potential dangers?
4. For each hazard, ask, "What can I do to prevent or control this hazard?"

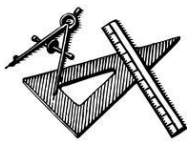
When you look for hazards on a job, where would you look? What types of things would you examine?

Note: OSHA Publication 3071, ***Job Hazard Analysis***, is available on your *Tools and Resources* CD.

THREE TYPES OF CONTROL

Once you have identified a hazard or a potential danger, there are three types of control you can use to eliminate or reduce the hazard.

TYPE OF CONTROL	EXAMPLES
1. Engineering controls • Most important • Preventive • Not dependent upon human actions	
2. Administrative controls • Second most important • Preventive • Dependent upon human actions	
3. Personal protective equipment • Control of last resort • Protects people after an accident occurs • Dependent upon human actions	



BASIC JOB HAZARD ANALYSIS

Directions: In your group, identify a process from your work and list the steps involved in performing the process. Then identify the potential hazards associated with each step. Finally, identify some controls that can protect you from the hazards.

Work Process:		
Steps to Perform the Work Process	**Hazards/Potential Hazards**	**Controls**
1.		
2.		
3.		
4.		
5.		
6.		

Note: A copy of this form is available on your *Tools and Resources* CD.

SAMPLE PROJECT HAZARD ANALYSIS FORM

Complete daily before beginning work.

(1) JOB INFORMATION				
Date:	Job name:	Job number:		
Physical address:		Longitude:	Latitude:	Supervisor:

(2) PROJECT PERSONNEL (GC and Sub-Tier, if applicable)					
Name:	Company:	CPR/First Aid		Name:	Company:
		☐ Yes	☐ Yes		
		☐ Yes	☐ Yes		
		☐ Yes	☐ Yes		

(3) EMERGENCY PROCEDURES (List telephone numbers and attach directions to the site)			
Are 911 systems functional with cell phone use?	☐ Yes	☐ No	
Tower rescue procedures to be used:	☐ Fire Department	☐ In-House (Crew must be properly trained in rescue.)	☐ Other: Please describe
Ambulance:	Fire:	Police:	
Local hospital:	Telephone Company:	Utility Company:	
Evacuation Point:			

(4) JOB/TASKS FOR TODAY			
Check Work Being Performed ☐ Line and antennas ☐ Tower erection	☐ Electrical ☐ Testing (sweeps)	☐ Civil/concrete ☐ Decommissioning	☐ Other (please describe)
Job/Tasks: (List jobs in sequential steps)	Potential hazards: (List hazards for each step)	Preventative measures: (List each control for each hazard)	

SAMPLE PROJECT HAZARD ANALYSIS FORM—continued

(5) JOB/TASKS FOR TODAY

Hazard identification: Items checked below relate to existing conditions or may be a result of site operations.

Physical Hazards		Health Hazards	
☐ Confined space ☐ Permit required	☐ Intrusive activity	☐ Chemical exposure	☐ Silica exposure (concrete cutting)
☐ Electrical	☐ Overhead utilities	☐ Cold stress	☐ Other
☐ Elevation/site terrain	☐ Slips, trips or falls	☐ EME/RF	
☐ Falls from elevations	☐ Underground utilities	☐ Heat stress	
☐ Fire hazards	☐ Vehicle traffic	☐ High noise (>85dBA)	
☐ Heavy equipment	☐ Other	☐ Lifting hazards	

(6) HAZARD CONTROL MEASURES

Personal Protective and Monitoring Equipment	Inspections (Complete all prior to use)	Safety Systems/Training
☐ Fall protection	☐ Tools/equipment	☐ 4-in-1 sign (banner of notices and warning signs)
☐ Gloves	☐ Rigging	☐ Excavation log
☐ Hard hat	☐ Housekeeping	☐ Lockout/tagout
☐ Hearing	☐ Tag lines	☐ Permit System (hoisting personnel, confined space, excavation, etc.)
☐ RF monitors	☐ Ground fault protection	☐ High noise (>85dBA)
☐ RF suits	☐ Gin poles	☐ Lifting hazards
☐ Safety glasses	☐ Hoists	

NOTE: Notify and confirm proper mitigation and/or protective steps taken with your company Safety Representative/Manager before entering any trench or any general excavation that is greater than 5' deep; or any confined space—above or below ground.

(7) COMPLETE FOR CIVIL WORK

1. Describe type and depth of excavations:
2. Cave-in control measures to be used if excavation will be great than 5 feet and personnel are entering the trench:

   ☐ Sloping ☐ Benching ☐ Shoring ☐ Trench ☐ Shield ☐ Ladder in trench at 4 feet
3. Describe elevation/site terrain/environmental concerns or hazards:
4. Describe hazards with site/vehicle access (e.g. boom and cranes/electrical lines) and storage of materials:
5. Describe type of electrical concerns or hazards:

(8) COMPLETE FOR TOWER WORK (FALL PROTECTION & SUSPENDED PERSONNEL PLATFORM)

Type of tower/rooftop: Type of Antenna boom:

Fall protection to be used:

☐ Full body harness	☐ Double leg or two lanyards	☐ Rope grab	☐ Cable grab
☐ Retractable lifeline	☐ Anchorage straps	☐ Ropes	☐ Descenders

Has each employee inspected his or her fall protection equipment?

Describe the fall protection system to be used when accessing antenna booms or performing tower erection:

Hoisting equipment to be used:

☐ Suspended personnel platform (manbasket) ☐ Crane ☐ Gin

Suspended personnel platform checklist and critical lift plan completed? ☐ Yes ☐ No

(9) COMPLETE FOR CIVIL WORK

Superintendent/foreman		Lower-tier subcontractor supervisor	
Name	Signature	Name	Signature

Note: The above form is adapted from and provided courtesy of Orion, L.L.C. A copy of this form is available on your *Tools and Resources* CD.

MODULE 3
RECOGNIZING AND CONTROLLING HAZARDS FROM WORKING AT HEIGHTS

Module Purpose:

The purpose of this module is to examine falls—the leading cause of fatalities at wind turbine construction sites. Emphasis will be placed on the proper use of fall protection, scaffolds, guarding and ladders. You will identify specific injury prevention strategies for falls and learn the OSHA regulations related to falls.

Objectives:

When we are done with this module, you will be able to:

- Analyze wind energy worksites for fall-related hazards.
- Identify best practices and important controls for preventing falls.
- Practice the proper use of fall protection gear.
- Recognize and use OSHA standards related to falls and fall protection.

TEST YOUR KNOWLEDGE OF FALLS

Directions: How much do you know about falls? Here is a quick quiz to test your knowledge. Read the question, then select the answer you believe is correct.

1. What is the leading cause of death from falls among wind turbine workers?
   - ☐ A. Slipping on ice or another slippery surface
   - ☐ B. Tripping over a tool or piece of equipment
   - ☐ C. Falling from the bed of a truck carrying large equipment
   - ☐ D. Falling from heights

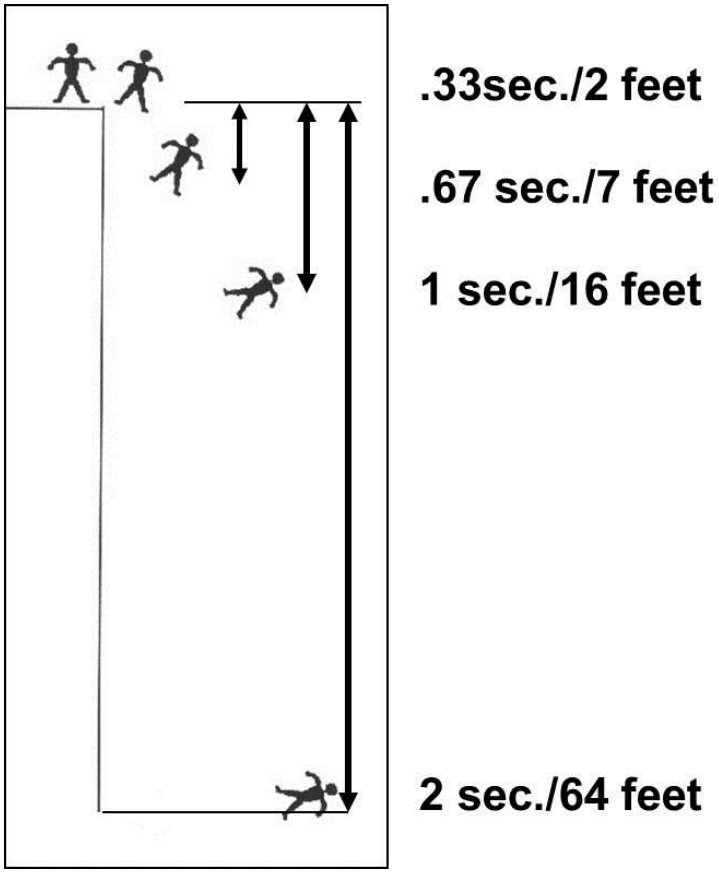
2. What percentage of all construction deaths come from falls?
   - ☐ A. 14%
   - ☐ B. 26%
   - ☐ C. 33%
   - ☐ D. 41%

3. In a personal fall arrest system, lanyards and vertical lifelines must have a minimum breaking strength of:
   - ☐ A. 2,000 pounds.
   - ☐ B. 3,500 pounds.
   - ☐ C. 5,000 pounds.
   - ☐ D. 6,500 pounds.

4. Personal fall arrest systems, when stopping a fall, must be rigged so that no employee can free fall more than _____, nor contact any lower level.
   - ☐ A. 6 feet
   - ☐ B. 8 feet
   - ☐ C. 10 feet
   - ☐ D. 12 feet

ANATOMY OF A FALL

Some people assume that, when they feel they are about to fall, they can grab onto something to prevent the fall. But when you consider the anatomy of a fall, you will understand that, by the time to recognize you are falling, it is too late.



- It takes people about 1/3 of a second to figure out something is wrong.
- In that amount of time, you fall two feet.
- It takes another 1/3 of a second for a person to react.
- In that amount of time, you fall another five feet.
- Within two seconds, you can fall over 50 feet.
- A fall happens so fast, there is just not enough time to grab onto anything.

JOB HAZARD ANALYSIS FOR FALLS

Directions: Assume that the job you are working on requires you to work on top of the rebar. Let's perform a job hazard analysis for falls. What are the potential fall hazards? For each fall hazard, identify the appropriate controls. Record your answers below.

Photo courtesy of Orion, L.L.C.

Work Process: Working on top of rebar

Fall Hazards	Controls

JOB HAZARD ANALYSIS FOR FALLS

Directions: Assume that the job is to offload these tower parts to the worksite. Let's perform a job hazard analysis for falls. What are the potential fall hazards? For each fall hazard, identify the appropriate controls. Record your answers below.

Photo courtesy of Orion, L.L.C.

Work Process: Offloading the tower parts

Fall Hazards	Controls

JOB HAZARD ANALYSIS FOR FALLS

Directions: Assume that the job is to perform routine maintenance at the top of this lattice tower. Let's perform a job hazard analysis for falls. What are the potential fall hazards? For each fall hazard, identify the appropriate controls. Record your answers below.

Photo courtesy of Jenny Heinzen

Work Process: Climbing to get to the nacelle for maintenance

Fall Hazards	Controls

JOB HAZARD ANALYSIS FOR FALLS

Directions: Assume that the job is to perform routine maintenance on the nacelle. Let's perform a job hazard analysis for falls. What are the potential fall hazards? For each fall hazard, identify the appropriate controls. Record your answers below.

Photo from istockphoto.com

Work Process: Nacelle maintenance

Fall Hazards	Controls

JOB HAZARD ANALYSIS FOR FALLS

Directions: Assume that the job is to perform routine maintenance on the tower joint. Let's perform a job hazard analysis for falls. What are the potential fall hazards? For each fall hazard, identify the appropriate controls. Record your answers below.

Photo courtesy of Seventh Generation Energy Systems

Work Process: Working on a monopole

Fall Hazards	Controls

WORKSITE ANALYSIS FOR FALLS

Directions: Following is a list of typical work activities that occur at wind turbine sites that may have some intrinsic fall hazards. For each activity, identify the potential **fall** hazards. Then identify some controls that can protect workers from these hazards.

Activity/Work Process	Fall Hazards	Controls
1. Working when ground conditions are icy		
2. Walking on a rebar surface		
3. Standing on a trailer while offloading turbine components		
4. Climbing a lattice or a monopole (freestanding) tower		
5. Transferring from lattice tower to nacelle platform		
6. Climbing inside the tower		
7. Attaching/bolting tower segments		
8. Working in a man-lift basket		
9. Attaching rotor blades to nacelle		
10. Working outside nacelle and transferring to the hub		
11. Working inside nacelle		

BEST PRACTICES

Following is a list of practices that can protect your employees from falls. Score your organization on each item using the following guidelines.

3 = We do this consistently and purposefully.
2 = We do this sometimes, but not always. We could be more consistent.
1 = We really could use improvement with this item.

Item	3	2	1
General Practices			
— Have a policy never to climb alone			
— Perform pre-climb stretches to warm up your body and stay limber			
— Have an onsite, documented rescue plan, including emergency phone numbers			
— Require tower climber training			
Good Housekeeping			
— Floor holes are guarded or covered			
— Employees wear slip-resistant shoes			
— Floor/ground of work area is free and clean of debris			
Ladders			
— Are in good condition (rungs, steps, side rails, locking components)			
— Side rails secured at the top to a rigid support for access ladders			
— Are within ladder weight specifications			
— Rungs are free of oil, grease, ice or snow			
Scaffolds			
— Erected under the supervision of a competent person			
— Undamaged and in good condition			
— Have sufficient guardrails			

BEST PRACTICES—Continued

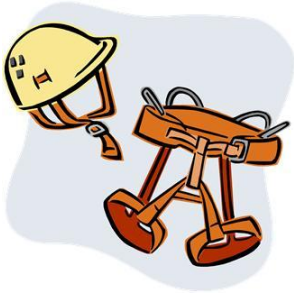
— Scaffold can support its own weight plus four times the weight of the maximum load			
— Work deck fully planked with no open spaces			
— Supported with firm foundations and base plates			
— Has toe boards to prevent tools and other loose equipment from falling below			
Guardrails			
— Top edge between 39 and 45 inches			
— Capable of withstanding 200 pounds of force from any direction			
— Free of rough edges or surfaces			
Fall Arrest Systems			
— Use personal fall arrest systems, including a harness with lanyards			
— Calculate fall distances before choosing fall arrest system			
— Ensure that the gear is free of wear, damage and deterioration			
— The harness must be secured to appropriate anchor at all times			
— Do a buddy check before climbing to ensure that all equipment is clipped properly and that nothing is tangled			
— Have a rescue plan is in place			

Note: A copy of this form is available on your *Tools and Resources* CD.

In the space below, identify one or two items from the above list that you plan to improve:

PROPER USE OF FALL PROTECTION GEAR

Directions: Take notes in the space below as you watch the demonstration of the proper use of fall protection gear.



THE RESCUE PLAN

What do you do if someone falls and becomes suspended toward the top of the tower? Would you know how to get that person down? A rescue plan helps everyone understand what to do before a fall.

Following are some important components of a rescue plan.

- ☐ Gain an understanding of the physical environment you will be working in.
- ☐ Determine the proximity of a professional rescue team.
- ☐ Determine if 911 works from the area where you would be calling.
- ☐ Determine approximate response time for 911 responders.
- ☐ Understand the type of rescue that may be necessary (lowering a victim from a ladder, platform or manbasket).
- ☐ Determine who is trained to do the rescue.
- ☐ Decide if the rescuers will be on-site or stand-by. If stand-by, determine the response time.
- ☐ Perform a job safety analysis of the rescue.
  - Is the victim clear of obstructions when s/he is lowered?
  - Does the lifeline deploy correctly?
  - Is the lifeline long enough?
  - Can you see the victim throughout the entire rescue operation?

In addition to having a plan, it is also important to have rescue equipment and supplies on site and ready to be used.

- ☐ Rescue devices that can raise or lower a victim, such as a controlled rate descent device
- ☐ Ropes and lifelines rated for rescue and evacuation
- ☐ Rolling edge protectors or Velcro edge protectors to protect the rope from sharp edges and abrasion
- ☐ Designated anchor points for rescue equipment (rated at least 3100 pounds)
- ☐ Anchor straps and carabiners for making an anchor point when one is not available or convenient
- ☐ First aid kit and defibrillator

Note: A copy of this checklist is available on your *Tools and Resources* CD.

THE GUIDELINES AND REGULATIONS

There are many OSHA standards designed to protect workers from falls. There are four major parts of OSHA 29 CFR 1926 that address fall protection (Subparts E, L, M and X). To read more about any of these regulations, see the OSHA website at www.osha.gov.

If you want to know about:	**Then refer to:**
Safety standards for scaffolds	OSHA 29 CFR 1926, Subpart L
– Definitions of various terms related to scaffolds	1926.450(b)
– Requirements for scaffolds	1926.451
– Type of fall protection to use with each type of scaffold	1926.451(g)(1)
Standards for fall protection equipment	OSHA 29 CFR 1926, Subpart M
– Statement of employer's duty to have fall protection	1926.501
– Statement of need for fall protection	1926.501(b)(1)
– Criteria for fall protection systems	1926.502
– Criteria for guardrail systems	1926.502(b)
– Criteria for fall safety net systems	1926.502(c)
– Criteria for fall arrest systems	1926.502(d)
– Criteria for a personal fall arrest system	1926.502(d)(16)
– Criteria for a fall protection training program	1926.503(a)
Standards for ladder safety	OSHA 29 CFR 1926, Subpart X
– Criteria for safe ladder use	1926.1053

Note: In addition to OSHA regulations, the American National Standards Institute (ANSI) has developed a Fall Protection Code (ANSI Z359).

MODULE 4
RECOGNIZING AND CONTROLLING ELECTRICAL HAZARDS

Module Purpose:

The purpose of this module is to provide you with an opportunity to examine the hazards that cause the most frequent electrical injuries and the controls that can keep you safe from electrical injuries.

Objectives:

When we are done with this module, you will be able to:

- Analyze wind energy worksites for electrical hazards.
- Recognize the danger of arc flash and identify steps to reduce the danger.
- Identify best practices and important controls for preventing electrical injuries and fatalities.
- Practice the proper use of lockout/tagout.
- Recognize and use OSHA standards related to electrical safety.

TEST YOUR KNOWLEDGE OF ELECTRICAL SAFETY

Directions: How much do you know about electrical safety? Here is a quick quiz to test your knowledge. Read the question, then select the answer you believe is correct.

1. How many workers die every year in electrical accidents?
   - ☐ A. 150
   - ☐ B. 250
   - ☐ C. 350
   - ☐ D. 450

2. Which industry has more electrocutions every year than any other industry?
   - ☐ A. Utilities
   - ☐ B. Landscaping
   - ☐ C. Construction
   - ☐ D. Manufacturing

3. When is it necessary to use lockout/tagout procedures to prevent electrical injuries?
   - ☐ A. When anyone is working around electrical equipment
   - ☐ B. When anyone is working on equipment that has multiple energy sources
   - ☐ C. When two or more employees are performing maintenance on the same electrical equipment
   - ☐ D. When there is potential for an unexpected energization of equipment that could cause injury to an employee

4. Equipment such as cranes, forklifts, backhoes and scaffolding must maintain at least a _____ foot minimum clearance from overhead power lines.
   - ☐ A. 6
   - ☐ B. 10
   - ☐ C. 12
   - ☐ D. 20

WORKSITE ANALYSIS FOR ELECTRICAL HAZARDS

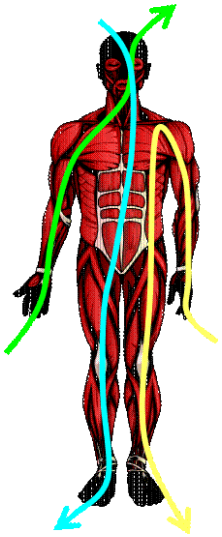
Directions: Electrical hazards can come from many sources. For each of the following sources of electrical hazard, identify where at your worksite it might be found.

Hazard	Where Hazard Might be Found
Energized electrical equipment	
Energized power sources	
Ground fault	
Wiring	
Damaged power tools	
Damaged extension cords	
Residual voltage	
Wet conditions	
Storms	
Arc flash	

ELECTRICAL HARM

Electricity is a funny thing. You can't see it or taste it, but if you come into contact with it, it can do considerable damage. The chart below describes what can happen to a person if he or she has amperage that runs across the chest.

Estimated Effects of AC Currents (U.S. Standard 60 Hz)	
1 milliamp (mA)	Barely perceptible
16 mA	Maximum current an average man can grasp and "let go"
20 – 30 mA	Paralysis of respiratory muscles
100 mA	Ventricular fibrillation threshold
2 Amps	Cardiac standstill and internal organ damage
15/20/30 Amps	Common U.S. household breakers



Electrical Damage to the Body

- If you touch a power line, or energized equipment, electricity will attempt to travel through your body.
- It heats up and burns body tissue internally.
- Electricity leaves the body violently, causing burns or even blowing out an exit hole.

Entrance Wound

Exit Wound

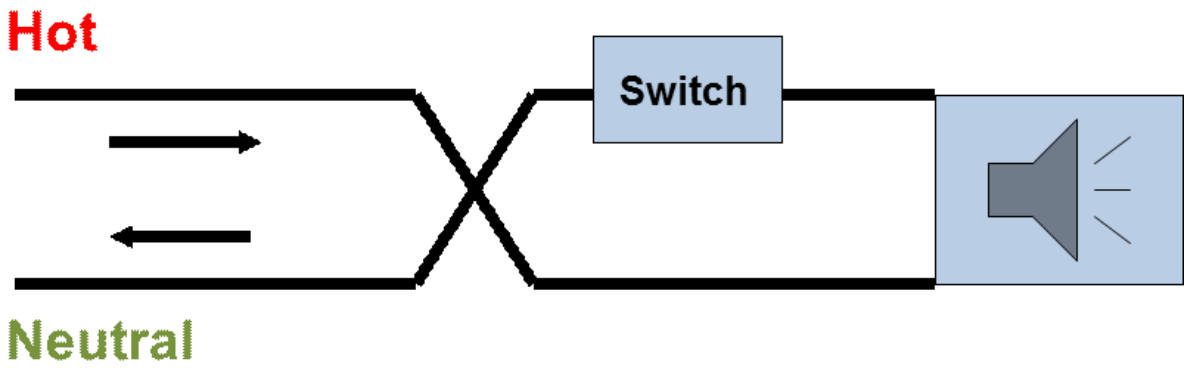
GROUND FAULT CIRCUIT INTERRUPTERS (GFCI)

It is important that you use a ground fault circuit interrupter with an open neutral protection at your wind turbine site.

- A GFCI monitors current flow between hot and neutral wires.
- It will trip between 4-6 mA in 1/40th of a second.

Ground Fault Circuit Interrupter

Reverse Polarity



- Tool could be hot with the switch off.
- Hot wire and neutral wire are reversed.
- Even though a switch is off, the circuit could be hot.

Notes: _____

_____

_____

_____

_____

POWER LINES

You must assume that all power lines are energized unless the utility company confirms that the power line has been de-energized and visibly grounded at the worksite.

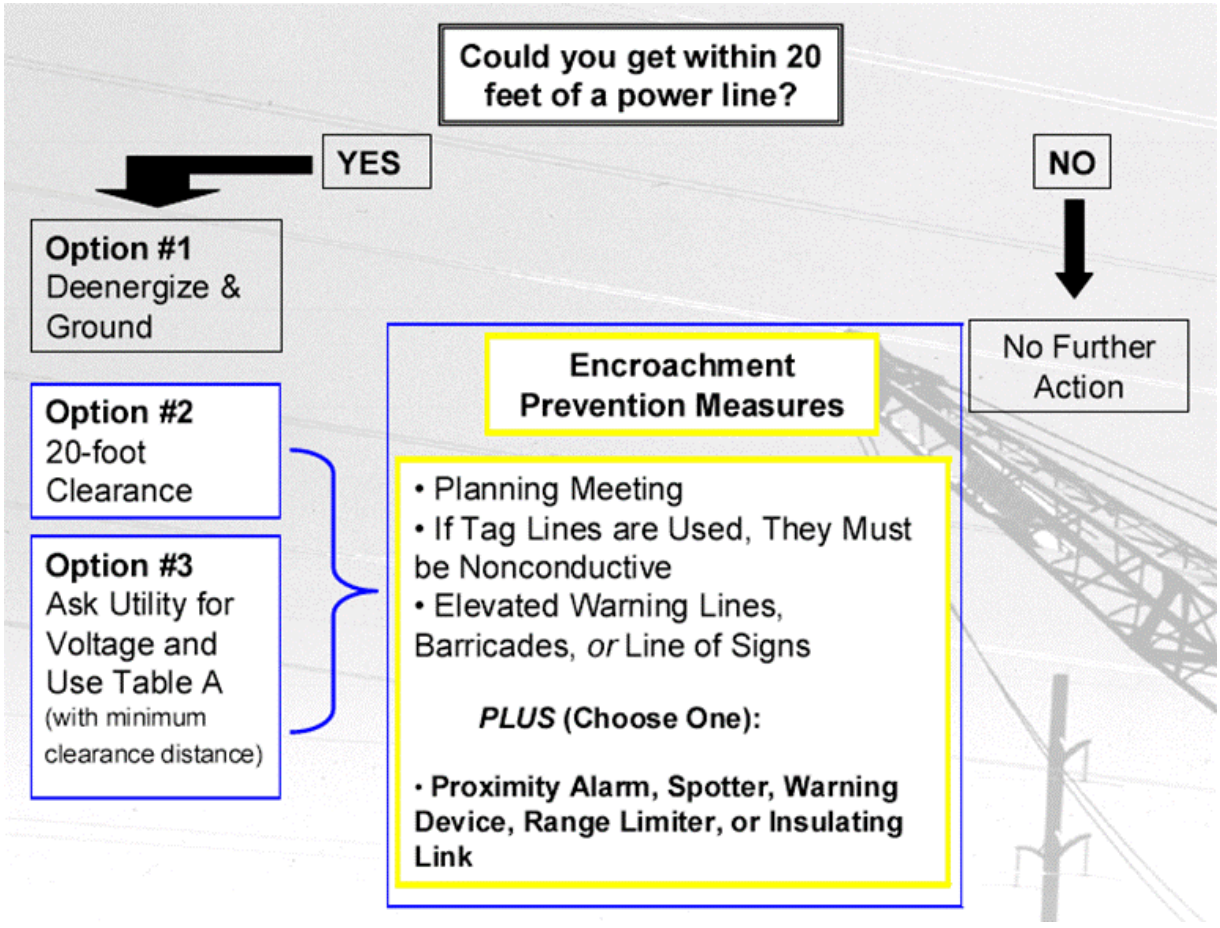
Operations Around Power Lines (up to 350kV)

According to OSHA 29CFR 1926.1408, the employer must make a hazard assessment and must define a work zone by demarcating boundaries.

Option 1—De-energize and ground the ground line.

Option 2—Ensure that no part of the equipment, load line or load gets closer than 20 feet to the power line.

Option 3—If line voltage is known, cannot get closer than minimum distances in Table A.



THE DANGER OF THE ARC FLASH

Definition of Arc Flash

An arc flash is a short circuit that flashes from one exposed live conductor to another, or from an exposed live conductor to the ground.

Some Facts About Arc Flash

- The ionized air in an arc flash creates very hot plasma that is electrically conductive.
- Temperatures can reach over 5,000° F.
- The explosion lasts for only a fraction of a second.
- The explosion creates a bright flash.
- The explosion has the impact of several sticks of dynamic.
- Although electric shock is more common on a wind farm, the ever-increasing voltages inside of turbines creates an ever-increasing danger of arc flash.

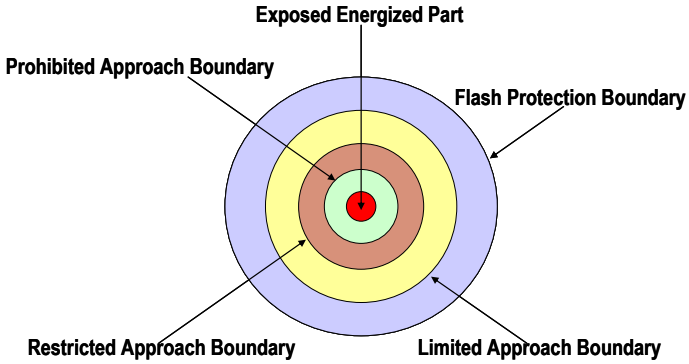
Preventing Injury from Arc Flash

- Have a certified professional conduct an arc flash study of your site to determine if/where there are any arc flash dangers.
- During an arc flash study, an electrical engineer calculates both the energy present in a system as well as the trip settings on the protection devices to determine a recommended safety level for your equipment.
- Only trained and qualified employees should be permitted to work around equipment with a high risk of arc flash.
- Personnel working around this equipment should wear fire resistant clothing.
- Personnel need to be trained to keep tools and other equipment away from the open circuit.

Photo courtesy of IAEI

Limits of Approach

This diagram illustrates the boundaries *that will be used by the qualified person when working with energized components*. Note that the outermost boundary is for flash protection. All of the inner boundaries are for shock protection.



Boundary	Meaning
Flash protection boundary	■ This is the outer boundary of the flash protection zone. ■ Employees passing it must wear flash protective equipment.
Limited approach boundary	■ A person crossing this line must be qualified to do the job/task. ■ They must wear flash protective equipment. ■ Unqualified workers are prohibited from crossing this boundary.
Restricted approach boundary	■ A person crossing this line enters into restricted space. ■ Only qualified people may cross this boundary. ■ Qualified people must have a written plan that is approved by authorized management. ■ They must use PPE appropriate for working near energized parts. ■ They must ensure no body part crosses the prohibited line and keep as much of their body out of the restricted space as possible.
Prohibited approach boundary	■ Crossing this line is the same as having contact with the live part. ■ Only qualified people may cross this line. ■ They must have specified training to work on energized parts. ■ They must have a documented plan and a risk hazard analysis that are approved by authorized management. ■ They must wear PPE appropriate for working on live parts.

BEST PRACTICES

Following is a list of practices that can protect employees from electrical injury. Score your organization on each item using the following guidelines.

3 = We do this consistently and purposefully.
2 = We do this sometimes, but not always. We could be more consistent.
1 = We really could use improvement with this item.

Item	3	2	1
General Practices			
___ Never assume a power source is de-energized unless checked personally.			
___ Use equipment only for its designed purpose.			
___ Have an emergency response plan for electrical emergencies.			
___ Periodically practice the emergency response plan for electrical emergencies.			
___ Use lockout/tagout.			
___ Create and use a written system for inspecting electrical equipment.			
___ Maintain a policy not to work on live electrical equipment in wet weather.			
Good Housekeeping			
___ Properly label power tools.			
___ Keep electrical enclosure doors closed and locked.			
___ Discard tools and cords that are frayed or damaged.			
___ Put tools away when not in use.			

BEST PRACTICES—Continued

Power Tool Safety			
— Use double-insulated tools.			
— Avoid carrying power tools by the cord.			
— Disconnect power tools before servicing them or before changing blades or bits.			
— Keep finger away from the "ON" switch when carrying a plugged in tool.			
— Avoid using power tools in damp or wet locations unless tools are specifically approved for such use.			
— Tag damaged tools with "Do Not Use".			
Extension and Flexible Cord Safety			
— Maintain a system for auditing cords to ensure they are in good working order and that they are the proper cord for the purpose.			
— Use only extension cords that are three-wire type.			
— Use only extension cords that are marked with a designation code for hard or extra-hard usage.			
— Avoid straining or stretching flexible cords.			
— Keep ground plugs intact.			
Ground Fault Protection			
— Ground all electrical equipment.			
— Use ground fault circuit interrupters (GFCIs) on all 120-volt, single-phase, 15 and 20-ampere receptacles.			
— Follow manufacturers' testing procedures to ensure GFCI is working properly.			
— Avoid using tools with missing ground prongs.			
— Avoid using tools with cracked tool casings.			

BEST PRACTICES—Continued

Working Around Power Lines			
—— Look for overhead power lines when entering a turbine construction site.			
—— Contact utilities to locate buried power line locations.			
—— Identify safe routes where cranes and other equipment must travel.			
—— Maintain required clearances from all power lines.			
—— Use spotters around overhead power lines.			

Note: A copy of this form is available on your *Tools and Resources* CD.

In the space below, identify one or two items from the above list that you plan to improve:

LOCKOUT/TAGOUT—AN ESSENTIAL BEST PRACTICE

What is lockout/tagout?

Procedures for Lockout/Tagout

1. The circuit or equipment must first be de-energized.
2. Every person working on the circuit or equipment must verify that the system is de-energized prior to starting work.
3. Every person working on the system must employ his/her own lock to isolate the energy.
4. The locked system must be properly identified with tags to indicate the system must not be tampered with.
5. As each person completes his/her task, they remove their padlock and tag.
6. Before re-energizing the system, all covers and panels must be securely re-attached.
7. A system cannot be re-energized until the final lock is removed.
8. People who perform lockout/tagout must be trained
9. Employees who work around locked and tagged equipment must be trained on the hazards of electricity and the importance of leaving the locks and tags intact.

THE GUIDELINES AND REGULATIONS

There are many OSHA standards designed to protect workers from electrical hazards. Some are in OSHA 29 CFR 1910, General Industry Standards. Others are in OSHA 29 CFR 1926, Construction Standards. To read more about any of these regulations, see the OSHA website at www.osha.gov.

If you want to know about:	**Then refer to:**
Lockout/tagout	OSHA 29 CFR 1910.147
– Definitions related to lockout/tagout	1910.147(b)
Safe use of hand and power tools	OSHA 29 CFR 1926, Subpart I
– Standards for power operated hand tools	1926.302
Standards for electrical safety	OSHA 29 CFR 1926, Subpart K
– General requirements for electrical equipment	1926.403
– Clearance guidelines for working around electricity	1926.403(i)(1)(ii)
– Guidelines for electrical installations	1926.403(j)(2)
– Requirements for wiring design and protection	1926.404
– Standards for wiring methods, components and equipment for general use	1926.405
– General requirements for worker safety around electricity	1926.416
Crane and derrick standards	OSHA 29 CFR 1926, Subpart CC
– Standards for operating cranes and derricks around electrical lines	1926.1407 through 1926.1411

Note: In addition to OSHA regulations, two other organizations have developed standards relevant to electrical safety on wind turbines. The National Fire Protection Association (NFPA) has developed NFPA 70, a United States standard for the safe installation of electrical wiring and equipment, and the International Electrotechnical Commission (IEC) has developed IEC 61400-1, a standard for wind turbines.

MODULE 5
RECOGNIZING AND CONTROLLING EXCAVATION AND TRENCHING HAZARDS

Module Purpose:

This module will allow you to examine safety issues related to excavations at wind turbine sites. You will be given a chance to perform a worksite analysis for excavations. You will be introduced to best practices to use in order to have safe excavations. Finally, you'll be introduced to the OSHA regulations that apply to safety at excavation sites.

Objectives:

When we are done with this module, you will be able to:

- Analyze your worksite for trenching and excavation hazards.
- Identify best practices and important controls for preventing trenching and excavation injuries.
- Recognize and use OSHA standards related to trenching and excavation.

TEST YOUR KNOWLEDGE OF EXCAVATIONS

Directions: How much do you know about excavations? Here is a quick quiz to test your knowledge. Read the question, then select the answer you believe is correct.

1. How many workers are fatally injured each year by cave-ins from excavations?
   - ☐ A. 28
   - ☐ B. 54
   - ☐ C. 67
   - ☐ D. 83

2. A stairway, ladder, ramp or other safe means of egress must be located in trench excavations that are _____ or more in depth.
   - ☐ A. 2 feet
   - ☐ B. 3 feet
   - ☐ C. 4 feet
   - ☐ D. 5 feet

3. How far back from an excavation must the spoils be?
   - ☐ A. 2 feet
   - ☐ B. 6 feet
   - ☐ C. 10 feet
   - ☐ D. 12 feet

4. When must excavations have protection systems?
   - ☐ A. Always
   - ☐ B. When the excavation is deeper than it is wide
   - ☐ C. When the excavation is over five feet deep, or less than five feet deep and there is an indication of a potential cave-in
   - ☐ D. When the excavation is over eight feet deep, or less than eight feet deep and there is an indication of a potential cave-in

WORKSITE ANALYSIS FOR EXCAVATION HAZARDS

Directions: Following is a list of typical work activities that occur at wind turbine sites that may have some intrinsic excavation hazards. For each activity, identify potential **excavation** hazards. Then identify some controls that can protect workers from these hazards.

Activity/Work Process	Excavation Hazards	Controls
1. Digging a site for a wind turbine		
2. Performing foundation work inside of a trench		
3. Installing rebar in the excavation cavity		
4. Entering or exiting an excavated site		
5. Transferring equipment and materials to and from trench		
6. Walking on a rebar surface in the trench		
7. Crossing over an excavated site on a walkway		
8. Walking near the edge of an excavation		
9. Operating a vehicle around an excavated site		
10. Working in an excavated area during a storm		

BEST PRACTICES

Following is a list of practices that can protect your employees from excavation-related injuries. Score your organization on each item using the following guidelines.

3 = We do this consistently and purposefully.
2 = We do this sometimes, but not always. We could be more consistent.
1 = We really could use improvement with this item.

Item	3	2	1
General Practices			
— Wear hard hat at all times			
— Avoid working or walking under a suspended load			
— Avoid working on faces of sloped or benched excavations above other workers			
— Set spoils back at least 2 feet back from excavation			
Good Housekeeping			
— Keep excavation site free of tools and debris			
— Wear slip resistant shoes			
Protection Systems			
— Installation supervised by a competent person			
— Maintain type of protection system that is adequate for the soil type			
— Inspected every day by a competent person			
Safe Entry and Egress			
— Have a safe way to enter and exit if excavation is 4 or more feet deep			
— Maintain entry/exit within 25 lateral feet of workers			
— If earthen ramp is used, it is level, and workers are able to walk upright on them			
— Ladders are secured and are at least 36 inches above the landing			
— Use non-metal ladders if electricity is present at the site			

BEST PRACTICES—Continued

Vehicle Safety			
— Wear clothing marked with or made of reflective or highly-visible material			
— Use a trained flag person to direct traffic at the excavation site			
— Fence or barricade excavation when work not in process			
Water Management			
— If water is present, site has water removal equipment, such as pumps, used an monitored by a competent person			
— Surface waters are diverted from the excavation			
— Site is inspected by a competent person after every rain and before workers are permitted to re-enter			
Hazardous Atmosphere			
— Test atmosphere in excavation for oxygen depletion or build-up and other air quality hazards			
— Make emergency equipment readily available			
Inspections			
— Inspect site daily and before the start of each shift by a competent person			
— Inspect site after rainstorms and other events such as snow or windstorms, thaws, tornadoes or earthquakes			
— Inspect site when fissures, cracks, sloughing, water seepage or bulging on the bottom occur.			
— Inspect site when there is a change in the size, location or placement of spoil pile			
— Document all inspections			

Note: A copy of this form is available on your *Tools and Resources* CD.

In the space below, identify one or two items from the above list that you plan to improve:

PROTECTION SYSTEMS

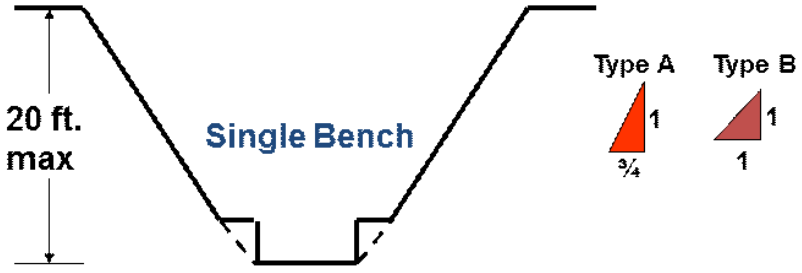
The OSHA requirements for protection systems are designed to help prevent cave-ins at excavation sites. There are several factors to consider when determining which type of protection system to build.

- It is important to determine the type of soil that exists where your wind turbine will be erected.
- A key question to ask is, "Are we creating a hole that can be sustained by the soil?"
- The competent person in the excavation company that you hire should perform a soil test.

Notes: _____

_____

_____



Notes: _____

_____

_____

HAZARDS/BEST PRACTICES ANALYSIS

Directions: Following is a photo of an excavation site. Identify the best practices you see in use at this site. Then identify any hazards you see.

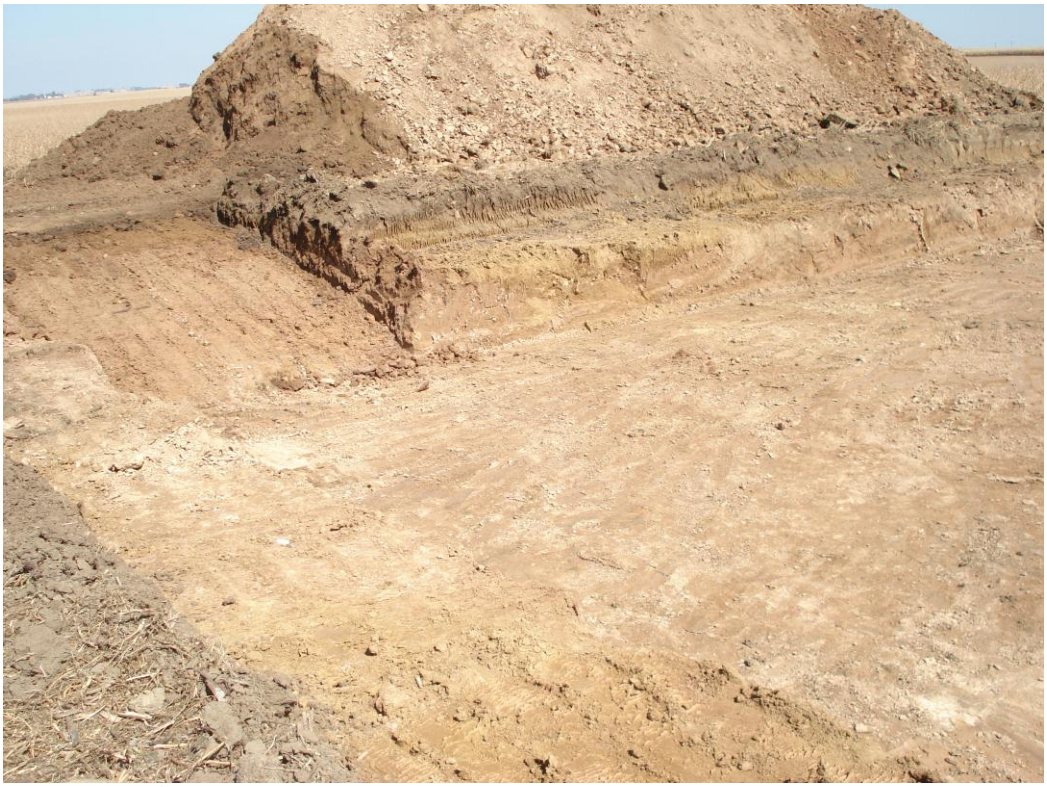


Photo courtesy of Orion, L.L.C

Best Practices	Hazards

HAZARDS/BEST PRACTICES ANALYSIS—continued

Directions: Following is a photo of an excavation site. Identify the best practices you see in use at this site. Then identify any hazards you see.

Photo courtesy of Orion, L.L.C

Best Practices	Hazards

HAZARDS/BEST PRACTICES ANALYSIS—continued

Directions: Following is a photo of an excavation site. Identify the best practices you see in use at this site. Then identify any hazards you see.

Photo courtesy of Seventh Generation Energy Systems

Best Practices	Hazards

HAZARDS/BEST PRACTICES ANALYSIS—continued

Directions: Following is a photo of an excavation site. Identify the best practices you see in use at this site. Then identify any hazards you see.

Photo courtesy of Seventh Generation Energy Systems

Best Practices	Hazards

HAZARDS/BEST PRACTICES ANALYSIS—continued

Directions: Following is a photo of an excavation site. Identify the best practices you see in use at this site. Then identify any hazards you see.

Photo courtesy of Seventh Generation Energy Systems

Best Practices	Hazards

THE GUIDELINES AND REGULATIONS

There are many OSHA standards designed to protect workers from excavation-related injuries. There are three major parts of OSHA 29 CFR 1926 that address excavation hazards (Subparts D, E and P). To read more about any of these regulations, see the OSHA website at www.osha.gov.

If you want to know about:	**Then refer to:**
Environmental controls in excavations	OSHA 29 CFR 1926, Subpart D
– Protecting employees from gases, vapors, fumes, dusts and mists	1926.55
– Ventilation requirements	1926.57
Personal protective and lifesaving equipment	OSHA 29 CFR 1926, Subpart E
– Keeping workers safe around water	1926.106(a)
Worker safety at excavations	OSHA 29 CFR 1926, Subpart P
– Definitions related to excavations	1926.650(a)
– Requirements for excavation entry and exit	1926.651(c)
– Warning systems for mobile equipment around excavations	1926.651(f)
– Protecting workers from excavation spoils	1926.651(j)
– Inspection requirements	1926.651(k)
– Requirement to remove workers from hazardous situations	1926.651(k)(2)
– Requirements for protective systems	1926.652
– Evaluating soil conditions	Appendix A
– Selecting appropriate protective systems	Appendix F

MODULE 6
RECOGNIZING AND CONTROLLING STRUCK-BY HAZARDS

Module Purpose:

In this module, you will learn about the hazards that cause workers to be struck by objects. Emphasis will be placed on struck-by injuries caused by vehicles, suspended objects and objects falling from above. You will learn how to protect yourself with appropriate work practices and the use of PPE.

Objectives:

When we are done with this module, you will be able to:

- Analyze your worksite for struck-by hazards.
- Identify best practices and important controls for preventing struck-by injuries.
- Recognize and use OSHA standards related to the prevention of struck-by injuries.

TEST YOUR KNOWLEDGE OF STRUCK-BY HAZARDS

Directions: How much do you know about struck-by hazards and injuries? Here is a quick quiz to test your knowledge. Read the question, then select the answer you believe is correct.

1. What is the primary cause of struck-by fatalities?
   - ☐ A. Lack of operator visibility
   - ☐ B. Being hit by falling objects
   - ☐ C. Getting struck by heavy equipment
   - ☐ D. Incorrect or misunderstood hand signals

2. What percentage of struck-by fatalities involves heavy equipment, such as trucks or cranes?
   - ☐ A. 34%
   - ☐ B. 50%
   - ☐ C. 61%
   - ☐ D. 75%

3. Employees who direct or signal crane movements must be:
   - ☐ A. Certified.
   - ☐ B. Qualified by testing.
   - ☐ C. Wearing a colored vest.
   - ☐ D. Able to also operate a crane.

4. To prevent worker run-over accidents, which of the following should be used?
   - ☐ A. Back-up alarms
   - ☐ B. Spotters for equipment
   - ☐ C. High visibility clothing
   - ☐ D. All of the above

WORKSITE ANALYSIS FOR STRUCK-BY HAZARDS

Directions: Following is a list of typical work activities that occur at wind turbine sites that may have some intrinsic struck-by hazards. For each activity, identify potential **struck-by** hazards. Then identify some controls that can protect workers from these hazards.

Activity/Work Process	Struck-By Hazards	Controls
1. Movement of pedestrians and vehicles in the same area		
2. Loading and unloading of vehicles		
3. Moving and staging of large pieces of equipment		
4. Mechanical assembly of large components		
5. Overhead lifting of large components		
6. Guiding suspended pieces of equipment into place		
7. Falling objects from overhead		
8. Crane, derrick, forklift, skid loader or hoist operation		
9. Locking out of blades before maintenance work begins		

JOB HAZARD ANALYSIS FOR STRUCK-BY HAZARDS

Directions: Assume that the job is to connect these two tower sections. Let's perform a job hazard analysis for struck-by hazards. What are the potential struck-by hazards? For each hazard, identify the appropriate controls. Record your answers below.

Photo Courtesy of Seventh Generation Energy Systems

Work Process: Connecting two tower sections—small tower

Struck-By Hazards	Controls

JOB HAZARD ANALYSIS FOR STRUCK-BY HAZARDS

Directions: Assume that the job is to connect these two tower sections. Let's perform a job hazard analysis for struck-by hazards. What are the potential struck-by hazards? For each hazard, identify the appropriate controls. Record your answers below.

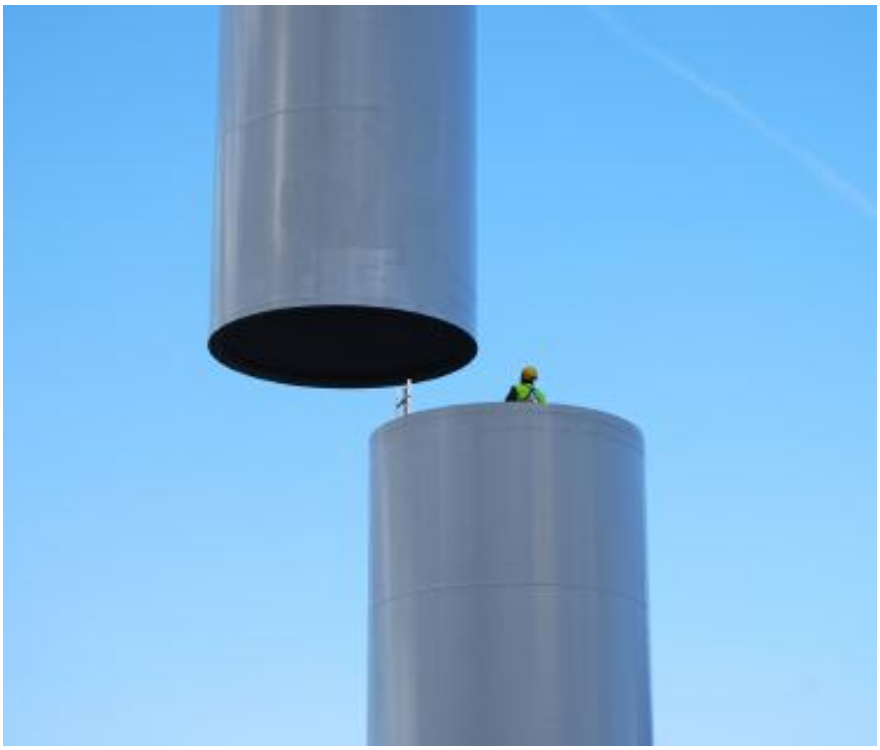


Photo from Istockphoto.com

Work Process: Connecting two tower sections—big tower

Struck-By Hazards	Controls

JOB HAZARD ANALYSIS FOR STRUCK-BY HAZARDS

Directions: Assume that the job is to raise this rotor and attach it to the nacelle. Let's perform a job hazard analysis for struck-by hazards. What are the potential hazards? For each struck-by hazard, identify the appropriate controls. Record your answers below.

Photo from istockphoto.com

Work Process: Raising rotor to attach to the nacelle

Struck-By Hazards	Controls

BEST PRACTICES

Following is a list of practices that can protect you from struck-by injuries. Score your organization on each item using the following guidelines.

3 = We do this consistently and purposefully.
2 = We do this sometimes, but not always. We could be more consistent.
1 = We really could use improvement with this item.

Item	3	2	1
General Practices			
— Wear hard hat at all times			
— Avoid working or walking under a suspended load			
— Maintain a drug and alcohol testing program			
— Use hearing protection			
— Wear safety glasses or a face shield			
Good Housekeeping			
— Keep worksite organized			
— Stack materials neatly so piles don't slide or collapse			
— Routinely inspect all vehicles to make certain they are in safe operating condition			
Falling/Flying Objects			
— Inspect cranes and hoists to ensure all parts are secure			
— Use toe boards on scaffolds and platforms to prevent dropped tools and debris from falling below			
— Avoid working underneath a scaffold or platform			
— When working above others, secure your tools to prevent them from falling			
— When working above others, barricade a safe area on the ground to warn people to stay clear			
Vehicle Operation			
— Create a traffic map that directs flow and requires all employees to use it			
— Create guidelines for operation of all vehicles			
— Train employees in the proper operation of vehicles			

BEST PRACTICES—continued

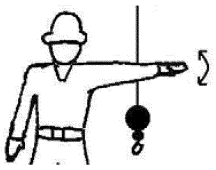
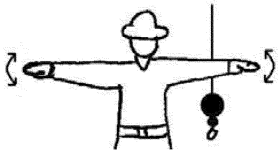
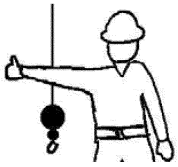
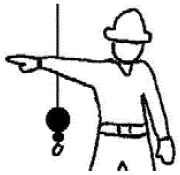
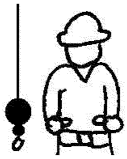
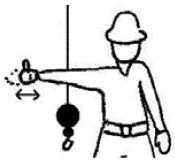
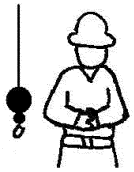
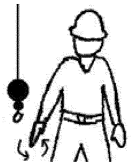
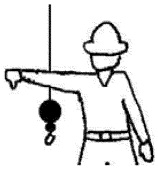
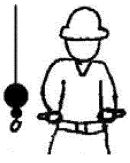
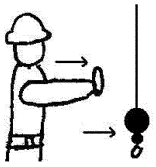
Item	3	2	1
___ Keep a fire extinguisher in the cab of all vehicles			
___ Keep brakes on all vehicles maintained			
___ Use only vehicles that sound warning when put in reverse			
___ Have a procedure that all workers must read operation manual before operating a vehicle			
___ Require safety belt use in all vehicles			
___ Use a signal person to guide you through blind spots			
___ Avoid carrying other workers on vehicle unless there is a safe place to ride			
___ Stay within the vehicle's rated lift or load capacity			
___ Set the parking brake when the vehicle is not in use			
___ Lower and lock bulldozer blades and end loader buckets when vehicle is not in use			
Working in High-Traffic Areas			
___ Train employees in the proper procedures for working around construction traffic			
___ Barricade areas where equipment will be operating			
___ Use stop and slow paddles to slow traffic down			
___ Wear sturdy non-skid shoes or boots			
___ Wear visible clothing, including reflective gear at night			
___ Use flashing lights to warn of your presence			
___ Stay a safe distance from a moving vehicle			

Note: A copy of this form is available on your *Tools and Resources* CD.

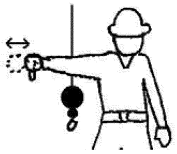
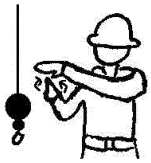
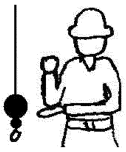
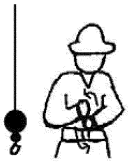
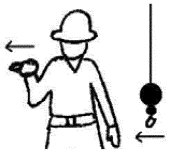
In the space below, identify one or two items from the above list that you plan to improve:

HAND SIGNALS FOR CRANE OPERATION

When there is a lot of traffic at a worksite, it is essential for workers to be able to use hand signals. Here are some standard hand signals for crane operation.

 **STOP –** With arm extended horizontally to the side, palm down, arm is swung back and forth.	 **EMERGENCY STOP** – With both arms extended horizontally to the side, palms down, arms are swung back and forth.	 **HOIST –** With upper arm extended to the side, forearm and index finger pointing straight up, hand and finger make small circles.
 **RAISE BOOM –** With arm extended horizontally to the side, thumb points up with other fingers closed.	 **SWING –** With arm extended horizontally, index finger points in direction that boom is to swing.	 **RETRACT TELESCOPING BOOM –** With hands to the front at waist level, thumbs point at each other with other fingers closed.
 **RAISE THE BOOM AND LOWER THE LOAD –** With arm extended horizontally to the side and thumb pointing up, fingers open and close while load movement is desired.	 **DOG EVERYTHING –** Hands held together at waist level.	 **LOWER –** With arm and index finger pointing down, hand and finger make small circles.
 **LOWER BOOM –** With arm extended horizontally to the side, thumb points down with other fingers closed.	 **EXTEND TELESCOPING BOOM –** With hands to the front at waist level, thumbs point outward with other fingers closed.	 **TRAVEL/TOWER TRAVEL** – With all fingers pointing up, arm is extended horizontally out and back to make a pushing motion in the direction of travel.

HAND SIGNALS FOR CRANE OPERATION—continued

 **LOWER THE BOOM AND RAISE THE LOAD –** With arm extended horizontally to the side and thumb pointing down, fingers open and close while load movement is desired.	 **MOVE SLOWLY –** A hand is placed in front of the hand that is giving the action signal.	 **USE AUXILIARY HOIST** (whipline) **–** With arm bent at elbow and forearm vertical, elbow is tapped with other hand. Then regular signal is used to indicate desired action.
 **CRAWLER CRANE TRAVEL, BOTH TRACKS –** Rotate fists around each other in front of body; direction of rotation away from body indicates travel forward; rotation towards body indicates travel backward.	 **USE MAIN HOIST –** A hand taps on top of the head. Then regular signal is given to indicate desired action.	 **CRAWLER CRANE TRAVEL, ONE TRACK –** Indicate track to be locked by raising fist on that side. Rotate other fist in front of body in direction that other track is to travel.
 **TROLLEY TRAVEL** – With palm up, fingers closed and thumb pointing in direction of motion, hand is jerked horizontally in direction trolley is to travel.		

Source for hand signals: OSHA 29 CFR 1926, Subpart CC, Appendix A

BEST PRACTICES ANALYSIS

Directions: Following is a photo that shows a crane preparing to lift a rotor to the nacelle. Identify the best practices you see in this photo.

Photo courtesy of Orion, L.L.C

Best Practices

BEST PRACTICES ANALYSIS—continued

Directions: Following is a photo that shows a holding area for a construction site. Identify the best practices you see in this photo.

Photo courtesy of Orion, L.L.C

Best Practices

THE GUIDELINES AND REGULATIONS

There are four major parts of OSHA 29 CFR 1926 that address struck-by hazards (Subparts E, G, L and O). To read more about any of these regulations, see the OSHA website at www.osha.gov.

If you want to know about:	Then refer to:
Personal protective and lifesaving equipment	OSHA 29 CFR 1926, Subpart E
– The requirement for protective headgear	1926.100(a)
– The requirements for eye and face protection	1926.102
Important signs, signals and banners	OSHA 29 CFR 1926, Subpart G
– The need for flaggers to use warning garments and to use appropriate signals	1926.201
– The requirement for having barricades to protect employees	1926.202
Standards for scaffolding	OSHA 29 CFR 1926, Subpart L
– The need for scaffolding to be equipped with protection from falling objects	1926.451(h)
The safe use of motor vehicles and mechanized equipment	OSHA 29 CFR 1926, Subpart O
– Requirements for motor vehicles that operate at off highway job sites	1926.601
– Requirements for all vehicles to have adequate braking systems	1926.601(b)(1)
– Requirement for all vehicles to be inspected at the beginning of each shift	1926.601(b)(14)
– Requirements for earth moving equipment	1926.602

MODULE 7
RECOGNIZING AND CONTROLLING HAZARDS FROM EXPOSED ENVIRONMENTS

Module Purpose:

In this module, you will learn about the hazards related to working in an exposed environment. You will examine factors that can affect the body's natural ability to balance its temperature. You will learn how to recognize heat and cold stress, and you'll identify methods for protecting yourself in extreme weather conditions.

Objectives:

When we are done with this module, you will be able to:

- Explain the factors that affect thermal balance.
- Recognize the signs of heat stress.
- Recognize the signs of cold stress.
- Recognize other potential hazards from working in an outside environment.
- Identify best practices and important controls for keeping safe while working outside.
- Identify obstacles to using safe practices at your worksite.
- Identify the resources available on your *Tools and Resources* CD.

THERMAL STRESS

Thermal stress occurs when a person's environment is either extremely hot or extremely cold. A person can comfortably operate within a few degrees of core body temperature, but once temperatures become extreme in either direction, the body begins to react.

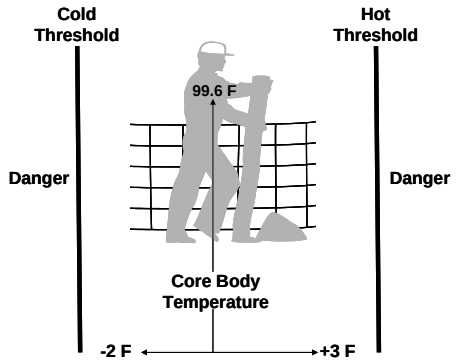


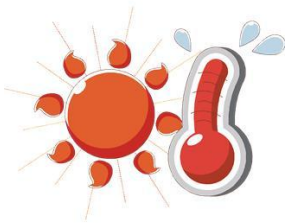
Diagram Courtesy of Susan Stites, Management Allegories

There are several factors that can affect a body's thermal balance. Check the boxes below that apply to you at your wind construction sites.

Climatic Conditions	❑ Temperature ❑ Humidity or moisture ❑ Wind speed or other air movement ❑ Radiant heat
Work Demands	❑ Amount of exertion ❑ Length of time in environment
Clothing	❑ Regular work clothes ❑ PPE
Personal Factors	❑ Amount of sleep ❑ Medication ❑ Age ❑ Physical condition ❑ Degree of acclimatization

SIGNS OF HEAT AND COLD STRESS

Can you recognize when you or a co-worker are showing signs of either heat or cold stress. In the space below, write some of the signs of thermal stress.

Signs of Heat Stress	Signs of Cold Stress
	

OTHER OUTDOOR DANGERS

Whether you are erecting a new turbine or performing maintenance, it is important to be aware of the natural environment around you. For each danger listed, check if it is a factor in the environment where you are currently working. Then identify some ways to control the risk.

Outdoor Danger	How to Control
❑ Sunburn	
❑ Tornados	
❑ Lightning	
❑ Windstorms	
❑ Hurricanes	
❑ Bees	
❑ Snakes	
❑ Spiders	
❑ Ticks	
❑ Mosquitoes	
❑ Scorpions	
❑ Poisonous plants	

BEST PRACTICES

Following is a list of practices that can protect you from thermal stress. Score your organization on each item using the following guidelines.

3 = We do this consistently and purposefully.
2 = We do this sometimes, but not always. We could be more consistent.
1 = We really could use improvement with this item.

Item	3	2	1
General Practices			
___ Maintain an acclimatization program			
___ Maintain a work/rest schedule			
___ Provide extra breaks during periods of extreme heat or cold			
___ Maintain a first aid program with trained personnel			
___ Maintain a medical screening and surveillance program			
___ Be knowledgeable of your environment and its inherent natural dangers			
Heat Stress			
___ Maintain a heat monitoring program			
___ Maintain a provision for rapid cool-down and make sure workers know how to use it			
___ Provide rest areas that are shaded and cool			
___ Provide plenty of liquid on the premises			
___ Provide chemical cold packs			
___ Provide ice or water-cooled garments for workers to wear			
Cold Stress			
___ Maintain a cold monitoring program			
___ Maintain a provision for rapid warm-up and make sure workers know how to use it			
___ Provide rest areas that are heated and out of the wind and other elements			
___ Provide warm liquid on the premises			
___ Provide chemical hot packs			
___ Maintain and require minimum standards for warm clothing, including layering, hats, boots and gloves			

Weather Conditions			
___ Leave the area during electrical storms			
___ Maintain a proper shelter for tornados, floods and electrical storms			
Insect and Plant Danger			
___ Wear light-colored, smooth-finished clothing			
___ Wear insect repellent			
___ Avoid perfumed soaps, shampoos and deodorants			
___ Wear clothing to cover as much of the body as possible			
___ Keep your work area clear of food and food crumbs			
___ Wash an insect bite with soap and water			
___ Apply ice to prevent bite from swelling			
___ Keep an insect bite lotion or cream on hand			
___ For workers with a history of allergic reactions, keep an epinephrine auto injector (EpiPen), and wear a medical identification bracelet			

Note: A copy of this form is available on your *Tools and Resources* CD.

In the space below, identify one or two items from the above list that you plan to improve:

OBSTACLES TO USING SAFE PRACTICES AT YOUR WORKSITE

Having policies and procedures to keep workers safe is a good practice. However, we all know that things happen at the worksite that require quick decisions and reactions. Let's discuss some of the challenges you face in implementing the practices we have discussed.

What are some of your challenges/barriers to protecting yourself and others at work?

Which procedures are the most difficult to follow?

How can you motivate others to follow safe working procedures?

THE TOOLS AND RESOURCES CD

Congratulations on completing the *Safety and Health in Wind Energy* training program. This program has offered you many tips and ideas for working safely at your wind turbine sites. In addition to applying what you have learned in class, you can continue your learning by using the *Tools and Resources* CD that accompanies this Participant Booklet.

This CD contains electronic files of all of the following.

- This participant booklet
- The PowerPoint slides used in today's program
- A Facilitator Manual that gives you step-by-step instructions for conducting this class for other employees at your worksite.
- An additional Facilitator Manual that gives you instructions for teaching this material in shorter tailgate sessions at your worksites.
- All of the forms introduced in this program
- A variety of OSHA forms related to the topics in this program
- A variety of publications related to the topics in this program
- A list of resources where you can find additional information

How will you use the information and resources you received in this class? Write your ideas in the space below.