MODULE 2
RECOGNIZING ELECTRICAL RISK FACTORS

At the end of this module, you will be able to…

- Define electrical risk factors.
- List and describe electrical risk factors that may contribute to workplace injuries.
- List the most important electrical risk factors to look for in your workplace.
- Identify the different methods for identifying electrical hazards in the workplace.
- Identify the causes of arc blast and the risk factors that could contribute to it.
- Presented with a problem, describe how to determine the risk factors, then list the risk factors.

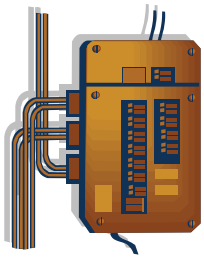
Electrical Risk Factors

Question: What is an electrical risk factor?

Answer:

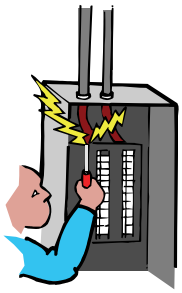
Four Electrical Risk Factor Categories

Environment—Risks that are in the work environment



Equipment—Risks that are inherent in the equipment employees use

Work Practices—Risks that are caused by work requirements, processes, or procedures



Individual—Risks that are unique to the individual, includes characteristics inherent in an individual as well as their habits and behavior

Risk Factors Relating to the *Environment*

Factor	Explanation
Weather	■ Snow, ice, wind and rain can damage or down power lines.
Wet working conditions	■ Wet working conditions can conduct electricity to or through a worker. Moisture on the body can intensify shock.
Overhead power lines	■ Overhead power lines are generally live. If they fall, they can be dangerous. They also pose a danger if someone on the ground touches the line with a conductive item (crane, ladder, metal rod).
Ungrounded electrical systems	■ Ungrounded electrical systems pose a danger if an unsuspecting worker comes into contact with them. Even a worker who is aware of the hazard could encounter danger if a tool or other conductive object comes into contact with the system.
Overloaded circuits	■ Overloaded circuits create fire damage.
Inadequate wiring	■ Inadequate wiring can cause an electrical fire or can create a fault that is a danger to the worker.
Atmospheric hazards	■ Dust particles or flammable vapors can ignite when exposed to an electrically-generated ignition source.

What are some environmental risk factors relating to electricity at your worksite?

Risk Factors Relating to *Equipment*

Factor	Explanation
Exposed electrical parts	■ Exposed electrical parts are those that are not suitably guarded, isolated, or insulated. They are capable of being inadvertently touched or approached nearer than a safe distance by a person. If a worker contacts any exposed electrical components, this is an electrical hazard.
Untested or unapproved tools or equipment	■ Tools and equipment that are not tested and approved by a Nationally Recognized Testing Laboratory (NRTL) may pose a hazard. For a list of NRTL, please refer to the osha.gov website.
Inadequate insulation	■ Tools with insulation that is worn or that exposes electrical parts create a shock hazard.
Ungrounded tools	■ Tools that lack proper grounding (such as the third pin on a plug) can create electrical hazards.
Damaged tools	■ Tools that have been dropped or stored improperly may have damaged wiring or worn insulation.
Conductive ladders	■ Metal ladders are dangerous if they are used around overhead power lines or in wet working conditions.

What are some electrical risk factors relating to equipment at your worksite?

Risk Factors Relating to *Work Practices*

Factor	Explanation
Poor housekeeping	■ Clutter, failure to wipe up moisture, failure to replace electrical covers and other poor housekeeping procedures can create electrical hazards.
Misuse of tools	■ Failure to replace old or faulty equipment, using an incorrect tool for the job or using a tool incorrectly will create electrical hazards.
Rushing	■ Workers who are in a hurry or who are encouraged to consider productivity even at the cost of safety will overlook electrical safety precautions.
Lack of signage	■ Signage warns workers of live electricity and designates safe boundaries. A lack of signage poses a hazard to workers who are unaware of the live parts.
Failure to use proper PPE	■ An unprotected or improperly protected worker puts that worker at risk for electric shock.
Lack of clear safety procedures	■ If an organization's safety procedures are unclear or lacking altogether, workers may take costly shortcuts or work in a dangerous manner.
Lack of training	■ Employees need training on the proper procedures for working around electricity. If that training is left to chance or non-existent, employees may take costly shortcuts or work in a dangerous manner.
Lack of enforcement	■ If an organization fails to enforce electrical safety procedures, it is conveying the impression that it doesn't care about them. Employees will follow that example.

What are some electrical risk factors relating to work practices at your worksite?

Risk Factors Relating to the *Individual*

Factor	Explanation
Body mass	■ A large body mass provides more resistance to electric shock that a smaller body mass.
Vision	■ A worker who doesn't see well may overlook a warning sign or a visual hazard (such as a frayed electrical cord).
Unsuitable PPE	■ If an employee chooses unsuitable PPE because it is more comfortable, the employee is at risk for injury.
Failure to use PPE	■ If employees fail to use PPE, they are completely at risk if there is an electrical incident.
Lack of attention	■ Workers who are not focused or who are inattentive to their environment may not notice an electrical hazard.
Using improper tools	■ Employees who use tools that are damaged or are the improper tool for the job put themselves at risk.
Failure to follow procedures	■ Employees who ignore their organization's electrical safety procedures put themselves and others at risk.

What are some of the individual risk factors relating to electricity at your worksite?

Identifying Electrical Hazards

Once you know what the electrical risk factors (or hazards) are, it is important to have some consistent methods for identifying them. Chances are your organization already uses some hazard recognition tools. As we review the items below, check the appropriate box to indicate whether the activity is something your organization does.

Method	Description	Does Your Organization use? Yes	No
Tailgate meetings and job briefings	Prior to performing an electrical project, a meeting is held and potential hazards and concerns are discussed	❒	❒
Checklists	Using checklists to assess a worksite for electrical hazards	❒	❒
Job safety analysis	Using the job safety analysis process to identify and correct electrical hazards	❒	❒
Safety inspections	Using the safety inspection process to identify and correct electrical hazards	❒	❒
OSHA log analysis	Reviewing OSHA logs to determine if there is one or more recurring electrical hazard that is causing problems	❒	❒
Incident investigation reports	Reviewing incident investigation reports to determine if there is a recurring hazard that is causing a problem	❒	❒

↑ PROACTIVE

REACTIVE ↓

Note that the items toward the top of the list are proactive. As you move further down the list, the items become more reactive.

Topics for the Job Briefing

During the job briefing, or tailgate meeting, it is important to get employees to recognize the potential hazards of the job or project. The following are some examples of topics to be addressed.

- ❒ Discuss the importance of working with a buddy and assign buddies.
- ❒ Identify the steps that will be performed to accomplish the task or project.
- ❒ Identify the electrical hazards inherent in each step.
- ❒ Assess the electrical knowledge and experience necessary to do the job.
- ❒ Determine if a qualified person is required on the project. If so, identify this person.
- ❒ Review lockout/tagout procedures.
- ❒ Identify the tools required to do the job safely.
- ❒ Determine the safety and working condition of the tools.
- ❒ Identify the shock protection boundaries.
- ❒ Identify arc flash protection boundaries.
- ❒ Identify the PPE.
- ❒ Discuss the things that could go wrong.
- ❒ Identify the safety measures employees must take to get the job done safely.
- ❒ Review what to do in an emergency.
- ❒ Encourage employees to speak up to their supervisor or to the qualified person if they feel they lack the knowledge, training, or experience to do the job, or if they have other concerns.
- ❒ Emphasize that their safety is the most important priority.

Note: For your use in planning job briefings, this checklist is available on your *Tools and Resources* CD-ROM. If you would like to review an additional checklist, Annex I of NFPA 70E has a checklist titled ***Job Briefing and Planning Checklist***.

Electrical Hazard Checklist

Every day, when you begin work you should check for hazards that could cause an electrocution. Following is an example of a checklist you can use.

ITEM	OK?	CORRECTIVE ACTIONS
General Electrical Safety		
• Do you assume power sources are energized unless you know for certain they are not?	_____	_____
• Do you use equipment only for its designed purpose?	_____	_____
• Do you avoid making extension cords with ROMEX® wire?	_____	_____
• Do you avoid using equipment outdoors that is labeled for use indoors?	_____	_____
• Do you avoid attaching ungrounded, two-prong adapter plugs into three-prong cords or tools?	_____	_____
• Do you avoid using circuit breakers or fuses with the wrong rating (example: using a 30-amp breaker in a system with a 15- or 20- amp outlet)?	_____	_____
• Do you have an emergency response plan for electrical injuries?	_____	_____
• Do you practice your emergency response plan for electrical injuries?	_____	_____

Electrical Hazard Checklist—continued

ITEM	OK?	CORRECTIVE ACTIONS
Power Tool Safety		
• Do you avoid carrying power tools by their cords?	_____	_____
• Do you avoid yanking cords to disconnect them from outlets?	_____	_____
• Do you keep cords away from heat, oil and sharp edges?	_____	_____
• Do you keep cords away from cutting surfaces of power saws or drills?	_____	_____
• Do you disconnect tools when not in use?	_____	_____
• Do you disconnect tools before servicing or when changing blades or bits?	_____	_____
• Do you avoid holding your finger on the "ON" switch when carrying a plugged-in tool?	_____	_____
• Do you use gloves and safety footwear when using electrical tools?	_____	_____
• Do you avoid using tools in damp or wet locations unless tools are specifically approved for such use?	_____	_____
• Do you operate tools in a well-lit area?	_____	_____
• Do you tag damaged tools with "Do Not Use"?	_____	_____

Electrical Hazard Checklist—continued

ITEM	OK?	CORRECTIVE ACTIONS
Extension and Flexible Cord Safety		
• Do you use factory assembled cord sets?	_____	_____
• Do you use only extension cords that are three-wire type?	_____	_____
• Do you use only extension cords that are marked with a designation code for hard or extra-hard usage?	_____	_____
• Do you avoid yanking cords to disconnect them from outlets?	_____	_____
• Do you have a system for auditing cords to ensure they are the proper kind?	_____	_____
• Do you avoid straining flexible cords?	_____	_____
• Do you avoid dragging flexible cords along window and other sharp edges?	_____	_____
• Do you avoid dragging flexible cords through staples and other sharp objects?	_____	_____
• Do you avoid removing ground plugs?	_____	_____

Electrical Hazard Checklist—continued

ITEM	OK?	CORRECTIVE ACTIONS
Ground Fault Protection		
• Are all your power supply systems grounded?	_____	_____
• Are all your electrical circuits grounded?	_____	_____
• Is all your electrical equipment grounded?	_____	_____
• Do you use ground-fault circuit interrupters (GFCIs) on all 120-volt, single-phase, 15- and 20-ampere receptacles?	_____	_____
• Do you follow manufacturers' testing procedures to ensure GFCI is working properly?	_____	_____
• Do you use double-insulated equipment?	_____	_____
• Do you use tools according to their instructions?	_____	_____
• Do you avoid using tools with frayed cords?	_____	_____
• Do you avoid using tools with missing ground prongs?	_____	_____
• Do you avoid using tools with cracked tool casings?	_____	_____
• Do you ground all exposed metal parts of equipment?	_____	_____
• Are all of your electrical systems grounded?	_____	_____

Electrical Hazard Checklist—continued

ITEM	OK?	CORRECTIVE ACTIONS
Working Around Power Lines		
• Do you look for overhead power lines when you enter a worksite?	_____	_____
• Do you contact utilities for buried power line locations?	_____	_____
• Are power lines de-energized, guarded or insulated?	_____	_____
• Do you post warning signs when power lines can't be de-energized?	_____	_____
• If power lines are not de-energized, do you allow enough clearance?	_____	_____
• Do you identify safe routes where cranes and other equipment must travel?	_____	_____
• Do you operate cranes at slower-than-normal speeds when near power lines?	_____	_____
• Do you designate a signal person to indicate when clearance is safe?	_____	_____
• Do you avoid touching or handling the crane or its load until a signal person says it is safe to do so?	_____	_____
• Do you use boom guards?	_____	_____
• Do you use insulating links?	_____	_____
• When handling equipment or materials with a crane boom, do you use equipment that has an electrical ground connected directly to the upper structure of the boom?	_____	_____

Electrical Hazard Checklist—continued

ITEM	OK?	CORRECTIVE ACTIONS
Working Around Power Lines—continued		
• Do you ground the metal frames and tracks of electrically operated cranes?	_____	_____
• Do you ground the frames of non-electrically driven elevator cars to which electric conductors are attached?	_____	_____
• Do you ground hand-operated metal shifting ropes or cables of electric elevators?	_____	_____
• Are ladders made of non-conductive wood or fiberglass?	_____	_____

The items for this checklist were derived from the following OSHA resources.

OSHA 29 CFR 1910, Subpart I
OSHA 29 CFR 1910, Subpart P
OSHA 29 CFR 1910, Subpart S

Note: For your use in assessing potential electrical hazards in your organization, this checklist is available on your *Tools and Resources* CD-ROM.

OSHA Small Business Checklist

Another checklist you can use to look for electrical hazards in your workplace is this one from the OSHA Small Business Handbook.

- ❒ Do you require compliance with OSHA standards for all contract electrical work?
- ❒ Are all employees required to report any obvious hazard to life or property in connection with electrical equipment or lines as soon as possible?
- ❒ Are employees instructed to make preliminary inspections and/or appropriate tests to determine conditions before starting work on electrical equipment or lines?
- ❒ When electrical equipment or lines are to be serviced, maintained, or adjusted, are necessary switches opened, locked out or tagged, whenever possible?
- ❒ Are portable electrical tools and equipment grounded or of the double insulated type?
- ❒ Are electrical appliances such as vacuum cleaners, polishers, vending machines, etc., grounded?
- ❒ Do extension cords have a grounding conductor?
- ❒ Are multiple plug adaptors prohibited?
- ❒ Are ground-fault circuit interrupters installed on each temporary 15 or 20 ampere, 120 volt alternating current (AC) circuit at locations where construction, demolition, modifications, alterations, or excavations are being performed?
- ❒ Are all temporary circuits protected by suitable disconnecting switches or plug connectors at the junction with permanent wiring?
- ❒ Do you have electrical installations in hazardous dust or vapor areas? If so, do they meet the National Electrical Code (NEC) for hazardous locations?
- ❒ Are exposed wiring and cords with frayed or deteriorated insulation repaired or replaced promptly?
- ❒ Are flexible cords and cables free of splices or taps?
- ❒ Are clamps or other securing means provided on flexible cords or cables at plugs, receptacles, tools, equipment, etc., and is the cord jacket securely held in place?
- ❒ Are all cord, cable and raceway connections intact and secure?
- ❒ In wet or damp locations, are electrical tools and equipment appropriate for the use or location or otherwise protected?
- ❒ Is the location of electrical power lines and cables (overhead, underground, under floor, other side of walls, etc.) determined before digging, drilling, or similar work is begun?
- ❒ Are metal measuring tapes, ropes, hand-lines or similar devices with metallic thread woven into the fabric prohibited where they could come in contact with energized parts of equipment or circuit conductors?
- ❒ Is the use of metal ladders prohibited where the ladder or the person using the ladder could come in contact with energized parts of equipment, fixtures, or circuit conductors?

OSHA Small Business Checklist—continued

- ❒ Are all disconnecting switches and circuit breakers labeled to indicate their use or equipment served?
- ❒ Are disconnecting means always opened before fuses are replaced?
- ❒ Do all interior wiring systems include provisions for grounding metal parts of electrical raceways, equipment and enclosures?
- ❒ Are all electrical raceways and enclosures securely fastened in place?
- ❒ Are all energized parts of electrical circuits and equipment guarded against accidental contact by approved cabinets or enclosures?
- ❒ Is sufficient access and working space provided and maintained around all electrical equipment to permit ready and safe operations and maintenance?
- ❒ Are all unused openings (including conduit knockouts) in electrical enclosures and fittings closed with appropriate covers, plugs, or plates?
- ❒ Are electrical enclosures such as switches, receptacles, junction boxes, etc., provided with tight-fitting covers or plates?
- ❒ Are disconnecting switches for electrical motors in excess of two horsepower able to open the circuit when the motor is stalled without exploding? (Switches must be horsepower rated equal to or in excess of the motor rating.)
- ❒ Is low voltage protection provided in the control device of motors driving machines or equipment that could cause injury from inadvertent starting?
- ❒ Is each motor disconnecting switch or circuit breaker located within sight of the motor control device?
- ❒ Is each motor located within sight of its controller or is the controller disconnecting means able to be locked open or is a separate disconnecting means installed in the circuit within sight of the motor?
- ❒ Is the controller for each motor that exceeds two horsepower rated equal to or above the rating of the motor it serves?
- ❒ Are employees who regularly work on or around energized electrical equipment or lines instructed in cardiopulmonary resuscitation (CPR)?
- ❒ Are employees prohibited from working alone on energized lines or equipment over 600 volts?

Note: For your use in assessing potential electrical hazards in your organization, this checklist is available on your *Tools and Resources* CD-ROM.

You can also download it from the following website:
http://www.osha.gov/Publications/smallbusiness/small-business.html#electrical

Warning Signs

At times, you will get an indication that there is a hazard. Although this indication may seem minor, it's important to pay attention to it. Following is a list of some indications of electrical hazards. For each indication, write what it could mean and what the potential danger is.

Indication	What it Could Mean	What it Could Cause
1. Tripped circuit breaker		
2. Warm junction box		
3. GFCI that frequently shuts off a circuit		
4. The smell of something burning		
5. Frayed insulation around a wire		
6. Frequent calls to maintenance		
7. Mild shock when power tool is used		

Recognizing Arc Blast Hazards

Question: Can you remember the definitions of arc flash and arc blast?

Answer:

- Arc flash
- Arc blast

What Happens in an Arc Flash/Blast?

- Heat builds to 35,000º F
- Copper expands by a factor of 67,000
- Metal melts
- There is intense light
- There are pressure and sound waves
- Shrapnel flies

Consequences of Arc Flash/Blast

- Skin burns
- Ignition of clothing
- Damage of eyesight
- Hearing loss/ruptured eardrums
- Lung collapse (caused by pressure on the chest from the blast)
- Concussion/loss of memory
- Shrapnel wounds from metal parts
- Physical wounds (from being thrown off of ladders or scaffolding or being thrown into walls)
- Loss of life
- Lost work time
- Loss or damage of equipment

Recognizing Arc Blast Hazards

Where Arc Flash/Blast can Occur

- Panel boards
- Switchboards
- Motors
- Transformers
- Motor starters
- Drive cabinets
- Fused disconnects

Causes of Arc Flash/Blast

- Proximity to a high-amp source with a conductive objective
- Equipment failure caused by substandard parts
- Improper installation of equipment or outlets
- Worn or damaged equipment
- Broken insulation
- A dropped tool (screwdriver, drill, etc.) falling across two conductors
- Dust, corrosion or other impurities on the surface of the conductor or in the air
- Accidental contact (by animals or humans)
- Improper work procedures

Hazardous Tasks that may Cause Arc Flash/Blast

- Removing or installing circuit breakers or fuses
- Working on energized control circuits
- Racking circuit breakers in and out of switch gear
- Applying safety grounds
- Removing and replacing panel covers

Photo courtesy of Schneider Electric

Activity: Can You Find The Electricity-Related Hazards?

Directions: Look at the slides your facilitator shows you. Can you find the hazards that relate to electricity? Write them in the space below.

Case #1

Case #2

Case #3

Case #4

Planning for Your Small Business

Directions: Based on what you've learned in this module, what will you do back on the job?

1. Identify two or three actions you will take when you return to your worksite.
2. In addition, identify the potential barriers you might encounter in taking these actions.
3. Next, list ideas for overcoming the barriers identified.

Action Plan

Action	Potential Barriers	Overcoming the Barriers