NATIONAL UTILITY INDUSTRY TRAINING FUND

LINEMAN APPRENTICESHIP

First Year Lesson Learning Objectives

Outside Lineman Apprenticeship

Year 1

1st Year – Level 1

Lesson Learning Objectives

This course begins with a lesson that instructs the student on how to study the course and gives helpful pointers on negotiating the course materials. The next lessons present the responsibilities of the apprentice and the advantages of an IBEW/NECA apprenticeship. Other lessons teach the student about safety and hazard awareness and how to identify and care for basic tools of the trade. An introduction to OSHA is given and then the last lessons cover topics such as fall protection, climber cutouts, climbing poles, and pole top and bucket rescues.

Lesson 1 How to Study This Course and Achieve Your Personal Goals

Introductory Information:

What you get out of this course will, to a great degree, determine your employability for years to come. This course and its contents are certainly not all it takes to make a Journeyman, but it is one of the most essential parts. You should apply yourself at all times and learn everything you can, not because it is required, but because it will make your future in this industry much better.

Certainly, you will not always see why you should study certain subjects. You will even have some poorly trained co-workers tell you that you do not need to know some of the things you study. It would be wise to compare this individual's knowledge and skill with that of the Qualified Journeymen Electrical Workers who promote the concept of quality training.

It is important that you read and review the introductory statement and the reference in each lesson. This lesson will enable you to better understand what is expected of you and how you can best succeed in studying this material.

Remember, this material is produced by your industry, for your industry, and is designed to produce **QUALIFIED** Journeymen Electrical Workers.

Learning Objectives:

After completing this lesson, you will be able to:

1. Demonstrate a positive attitude toward related training throughout your apprenticeship by completing all assignments and participating in classroom activities.
2. Develop and demonstrate good study habits by being prepared for class and asking pertinent questions related to the lesson.

Lesson 2 Knowing Your Apprenticeship and Your Responsibilities

Introductory Information:

Your Apprenticeship Agreement is a very important document in your file. It sets down, in a legal contract, what you will do and what the Committee will do in regards to your apprenticeship. You should know the terms of your apprenticeship as set forth in your Apprenticeship Agreement and the Local Standards.

Learning Objectives:

After completing this lesson, you will be able to:

1. Demonstrate an understanding of the terms and conditions of your Apprenticeship Agreement through classroom discussion.
2. Answer test questions pertaining to your Apprenticeship Agreement.
3. Display a positive attitude or appreciation for the investment this industry is making in your apprenticeship.

Lesson 3 The Attributes of an IBEW/NECA Apprenticeship

Introductory Information:

This lesson is designed to more properly introduce you to our apprenticeship system. We believe you should know what our objectives are and what we look for when selecting, training, and employing apprentices.

Read and study the reference several times and ask questions so you thoroughly understand the local AJATC policies, rules, and penalties.

Learning Objectives:

After completing this lesson, you will be able to:

1. List the qualities which identify a competent, qualified Journeyman electrical worker.
2. List the quality characteristics the JATC seeks in an applicant for apprenticeship.
3. State the primary purpose for which apprenticeship exists.

Lesson 4 Your Job and The Future It Holds for You

Introductory Information:

You are a part of a vital, growing, and expanding industry. During your career, work may vary from installing an overhead feeder drop to a residence to working on large transmission towers. Qualified Electrical Workers may work for a small contractor or for a huge international electrical contracting firm. You may view yourself as a first-rate Qualified Electrical Worker, or you may decide to take the broad view and acquaint yourself with the vast implications of manpower, taxes, profits, organizations, production, safety, legislation, and hundreds of other factors affecting this industry. Our locals and our employers need informed leadership. What you get out of this industry and what you contribute to it is up to you, but as you later look back at your career, one fact is indisputable – opportunity was, and is there.

Remember also that what our Industry represents tomorrow is determined by our (yours and my) efforts today. To be successful in building and maintaining this Industry, we must all be knowledgeable of the trade, highly skilled in the mechanics of the trade and demonstrate a positive attitude toward our Union and our Contractors. To do this, we must understand the problems encountered by our Contractors.

Learning Objectives:

After completing this lesson, you will be able to:

1. Explain why your future is linked directly with the contractor.
2. List the five costs of doing business.
3. Explain why management is vitally interested in training.
4. List four qualities an IBEW-NECA Journeyman must have.

Lesson 5 Safety Awareness - On the Job

Introductory Information:

The subject matter provided in the references for this lesson is intended to develop safety awareness on the job, which should help to shape proper working attitudes that are positive and safety oriented. It is not intended to replace or conflict with an employer's safety directives or work rules. It is to be used as a reference to broaden views of the subject and to assist those who may not be exposed to organized safety programs.

Learning Objectives:

After completing this lesson, you will be able to:

1. State the need for everyone on a job site to work in an alert and safety-conscious manner.
2. Identify positive, safe attitudes as well as negative, dangerous ones.
3. Explain common safety practices employed in the line building industry.
4. Discuss the possible negative repercussions of an accident.

Lesson 6 Identify Some Basic Tools of the Trade

Introductory Information:

One of the first things that an apprentice must do is to become familiar with the tools of the trade. Qualified Electrical Workers working with these tools should know the correct names for them, as well as how to properly use them. It is a good idea to review the tools that may have been used in previous Groundman experience, and to help others with proper identification.

Quite often one tool might have more than one name; a proper name plus one or more “trade” or “slang” names. Qualified Electrical Workers should know the proper name as well as any “trade” name(s) used in their area. Sometimes tools will be called by different names in different areas. Knowing the proper name for the tool will help to determine what tool is being referenced.

Identify as many of the tools as possible. Once again, do not hesitate to ask for assistance. After all of the tools have been identified, review them until each tool can be accurately recognized.

Apprenctices' knowledge of tools in the field will continue to expand as they are introduced to new tools. If the name of a tool is unknown, ASK!

Learning Objectives:

After completing this lesson, you will be able to:

1. Identify the more commonly used hand tools of the electrical industry.

Lesson 7 Use and Care of Hand Tools

Introductory Information:

When entering the electrical field, it will become clear that a large number of hand tools are used to perform job tasks. It is necessary to properly identify the hand tools that are required to perform the job. The various tools are all designed to help complete the task at hand. It is critical that employees use the hand tools in a safe manner.

Become familiar with all the tools needed in the field and their safety requirements. Many injuries result from defective tools, or using tools improperly. Safety is always a concern and working with worn or improperly cared for tools is a workplace hazard. The U.S. Consumer Product Safety Commission reported that more than 100,000 injuries requiring hospital treatment due to the misuse of common hand tools occur each year. Be advised that the proper Personal Protective Equipment (PPE) must also be used. Properly using tools will create a safe work environment not only for the individual, but for those working in the area as well.

This lesson contains some general rules for the safe use and care of tools. Understanding how to use hand tools correctly can eliminate injury and lead to a long, productive, and enjoyable career.

Another factor, not as serious as injury but still important to consider, is the high cost of hand tools, both personal and company supplied. The improper use of hand tools can lead to premature breakage, which can cost employees or their employer a great deal of money.

One sure sign of a good mechanic is demonstrated in the use and care of his or her hand tools.

Learning Objectives:

After completing this lesson, you will be able to:

1. Demonstrate (on the job) the proper selection, safe application, and care for all tools of the trade.
2. Discuss how important proper tool usage is to safety, productivity, and the tool's life span.
3. Describe how to use basic hand tools properly.
4. List defects that make a tool unusable.

Lesson 8 Introduction to OSHA

Introductory Information:

The Occupational Safety and Health Administration (OSHA) was formed in 1970 to “provide for the general welfare, and to assure so far as possible every working man and woman in the Nation safe and healthful working conditions, and to preserve our human resources.” OSHA places a great responsibility on your employer to assure a workplace that is free from hazards. OSHA ensures workplace safety. The purposes of this lesson are to introduce OSHA, to introduce the regulations to be followed and discuss where to find documentation of such regulations, and to provide a basic knowledge of how OSHA operates. Understanding these critical issues ultimately leads to safer work places and better work practices.

Learning Objectives:

After completing this lesson, you will be able to:

1. State the reasons for the formation of and need for OSHA.
2. State the need for OSHA.
3. Describe the responsibilities of the employer under OSHA.
4. Describe the rights and responsibilities of the employee under OSHA.
5. State the basic regulations in 1910.269, 1926 subpart V, 1910.268, the NESC and how they relate to each other.

Lesson 9 Hazard Awareness

Introductory Information:

For Qualified Electrical Workers, few job site hazards are of more concern than the risk of electrical shock. Lives depend upon the Qualified Electrical Worker’s knowledge and understanding of the information contained in this lesson.

Grounding will be briefly introduced in this lesson. More detailed and comprehensive lessons on this subject will be presented later in the apprenticeship program. This basic introduction is important and will introduce a number of the effects and techniques for grounding. Voltage gradients and boom truck grounding are essential for personnel and job site safety and will also be introduced. Recognize and understand similarities and differences between personal protective grounding and grounding a circuit.

How many times has a life been at risk due to using ungrounded portable tools, or improperly protected tools on ungrounded equipment? Qualified Electrical Workers need to be aware of the potential hazard of electrical shock. This hazard is **always** present. Safety is only costly when it is ignored.

Learning Objectives:

After completing this lesson, you will be able to:

1. Determine what factors will affect the severity of an electrical shock, including various shock current intensities and their effects.
2. Discuss techniques and devices for protecting personnel against electrical accidents.
3. Discuss voltage gradients, ground faults, and grounding techniques for boom trucks.
4. Discuss the dangers involved with improperly protected portable tools.

Lesson 10 Energized and Non-Energized Parts

Introductory Information:

In order to comply with industry safety regulations at the federal, state, and local levels, as well as an employer's safety requirements, it is imperative to be able to recognize electrical hardware. Knowing the function of different types of hardware used throughout the industry and what parts could normally be expected to be energized is important. Only "qualified" employees may work on or near energized electrical apparatus. Industry safety standards establish the minimum distances that must be observed when approaching energized equipment. This lesson will help to develop the skills necessary to recognize and distinguish energized from non-energized electrical apparatus. Future lessons will provide a more in-depth explanation of various types of hardware and their uses.

Learning Objectives:

After completing this lesson, you will be able to:

1. Distinguish energized line parts from other parts of electrical equipment.
2. Determine the nominal voltage of exposed, energized parts.
3. Determine the distance that must be maintained when a qualified employee approaches exposed energized parts.

Lesson 11 Climbing Equipment Inspection and Care

Introductory Information:

Climbing equipment, when properly cared for, will last for many years and will afford the maximum in comfort and safety. Many serious accidents have resulted from the improper inspection and care of climbing equipment.

One person, and one person only, is responsible for the care and inspection of climbing equipment. That person is the one who uses it! This is a responsibility that cannot be passed to someone else or dismissed as unnecessary. It is an obligation all competent Qualified Electrical Workers must be willing to accept. If there is inspection or maintenance required that is not covered in this lesson, refer to the manufacturer's instructions.

Don't be a victim of a climbing accident!

Learning Objectives:

After completing this lesson, you will be able to:

1. Describe how to properly inspect and care for climbing equipment.
2. Discuss proper gaff care.
3. Explain how to clean and dress leather.

Lesson 12 Fall Protection

Introductory Information:

The most common cause of worker fatalities in the construction industry is falling. OSHA Subpart M is a fall protection standard designed to reduce worker fatalities from falls on construction sites. The

purpose of this lesson is to review the requirements of Subpart M as they relate to worker protection from falls. By studying the requirements of this OSHA standard, workers will understand when fall protection is required and what options are available for their protection.

Learning Objectives:

After completing this lesson, you will be able to:

1. Identify job place working conditions that require fall protection.
2. Discuss the fall protection options that are available once the need for fall protection has been established.
3. State individual elements of each of the fall protection options.
4. Define the fall protection terms used throughout the fall protection standard.

Lesson 13 Climber Cutouts

Introductory Information:

Apprentice Electrical Workers are exposed to the usual hazards that are associated with construction work. They will also be exposed to other hazards such as falling and electrical shock. These hazards are fundamentally part of the trade. If accidents are to be reduced in these areas, Qualified Electrical Workers must develop a safety-conscious attitude and keep constantly on alert for practices and conditions that contribute to or cause almost all accidents. Awareness can make the difference between a safe job and a tragic accident.

Learning Objectives:

After completing this lesson, you will be able to:

1. Recognize the causes of climber cutouts.
2. List specific causes of cutout accidents.
3. Discuss procedures that can help prevent cutouts.

Lesson 14 Climbing Poles

Introductory Information:

The Qualified Electrical Worker's safety depends on the safety equipment. It is vitally important to understand equipment, how to care for it, and how to use it properly. If a Qualified Electrical Worker experiences problems in climbing, such as climber cutouts, discuss the problem with experienced co-workers on the job. Climbing poles is not particularly hazardous when the proper equipment and correct climbing techniques are used. When climbing wood poles, always wear a long-sleeved shirt and a good pair of work gloves to protect from the possibility of splinters or cuts.

Some of the reference material refers to a safety strap, but the correct term used throughout this course is a pole strap. The pole strap is a work-positioning strap used when climbing poles or other high structures.

Learning Objectives:

After completing this lesson, you will be able to:

1. Explain how to properly prepare to climb a pole.
2. List the climbing hazards that a Qualified Electrical Worker needs to be aware of.

3. Inspect climbing equipment for fit and function.
4. Explain proper climbing technique.

Lesson 15 Pole-Top Rescue

Introductory Information:

Pole-top rescue is a skill that every Qualified Electrical Worker must be proficient in, for the safety of not only fellow workers but also their own. As previously learned, if a person's heart goes into fibrillation or stops, a rescuer only has four minutes (some providers are now using six minutes) in which to start CPR.

This is one portion of the program that could very well mean the difference between life and death someday. Study the references carefully and remember that practice makes perfect. Every Qualified Electrical Worker hopes to never be faced with having to do a pole-top rescue, but hopefully, this lesson will help to prepare anyone ever faced with the situation.

Learning Objectives:

After completing this lesson, you will be able to:

1. List the basic steps in pole-top rescue.
2. Describe the steps that should be followed when climbing to the rescue position.
3. List the steps required to lower the injured person.
4. Describe basic CPR.

Lesson 16 Bucket Rescue

Introductory Information:

The crew on the ground can accomplish retrieval of a worker from a truck quickly and safely with proper planning before work is started and with prompt action. Should an accident happen and a worker become injured or unconscious while working in a bucket, every second counts.

This lesson will cover basic bucket rescue and aerial lift procedures. Each employer should have a program in place for employee rescue in the event a worker becomes incapacitated while working in a bucket. Qualified Electrical Workers should become familiar with the capabilities and controls of the equipment they will be working with and the information contained in this lesson.

Learning Objectives:

After completing this lesson, you will be able to:

1. Explain how critical time is in a bucket rescue.
2. Identify the need for personal safety in bucket or aerial platform rescue.
3. Describe the four acceptable methods of bucket rescue.

1st Year – Level 2

Lesson Learning Objectives

This course covers a wide variety of topics. Students learn about how to avoid sexual harassment and the dangers of drug use. They also gain a thorough understanding of the history of the IBEW and NECA. Lessons cover the care and use of rubber gloves and protective line devices. The apprentice will learn how to work in a confined space and how to work with powered equipment, wood poles, and energized circuits. Safety topics and hand signals will also be covered.

Lesson 1 Sexual Harassment

Introductory Information:

Webster tells us that to harass is to disturb persistently, to torment, pester or persecute; to trouble by repeated attacks. Add to this, a sexual oriented motive and you have now created Sexual Harassment; something which is quite distasteful AND against the law.

On today's job sites, there simply is no room for sexual harassment. It is a serious issue—very serious if you happen to be a victim of it—and quite simply, it should not be tolerated, for whatever reason. Recent legislative and judicial action has been taken to ensure that all men and women have the right to work in an environment which is free of such discourteous and repugnant activity. Surely, this is a freedom that we all deserve and one which we must respect.

This lesson will give you an opportunity to explore the different types of situations and circumstances which can develop into a harassing situation. It isincumbent upon each and every one of us to acquire a good understanding of what constitutes sexual harassment in the workplace. By so doing, we will individually refrain from participating in such conduct and, just as important, we will be able to readily identify harassing situations and be prepared to immediately take whatever corrective action is necessary.

Needless to say, this is not a matter which should be taken lightly—it is profoundly important and carries extraordinary ramifications with it. Individuals, contractors, associations, committees and local unions can all be adversely affected by sexual harassment in the workplace; if they chose to simply ignore it. Thankfully, our industry has chosen to do just the opposite; we recognize that harassing activity is wrong and the IBEW and NECA have both taken numerous actions directed at guaranteeing basic human rights for one and all.

As responsible human beings, sincerely concerned about the well being of each other and the IBEW-NECA family, let us do everything we possibly can to protect ourselves from the social menace of Sexual Harassment.

Learning Objectives:

After completing this lesson, you will be able to:

1. Define sexual harassment in the workplace.
2. List factors which are considered by the courts in sexual harassment cases.
3. Identify sexual harassment activity.

4. Explain the possible repercussions of participating in harassing activity.
5. React appropriately to a situation involving sexual harassment.

Lesson 2 Marketing I

Introductory Information:

This lesson introduces some important qualities required for successful marketing. These qualities are important to the worker, contractor, and customer, as well as to other groups that depend on a successful and profitable business. Without profit, businesses cannot contribute to the well-being and success of the workers, customers, community, and the nation. This lesson is about the role the Qualified Electrical Worker plays in the scheme of marketing. Study this lesson as though your job depended on it.

Learning Objectives:

After completing this lesson, you will be able to:

1. Explain the importance of satisfied customers.
2. Identify those responsible for securing and maintaining satisfied customers.
3. Explain why job performance, behavior, and appearance are important to the future of the Electrical Worker and electrical contractor.

Lesson 3 The IBEW and Its History

Introductory Information:

This lesson is intended to present the story of the founding and development of unions and to illustrate their contribution to the economy and to the industry. Understanding unions and the industry is very much a part of an apprenticeship. The IBEW recognizes, as it always has, that its future depends on its Qualified Electrical Workers. The technical knowledge acquired, the skills developed, and the attitude projected by Qualified Electrical Workers will determine the future of the IBEW. A lack of technical knowledge will prevent the IBEW from being able to cope with the rapid changes in this highly technical electrical industry. A lack of skills will cause nonunion competition to be more appealing to the public—our customers. A negative attitude would destroy all of our potential. Qualified Electrical Workers must care, for the sake of their future.

Learning Objectives:

After completing this lesson, you will be able to:

1. Have knowledge about the IBEW and its contributions in dignifying the lifestyle of all Electrical Workers.
2. Develop a positive attitude toward the industry and contribute to its cause.
3. Display an appreciation for what the IBEW has to offer its members.
4. Participate in a discussion concerning the history of the IBEW.

Lesson 4 NECA's Structure and Heritage

Introductory Information:

The National Electrical Contractors Association, which represents the management half of our industry, has worked with the IBEW for many years in the development of electrical construction. NECA was begun by contractors who recognized that union labor could be an asset to their

business. Very little of what we see today as a progressive industry would have been possible without the cooperative feelings of these early contractors, a spirit which prevails in NECA policy even today.

Learning Objectives:

After completing this lesson, you will be able to:

1. Through discussion, demonstrate a basic knowledge of the NECA's history and structure.

Lesson 5 Shock, Arc, and Blast

Introductory Information:

Factors that affect the severity of an electrical shock were previously taught. This lesson takes that understanding one step further and looks at three hazards that are directly related to electricity: shock, arc, and blast. For Qualified Electrical Workers, the need for awareness of these hazards and the understanding of how electricity acts in each of these hazards is vital. It is hoped that by understanding the theory behind these electrical hazards, Qualified Electrical Workers will be better prepared to confront these hazards on the job.

Learning Objectives:

After completing this lesson, you will be able to:

1. Describe how electricity acts in shocks, arcs, and blasts.
2. Identify the major elements of a shock, arc, and blast.
3. Discuss the effects of electricity on the human body.
4. State the proper PPE for a particular job assignment and job hazard.

Lesson 6 Rubber Gloves and Sleeves, Care and Use

Introductory Information:

This lesson teaches the use and care of rubber gloves and sleeves, a subject of great importance to the wellbeing of Qualified Electrical Workers. One of the most important things to remember is that the most important article of protection for the Qualified Electrical Worker is a good pair of rubber gloves of the proper dielectric strength. Also important to remember is that they will not protect a Qualified Electrical Worker unless they are worn. Statistics show that in most electrical burn cases, at least one point of contact is the hands of the victim. Most companies have established the ground to ground safety rule, which is: always wear rubber gloves and sleeves on any part of a pole carrying energized conductors. Statistics also show that a large percentage of fatal burns in our industry are caused by secondary voltages. Develop the habit of wearing rubber gloves and sleeves when working with any voltage. It can save a life.

Before every use of rubber gloves, workers shall personally inspect each glove for defects, and perform an air test on each rubber glove. After using the gloves, they should also be checked to make sure no damage was caused. Additionally, OSHA standards require periodic electrical testing of rubber gloves and rubber sleeves.

Learning Objectives:

After completing this lesson, you will be able to:

1. State how to visually inspect a pair of rubber gloves and sleeves.
2. Explain how to wash and dry rubber gloves.
3. Perform an air test on a pair of rubber gloves.
4. Discuss how problems with rubber protective equipment can start.

Lesson 7 Protective Line Devices, Care and Use

Introductory Information:

Rubber protective devices should be kept dry, clean, and in first-class condition, but do not be afraid to wear them out. Cover all energized conductors and grounds that Qualified Electrical Workers could possibly touch, reach, or fall into. Today many fiber and plastic line guards are being used on distribution and lower transmission voltages. They should be given the same care and consideration as rubber goods. **Remember: line guards are to prevent accidental contacts only.**

Learning Objectives:

After completing this lesson, you will be able to:

1. Describe how rubber protective equipment and the Minimum Approach Distance relate.
2. Describe how to apply various insulating equipment over energized equipment.
3. Describe how line hoses are used.
4. Explain how ozone cutting of rubber equipment takes place in the field.
5. Care for and use rubber goods and PPE.

Lesson 8 Working in Confined Spaces/Vault Rescue

Introductory Information:

Work in permit-required confined spaces is one of the most dangerous types of work Qualified Electrical Workers can encounter. Manholes, vaults, and other confined spaces present potential atmospheric hazards in addition to the electrical hazards to which workers are accustomed. The purpose of this lesson will be to review the requirements of the Occupational Safety and Health Administration's (OSHA's) confined space standard and to explain the duties and responsibilities that each worker has when working in permit-required confined spaces. Most importantly, workers must understand that almost 60% of confined space fatalities occur among would-be rescuers. Confined space rescue should only be attempted by those who are properly trained to do so and who are equipped with the proper rescue equipment.

Learning Objectives:
After completing this lesson, you will be able to:

1. Define a confined space and a permit-required confined space.
2. Discuss the duties of the authorized entrant, attendant, and entry supervisor when working in permit-required confined spaces.
3. State the procedures when summoning rescue or emergency services for confined space operations.
4. State the requirements of the permit-required written program, including the permit system requirements.

Lesson 9 Safety Meetings, Job Briefing (Tail-Board) Discussions

Introductory Information:

The safety of a Qualified Electrical Worker depends on their training, emotional stability, and how well they follow safety rules—both company rules and commonsense practices.

A portion of the reference materials deal with job site safety. The tips contained in this material can be practiced on any job site, whether working in a distribution substation or a new line construction project. Remember to be observant, report any unsafe conditions to the supervisor, and demonstrate good safety practices at all times.

On many crews, the expression: “Plan your work–then work your plan” can be heard; line work is essentially teamwork. Only when a crew is fully informed and working harmoniously, is it the safest and most productive. Communication plays a very important role in determining the outcome of a job.

Learning Objectives:

After completing this lesson, you will be able to:

1. State the importance of job briefing (tail-board) discussions.
2. Conduct a productive safety meeting.
3. State why everyone should participate in discussions.
4. Describe what it takes to be a good foreman and a good crew member.

Lesson 10 First Aid, Safety, and Health

Introductory Information:

An apprentice Electrical Worker should know that safety training is important to each individual and their coworkers. Qualified Electrical Workers must work as a team to complete the project and rely on each other for the safety of their entire crew. The purpose of this lesson is to review the two safety-related training issues that can have an impact on the safety preparedness of the entire crew. The first part of the lesson will focus on OSHA’s requirements for job site medical attention. The second part covers bloodborne pathogens and was added to the OSHA regulations in 1992.

Learning Objectives:

After completing this lesson, you will be able to:

1. Identify how to meet the OSHA requirements for medical assistance on construction sites.
2. Define bloodborne pathogens and why employers must protect all affected employees from exposure to them.
3. State the major elements of the OSHA bloodborne pathogens standard.

Lesson 11 Hand Signals

Introductory Information:

Hand signals used in line work are very important and should be clearly understood by all involved. This requires the standardization of signals. In many instances, messages must be communicated near noisy equipment, in high winds, or over great distances. These conditions make audible signals ineffective and subject to misinterpretation, which could cause a serious accident.

Visible signals should be used when possible. The work of the crew will be easier, safer, and more orderly if proper hand signals are used. Persons giving signals (instructions) to operators or helicopter pilots must be clearly visible at all times.

Signaling is a very exact and precise procedure. It should only be done by those who take it seriously and are willing to accept the associated responsibility.

Learning Objectives:

After completing this lesson, you will be able to:

1. State the importance of hand signals in line work.
2. Demonstrate how to give basic hand signals for material handling.
3. Demonstrate the ability to follow hand signals when given.

Lesson 12 Powered Equipment Safety – Compressors and Portable Generators

Introductory Information:

Two pieces of equipment used in electrical construction work are air compressors and portable generators. Air compressors provide compressed air for running pneumatic tools, such as jackhammers or drills. Compressed air also poses a hazard due to the force behind the air. Respect the dangers of compressed air. Always wear hearing protection when working with compressed air; once permanent hearing loss begins, it cannot be reversed.

Generators make our work in the field easier, allowing us to use power tools. Comply with all electrical safety precautions when working with a generator. In addition, only use a generator in an open, well-ventilated area, never inside. Deadly exhaust and gas fumes can overtake an individual in just a few breaths. Never connect a generator directly to household wiring. A dangerous “back-feed” situation could arise and threaten Qualified Electrical Workers many miles away working on what they think is a dead line. There should be some type of open point between the generator and the utility company’s meter before the generator is connected and started.

Learning Objectives:

After completing this lesson, you will be able to:

1. List the electrical hazards associated with generator use.
2. Describe the hazards associated with exhaust and gas fumes.
3. State the hazards associated with compressed air.
4. State where and how to use a generator.
5. Locate the OSHA requirements for noise levels and exposure limits.

Lesson 13 Wood Poles – Inspection and Maintenance

Introductory Information:

A large portion of the work a Qualified Electrical Worker does is associated with wood poles. They can be viewed as the foundation upon which electric lines are built. Understanding their strength and other characteristics is very important to Qualified Electrical Workers. Safe, reliable, and economical transmission and distribution of electrical energy via wood poles require efficient, effective programs to detect and treat deteriorating poles before replacement becomes necessary.

Learning Objectives:

After completing this lesson, you will be able to:

1. List different types of organisms that deteriorate poles.
2. State inspection techniques and treatments for wood poles.
3. Interpret wood pole specification tables.

Lesson 14 Setting Poles, and Setting Poles Near or Around Energized Circuits

Introductory Information:

Not too many years ago, practically all poles set were “piked” into the hole. Today, methods have changed and improved to the point where power winches are available on all jobs, and even the use of helicopters is not uncommon. This does not mean that Qualified Electrical Workers can afford to ignore the older systems. A Qualified Electrical Worker may be called on to work in an area where only the “old” ways will work.

Learning Objectives:

After completing this lesson, you will be able to:

1. List the different steps for setting poles manually and with equipment.
2. State procedures for setting poles through or around energized conductors.
3. Describe pole facing procedures.
4. Identify and list the purpose of guying poles.

Lesson 15 Digging Holes and Trenches

Introductory Information:

This lesson is of a practical nature and is intended to broaden the Qualified Electrical Worker’s view of doing manual tasks. There is little doubt that Qualified Electrical Workers can learn to do this type of job without written lessons. However, this lesson will assist in the learning curve and give some background knowledge about how the job is done before being assigned to do it. Also, learning how to approach this type of work in a safety-conscious manner will be discussed.

Needless to say, when using power equipment to dig or bore, Qualified Electrical Workers must be mindful of what might be buried in the work area. It is not uncommon to confront obstructions, such as power cables, communication cables, gas lines, water lines, and drain tiles. Additionally, Qualified Electrical Workers must call 811 for a one call before digging anywhere. Furthermore, most utilities require the first three feet to be dug by hand. By observing proper procedures, obstruction damage and personal injury can be avoided.

Learning Objectives:

After completing this lesson, you will be able to:

1. List methods used in digging, trenching, and boring.
2. Discuss and observe safety precautions that should be taken whenever digging or trenching.
3. Perform pole hole digging and sizing with power and manual methods.

Lesson 16 Avoiding the Hazards of Drug Abuse

Introductory Information:

Using any form of illegal drugs is DUMB! That's why they call the stuff "dope." It should also be known that using alcohol, while legal for those of age, is not very intelligent either. Because the use of alcohol among adults is socially acceptable, many are lured into using it and they become victims of alcoholism or accidents induced by the mind-altering effects of alcohol.

The use of illegal drugs and alcohol in the workplace leads to unsafe working conditions, loss of productivity, and unsatisfactory work practices. NECA and the IBEW have jointly agreed to a resolution which says in part that they do *NOT* condone substance abuse in the workplace.

Careful study of this lesson will help to lead to an understanding of the problem and possible solutions to it.

Learning Objectives:

After completing this lesson, you will be able to:

1. List the kinds of drugs there are.
2. Identify ways to deal with drug abuse.
3. State ways to keep your family free from alcohol and other drugs.
4. Identify specific sources available for those in need of help.

1st Year – Level 3

Lesson Learning Objectives

The course opens with an introduction to whole numbers, fractions, decimals, and percentages. Lessons then transition to electron theory and electrical units. The apprentice also learns about ropes, knots, hitches and splices, ladders, powered equipment safety pertaining to underground, and digger derricks. The last lessons cover hazard communication and personal protective equipment.

Lesson 1 Math Basics with Whole Numbers

Introductory Information:

Every day, everyone is exposed to mathematics in some form. Qualified Electrical Workers are expected to be able to use math for a variety of purposes. This lesson reviews the basic operations involved in using whole numbers, both positive numbers and negative numbers. These basic skills are the same skills employed later in more complex operations. Remember, developing a solid foundation now will allow Qualified Electrical Workers to build upon their skills later with absolute confidence!

Whole numbers, or integers, are numbers that contain no fractions or fractional parts. The whole numbers, along with the operations of addition, subtraction, multiplication, and division, form the basis of the decimal numbering system. These whole numbers are the simplest form of numbers and are the easiest to work with since they have no fractional parts. In all of these operations with integers, one of the most important keys to ensuring the correct answer is to properly align the numbers involved.

Learning Objectives:

After completing this lesson, you will be able to:

1. Add, subtract, multiply, and divide whole numbers.
2. Demonstrate skills in interpreting and solving word problems using whole numbers.
3. Understand the concept of negative numbers.
4. Understand order of operations.

Lesson 2 Fractions

Introductory Information:

It is not always possible to work calculations with whole numbers. This lesson presents ways to work with fractions. A fraction is one or more parts into which a whole unit has been divided. Fractions are regularly used in everyone's lives. It is important for Qualified Electrical Workers to be as comfortable working with fractions as working with whole numbers. Measurements and values used on the job frequently do not work out in even numbers. Therefore, it is essential to understand how to work with fractions.

This lesson covers the basic operations of addition, subtraction, multiplication, and division using fractions. Carefully study the references for this lesson, then work through the problems. If encountering any difficulties, be sure to seek the help of an instructor. His or her experience, skill, and interest in teaching this subject will be a valuable aid.

Learning Objectives:

After completing this lesson, you will be able to:

1. Demonstrate skill in working with proper fractions, improper fractions, and mixed numbers to achieve the correct form required to solve specific problems.
2. Reduce fractions to their simplest form.
3. Add, subtract, multiply, and divide numbers with fractions.
4. Demonstrate skills in solving word problems involving fractions.

Lesson 3 Decimals

Introductory Information:

In a previous lesson, basic operations with fractions were reviewed. Fractions are one way of expressing parts of whole numbers. Decimals are another, and this lesson will review addition, subtraction, multiplication, and division of decimals.

Decimals are actually fractions. In the base 10 numbering system, each digit in a decimal number represents its value times a defined power of 10, and each position is known as a place value. In working with decimals, it is important to align the individual decimal numbers correctly to solve a given problem, and the ability to determine the correct decimal point location is critical. So, remember to keep any work neat and organized, as sloppy calculations will result in errors.

The dollar system of money is the most common use of decimals that a Qualified Electrical Worker can expect to encounter. But further, in everyday work, different systems of measurement are encountered. For example, auger bits are identified by a system based on fractions of an inch, such as $^{7}/_{16}$, $^{11}/_{16}$, or $^{13}/_{16}$, while wire diameters are listed as decimal numbers, such as 0.2576 inches for the diameter of No. 2 wire. Obviously, it is necessary to be able to use and understand both systems and to convert from one system to the other.

Learning Objectives:

After completing this lesson, you will be able to:

1. Convert fractions to decimal numbers and decimal numbers to fractions.
2. Recognize common fraction and decimal equivalents.
3. Add, subtract, multiply, and divide decimal numbers.
4. Demonstrate skills in solving word problems that involve decimal numbers.

Lesson 4 Percentages

Introductory Information:

A percent is simply a measurement that compares a number to 100 and uses the symbol % for percent, which means *hundredths*. People use percentages daily for such things as calculating the sales tax on a purchase or determining the interest payment due, based on a given percentage rate. As a Qualified Electrical Worker, it is necessary to be comfortable and confident in working with percentages, which are used in a variety of ways in the industry. Electrical and safety codes use percentages to specify values, and percentage calculations are used to determine such things as voltage drop, transformer impedance, overload capabilities, wage rates, and take-home pay.

In this lesson, skills of decimal multiplication previously presented, along with skills developed in working with fractions will be used. This is another basic math skill that will serve Qualified Electrical Workers well for the rest of their lives and help them master their trade.

Learning Objectives:

After completing this lesson, you will be able to:

1. Convert percentages to or from decimals and fractions.
2. Accurately calculate percentages.
3. Demonstrate skills in using percentages to express values and to solve word problems.

Lesson 5 What is Electricity?

Introductory Information:

Electricity has always existed in nature, but only with the development of a scientific explanation of what it is and where it comes from has it become possible to create the vast variety of electrical and electronic devices available today. A thorough understanding of the nature of matter is necessary to understand electrical theory. The Qualified Electrical Worker works daily with the invisible forces of the atom which are as potentially dangerous as they are useful.

In a solid material such as copper, electrical current flow is said to be electron flow. To understand current flow it is necessary to understand the behavior of electrons.

This lesson will provide the foundation necessary to understand what has to happen to be able to create electricity.

Learning Objectives:

After completing this lesson, you will be able to:

1. Describe the basic structure of an atom.
2. Name the three main particles which are part of all but the simplest atom.
3. Describe the electrical characteristics of an atom.
4. Describe the relation between valence (free) electrons and electron movement (current flow).

Lesson 6 Electron Theory

Introductory Information:

Electrical energy may be produced in several ways and can be utilized by taking advantage of its different effects. When current flows through an electric range element, the heat produced is useful and desirable. When current flows through an electric motor, heat produced is undesirable, but its magnetic effect is useful.

Work toward understanding the principles by which all electrical devices operate.

Learning Objectives:

After completing this lesson, you will be able to:

1. Demonstrate an understanding of the term valence (free) electron by explaining how electron movement produces current flow.
2. Explain the atom, its structure, and its characteristics.

3. Describe electrical charges and atomic bonds.

Lesson 7 Electrical Units I

Introductory Information:

Before going on to the study of Ohm's law, it will be helpful to study the assigned references in order to understand the terms most commonly used in conversation concerning electrical work. It is necessary to understand the terms *voltage, EMF, potential difference, current, amperes, resistance, ohms,* etc.

These terms are used in electrical calculations. They will also help in understanding of electricity. For example, a Qualified Electrical Worker's body could accidentally contact an energized conductor. The nature of the contact would determine the resistance the body offers to the flow of current. Whether or not the Qualified Electrical Worker survives could be predicted by a simple electrical calculation.

Becoming familiar with these terms will begin development of the language used in the electrical trade. Please note, reference sources may vary on their symbol for voltage. Some use *E*, while others indicate *V*.

Learning Objectives:

After completing this lesson, you will be able to:

1. Identify the basic electrical terms used in line work.
2. Define electrical terms and recognize appropriate symbols.
3. Explain how basic electrical units relate to each other.

Lesson 8 Electrical Units II

Introductory Information:

Previously studied electrical units, such as volts, watts, ohms, amperes, and others are basic units and are not always how quantities are expressed. For example, a 500,000-volt transmission line would usually be called a 500-kilovolt line.

Since electricity is science, the metric system and powers of 10 are both used to express electrical quantities. In order to work with electricity, one must not only be familiar with these methods of expressing electrical quantities but also be able to work with these units to make appropriate conversions.

Metric prefixes are used extensively to report measurements of electrical units. Measurements such as kilovolts, megohms, and milliamperes are common in electrical terminology. Therefore, how to work with metric prefixes in order to use and understand these electrical quantities must be learned.

Knowledge of how to use powers of 10 will simplify the process of solving problems involving numbers that contain a large number of zeros. Knowing how to use powers of 10 will also help to easily estimate the results of simple calculations containing numbers with a large number of zeros.

Learning Objectives:

After completing this lesson, you will be able to:

1. Identify electrical units of measurement.
2. Demonstrate the ability to convert units of electrical measurement.
3. Explain the value of metric prefixes.
4. Change prefixed numbers to whole numbers and whole numbers to prefixed numbers.
5. Use powers of 10 to quickly perform basic mathematical functions.

Lesson 9 Sources and Effects of Electricity

Introductory Information:

Electrical energy may be produced in several ways and can be utilized by taking advantage of its different effects. When current flows through an electric range element, the heat produced is useful and desirable. When current flows through an electric motor, the heat produced is undesirable but its magnetic effect is useful.

Work toward understanding the principles by which all electrical devices operate.

Learning Objectives:

After completing this lesson, you will be able to:

1. Identify and describe the different means of producing electric current.
2. Recognize and explain the products (effects) of electric current.

Lesson 10 Ropes, Knots, Hitches, and Splices

Introductory Information:

Rope plays a very important role in the work of a Qualified Electrical Worker. To use it properly, Qualified Electrical Workers should understand its strength, deterioration rate, safety factor, dielectric properties, inspection requirements, use, and care.There are few experienced Qualified Electrical Workers who have not at one time or another seen ropes fail, with alarming or serious results. By properly studying rope and how to tie knots properly, similar experiences can be avoided. **Remember**: When a rope breaks, a mistake in judgment has been made.

This lesson can be taught in the classroom, but more will be learned on the job. Talk with a foreman and a fellow Journeyman Electrical Worker and ask them to share their experience and knowledge.

In too many cases, Qualified Electrical Workers become so familiar with rope that they tend to judge safe loading in terms of rope failure that they have seen at some previous time. This practice may not allow enough of a safety factor. **Remember**: Never under-rig.

Learning Objectives:

After completing this lesson, you will be able to:

1. Explain the advantages and limitations of various knots, hitches, and splices and be able to properly tie them.
2. Explain the properties of different types of fiber rope and select the proper rope for a given job.
3. Discuss how to properly care for rope.

Lesson 11 Wire Rope

Introductory Information:

Due to the heavy mechanical lifting requirements of the line construction industry, it is very important that Qualified Electrical Workers understand all components involved in heavy lifting and rigging.

A thorough understanding of wire rope characteristics is essential. This means becoming familiar with operating conditions, load factors, rope grades, and construction. Full recognition of their inherent use/potential is derived from a realization of the great number and wide variety of wire rope available for general and special operating needs. It is important that the user become familiar with the particular characteristics of wire rope and the various constructions or types of wire rope in order to make the right selection for a given function.

The lesson will cover wire components, fiber core, IWRC, construction, lays, sizing, grades strand classifications, non-rotating wire rope, seizing, and replacement.

Learning Objectives:

After completing this lesson, you will be able to:

1. Identify wire rope parts and construction characteristics.
2. Determine wire rope size, grade, and working strengths.
3. Understand how to properly use and maintain wire rope.

Lesson 12Ladders/Step Bolts

Introductory Information:

Apprentice Electrical Workers are accustomed to working at great heights on poles and towers. It is important to not let this fact lead to ignoring the possibility of injury resulting from the use of ladders. Many people are killed or injured each year as a result of the misuse of ladders.

This lesson contains information on the selection, use, and care of extension ladders. Also covered are key points of safety when working from hook ladders and climbing fixed ladders and step bolts on structures.

Learning Objectives:

After completing this lesson, you will be able to:

1. Select the right ladder for a job.
2. List what needs to be checked on a ladder before it is put into use (including hook ladders).
3. Explain how to use ladders properly on the job site.
4. Describe how to care for ladders.

Lesson 13 Powered Equipment Safety – Underground

Introductory Information:

Power equipment is necessary for efficient underground construction; however, it does pose many hazards to the crew. Crew members should have an understanding of the equipment used on the job site. Safety on and around any power equipment is vital, as well as the proper and safe operation of the equipment. The job site conditions such as terrain, access, and utilities all raise concerns of safety. A “One Call” must be performed before any ground is broken. This needs to be done so the location of any underground utilities are known. There is a standard number. To call this number, simply dial 811. This could be the difference between life and death. Most apprentices are not given the responsibility of operating equipment early in their career. However, they do need to understand how to work around equipment. Communication with the equipment operator is key to safety on the job site.

Learning Objectives:

After completing this lesson, you will be able to:

1. Discuss the safe working distance from equipment.
2. Discuss how to react to utility damage safely.
3. Maintain and service an underground machine as per the operator’s manual.
4. State the importance of the operator’s manual.

Lesson 14 Powered Equipment Safety – Digger Derricks

Introductory Information:

Digger derricks are commonly used in the electrical construction industry, not only for digging holes and setting poles, but often also to handle other heavy materials used in day-to-day work.

Safe operation of digger derricks is key to preventing injury and material or equipment damage. Qualified Electrical Workers have been injured or killed when they have failed to recognize hazards or follow safety rules and manufacturer’s guidelines.

This lesson will help build a solid foundation to become skilled and knowledgeable in working on or around digger derricks. The next step is to apply what is learned in this lesson “on the job” by becoming familiar with the operator’s manual and the equipment one will be operating or working around.

Learning Objectives:

After completing this lesson, you will be able to:

1. Discuss the safe operation of digger derricks.
2. State associated hazards with the operation of a digger derrick.
3. Interpret load charts and manuals.
4. State the location of safety labels and inspection points found on a digger derrick.

Lesson 15 Hazard Communication

Introductory Information:

OSHA estimates that there are close to 650,000 chemical products that could potentially harm workers who are exposed to them. In an effort to protect exposed employees, OSHA issued a Globally Harmonized System, that is the new name for Hazard Communication Standard, to ensure that information about these potentially hazardous chemicals is passed on to the exposed workers.

The purpose of this lesson is to review the major provisions of the standard, and become familiar with proper hazard awareness precautions when working around these chemicals..

Learning Objectives:

After completing this lesson, you will be able to:

1. State the major provisions of the OSHA Hazard Communication Standard.
2. Discuss the differences between physical and health hazards.
3. Read and use a Safety Data Sheet (SDS) to identify potential chemical hazards.
4. List the requirements for labels and labeling of hazardous chemicals.

Lesson 16 Personal Protective Equipment

Introductory Information:

When job site hazardous conditions cannot be removed, it becomes necessary to use personal protective equipment (PPE) to protect workers. PPE is any equipment that can be used to create a barrier between the worker and the job site hazard. If, for example, the potential for falling objects is present on a job, hard hats (helmets) are to be worn to protect the worker.

The purpose of this lesson will be to review some of the common types of PPE that are available, and understand when they are required to be used by the Qualified Electrical Worker. In addition, everyone must understand the limitations of PPE and the importance of ensuring their PPE is in good operating condition prior to use.

Learning Objectives:

After completing this lesson, you will be able to:

1. Select the proper type of PPE for the conditions that are present on the job.
2. Describe when PPE is required by the OSHA standards.
3. Identify the limitations of PPE as they relate to their job site usage.

1st Year – Level 4

Lesson Learning Objectives

To be successful in this industry, an Outside technician must be knowledgeable about mathematics and Ohm's Law. This course covers solving basic algebraic equations and solving power calculations. Students will learn about resistance, current, voltage and power in series circuits. Lessons explore the use and operation of blocks, slings, and chokers as well as various rigging tools and equipment. Guy types, anchors, line conductors, crossarms, and insulators also are covered.

Lesson 1 How to Solve Basic Algebraic Equations

Introductory Information:

The processes necessary to solve simple equations are a necessity in the study of electricity. You will need to work with many formulas in the course material as you go along.

The lesson will not attempt to teach you algebra, but is intended as a review and refresher in handling simple equations. If necessary, arrange to take further schooling in this subject matter by utilizing the *electrical training ALLIANCE Building a Foundation in Mathematics* course. More mathematical skills and knowledge will be demanded of you as the related material becomes more complex.

Review these points to successfully complete questions:

- Be prepared to show your work. All calculations must be completed on paper and taken with you to class.
- Questions that require a keyed numerical answer must be answered in the form of a decimal as opposed to a fraction.
- Answers for some problems might be needed to answer later questions.
- For all mathematical calculations, it is best to save rounding the answer to the last step of the calculation if at all. Rounding too soon may cause missed answers.
- When performing calculations that include the square root of three or the use of pi, use at least two decimal places. For example, $\sqrt{3} = 1.73$ or $\pi = 3.14$. Use of your calculator's π button is recommended.

Learning Objectives:

After completing this lesson, you will be able to:

1. Demonstrate your skill in developing algebraic formulas to solve word problems.
2. Demonstrate in class your ability to solve algebraic equations.
3. Work with arithmetic signs of operation in setting up and solving algebraic definitions.

Lesson 2 The Electrical Circuit and Ohm's Law

Introductory Information:

In the last lesson you were introduced to three units of measurement in an electrical circuit. In this lesson we will expand on the importance of these units and explain how they are affected under certain conditions. You will also be introduced to using Ohm's Law and see how this law is used to solve for the unknown in an electrical circuit.

This lesson is one of the most important that you will ever study. You will see how Ohm's Law defines the relationship between these three basic electrical units. You will see that as long as you know any two of the three values, ***E*** (**E**lectromotive force or Voltage), ***I*** (current or **I**ntensity), or ***R*** (**R**esistance), then the third unknown one can be easily solved by a simple arithmetic process. Be sure that you understand the relationship between the three quantities and are accurate with the arithmetic involved.

Review these points to successfully complete questions:

- Be prepared to show your work. All calculations must be completed on paper and taken with you to class.
- Questions that require a keyed numerical answer must be answered in the form of a decimal as opposed to a fraction.
- Answers for some problems might be needed to answer later questions.
- For all mathematical calculations, it is best to save rounding the answer to the last step of the calculation if at all. Rounding too soon may cause missed answers.
- When performing calculations that include the square root of three or the use of pi, use at least two decimal places. For example, $\sqrt{3} = 1.73$ or $\pi = 3.14$. Use of your calculator's π button is recommended.
-

Learning Objectives:

After completing this lesson, you will be able to:

1. Describe the operation of simple circuits.
2. Solve mathematical problems using Ohm's Law.
3. Explain how and why prefix multipliers are used in equations and circuit values.

Lesson 3 Solving Power Calculations

Introductory Information:

Previous discussions have focused on electrical units and Ohm's law, current, voltage, and resistance and their interrelationship in an electrical circuit were taught. Now it is time to focus on another term: power. Any time a voltage is impressed and current flows, a definite quantity of power is expended. This amount of power is just as definite and follows mathematical laws, as do *E*, *I*, and *R*.

Learning Objectives:

After completing this lesson, you will be able to:

1. Describe how electrical power is utilized or dissipated.
2. Mathematically solve circuit problems using Ohm's law and/or Ohm's law for power.
3. Demonstrate familiarity with the properties of an electrical circuit and how these properties affect power.
4. Explain the units of measurement for mechanical and electrical power

Lesson 4 Use and Operation of Blocks

Introductory Information:

Due to the heavy mechanical lifting requirements of the electrical construction industry, it is important that Qualified Electrical Workers have a working knowledge of the uses and operations of blocks. This means each apprentice needs to become familiar with the different

types of blocks, the function and various components of blocks, and the design safety factors used when working with blocks.

It is also important that the apprentice become familiar with particular applications of the various blocks so that the right block is selected for any given task.

Learning Objectives:

After completing this lesson, you will be able to:

1. Calculate safe working loads and rigging methods for blocks.
2. Identify the various types of blocks used in electrical construction.
3. Determine the proper application of blocks.

Lesson 5 Slings and Chokers

Introductory Information:

Due to the heavy mechanical lifting requirements of the electrical construction industry, it is very important that Qualified Electrical Workers have a working knowledge of slings and chokers.

A thorough understanding of slings and chokers is essential. This means familiarity with the different types of slings and chokers, the function of each component, and the design safety factor of each type of sling and choker.

Full recognition of the inherent use potential derives from a realization of the great number and wide variety of slings and chokers available for general and special operating needs. It is of special importance that the user becomes familiar with the particular applications of the various slings and chokers in order to make the right selection for a given task.

Learning Objectives:

After completing this lesson, you will be able to:

1. Determine safe working loads and rigging methods for slings and chokers.
2. Determine the proper application of slings and chokers.
3. Identify the various types of slings and chokers that are commonly used in the electrical construction industry.

Lesson 6 Rigging Tools and Rigging Equipment

Introductory Information:

Due to the heavy mechanical lifting requirements of the electrical construction industry, it is very important that Qualified Electrical Workers understand all the components involved in heavy lifting and rigging.

A thorough understanding of rigging hardware components is essential. This requires familiarity with the different types of hardware, the function of each component, and design safety factors.

An awareness of the large number and wide variety of hardware components available for general and special operating needs is essential. It is of utmost importance that the user becomes familiar with the particular applications of the various hardware components in order to make the right selection for a given function.

Wire rope clips, shackles, hooks, wedge sockets, eye bolts, turnbuckles, rings and links, spreaders, and equalizer beams will all be covered.

Learning Objectives:

After completing this lesson, you will be able to:

1. Determine the proper application of rigging hardware.
2. Determine safe loads for equipment.
3. Identify rigging hardware components.

Lesson 7 Guy Types, Guy Strength and Sizes

Introductory Information:

A pole can support only a vertical load. Anchors and guys are needed for every deadend and corner to keep a pole standing straight. If a line is constructed 90° to the prevailing winds, storm guys are installed at intervals to help keep the poles straight. There are also locations where storm guys are installed in four directions at intervals along the line to prevent a cascading effect from severe ice storms or hurricanes. Proper anchoring and guying gives a pole line the appearance of good workmanship and allows the pole positions and wire sag to remain constant throughout the life of the line. Many line construction jobs have been made to look shabby by poor anchoring and guying.

There is much to know about the strength of guys and the strain placed on them. Study this lesson very carefully. If any questions remain, ask an instructor for clarification.

Learning Objectives:

After completing this lesson, you will be able to:

1. Define the different types of guys used in line work.
2. Select the correct guy for a given situation.
3. Explain the terminology associated with guying.
4. Locate the correct position for guy anchors.
5. Calculate line loads and guy loads for guy installations.

Lesson 8 Guy Installation

Introductory Information:

It might seem that a subject such as guy installation could be learned on the job without the use of a written lesson. However, for best results, the Electrical Worker should compare his or her knowledge of the subject before and after this lesson. The efficiency of the crew can be enhanced by pre-assembling guys, saving both time and money.

Learning Objectives:

After completing this lesson, you will be able to:

1. Discuss proper guy installation techniques.
2. Recognize safety practices necessary in guy installation.
3. Identify the tools required for guy installations.
4. Calculate the length of a guy.

Lesson 9 Anchors

Introductory Information:

Qualified Electrical Workers install many types of anchors. Several factors influence the decision as to which anchor to use. Strength requirements, ease of installation, soil conditions, and cost must be considered. For distribution work, most utilities standardize by using one or two sizes of anchors of the types most suitable for the soil conditions found in their service areas. Anchors chosen for transmission projects are based on soil and engineering studies.

The quality of the finished pole line depends more on the design and workmanship of the guy installation, including anchors, than on any other part of the construction.

If poles are to remain in place and conductors sagged properly, the guys on a line must serve their intended purpose for many years. This can happen only if anchors are properly installed.

Learning Objectives:

After completing this lesson, you will be able to:

1. Identify the different types of guy anchors used in linework.
2. Select the correct anchor for a given installation.
3. Explain how different anchors should be installed.
4. Recognize the importance of proper anchor installation.

Lesson 10 Line Conductors

Introductory Information:

The Qualified Electrical Worker should be familiar with the basic types of conductors used in line work, the materials from which they are made, and the reasons for their use.

Later in the apprenticeship program, additional aspects of line conductors will be explained.

Learning Objectives:

After completing this lesson, you will be able to:

1. Identify commonly used line conductors.
2. Explain the individual characteristics of different types of conductors.
3. Recognize where certain conductors should be used.

Lesson 11 Crossarms and Attachments

Introductory Information:

Crossarms, whether used on wood poles or steel towers, serve only one purpose: to maintain proper distances between conductors, and between the conductors and the tower or pole. For instance, the minimum separation for distribution line pins is $14^{1}/_{2}$ inches, and the minimum distance between the pins next to a pole is 30 inches. Often, crossarm pin spacing exceeds 30 inches to allow additional space for Qualified Electrical Workers to work.

There are many types of arms and numerous methods of installing them. Wood arms, for example, are used because of their insulating properties. They are usually made of either fir or pine, and have their tops rounded off for water drainage.

No one can learn to do line work by completing a course of study. These lessons are intended to point out possible ways to perform job duties and are not to substitute for actual field experience. An apprentice should use this lesson to become acquainted with the types of construction that he or she has not worked on thus far.

Many job procedures are arbitrarily determined and, to some extent, should be worked out between the people on the job. However, there is a point which should never be compromised: all jobs should be done in a way that ensures maximum safety to all workers involved.

Learning Objectives:

After completing this lesson, you will be able to:

1. Discuss pole framing fundamentals.
2. Recognize different types of crossarms and braces.
3. Describe the proper installation procedures for pin insulators, crossarms, and braces.

Lesson 12 Insulators

Introductory Information:

Insulators are used to insulate and separate line conductors from the pole or tower and from each other. The voltage of the line largely determines the type and size of insulators used. This condition makes it possible for a knowledgeable Qualified Electrical Worker to determine the voltage class of a line simply by looking at it. This is important because it may alter the work procedure to ensure safety.

The material that is used to make an insulator can have a direct effect on its performance. For example, porcelain can withstand heavy compression, but fails quickly under tension.

Design plays an important role as well. Pin insulators are often selected over the suspension type for lower voltages, due to cost and the fact that the same conductor height can be achieved with shorter poles.

Learning Objectives:

After completing this lesson, you will be able to:

1. Identify different types of insulators.
2. Explain how insulators are made and list individual characteristics.
3. Determine where specific types of insulators should be used.

Lesson 13 Resistance in Series Circuits

Introductory Information:

An electrical circuit is any combination of a power source, a load, and the necessary connecting wires (or circuit conductors) to complete the circuit. The most basic type of electrical circuit is the series circuit. In the series circuit, there is a single path for electrons to flow from one terminal of the power source, through the circuit conductors, through the load, and back through more circuit conductors to the other terminal of the power source. All electrical currents in a series circuit flow through every component in the circuit.

In a series circuit, the load, connecting wires, and even the power source all contribute to the resistance of the circuit.

Learning Objectives:

After completing this lesson, you will be able to:

1. Calculate the total resistance in a series circuit using the formula for series resistance.
2. Properly connect and read circuit component resistance values using analog or digital multimeters.
3. Identify resistor types and characteristics.

Lesson 14 Current in Series Circuits

Introductory Information:

In almost all electrical circuits, wires are used to connect components together. These wires provide a path between the circuit elements for the electrons, which comprise the electrical current. In a series circuit, there is only one path for these electrons, and they must all travel this same path.

An electrical current is defined as the movement of electrons. If all electrons must travel the same path throughout the electric circuit, then the current will be the same for all points in a series circuit. Since all circuit current flows through every component in the circuit, each component must be considered as a load in determining the total current. Ohm's Law defines the relationship between voltage, resistance, and current. Previous discussions covered how the resistances of individual components in a series circuit cumulatively determine total resistance. Now it is time to look at how voltage and total circuit resistance play equally important roles in determining series circuit current.

A very important part of understanding Ohm's Law and current in series circuits is knowing how to measure current in a circuit. This lesson helps to study how the current in a series circuit can be measured.

Please make note of subscripts (I_T = total current) that are often used in electrical formulas to properly identify which components are being referenced.

Learning Objectives:

After completing this lesson, you will be able to:

1. Use Ohm's Law, series circuit laws, and proportional ratio laws to calculate circuit current values.

2. Calculate the effect of changing voltages and resistances on a series circuit.
3. Properly take circuit current measurements using analog and digital multimeters.

Lesson 15 Voltage in Series Circuits

Introductory Information:

Every electrical circuit must have a source of voltage in order to operate. The voltage source provides potential energy to the circuit. This energy is utilized by the circuit to accomplish work, but no work is done in the circuit unless the voltage source is connected to the circuit in such a way that current flows through the circuit. The voltage source is sometimes referred to as the voltage potential or potential source.

In the series circuit, voltage sources are connected in series with the load or loads and any interconnecting wires that may be incorporated into the circuit. This voltage supply to the circuit may be a simple voltage source, such as a single battery, or it may be more complex, such as when several voltage sources are connected in series. For example, in some flashlights, more than one battery cell is required.

The voltage is supplied in a series circuit. It is the source that determines the energy available to that circuit. Circuit voltage is as important in determining circuit current as is the total resistance of the circuit. Ohm's law defines the relationship between these two electrical variables and the current (electrons) that flows in the circuit.

The relationship between voltage, resistance, and current in the series circuit will be reviewed. However, the emphasis will be on the voltage source found in the circuit and on the voltages developed across individual components in the circuit. For unlike current, the voltage across each component of a series circuit will vary in proportion to the resistance of that circuit component.

Learning Objectives:

After completing this lesson, you will be able to:

1. Use Ohm's Law to determine the voltage applied to a series circuit or to individual components in a series circuit.
2. Calculate the effective voltage applied to series circuits.
3. Use analog and digital multimeters to measure voltages across series circuit components.

Lesson 16 Power in Series Circuits

Introductory Information:

The amount of power delivered to a circuit is a measure of the amount of work done by that circuit. Some power is delivered to the load and performs useful work, while other power that may be delivered to the circuit is dissipated as heat and is wasted in the circuit (unless, of course, the circuit is designed to generate heat).

A strong understanding of power in series circuits includes an understanding of how the total power delivered to a series circuit can be calculated. In addition, it is important to know how to determine the power dissipation of any individual component in the series circuit.

One important consideration is how much power is lost, or not actually used to perform the work for which the circuit was designed. Circuits in which there are power losses will be examined, and the process of calculating those power losses will be taught.

Learning Objectives:

After completing this lesson, you will be able to:

1. Calculate the total power used in series circuits.
2. Calculate the power used by individual components in series circuits.
3. Calculate the power wasted in a circuit.

1st Year – Level 5

Lesson Learning Objectives

This course opens with lessons on voltage, resistance, current, and power in parallel circuits. The principles of magnetism and the electric system are then explored. Students then are taught about wire sizes and stringing. They learn about sagging in conductors and connecting an overhead service. The course ends with lessons on insulated platforms and good housekeeping.

Lesson 1 Mathematics for Parallel Circuits

Introductory Information:

The study and understanding of parallel resistances is necessary in the study of electricity. 4/0 AWG wire is a better conductor than 2 AWG wire because its resistance is lower. This is true because in the larger conductor there are more paths for current to flow in parallel.

Parallel circuits cannot be understood without understanding the mathematics associated with them. This lesson is designed to give the required mathematical background for the lesson on parallel circuits.

Learning Objectives:
After completing this lesson, you will be able to:

1. Define the term *least common denominator*.
2. Solve mathematical problems involving the addition, subtraction, multiplication, and division of fractions with different denominators.
3. Reduce fractions to their simplest form (lowest terms).
4. Solve problems with different signs.
5. Work with equations and variables.

Lesson 2 How Voltage Functions in a DC Parallel Circuit

Introductory Information:

In series circuits there is only one path for current flow, meaning the current in all components of the circuit is the same.

Another type of circuit is the parallel circuit. In parallel circuits, there are alternative paths for the current to flow within the circuit. Since there are different current paths, the current through each component in the circuit is not necessarily the same. In fact, in parallel circuits, the total current in the circuit is equal to the sum of the current through all of its branches: $I_T = I + I + \ldots I_N$.

However, in parallel circuits all components are connected across the same voltage source. As a result, the voltage applied to each component in the circuit is the same: $V_T = V_1 = V_2 = \ldots V_N$. Subsequently, Ohm's Law is applied differently in solving problems involving parallel circuits.

The first step is to gain an understanding of how voltage functions in parallel circuits, including more characteristics of electrical circuits.

Learning Objectives:

After completing this lesson, you will be able to:

1. Solve problems involving voltage in parallel circuits using Ohm's Law.
2. Identify and describe differences between voltage sources in series and parallel circuits.
3. Describe how parallel circuit voltage rules differ from series circuit voltage rules.

Lesson 3 Resistance in a DC Parallel Circuit

Introductory Information:

In series circuits, the total circuit resistance is always greater than any of the individual resistances in the circuit.

In parallel circuits, on the other hand, the total circuit resistance is always less than any of the individual resistance values in the circuit. In many applications, the total or equivalent resistance of the parallel circuit is more important than the values of the individual resistors. In other applications, the reverse is true.

A thorough understanding is needed of the formulas that can be used to solve for resistance values in parallel circuits.

Learning Objectives:

After completing this lesson, you will be able to:

1. Calculate the total resistance of parallel circuits with resistors of equal value.
2. Calculate the total resistance of parallel circuits with two resistance values using the product-sum method.
3. Calculate the total resistance of parallel circuits with two or more resistance values using the reciprocal method.
4. Describe how the parallel circuit resistance rule differs from the series circuit resistance rule.

Lesson 4 How Current Reacts in a DC Parallel Circuit

Introductory Information:

The previous study on series circuits taught that the current through each component of the circuit was the same, and that the sum of the voltages dropped across each of the loads in the circuit was equal to the source voltage for that series circuit.

The definition of a parallel circuit is a circuit in which there are one or more points where the current divides and follows different paths. A circuit in which there is only one current path cannot be a parallel circuit.

The total current in a parallel circuit is defined as the sum of the branch currents ($I_T = I_1 + I_2 + \ldots I_N$), just as the total voltage in a series circuit was defined as the sum of the load voltage drops. In a parallel circuit, the current in any one branch is not affected by the currents in any of the other branches. However, the total current is affected by each of the branch currents.

Power sources of equal voltages can also be connected in parallel. When this is done, each source provides an equal portion of the current that is supplied to the connected load or loads. Therefore,

the circuit's total current divided by the number of power sources connected in parallel will determine the current supplied by each source ($I_S = {}^{I_T}/_{N_S}$).

Learning Objectives:

After completing this lesson, you will be able to:

1. Describe how the current flow rule for parallel circuits differs from the current flow rule for series circuits.
2. Calculate the currents in individual branches of parallel circuits.
3. Determine the total current in parallel circuits.

Lesson 5 How to Calculate Power in a DC Parallel Circuit

Introductory Information:

Power calculations for parallel circuits are similar to power calculations for series circuits, in that the total power consumed in a parallel circuit is the sum of the power consumed in the individual components of that circuit; just as the total power in a series circuit is equal to the sum of the power in the individual components of that circuit. Power calculations for these two types of circuits are also similar because in both circuits, the total power is the product of the source voltage and the total circuit current.

A deeper understanding of the relationships between the variables in series and parallel circuits will help when dealing with combination circuits, or circuits that contain both series and parallel components.

Learning Objectives:

After completing this lesson, you will be able to:

1. Show the power required by each individual component in a parallel circuit.
2. Calculate the total power consumed in a parallel circuit using the power consumed by individual components.
3. Calculate the total power consumed in parallel circuits from the source voltage and total current delivered to that circuit.
4. Determine power ratings of components in parallel circuits.

Lesson 6 The Principles of Magnetism

Introductory Information:

Without magnetism, a major source of electrical energy would be lost. Most of the magnetic fields used in industry are created by electrical current. Whenever electrons flow, magnetic flux is produced. Whenever magnetic flux lines are cut by a conductor, a voltage is induced in that conductor. Whenever a voltage is present and a circuit is complete, electrons (current) will flow. As an electrical apprentice, nearly everything done involves (directly or indirectly) one or more of the conditions described above. It is essential to understand the principles that are involved and to focus on the relationships of electron flow and magnetic flux.

Learning Objectives:

After completing this lesson, you will be able to:

1. Explain the theories of magnetism.
2. Explain how electromagnetism performs useful and meaningful work.
3. Demonstrate an understanding of magnetic materials through classroom discussion.

Lesson 7 Magnetic Induction

Introductory Information:

Qualified Electrical Workers know that it is possible to be shocked or even killed by “static” on a conductor that is near other energized conductors, even though the conductor is not connected to any source of voltage. How does a disconnected conductor become “hot”? It becomes “hot” by a principle known as magnetic induction. The energized conductor is connected to the other conductor by an invisible, but very real, magnetic field. This is undesirable in the case cited, yet it is the fundamental principle on which generators, motors, transformers, regulators, and other electrical apparatus operate. Magnetism and its relationship to electricity must be learned in order to understand the equipment being worked on.

Learning Objectives:

After completing this lesson, you will be able to:

1. Describe how electron flow creates magnetic fields.
2. Explain how magnetic fields interact with each other.
3. Discuss electromagnetism and give examples of how it is used.
4. Understand the basic purpose and operation of a generator.

Lesson 8 Ratios and Proportions

Introductory information:

If you are able to understand transformers, you must understand the ratios of turns, volts, and currents. To properly select pulleys and gears for motor drives, you must figure the ratio of sizes needed to give the desired speed.

Many circuits involve the division of loads in proportion to the components.

Keep in mind that a ratio is a divisionary comparison (in the form of a fraction) of two like quantities that are expressed in the same units of measurement.

Proportion is a statement which indicates that two ratios (fractions) are equal to each other. There are two types of proportional relationships, *direct* proportion and *inverse* proportion. Make sure you understand the difference and how to set up each proportion correctly. When solving proportion problems, always remember to: set up the proportion in correct order, substitute the known values, solve by using cross-multiplication.

Review these points to successfully complete questions:

- Be prepared to show your work. All calculations must be completed on paper and taken with you to class.

- Questions that require a keyed numerical answer must be answered in the form of a decimal as opposed to a fraction.
- Answers for some problems might be needed to answer later questions.
- For all mathematical calculations, it is best to save rounding the answer to the last step of the calculation if at all. Rounding too soon may cause missed answers.
- When performing calculations that include the square root of three or the use of pi, use at least two decimal places. For example, $\sqrt{3} = 1.73$ or $\pi = 3.14$. Use of your calculator's π button is recommended.

Learning Objectives:

After completing this lesson, you will be able to:

1. Demonstrate your knowledge and ability for solving ratio and proportion problems.
2. Demonstrate an understanding of mathematical rules as they apply to ratio and proportion problems.
3. Recognize and solve problems involving both direct and inverse relationship.

Lesson 9 The Electric System

Introductory Information:

Learning about the "electric system," both as a whole and in terms of the different components that form the system, will lead to a better understanding of the various systems that Qualified Electrical Workers work on daily as well as how Qualified Electrical Workers contribute in supplying power to customers.

Details of the electric system components are covered throughout the training program.

Learning Objectives:

After completing this lesson, you will be able to:

1. Describe the distribution system.
2. Describe the transmission system.
3. List the different components that are involved in the electric system.
4. Describe different types of generating stations.

Lesson 10 Wire Sizes, Types, and Characteristics

Introductory Information:

A Qualified Electrical Worker's career involves working with many sizes and types of conductors, ranging from small conductors, 6 AWG or 8 AWG, to the large, high-strength conductors used today for transmission purposes. To meet the increased demand for electrical energy, both voltages and conductor sizes have been increasing steadily. Many installations with bundled conductors, consisting of two or more conductors in parallel, are seen today.

Wire may be used as a bare conductor in some applications. In other cases, it will have insulation. Types of insulation vary greatly and are designed to be used for particular environments and applications. Qualified Electrical Workers need to be familiar with the different types of insulation used on conductors and insulations properties.

Study the reference tables carefully and observe the relationships between the various conductor sizes.

Learning Objectives:

After completing this lesson, you will be able to:

1. Discuss the electrical characteristics of a conductor.
2. Explain how electrical conductors are sized and classified.
3. Discuss the factors considered in conductor selection.

Lesson 11 Stringing Wire

Introductory Information:

Conductor stringing is an exacting and important part of the Qualified Electrical Worker's job. The job is often complicated by streets, highways, and railroads, as well as existing hot power lines and communication circuits.

Completing the stringing job without damage to the conductors or injury to the workers involved requires the proper application of both skill and knowledge.

Learning Objectives:

After completing this lesson, you will be able to:

1. Define terms used in conductor stringing.
2. Describe the difference between slack and tension conductor stringing.
3. Discuss tension conductor stringing for transmission and distribution lines.
4. Recognize the need for proper safety precautions when stringing conductors.

Lesson 12 Sagging and Tying In Conductors

Introductory Information:

During the first year of apprenticeship, tying in conductors will probably be included in on-the-job training. Conductors are either sitting on top-tie-insulators or suspended from insulator strings. The tying-in process ensures, if done properly, that the conductor will remain insulated and protected from abrasion for the life of the structure.

Sagging conductors is critical to the projected life and security of the conductor.

In many cases, the Qualified Electrical Worker will have to select the type of tie to be used, and in all cases he or she will be expected to tie in the conductor properly. Studying this process carefully will help to develop a working knowledge of the tying-in procedure.

Learning Objectives:

After completing this lesson, you will be able to:

1. Understand the importance for proper sag.
2. Explain the need to follow the sag charts.
3. Explain methods used to sag conductor.
4. Explain the different methods of tying/clipping in.
5. Explain the importance of tying/clipping in to specifications.

Lesson 13 Connecting an Overhead Service

Introductory Information:

Installing services occupies much of the time allotted to line work, and there is much to learn to do this job properly. An improper electrical connection could result in damage to the customer's equipment. Additionally, if conductor clearance requirements are not observed, injury may result to the general public.

Care must be taken to ensure a quality service installation. The fact that one end of the service must be attached to the customer's building makes good workmanship necessary in order to establish positive public relations. That same pride in workmanship that brought the power this far should certainly be applied in terminating it.

Learning Objectives:

After completing this lesson, you will be able to:

1. Explain how to properly install an overhead service.
2. Discuss testing of the service.
3. Identify single-phase distribution overhead services.

Lesson 14 Insulate and Isolate

Introductory Information:

To protect from electrical contact injuries, Qualified Electrical Workers must either isolate themselves from an energized electrical circuit, or insulate themselves from the circuit. Isolating from a live electrical circuit means either keeping beyond the minimum approach distance, or isolating and grounding the circuit. The most common method of insulating an electrical circuit is through the use of cover-up (rigid plastic or rubber) on the conductors. Cover-up can be rubber, typically put on with rubber gloves, or rigid, put on with a shotgun stick. Cover-up is available only up to 69 kilovolts.

Qualified Electrical Workers can insulate themselves somewhat by using rubber gloves/sleeves. These protect only the hands and arms, and are only available for distribution level voltage. EH footwear is backup insulation protection that may make a difference. Live-line tools can be considered isolating or insulating, depending on how the tools are being used.

Learning Objectives:

After completing this lesson, you will be able to:

1. Explain what it means to isolate from live electrical circuits.
2. Explain what it means to insulate from a live electrical circuit.
3. Describe how to isolate from a live electrical circuit.
4. Describe how to insulate from a live electrical circuit.

Lesson 15 Insulated Platforms and the Second Point of Contact

Introductory Information:

It is important to be familiar with the types of insulated platforms available to Qualified Electrical Workers, and the concept of the second point of contact and how an insulated platform can insulate a Qualified Electrical Worker from it. If a mistake is made while working on an insulated platform, there may be a second chance. In other words, an insulated platform is similar to personal protective equipment. It may provide backup protection when things go wrong.

Learning Objectives:

After completing this lesson, you will be able to:

1. Introduce the concept of the second point of contact.
2. Discuss the insulated platform and its purpose.
3. Discuss methods used for protection from the second point of contact.

Lesson 16 Good Housekeeping

Introductory Information:

Whether a citizen, union member, or tradesman, it is most important to have one's house in order.

It is necessary to maintain awareness of the surroundings in order to determine what can be done to promote harmony, safety, efficiency, and the public image of the craft and the industry.

Learning Objectives:

After completing this lesson, you will be able to:

1. List recommended considerations for establishing a safe, productive job site.
2. Recognize the need for neatness on the job site.
3. Explain how good housekeeping procedures affect the work environment.

1st Year – Level 6

Lesson Learning Objectives

This course begins with lessons on resistance, current, voltage, and power in combination circuits. The student will then learn about two-way radios, underground systems, and excavation and shoring. Laying conduit and pulling cable are covered. The next lessons touch on manholes, underground systems, basket, aerial lifts, and platforms. The course closes with discussions on grounding and protective grounds, taking a line out of service, and lockout/tagout applications.

Lesson 1 Understanding Resistance in DC Combination Circuits

Introductory Information:

The third type of circuit is the combination, or series-parallel circuit. In these circuits, there are components that are connected in series, as well as components that are connected in parallel. In these types of circuits, it is occasionally necessary to know how to use the rules that apply to "series-only circuits" as well as the rules that apply to "parallel-only circuits," depending on how the components are connected in the circuit.

In order to correctly understand combination circuits, each part of the circuit must be analyzed. A determination is made as to whether a part of the circuit is connected in series or in parallel, and then, the correct rules are applied to determine the operational characteristics of that part of the circuit. Many times, a combination circuit that appears to be quite complicated can easily be understood when it is redrawn. Advancing through the equivalency process may require redrawing the circuit more than once. Each time it becomes simpler, until finally, there is just one resistive source connected in series with the voltage source.

In combination circuits, the rules for resistance in series and in parallel may be applied to reduce the circuit to an equivalent resistance, which will have the same total current and resistive value as the original circuit. Additionally, branches of the combination circuit may be reduced in the same way to allow for proper analysis of the different parts of the circuit. To solve unknown values in a combination circuit, use series circuit rules for those sections of the circuit that are connected in series and parallel circuit rules for those sections connected in parallel.

There are four basic steps in reducing a combination circuit to its simplest form:

1. Redraw the circuit to show parallel and series combinations.
2. Solve for each simple parallel or series circuit.
3. Substitute the equivalent values for each simple parallel or series circuit into the original circuit.
4. Solve for the resulting series circuit.

Learning Objectives:

After completing this lesson, you will be able to:

1. Identify circuits that are classified as combination or series-parallel circuits.
2. Analyze components in a combination circuit to determine whether they are connected in series or parallel with other components.
3. Apply the rules learned for series and parallel resistors to reduce a circuit to its equivalent resistance.

Lesson 2 How Current Reacts in a DC Combination Circuit

Introductory Information:

In series circuits, the current is the same in every component, while in parallel circuits, the current splits and follows two or more different paths through the circuit. In combination circuits, both types of currents are present.

It is important to know how to determine branch and circuit currents, as well as solve for unknowns in combination circuits. Remember to apply a systematic approach, using the principles of series and parallel circuits.

Learning Objectives:

After completing this lesson, you will be able to:

1. Apply Ohm's Law to determine the current through any branch or component of a combination circuit.
2. Determine which components will carry total circuit current in combination circuits.
3. Identify alternative current paths in combination or series-parallel circuits.

Lesson 3 How Voltage Functions in a DC Combination Circuit

Introductory Information:

The current is the same in every component in series circuits, while in parallel circuits, the current splits and follows two or more different paths through the circuit. In combination circuits, it is easy to see that there are both types of currents.

It is important to know how to determine branch and circuit currents, as well as how unknowns are solved in combination circuits. Remember to apply a systematic approach, using the principles of series and parallel circuits.

Learning Objectives:

After completing this lesson, you will be able to:

1. Apply Ohm's Law to determine the voltage drop across components in combination circuits.
2. Calculate the total or equivalent resistance of groups of components in combination circuits.
3. Calculate current flow through components or through complete combination circuits.

Lesson 4 How to Calculate Power in a DC Combination Circuit

Introductory Information:

As with the other types of circuits studied, the total power utilized in a combination circuit is the sum of the power dissipated in each of the individual components in that circuit, and it is also equal to the power developed by the "equivalent resistance" of the circuit.

Try to relate the problems solved here, involving power in series-parallel circuits, to on-the-job experiences. These principles are at work day in and day out.

And what about “wasted energy”? Energy that is lost or dissipated in the components of wiring systems (which are not designed to use power) is wasted energy. Heat generated in an undersized extension cord, or by a bad connection on a motor, is not only an indication of power lost in the system, but it is also a potentially dangerous condition. The principles that will be studied here are very important to the foundational understanding of how power reacts in combination circuits.

Learning Objectives:

After completing this lesson, you will be able to:

1. Calculate the total power consumed in a DC combination circuit.
2. Calculate the power consumed by a component, or group of components, in a DC combination circuit.
3. When given the power consumption, determine each circuit component’s current, voltage, and resistance value.

Lesson 5 Two-Way Radios – Proper Use Procedures

Introductory Information:

Two-way radios are widely used in the line construction industry. During the apprenticeship and as a Qualified Electrical Worker Journeyman, there will be many opportunities to use two-way radios on the job. When using two-way radios, be aware that their use is federally regulated. Always use common courtesy when talking on any radio. As with any tool, proper use of the tool adds to the user’s efficiency. Using a two-way radio efficiently requires that the radio equipment be used correctly.

Learning Objectives:

After completing this lesson, you will be able to:

1. Explain how to use a two-way radio properly.
2. Recognize the responsibilities that go along with radio operation.
3. Identify who controls two-way radio usage.

Lesson 6 Underground Systems

Introductory Information:

Electric energy today is delivered from the generating station to the customer either on overhead or underground systems, or through a combination of both methods. Today there is a noticeable move towards underground systems. The rapid growth of urban areas, demand for improved appearance of cities and residential areas, awareness of public safety, and possible reduced material cost through improved research and manufacturing methods are making underground systems more desirable.

Residential underground distribution systems are on the rise due to improved and lower-cost materials and procedures. This work will become more available to Qualified Electrical Workers.

Underground conduit and direct buried systems will be more common in the foreseeable future. Qualified Electrical Workers should have an understanding of these types of systems and be prepared to handle this type of work.

Learning Objectives:

After completing this lesson, you will be able to:

1. Describe the advantages and disadvantages of underground systems.
2. Describe the key parts of an underground system.
3. Understand the different methods for constructing an underground system.

Lesson 7 Excavation and Shoring

Introductory Information:

With the advent of Underground Residential Distribution (URD), safe practices in excavating and shoring have become increasingly more important. The weight of collapsing walls in a trench or excavation can cause injury or death to workers. Awareness of these dangers and compliance with safe work practices will help to keep every worker from becoming a statistic. Keep in mind that in addition to cave-in hazards, other hazards, such as hazardous atmospheres, may also be present in excavations.

Proper planning prior to the start of the job is one of the most important factors in reducing worker injuries and fatalities related to excavations and working in trenches. The job-site briefing is an important part of keeping workers safe when working in excavations and trenches.

Learning Objectives:

After completing this lesson, you will be able to:

1. Identify hazards associated with excavations and trenches.
2. Discuss the duties of a competent person as related to excavations and trenches.
3. Discuss OSHA Subpart P safety requirements for excavations and trenches.

Lesson 8 Laying Conduit

Introductory Information:

Cable installations are relatively expensive; therefore, every part of their installation should be done thoroughly and carefully. It is important to know how to properly install conduit and how duct banks are constructed. Laying conduit properly is an important part of the underground distribution system. Proper installation will lead to many years of trouble-free operation.

Learning Objectives:

After completing this lesson, you will be able to:

1. Identify different types of conduit systems.
2. Install conduit to the proper depth and use proper backfill methods.
3. Apply proper methods for installing a duct bank.

Lesson 9 Manholes and Handholes

Introductory Information:

Manholes play a very important part in the electric system. Cables are terminated or spliced in manholes; equipment, such as transformers or switches, is set in manholes or vaults. Manholes help keep cables out of sight when poles and towers are not desirable.

The construction of manholes, which has been made much easier with the advent of precast-concrete manholes, is an important part of a Qualified Electrical Worker's duties. Proper setting of the manhole and termination of the conduit are critical to a correct installation. Particular attention should be focused on the construction of the manhole, how the different sections are set, and how the excavation area is backfilled.

A manhole with the pulling eyes in the wrong place or the opening poorly located can be very difficult to work on. It is important to understand what a properly constructed manhole is like.

Learning Objectives:

After completing this lesson, you will be able to:

1. Describe the purpose of manholes and vaults.
2. Explain proper construction techniques in the building of a manhole or vault, including placement of a precast structure.

Lesson 10 Cable Types

Introductory Information:

Qualified Electrical Workers who progress in the electrical industry will undoubtedly see an increase in the number of underground systems. Proper handling and care of cable have a high priority with power companies. It is an expensive installation and difficult to repair, so the utmost care and understanding must go into its installation.

New technologies have helped develop many new types of cable insulations. These new insulations have unique characteristics and applications. What type of material to use is a consideration many Qualified Electrical Workers face.

Knowledge of the types and construction of cables, including an understanding of the different types of cables available and the cables' proper applications, is a valuable asset to both the contractor and the industry.

Learning Objectives:

After completing this lesson, you will be able to:

1. Describe the different types of stranded conductors.
2. Explain the different types of insulations used.
3. Identify the different components used in shielded and nonshielded cables.

Lesson 11 Pulling Cable

Introductory Information:

Pulling cable is an important part of the job. Cable that is not pulled properly stands a very good chance of being damaged. A common cause of underground cable system outages is damaged cable resulting from improper handling and installation. Minor damage may not show up immediately, but it can lead to premature failure.

Cable is expensive, and any damage inflicted while pulling between manholes, into substations, or into transformers and switchgear, must be avoided.

Pay close attention to the general practices and cautions outlined in the reference material. Always work safely and be aware of the power equipment in the work area.

Learning Objectives:

After completing this lesson, you will be able to:

1. Set up the proper rigging and identify the different equipment used in pulling cable.
2. Understand and be able to follow general pulling practices and cautions.
3. Identify and follow proper safety techniques used in pulling cable.

Lesson 12 Planning and Design for Underground Systems

Introductory Information:

Almost all utility properties have some type of underground residential distribution (URD) program. Since there is no universal standard method, each utility has developed its own method of working URD. It would be advisable to inquire about work methods and construction standards in the area.

It appears that while overhead transmission and distribution are still used, underground installations have become more popular. With improvements in insulating materials, underground distribution is gaining popularity primarily because of its aesthetic effect and its lack of exposure to potential interruptions caused by man and nature.

More efforts in planning and design are required for underground installations due to problems with rights-of-way and coordination with other utilities.

Learning Objectives:

After completing this lesson, you will be able to:

1. Identify components and their uses in URD systems.
2. Understand the advantages and disadvantages of different types of systems.

Lesson 13 Baskets, Arial Lifts, and Platforms

Introductory Information:

Aerial equipment is commonly used in the electrical construction industry, not only for setting poles, but often also to handle other heavy materials used in day-to-day work. Man-lifts increase production, reduce stress, and increase safety for the worker.

The safe operation of aerial equipment is one key in preventing injury to personnel and equipment damage. Qualified Electrical Workers have been injured or killed when they have failed to recognize hazards or follow safety rules and manufacturer's guidelines.

Qualified Electrical Workers should have a solid foundation in working on or around aerial equipment. The next step is to apply what is learned in this lesson "on the job" by knowing where to find the operator's manual and becoming familiar with equipment to be operated or worked around.

Learning Objectives:

After completing this lesson, you will be able to:

1. Recognize associated hazards with the operation of aerial equipment.
2. Understand the safe operation of aerial equipment.
3. Recognize safety labels and inspection points found on aerial equipment.
4. Locate and understand operator's manuals.

Lesson 14 Grounding and Protective Grounds

Introductory Information:

Qualified Electrical Workers are frequently "grounding" ("earthing" in some English-speaking countries) to make situations safer. For example, workers may apply personal safety grounds to allow safer work on an isolated line. Or they may ground stringing blocks and ground gradient matting for safer stringing operations, or ground trucks for safer boom operation near live lines. System grounding may be needed to keep the electrical system operating safely. Good grounding is essential for the safe operation of an electrical system, but it is not always obvious to the worker. Ground rods must be installed and connections made as specified.

Learning Objectives

After completing this lesson, you will be able to:

1. State the reasons for grounding electrical circuits and equipment.
2. Identify hazards involved with system grounding.
3. Identify the factors that affect the resistance of a ground path.

Lesson 15 Taking a Line Out of Service

Introductory Information:

The process for taking a line out of service varies greatly depending on the utility. The process for distribution lines can be very formal, especially in urban areas, or very informal in rural areas. Only selected operators are allowed to operate switchgear and take lines out of service on behalf of a line crew. In other utilities, the Qualified Electrical Worker will prepare a switching order and do the

switching, tagging, and grounding. Ideally, in all cases, a line crew will have the ability to either carry out or verify the isolation of their line or equipment by a careful study of an operating drawing, a switching order, and the switchgear. Testing for isolation and the installation of protective grounds are the only absolutely sure methods to verify that the line is safe to work on. It is essential to learn, understand, and follow the process and terminology used by the utility/employer.

An introduction to the methods for installing protective grounds is also necessary. Grounding procedures can be one of the most complex subjects encountered by Qualified Electrical Workers, but there are some specifics that a first-year apprentice should know.

Learning Objectives:

After completing this lesson, you will be able to:

1. Discuss the process/procedure used to take a line out of service.
2. Explain the grounding and bonding principles.
3. Explain the procedure to install personal protective grounds.

Lesson 16 Lock-out/Tag-out-Line Applications

Introductory Information:

Qualified Electrical Workers are frequently required to work on apparatus that is necessary to be de-energized before work begins. As studied previously, a formal approach may be used by electrical utilities. In addition, it is necessary to review OSHA lockout/tagout requirements and how they apply to the electrical industry to protect workers from the unexpected startup or release of electrical energy. These regulations also apply to other energy sources such as pneumatic, hydraulic, mechanical, thermal, and chemical.

Learning Objectives:

After completing this lesson, you will be able to:

1. Describe the requirements for training under the lockout/tagout program.
2. Identify the elements necessary for all lockout/tagout programs.
3. Differentiate between lockout and tagout in use and in application.