

## Understanding Irrigation Electrical Safety for NRCS Employees: Part 1 - Why are we concerned? On-demand Captions (unedited)

>> Thank you Jerry I'm excited to go through the presentation part one and part two and talk about a subject very near and dear to me. Irrigation electrical safety. This course is really divided into two parts. Part one comment this part, we will talk about the big picture and why we are concerned. It that we will talk about safety rules and regulations that you as an employee need to be aware of. We will talk about human response to electric current. The hazards of electricity. What it can do to your body. And to give you an understanding of why you need to be safe around these systems. In the new will talk about the specific hazards that analogical powered or given. Gation system can cause. Part two, a separate webinar, will then talk about the details of how we are safe in the field. Where we talk about understanding the equipment. How it fits together. Identifying suspect installations or once -- unsafe conditions or understanding safe work practices, personal protective practices and equipment, and how to keep yourself safe. Those are the things we will be talking about as we go through the material. This graphic in this slide made its way around the Internet several times a number of years ago. We often ask the question with irrigation and logical powered machines comedy water and electricity mix well. You can see the question there becomes important as we are talking about what could happen if anything goes wrong in that graphic. The details of. In terms of the first bullet, electrical hazards responsible for 300 deaths in four -- 4000 workplace injuries each year. That is the details. The general to put that in perspective is, those are not deleting cause of workplace on the job accidents. But they are a disproportionately high number of actual fatalities. When we have analogical work with accident with electricity it tends to be a more fatal type of an accident than just in industry. If you are not already familiar with some of the codes and standards related to say for rectus is, it is probably time to at least get exposed to those including OSHA and NFPA 70 in the national electrical code. Those are the documents that really tell us how to be safe. What the rules are in the workplace around logical powered activity -- equipment. Safety awareness and how to recognize illogical hazard should be a way of life for every employer and employee out in the field irrigation safety becomes important because I was like to emphasize the point, just because a piece of equipment works doesn't means -- mean it is safe or that it will fail in a safe manner. During safety, maintenance, or testing of systems there are certain things you as an employee can do. Personal protective practices in personal protective equipment that you can use as well as workplace guidelines to ensure your safety who makes the rules? In the US, OSHA . The Occupational Safety and Health Administration. This is the federal group given responsibility and authority over workplace safety by Congress. Essentially Congress has given OSHA the authority to promulgate the rules related to safety in the workplace. OSHA requires that employers provide adequate protection to safeguard workers from injury caused by electrical hazards. The OSHA requirements are found in 29 CFR 1910 and the national electric code. Both of those documents point .2 NFPA 70E as the accepted means of electrical safety. And there are several things that it points to. How do you assess the hazard. How do you determine the personal protective equipment? PPE that you need for certain situations to guarantee your safety as well as the PPP comedy personal protective practices. What are they warning levels that you should be looking for in a equipment to the -- Ellery to the danger. Failure to comply with those requirements can result in significant fines for employers levied right OSHA. What is NFPA 70E that I have referred to several times? It is the standard for electrical safety in the workplace. OSHA adopts the rules and NFPA 70E tells us how to meet the rules with those -- and what those practices are. Is defined to work practices for protecting employees from electrical hazards during installation, inspection, operation, maintenance and demolition of electric conductors. In bold or yellow tax it specifies a poor practices for employees who may not be directly working on illogical equipment but who are performing work that might expose them to hazards. For many of you,

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that is the important piece here. Even though you're not installing equipment, repairing or maintaining on it, you are in the vicinity of that agreement, but you are not directly performing work on it. But you are exposed to the hazard. OSHA defies the general rules and NFPA 70E tells you how to meet those OSHA rules in terms of your employee performance.

>> OSHA illogical hazards are important. It requires to in the rules to understand the hazards and then how to mitigate those hazards. There is a website there that talks about general electrical hazards that I would refer you to for more information. It is about protecting workers from those hazards and using electricity. Specifically several different categories there. Electric shock. That tends to be the most visible when the people think about. Electrocutation, burns, shocks, startles and falls. We will talk in more detail about that category. Another less visible hazard of working around electricity is surprising equipment startup. This automated irrigate -- irrigation agreement can be sitting there and then automatically start. It is important to understand that equipment can start unexpectedly. That can cause entanglements and the loss of limbs. That is another hazard that is less visible in terms of people taking about electrical safety. The third category, fired ignition. Will be illogical sparks or arcing. Particularly around fossil fuel powered equipment that is powering the electrical Irick weight -- irrigation agreement are pumping the water, that can be a hazard. And then finally arc/or blast were beget a big arc that can cause major different electrical safety considerations. These protective practices that are required are mandatory under OSHA rules and regulations. Five who is responsible for illogical safety? The rules spell it out very quickly. We start with the employer. The employer has to give us some programs and protective equipment and requirements. And then the employee must implement those. OSHA requires that the employer or owner is responsible for OSHA requirements, electrical safety programs at their site. Safety policies and procedures and safety training. That implies essentially to employees on-site as well as the yellow highlighted contractors and others on the site. As a NRCS employee out on the agricultural operations IT would fall under that category of contractors and others regardless of how you would want to argue that in front of OSHA. That employee, contractor or other, while you are on somebody's site is responsible for implementing the employers safety procedures and using your PPE and PPE while you are in the vicinity of the hazard. These are the things that you need to understand while you are out on someone else's property. They are responsible for the overall program and the equipment, and you are responsible for following their safety training or any that they give you, and then the general rules for protecting yourself. NFPA 70E comedy electoral safety practice have a philosophy that says, to be safe, use the employee or subcontractor or other on-site, must be generally familiar with the claimant you are working on or near. In part two we will talk about familiarizing yourself with that increment. You must be qualified to work on or near the equipment, or if unqualified, no your safe clearance distance. In part two we will talk about those safe clearance distances if you are not comfortable touching that equipment or do not need to be touching it to keep you safe. The third bullet comment know the hazards of the claimant they are working on or near. We will be talking about those this morning and this afternoon in part one and two. And to know what safety measures are needed. Your TBP and PPE, for the Eagleman's that you are working on. OSHA requires employee -- employers trained workers proactively. One of the things were we sometimes lose a little communication is between employers and the subcontractor or other employee on people's sites where employers just assume, or owners assume that you have had some type of training.

>> One of the challenges that you as an NRCS employee working in the irrigation area have to think about is that there are a lot of different electrical codes and standards that come into play with

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irrigation systems. We have talked about NFPA 70E comedy center for electrical safety at the workplace that we will cover here within this webinar. NFPA 70 terms of the first bullet is the national electrical code. This covers the safe design and installation of electrical committee and components. NFPA 70E comedy and easy as an acronym talks about the rules and electrician, and installation company needs to use in how they install the electrical powered irrigation commits. IEEE C2, the third bullet to the national electric safety code covers the safe design and installation by the electric utility up until the point of the electric utility leaves off and the electrician then would take over on the installation and wiring of the increment. You could be exposed to both parts of the system or a close proximity in working the your gation systems. One of the challenges with the NEC is adoption by various different states. The national electric code is a voluntary standard that is written for state or local clinical subdivisions to adopt. The first tentative electrical safety is to understand the NEC covers safe installation of wiring and equipment. If we don't meet the NEC with the installation or wiring of the increment , by definition it is not a safe system. As a NRCS employee we need to understand is that not all states adopted the national electric code as a state statute or require licensed electricians to do the electrical work. They leave it up to local political subdivisions like counties, 50s, or other entities in some states. Some states have additional requirements beyond those in the NEC. So we have a situation where you have 50 states and potentially 51 or more sets of rules depending on where in NRCS you might be working. In the graphic on the right-hand side of the side, the states with purple adopt the 2014 NEC a -- as state rules. So theoretically from a state statute standpoint everybody has to follow the NEC. The states in yellow adopt an older version. They haven't adopted the 2014 yet. They are still using the 2011 NEC. The states and blue adopted the 2008 NEC. They are further behind in their adoption. And those in green do not do anything at the state level. They leave it up to counties or cities. So in terms of the first yellow bullet some states specifically exempt agriculture from compliance with the NEC. Think about that. If you are in a state that adopts the NEC but then exempts agriculture, what does that potentially mean about an electric powered irrigation system that you might be working around? It means that there was no real rule that said it had to meet the minimum safety installation and wiring standards. It probably wasn't inspected. This is where some of our irrigation and agricultural related electrical safety things fall through the cracks a bit in my opinion. I will add that as an editorial comment. Because we are exempt from some of these state rules and codes sometimes and certain geographic locations. Those are important things to understand in terms of some states irrigation systems are inspected and in some states they are not required to be. -- For the minimum safety compliance fix almost all irrigation and related equipment manuals from the manufacturers will indicate you come in needs to be installed to meet the national electric code and any additional state or local requirements.

>> A there is a little bit of a conundrum that you have to think about as a NRCS employee for -- or depending geographically where you are, the equipment -- the electrical powered irrigation devices may have been required by statute to meet the code and be inspected, or a be not. It is a bit up to you to figure out for your state what the rigor is in enforcing those statutes and inspections.

>> On safe work practices become important as well. Even a safe system that meets the NEC was installed correctly and asked -- inspected can be dangerous if employers and employees don't use safe work practices. Even the safest and best maintain systems could result in accidents essentially by people using poor or unsafe maintenance and testing of the system. OSHA is the promulgate or of the rules refers to the other codes for how to me to the rules and then OSHA can enforce those NFPA 70E

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requirements in one of three ways. Through the General duty clause in OSHA. The general duty clause number is listed there. And OSHA says they require the employer to provide safe work practices and to then communicate safe practices to employees, subcontractors and others working on their sites. In addition the General duty clause can't number 1, simply says that employees are responsible for employee safety on their sites. From a legal standpoint, the OSHA rules dictate that essentially you have to comply with any employers safe work practices while you are on their site. And then the third number down there, and additional OSHA rule that requires employees to use the protective equipment. And employers to essentially require it as well. Another challenge as a NRCS employee to put into perspective is that OSHA also has an exemption. OSHA and for -- enforcement guidelines for small farming operations indicated the appropriations act exempts small farming operations from enforcement of all rules, regulations, standards or orders under OSHA. If farming operation is listed exempt of all OSHA activities if the employees, 10 or fewer employees currently and at all times in the last 12 months or has not has an active temporary labor camp during the preceding 12 months. Note, family members or firm employees are not counted when determining the number of actual employees. Think about that challenge. The OSHA rules technically as the first yellow bullet says may not directly apply to many operations -- agriculture operations that you might be involved in was electrical powered irrigation systems. Sick about the quality of installation. If I happen to be in a state that doesn't adopt the national electric code, doesn't require an exception and the agricultural operator knows that they are exempt from OSHA regulations. There becomes our conundrum as an employee to think about are those systems required by anyone to actually be safe in those actual geographic locations? That is sometimes why we are concerned about electrical safety around these add -- agriculture irrigation systems. Safety in agriculture isn't important. You will hear people say that because of the OSHA exemption. Remember that some states exempt agricultural -- agriculture from the NEC. I would say that the rules still apply. You want to be safe but understand that there isn't as bit of a hammer for small agriculture operators to get in trouble before an accident happens. But after an accident happens they will still be in trouble. Those are the conundrum things that you have to think about, and wife that we do courses like this. Because sometimes some of those irrigation systems aren't as safe as we would like.

>> Some of you might be thinking, maybe I'm interested in more than just the general on for -- information. Where can I get a copy of this? You can actually get a copy of NFPA 70E by purchasing it at a bookstore. You can go to the NFPA website, NFPA.org and have a copy that you can read online at no charge but you have to register with NFPA before you get access to the online version. Those are places that you could either buy it, you could buy it at a bookstore from NFPA or read it online free for more information. Spot switching gears you want to talk a little bit about human response to electricity OSHA requires an understanding electrical hazards and what it might do to us. That means that we need to understand electricity's harmful effects on humans. When you are working around electrical professionals, it is not uncommon to hear people talk about this first bullet. How much voltage does it take to kill a person? People typically talk about the voltage of the circuit they were in contact with or -- or where the equipment operates at. The second bullet is important. It is not the volts that get you, it is the amps. -- Amps the amps are the rate of electrical flow. The voltage is the pressure. The amps or amp years that flow through you are going to tell you about the hazards of electricity that flow through your body. If you look at the subject of human response, in terms of human response to electricity, there are four different levels where we see market effects -- marks effects on the human body. The first

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one is called the perception level. The perception level is where people first start feeling that they are being shocked. So above the perception level we feel the tingling sensation of electricity flowing through our body. Our eyes may not hold out. Our hand may not stand on end, but we feel that something is there. If we move up that from that, and we will talk about these and more detail, the let go threshold level is kind of named the opposite of what we are talking about. That is because we cannot let go. We lose our muscles ability to let's go and operate our muscles because of what the electricity flowing to our body does to our muscles. The let go level is where you cannot let go. Remove further up from that and then we start getting a physical problem on the body. A burn. Most of you remember back from science class. The electrical current produces heat. At the burn level, we have the skin a human/being damaged by the heat produced by the electricity going through the body. If we move up further than that to the fourth level called the fibrillation level, that is a level above which we could potentially have an electrician occur. Fibrillation is where your heart goes into fibrillation. That is a medical definition. You can survive a fibrillation with CPR if there wasn't enough damage and burning to the body that your heart could be started again. Those are the four levels of human response at different levels of current that we talk about. The severity of the shock that you receive is but affected by three primary factors. The amount of current that will flow through your body which is based on several factors we talked about. The path of the current through your body where that is a hand to her foot or hand to hand, or some other path through your body and the length of time the current is in the body. All of those factors become important.

>> In terms of electric shocks. Those are the first category of electrical hazards that we talked about. Electricity, to refresh your memory from science class travels in closed circuits. Shocks occur when the body becomes part of the electrical circuit. That can be from hazardous short-circuits occurring in the increment. Ground faults where the current will still run but it is not wired correctly and pumping current into the earth or metallic parts of enclosures becoming energized in the wrong fuses installed in the equipment so that it cannot blow the fuses. So if you touch that equipment and something -- and something else that is grounded at the same time, then-current can flow through your body. We talked about the current flow causing the damage. You can see in the graphic to the right that the burning on the hand, or the heat from the current going into the body gave us the physical damage. That severity of the injury is caused by the amount of current flowing through it. It is less severe when nerve centers and vital organs aren't involved in the pathway. The graphic to the far right shows somebody holding a metal ladder touching the ground and then the overhead conductors of the installation has become cracked or broken off. That metal ladder completing a short circuit path to ground through the person from their hand to their feet and into the ground because that is the path through the body.

>> One of the first best ways for to keep from getting a logical shocker your body is not to become a path. Do not touch things that could be energized and make a path between your body and the earth or ground, or dirt as we call it, if you can help it. When we look at that perception level, the first level of hazardous current where we feel it, humans can feel current at about a level of a 1000 of an amp or 1 mA. For a typical human and normal conditions the perception level is defined as about 1000 of an amp. About that level a person typically feels the tingling sensation that many of you may have felt before. If you put your tongue on a 9 V battery, you will feel between the terminals the tingling sensation of the current flowing figure from one terminal better treat to the other. You see a lot of preteen adolescents do that because it is interesting for them to feel the effects. At higher levels the tingling sensation becomes more pronounced. Current could be flowing through your body below 1000

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of an amp, but for most people your nerves would not sense that. It could be flowing, but you would have no way to know it's because you do not perceive that it is there. That is why we call it above that level, the perception level where we typically feel it.

>> The let go level that we talked about is higher in terms of the current flowing to your body. The let's go level is the level that is defined where you start to lose control of your muscles. If you lose control of your muscles, you cannot let go of what they might have contracted around or your hand contracted around. That level is typically given as 15,000th of an amp or 15 mA. Above that let's go level, the electrons from the current flowing through your body are overriding the nerve impulses from your brain through your nervous system controlling your muscles. Above the 15,000th of an amp level the electricity tells your muscles to contract. You can look at your hand contracted around a piece of metal that was energized and look at your hand clamped onto the piece of metal and have your eyes and visualize that, tell your hand let go, that is not safe, but the message never gets to your hand. You are physically frozen onto the piece of equipment with your hand muscles clamped contracting around it until the power goes off, or somebody can pull you off of it. So that is the talent of getting above the let go level. Technically we could be above the let go level and our eyes might get very big. Our hair might stand on end. We might even say something and it might not be very nice. As long as we do not get to the burn level there will be no lasting physical damage of being exposed to current at that level. But that would give us a heck of a story to talk about coming into the office to say I had a close one today. If we move up to the next third level we get to the level that electricity can cause a burn. -- To the human skin and flesh. The burn level is where the heat starts to burn human skin, internal tissues, organs, and bones. That is about 50,000th of an amp or 500 of an amp. 50 oh amps. Analogical burn is typically characterized by an entry and exit wound where the electricity went into your body and then came out of your body as its completed the circuit through your body with burning on the inside of the body between the entrance and exit wounds. It can be a very different to burn down a plane burn or sunburn. Or the -- were the worst burning is on the outside of the body. Here the worst burning can be on the inside of the body where the electricity was flowing to the entry and exit wounds. This is the most common type of workplace electrical shock that we see in terms of electrical injury and hazard. There are three types of Burns. The heat from the current flowing through your body. We talked about that. The heat from an electrical arc where the electricity might be arcing from a piece of metallic equipment to your body. They are the heat from the electrical arc at the entry or exit wound is going to cause a very pronounced localized effects. And then the heat from the fireball and exploding shrapnel of an arc flash or blast that we will talk about later in the course as well. Those are the types of Burns that you could get that could be internal, external, or both on your body. The final fourth hazardous level that we are concerned about is known as the electrocution or fibrillation level. This is the level at which electricity can't cause your heart to go into fibrillation where it just vibrates or quivers like a bowl of Jell-O. Remember that your heart normally needs to pump the blood through your body and that rhythmic pumping manner with signals from your nervous system through your brain to tell it without even thinking about it. Above a 10th of an amp or 100 mA, the electrical impulses override those signals from your brain to your heart to tell it to pump and contract in that rhythmic manner. Your heart gets confused and just sits there quivering like a bowl of Jell-O not pumping blood to your body. Obviously, the human body takes over a 10th of an amp and you get to that level and your heart goes into fibrillation, need to get the heart pumping in that rhythmic manner again. So when we take away the electricity, then CPR is performed on a fibrillation victim to get their heart pumping and that's rhythmic

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manner again so that it can pump blood to the body to sustain the body. Contraction of the chest muscles, paralysis of the nerve centers and the ventricular fibrillation suspends the heart rhythm and hemorrhages in destruction of the tissue the nerves and muscles in the process can also have an impact on how easily the heart can be started again. That is why CPR is the key in electrical contact with the heart goes into fibrillation.

>> Those are the four different hazardous level depending on how much current flows through the human body.

>> We could back up now and ask, based on our understanding of current flowing through the body, how safe is a particular voltage. This slide says how safe is 120 V? You will hear working around electrical contractors come up farmers, and others that people walk into the office or on the field of talk about, I took 120 V last week or I was shocked by 240 V last week. Almost like it was a badge of honor showing how tough they are. Let's go through an exercise and think about how safe is 120 V circuit to the human body. In other words, the first bullet, what would happen if you walked up and put your finger -- one finger from each hand to each other hand on each side of a 120 V outlet. But one finger from each hand or hold a paper click like your mom taught you not to do and stick it into each slot of a 120 V receptacle. How much current would flow through your body from one hand to another if we did that? The pathway could also be from your hand to earth -- to the earth if you are standing on wet dirt barefoot, from one of your hand to the ground. It is probably going to be hand to hand with the past because you will probably have leather booths on or be standing on some type of carpet or tile floor that is not very conductive. -- In a typical residential application.

>> The next slide talks what human resistance. We need to understand that the resistance to the flow of electricity of a conductor or insulator can vary. The first bullet here, human resistance of berries and it varies by a number of factors. Skin condition when you make the electrical contact is a big factor. Is your skin dry or wet? If you are dry, you are a better insulator. If you are wet, you are a better conductor of electricity. Think about how damp your skin might be when you are working near an irrigation system in the summer. It could be hot and human. You could've been working and walking into the field and work up a sweat. In addition, how sick or callused your skin is where you make the contact versus how soft. Sick and callused try skin is a better insulator. Soft skin, particularly wet is a better conductor. Do you have next, scrapes, or cuts on your skin when you make contact? Those make you a better conductor. Think about the fact that if you have been working around equipment, you might have been working on your car or some other equipment over the weekend. You might have a hangnail. You might be wet from sweat or water in the irrigation system, or wet crops. And you might have soft skin. You might be in a worst case condition. In our best case condition we could be 10,000 homes as a conductor which isn't really a great conductor of electricity. Notice over here in the graphic on the right, a typical good path, if I am wet in my lowest case condition might have 500 ohms from one hand of the body and 500 ohms from the body to the other hand. We add those together and we get about 1000 ohms. That would be our worst case condition down here where we are 1000 ohms. Worry have damp skin. We have nicks, cuts and scrapes and we have thin-skinned. That would be our hand to hand resistance in our worst case from one hand, wet mix, scrapes, cuts and thin-skinned to the other hand. If we go to our best case condition where we were dry no next scrapes or cuts that same path could be 10,000 ohms. There is a factor of 10 between our best case and worse case condition and the biggest factor is how wet and good the path is. If we use a law of physics called ohms law we could then relate that best path

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or worst path to the 120 V circuit. In our best case condition ohms law says that amps equals volt divided by ohms. If I know that I stick my finger in one side of a 120 V outlet I have dry skin that is thick and callused and I do not have nicks, scrapes or cuts and I'm probably 10,000 ohms. The current that flows to my body is 120 V divided by the 10,000 ohms which gives us about 12,000th of an amp flowing through our body. -- Remember they for levels? That would be about the perception level of 1000 of an amp that slightly below the let's go level of 15,000 up and amp. Why would it be expected to feel this? I am probably at the level where I am not going to have my muscles contract and lock my wrist, hand or arm onto something and not be able to let go because I am slightly below that level. My eyes would probably get big. My hair might stand up. I would probably say something and it may not be very nice what comes out of my mouth, but I essentially once I get loose ample myself off and essentially collect my thoughts, I do not have any lasting physical damage to my body because it we haven't got to the burn level in my worst case condition where have nicks, scrapes, and cuts and thin-skinned I might be 1000 ohms. Let's go through the same calculation where the current flowing through our bodies the folders of the circuit the pressure or circuit of the 120 V divided by the resistance in my worst case situation, 1000 ohms and here you can see and hear you can see that I now have 120,000 of an amp .12 A going to my body. If we look back at the for levels of current response on humans, that is above that electrocution or fibrillation level. Now be hazardous affect be 120 V circuit might be mighty in the worst case condition and the current in my body to stop my heart or just to give me a really painful shock in my worst case condition. -- My best case condition. Best case has a painful shock. Worst-case, my heart goes into fibrillation. That is a pretty wide variation of what might happen to our body in terms of the 120 fold circuit. You can see if I got a painful shock when I was shocked by 120 in my best case condition, what was protecting me was dry skin, no next, scrapes, or cuts and things of that nature. If I am down at the worst case condition, have more concerns. Many electrical powered irrigation systems operate at 480 V of electrical pressure. So we can also go through that calculation. Notice of the circuit is 480 V, I'm in my worst-case resistance of wet comment nicks, scrapes and cuts 1000 ohms. I will tab half of an amp , which is four times the 120 V level which would make sense based on the calculation. Think about the yellow highlighted bullet at the bottom. What was the overriding condition that resulted in what happened to you as a conductor when you put your hands, one in each side of the outlet. How poor or good of a conductor that you were, how wet, and to the condition of your skin when you made contact with that electrical hazardous system. The condition of the skin is a big factor. It is a variable and it changes. As a NRCS employee I would argue that typically would probably be more towards my worst case condition out in the field because you could be sweating. You could have walked through wet crops to get to the equipment. A system might have been running and throwing water at you. Those are all possibilities to be towards the worst-case condition in the field.

>> Theological hazard of contact becomes important. We have gone through and talked about the hazardous effects of electricity on the body. Let's talk about a couple of those ways electricity could get to your body to create those had a -- hazardous EFax. One is an electrical contact. Talked about before different types or concerns of hazardous conditions earlier in the section. Part one. The NEC requires manufacturers to place warning signs on electrical enclosures containing live electrical parts. Live electrical parts means that they are energized unless you know specifically that they are not energized because you specifically shut the switches off upstream from them. These live parts contain potentially hazardous voltages and the warning signs are to alert personnel performing inspection, repair, and maintenance to the electrical has -- the potential hazard. Remember the electrical voltage to most

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irrigation machines be 240 or 480 V. Three-phase. If I look at the upper right-hand graphic, and irrigation standards, that the major manufacturers comply with, you are going to see typically on some of these boxes that are supplying the machine, or specifically on the machine, a sign that tells you the specific voltage and that helps you understand the hazard that you could be exposed to if you take off the cover to the live electrical energized parts inside of it. Notice this one. The standard says the manufacturer has to tell you what voltage it operates. In the field there would be a number here in front of the volts for that operating voltage. Do not open until the machine disconnect the on off switch is in the off position and locked out to deenergize and shut off the parts inside this enclosure. That is one of the subtlest ways to keep for making electrical contact when you see these danger or warning signs. Understand what the voltage is and that the parts inside could be energized if the machine has not been shut off or locked out or tagged out. Select just as a reminder, the final yellow bullet, was canned to forgery or 480 V due to the human body of your wet the, have thin-skinned with nicks, scrapes, or cuts. Your margin for error with these electrical irrigation systems at 240 and 480 V are much smaller than they are with 120 V circuit. Particularly if you have thick-skinned, you are dry and no nicks, scrapes, or cuts. That is a concern because we have a combination of potentially you being a good conductor with higher voltages on these irrigation systems. The second category of electrical hazards you are exposed to from electricity that OSHA says you must recognize is not and electrocution per se. It is safety from a lower level of electricity even though it is not going to burn or electrocute you, it could still be above perception. In the previous slide we were talking about levels that could put your heart into fibrillation or burn you. Particularly. Lasting physical damage. We understand from going through the material that there are still hazards of electricity even if it doesn't exceed the burn level or the fibrillation level. These are called surprise shocks or startled voltages. The reaction that you as an employee could have from a surprise shock or startled voltage when you are not expecting it. Startle voltages, surprise shocks, may not electrocute or burn you, but they can still cause a dangerous hazardous condition. What happens here is that even though you are not burned or electrocuted, you are surprised I shock. If you look at electrical accidents, those that are surprised by a shock when they are working on an elevated surface like a ladder or scaffolding, often exhibit a reaction. And that reaction is to get away from the shock, not thinking and fall off the ladder or scaffolding. And it wasn't the electricity that is essentially injured or killed the person, it was the fall from the shock that's killed or injured the person. That is a challenge here. The electricity didn't per se caused the damage. It was the fall caused by the starter or reaction, the surprise of the shock that caused the actual damage. How good a conductor are you on a metal ladder against a metal irrigation machine on wet dirt? You are probably going to be a fairly good conductor. Even though you may not be exposed to levels of electricity that burn or cause fibrillation, lasting physical damage, you still could at lower levels be exposed to surprise or startle voltages that will cause some type of reaction that will cause you to fall or step backwards and essentially step into another piece of equipment, step off of a ledge, or do something that would cause an unsafe condition.

>> The third category of an electrical hazard, even though you are not burned or have your heart go into fibrillation would be an entanglement or some other unsafe condition from the surprise start of a piece of electrical equipment you didn't expect to start when you are too close to it when it was operating, or essentially in the off mode, but going automatically into the automated turn back on mode. Industry standards, the national electric code and the irrigation industry require irrigation equipment manufacturers to provide safety signs on motors or other equipment that could start automatically to alert personnel performing repair maintenance or inspection of the potential hazard and shut off the

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power before working on the system. Shutting off the power to these automated systems before inspection, meeting its, or repair is called lockout tag out. In this section we talk about the principle or idea of lock out tag out. In part two of this course we talk about the details of how to do lockout/tagout later. Notice on the mower driving the irrigation tower on a center pivot machine typically the standards indicate that the manufacturer needs to put on the motor a caution or warning sign. That is what this sign here is at this location on the motor. This essentially says that this machine may start automatically. Do not service. And that means inspection, maintain, or repair, until the actual machine disconnects as the center pivot or at the source is in the off position and locked off. This is one of the challenges we see that people believe may be that they can essentially touch these parts, work on them, pull trash out of them, while you are out there looking at the numbers on the motor or on the system or looking at something to see if it is in compliance. The machine is not moving right now because essentially these machines stop and start automatically. While you have your hand in their pulling trash off of the driveline or pulling trash away or rubbing dirt off to see something visually the machine automatically starts. If the claimant has a short circuit, a bad connection, or anything like that, it could be electrified when the machine starts again and the motor is energized, or if you have your hand on the mechanical parts, it could grab your hand and give an entanglement. Those are my concerns, at that point in the system from an entanglement, or a start that automatically energizes this equipment suddenly, were you didn't take it was going to be a problem. That would be the third category then of electrical hazard that we are looking at in terms of the things that you need to understand as an employee out there working around these systems, doing inspections and other items. They can start automatically even though they are not moving right now. When they do that, then they could grab you or cause an electrical shock -- shock and unsafe condition. So the personal protective practice to avoid the hazard is to make sure that the claimant is shut off before doing inspection, maintenance, or repair.

>> The next electrical hazard that we want to think about is fires, combustion's, explosions and things of that nature. These are all things that could be a hazard on a site that are not caused or are not necessarily going to give us a shock, a burn, or a startle reaction or fibrillation. Aside from the shock that could burn or cause a fibrillation, or an automated piece of equipment turning on that could cause a shock, or entanglement, the third category of hazard is electrical fires, combustion, or explosions. These are possibilities when you look at electrical hazards around these electric irrigation systems as we have seen accidents in the past. Sparks or arcs from electrical shorts in the power drive unit and the irrigation system, both of those, can ignite fuels or any gas and oil accumulations from leaking storage systems, fuel lines, or improper storage of containers at the site. In my graphic to the right use the a fuel storage tank supplying this internal combustion engine and then connected over here to the pump to move the water. In addition, we have an electrical powered irrigation machine, a central pivot, that is actually applying the water. Notice over here that we also have some storage containers for oil for the deep shaft turbine, it looks like the bucket for draining oil or storing oil filters until it is full, used for maintenance over here as well. We have a battery that the blue line is pointing to to start the irrigation machine. We have a generator over here that might be making power for the electrical system if it is not connected to utility power. Over here in a very distraught -- small area we have several different storage containers for combustible material. And then we have several different sources of electrical shock if we happen to have bad equipment. There are multiple things that could combust if there were shocks, explosions, or combustion not controlled for multiple sources at this site. The challenge here is, as I said,

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most -- are most systems that you deal with this clean? From a fuel or combustion standpoint? I would argue that probably not. This is a very clean system. I don't see puddles of oil from the oil leaking that was changed over time or somebody forgot to do something. Oil filters that were just lined up over here on the ground by something so that the oil could drain out. Some of our producers tend to do a better job of disposal of the oil for maintenance and the filters then maybe they did 20 or 30 years ago now that recycling oil is important. That is another one of these issues to remember. This will be alert to fuel leaks from StorageTek, canted fuel lines. Gasoline or natural gas and propane can all ignite from a spark what they are at 2% to 50% of vapor concentrations. Be careful around unmarked storage containers because there is a high probability and agricultural operations that they don't contain what the label indicates. One of the easiest ways from a personal protective practice standpoint to avoid this hazard, fires, combustion's, and explosions is to shut the electrical safety or supply off for the inspection maintenance and repair. That eliminates the source of the spark or arc to cause the combustion. Think about that. You are not going to be able to eliminate the puddle of fuel or oil leaking from the system. From a prevented the combustion standpoint, if I cannot eliminate the combust of material, eliminate the spark that causes the combustion. If I shut the system down so it is not running, that I have less of a chance of any of the generator, battery, or illogical system causing a spark or arc to cause the combustion. That would be the strategy, the personal protective practice to prevent that type of and unsafe hazard.

>> In the next side we talk about the fourth category of electrical hazards, arc/or blast. This hazard doesn't relate to a shock or a current flowing through our body. This is another one of those hazards that a separate from being shocked and having a startle voltage, or a burn from the current flowing through our body or fibrillation. Although those still potentially could happen. Hear the arc/or arc blast could happen even though the hazardous condition ellipticity is not flowing to our body. What is an arc/or blast? Those two jargon terms are used to describe those. And arc flashes an electrical explosion. And arc or a blast that produces a fireball that we can visibly see where the electrical current is arcing from one conductor or device to another, or to us. Even though we are not part of the circuit, if electricity was arcing from one device to another, we might not be part of the path of the circuit, but we could be close enough to the arc to get the damaging effects of the heat or other problems associated with that arc/or blast. This happens when electrical fault, a short circuit in equipment or between equipment and a system creates an electrical arc the arc flash is best described as a short circuit through the air for one conductive device to other items that are conductive or ground. Via the/or explosion. This ionizes the air between the sources to form what science people which cause -- call a superheated plasma or arc. Instead of saying that it is hot, let me emphasize that it is really hot in terms of what our hazardous exposure is. Why the concern? The temperature of the arc and approach 35,000°F. You're not just talking about flame burns, what we are talking about is a huge and intense amount of heat. At that level of heat to, not only does the air antiqued expand and move rapidly, metals start to expand fast enough that they can melt or essentially explode. Monday metals explode, then we can have flying debris. Notice the upper right-hand graphic. We have the arc. We have the/. And then we have debris and molten metal and labor. This it has now been forced away from the/and if we are in line with that the brie and molten metal and vapor, then they shrapnel and heat from the shrapnel can also damage our body. Personnel can be burned, thrown off of a letter or off of a scaffold, or office and elevated surface by the blast force and hit by the shrapnel, blinded either light, deafened by the shockwave, or ecstasy aited -- executed by the toxic gases produced from the arc. Notice the upper right-hand graphic.

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We also have a sound pressure wave reduced by the arc/or blast. That sound is not good for our ears at a high level that's enough level that produces hearing damage. The pressure wave can actually blast us and move our body. The light can blind us. And the heat could cause all sorts of problems. The electrical arc in the bottom graphic shows us that temperature. The copper vapor, if it is a conductor and all of those other things that we are concerned about then moving away in the path that could be through us, and that could all happen in less than 2/10 of a second in most instances.

>> We are really concerned about the arc/or blast even though we may not be touching anything, Wiest could -- we could still be within a distance of the arc/or blast to have the hazardous effects of the arc/. That would be the fourth category of Hazard that electrically operated irrigation equipment could cause to us. In this case again much likely entanglement, we didn't have to have electricity flowing through our body. All we had to be was near enough to be in a hazardous condition. The arc/or blast is one of the newer things from an electrical safety hazard thing we are worried about in terms of overall OSHA requirements. Arc/or blast is listed as an OSHA, NFPA 70E specific safety hazard. Which means it has requirements. In part two of the course we will talk about the personal protective practices, or equal meant the NFPA 70E specifies that you as an employee contractor, subcontractor or other working on someone's site needs to be using. In addition, another way that we help alert employers, employees, subcontractors and others on a jobsite today is arc/warning labels. Today, the national electric codes can require arc flash warning labels on the outside of a piece of equipment. What an arc flash warning label does is help you what type of personal protective clothing, equipment, practices or other related things are required depending on what you are doing around that equipment. This particular installation in my graphic we have a worker turning the power off on a very large circuit breaker. As an employer doing the things that you do, you will not be generally working on or near this equipment that requires that level of personal protective practices and personal protective equipment. What are some of the personal protective increments that this individual has on in the graphic? Rubber boots. Flame protection clothing that will not burn. Gloves. They are rated for a certain level of heat. A face shield and a hardhat. Notice that the face is not pointed towards where the arc last, if it would happen, is going to happen. That is a personal protective practice. Using the limited practice to safely deenergize the equipment downstream so that can be worked on. What is the concern for this individual? If there was some type of a short circuit when this breaker was deenergize, the arc or last away from the breaker if they were standing right in front of it, could give them all sorts of his occult damage. This label on this equipment tells this person, the qualified person, the knowledgeable one thought what level of protection they need. It tells you as an -- a qualified NRCS employee, your safe distance for inspection when the claimant is energized. What distance should you not get closer to the equipment than to maintain the safe distance so it won't, or you will not be close to an arc/or blast should something go wrong with the equipment, even though nobody is working on it, or doing anything to it. That is the idea of arc blast safety. So equipment essentially is required by OSHA and NFPA 70E to be energized for inspection, maintenance, and repair. That is the first step. We use the lockout tag out procedures that we will describe in part two of this course. How to turn equipment off and then protects from arc/is part of lockout/tagout procedures. Understanding those hazards and then how to do that safe inspection, maintenance and repair is important. Notice that it even -- includes inspection. If I'm going to read labels on increment and get close enough, rub dirt off of the equal meant or grease, or other thing of, then that qualifies an inspection and I need to be deenergizing the equipment. That means that you need to understand, or whoever the two are working with is the employer, or the

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farmer at the site, how to safely Trinity equipment off. Obviously at the lower level of current and voltage it will not require some of the protective equip meant as my graphic those in an industrial condition. That equipment, if it must be lies, when you are working nearest, has approach or other boundary distances for you as a qualified employee. Part of the OSHA rules that we will talk about in part two with arc/safety is to help you understand the approach or boundary distances that you can safely get close enough to the equipment for inspection. Talks about the personal protective equipment if you are going to get closer than those approach or boundary distances and the personal protective practices if you are going to get closer than those approach or boundary differences we will talk about the details of those things in part two. Part one was to understand the dangerous effects of electricity comedy different hazards, shocks, startles, intake amend or equipment startup, and arc/. And then part two is to go deeper into those rules. What protects us in terms of electrical safety, working around electrical equipment? We've seen the hazards. We have to think about, what protects us? Insulation, obviously. If we think about to those hazardous effects of electricity, what do we do in terms of national codes, standards for equipment to protect electrical -- protects from elect go hazards for operators and people working around the equipment. We put insulation on cords and wires. Anybody that has used equipment understands that today we have plastic insulation that we put around courts, cables, so that the electricity flows on the conductors and we can then unplug things safely by connecting to the insulated cord. The question that you have to ask yourself and remember in the back of your mind is with electrical increment and protection, it is not a question of if the claimant will fail eventually, it is one. All of this material will fail at some point in the future. That means, when it fails, we would like it to fail in a safe manner. Some of you have probably seen older cables and cords were the insulation is cracked or come off or broken outside. One of the reasons when I essentially described insulation as plastic today, and not rubber is that we don't generally tend to use a lot of rubber in irrigation systems unless it is specialty rubber because it doesn't have ultraviolet light protection. It will get brittle and crack. Insulation can fail. We cannot rely on just seeing a cable or court has insulation to guarantee that it doesn't have cracks or breaks or have become brittle. Some people, when I asked the question what protects us with say, common sense. Think about the life lessons that you have learned. How many of you have seen people, maybe even relatives that do not have enough common sense not to stick things in the outlets even though mom said to never do it. We cannot rely on common sense as a backup. From a pretzel of engineering and equipment installation if we cannot rely and insulation because it can fail, our first level of safety and we cannot rely on common sense, than we have to have a backup to that insulation. That is what an electrical professional would call grounding. Grounding is the third wire on electrical equipment that is single phase. That gives us a backup way to trip the fuses and breakers and shut the equipment off when the installation fails. With grounding in a circuit and conductor when it is installed properly to a motor or irrigation system, if the installation fails when we have a short circuit, the grounding path will ensure that fuses blow or circuit breakers trip to shut the hazardous increment off in its condition. In addition to grounding we also rely on personal protective practices, not just in the insulation, common sense, and grounding. I referred to PVP in this course already. Personal protective actresses. One of those that we use is lockout/tagout . To set the equip Middaugh before inspection, maintenance, and repair so that we know even if the equipment has insulation problems, it could start up unexpectedly if we do not shut it off or cause an arc//if we turn it off it cannot do those things we have used a practice, and electrical practice to protect our personal safety while we are at the sites. In a ended -- addition to Burkett -- personal protective practices we can use personal protective equipment or PPE again we still rely on insulation, our common sense or grounding and our PPP. PPE is an

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additional level of backup protection. If I put all of these levels of protection together in terms of my thought strategy, my mind and how to be safe, I meet the OSHA and NFPA 70E rules by having a safe system of proper insulation even if the insulation has failed, I have grounding. If the backup grounding has failed I am still using personal protective practices. I shut the equipment off, and even if I do not shut the equip Middaugh, I have personal protective equipment to help me with the hazardous effects. So what I put all of that together, I have a philosophical strategy of saying, I had different levels of backup to rely on in terms of my electrical safety strategy so that I am not just relying on one thing and if that thing doesn't work or fails, I am not safe. That is essentially what we needed to think about in terms of the big Heckscher. In understanding irrigation system equipment, and the hazards associated with those, and then the details for part two of this class, what I want people to think about is want that you understand those hazards, the hazard effects of electricity on the human body, perception, let's go, burns and fibrillation that we talked about, then when I started thinking about the specific rules and PPP and PPE that I can use as backups, any toothache about how I am going to apply those to an electric powered irrigation system. In the big picture, in doing that, have to think about the type of energy supply that powers the system. That type of energy supply and what it is, and where it is could be electric, diesel, natural gas, propane or potentially renewable in the future. Why is that important. The electrical source or fossil fuel source is essentially the energy supply that I need to think about for the pump specifically and if I am looking at the pump parts, any to make sure I have turned off the pump and its supply. Some people refer to that as the power drive unit. Is the power drive unit powering my system, electric motors, fossil fuel engines, or how do I drive the units connected to the energy supply? Both at the irrigation system, but specifically the pumping system. I could have fossil fuel powered pumps but electric powered your gation systems. I have to think about both of those. The pumping or power drive unit system where it is, how it is powered, and then separately, potentially, the your gation system. Because the your gation distribution system has multiple types or technologies that we can use that could be a flood, or center pivot or traveling Spengler system. It might have associated with the big moving gun or center pivot system electric motors. In my have an electric control system as would a surge irrigation technology system have electric control valves opening and closing with timers on them. It might have ancillary equipment like booster pumps within the system or multiple pumps supplying one system. Understanding the layout to, the geographical system and connection of the power drive unit and the pump, and the air gation this abuse and system, what powers it, and where the disconnects come and how to turn it on and off can be important in terms of your electrical safety, your hazard awareness, and the understanding of how to turn the systems off, what systems need to be turned off, and where you have to go to turn those off to ensure that the power is off for inspection, maintenance, or repair. That brings us to the conclusion of part one of this section of the course.

>> The NRCS folks have asked me to provide you some links to some additional materials. The first link in additional materials is with the your gation Association. In the irrigation Association's website there is some information on electrical safety practices. Because it is from the air gation Association, that would be a reputable source and it is a -- some pretty basic at information in terms of the OSHA codes and standard rules and things that anybody might find important as reminders about electrical safety around irrigation systems. In addition, the second bullet is a link to an electrical safety document at the University of Nebraska extension site. That is an older document, but it is still relevant. That is another good it document or source of electrical safety irrigation systems in a handout form that you can read through to remind herself, print off, or give to others. NRCS also has a more detailed PowerPoint on

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safety around irrigation systems that floated around NRCS for a number of years that I developed in concert with some of the NRCS irrigation engineers a number of years ago that you can find on the NRCS website. In addition, my instructor contact information is given there at the bottom of the slide. My Texas A&M office and email is given. I am a person that gets very concerned about irrigation safety and irrigation systems because sometimes I have to go out and figure out what happened after a bad situation happened. My focus is to figure out if the codes and standards are met. Are the codes and standards having a whole and then that are not keeping our employees and agriculture operators safe and what we need to do in the future to ensure safety. In terms of this course and questions, I am always open for questions in regards to safety from NRCS employees by day through your national staff or emails for clarification, additional guidance, or answering questions on, is this okay or is this not okay.

>> Thank you Greg and Jerry for making the presentation today. Thank you to all participants for joining in. Participant provide your feedback about the webinar and if you selected to earn CE use, please return to your open browser window. This concludes our webinar presentation today. Thank you.