M E M O

Lesson 1: 3-Phase Motor

The direction that the motor turns is determined by the order in which you connect the three (3) hotwires. That tends to be problematic if you have, for example, an R&G hoist because if the motor turns the wrong way, it turns the pump. The pump will not pump the fluid, and may look like it's working, but it won't work. So what I decided 20 years ago was to build into the machines a special switch that turns off the machine and makes the machine completely dead if it's hooked up in the wrong location. A scaffold motor, if you pushed "up" and it went down, or you pushed "down" but it went up, that could be a little be confusing and at the same time dangerous. We built this same type of switch into the Tractel machines. So, if the rotation is wrong, then the machine doesn't work. It's completely dead. So if somebody gets a delivery from us, and reports that the motor is completely dead, and asks for a technician to come and fix it, more often than not, the problem is that the rotation is wrong. If somebody thinks they are smart and touches the rotation in the plug on the motor, or in the yoke, this would do the motor more damage than good. Never touch the electric any place but at the power source or at the pigtail, because if there is another problem later and we end up switching the electric cable, all of a sudden now you won't know where the problem is, and you go crazy trying to find it. All of our electric cables and all of our stuff are wired in a particular rotation for that reason. This very simple term of rotation is something that happens on a 3-phase machine, but the advantage of a 3-phase machine is that it less much less amperage to do the work than of a single phase, which is why it is much better for us. The learning curve to deal with 3-phase is only to get to this very simple concept. There is also a quick fix to this, which is to send out a "reversing tail". I invented this years ago, and all it really does is that it reverses 2 wires inside the plug, the red and the black, so when you plug it in, it will correct the rotation that's wrong without really going through the panel, and without touching a bunch of things, and that is why, this device, as long as we get it back, has some value. So a reversing tail is another way of correcting it.

There is a rotation device, which can actually monitor and check the rotation. When you plug it in, you can see if it's right or wrong. If you're going to wire a big jobsite, it might not be wise to send 50 reversing tails because one more thing can happen: suppose these tails were wired, and then they move it from one place to another, those tails were wired wrong. That's why we always want to keep all of our electric cables, pigtails and everything wired the same, and never touch the power anyplace except where it connects to the panel itself. It is very important to understand this concept.

When you wire electrical panel, most panels have the 3 phases, which I will refer to as X, Y and Z. X, sometimes people say it is red, Y we'll say it is white, and Z is black. But those colors might change depending on the electric cable. If we're using 4-wire, it's possible to have a 4W 1Ph pigtail. 1Ph will be 2 hot (? 6:17) and 1 neutral. I chose over the years to move away from that type of system because what we use for getting power on the scaffold, the step-down transformers, allows much more amperage for the tools on the scaffold than using the yoke. Those yokes with the extra conductor, the neutral wire, those are okay, but they don't give you enough amperage. If you're going to use a small tool like a radio or 4amp grinder, it's okay. If you start trying to use 15amps, 20amps, 30amps, you're

going to burn out your tools. 4w or 5w, it has something to do with the yoke. If it's a step-down transformer, then that device brings down 220 down the cord and it changes to 110-120 and it gives you better power for your tools.

Lesson 2: Wattage

When a motor turns, it requires a certain amount of horsepower, or wattage. Wattage is effort to do something. Some people are naïve and they think that if they line up bulbs at 200v, they use less amperage so you're using less money. Con Edison does not charge you for amperage. They actually charge you for wattage, or kilowatts. Let's say at the roof you have a 20amp circuit breaker, and you have 200v. 20amps x 200v is 4,000 watts. If you bring 110 on the cord, what happens is you're drawing twice the amperage to do the same amount of work. Imagine what I said before – 120 but the work to turn that motor is a certain wattage – whatever it is – let's say that a grinder is 15amps – 1800 watts. When you bring 110 down the cord to do 1800 watts – we already determined that it was 15amps – if we bring it down at 220 (9:55), what's the difference? And this is why power is the way it is in the city. Why is it that Con Edison has high voltage lines traveling the streets? It is because it's much easier to transfer high voltage than high current. It's the wattage that does the work. Once the power is correct at the machine, the transformer transforms it from 220 to 110. But if you only bring 8amps down the cord, then it's the amperage that caused you the voltage drop. It's clearly the amperage. So one very good rule, an approximate rule of thumb is this: with 500 feet of cord, for every amp you drop, you can drop approximately 1 volt. So if 2 motors, one with approximately 10 amps, and another also with 10 amps, so that's 20amps, and with each drawing 220v, but draws 10amps, those amps are added together if they are working at the same time. So you have 20 amps coming down the cord. This causes 20v a drop. If you start out with 208v and you drop 20v, you're at 188v. That's below the threshold of what a Tractel motor is designed to operate. Roughly speaking, it's 190v. This also depends on the state of the motor, how new, etc. When you drop 20v, the motor is in a place where it doesn't want to be. It works for a little while but eventually something happens to the motor. You burn up parts. Now, when you place a 3-phase motor there, it will draw maybe 5amps, 2 motors are 10amps. Now they're dropping 10v, so the machines still have the right power to still work.

Lesson 3: Boosters

Anytime that you use more than 250 feet of cord, if you know the input voltage to be 208v, you should always use a booster. At more than 250 feet of cord, the voltage drop will eventually damage the machine. There are other machines which have a lower threshold voltage like the Spider PC3 machine. That machine will operate down to approximately 170v. So they may have a small marketing advantage over us. They'll say, we don't need a booster while others do. These are little tricks, when you're approaching a customer they'll say, well I don't need a booster. He may not understand why he needs a booster. It took a long time to convince Tractel to make the machines stronger so that it could perform up against the competition.

Every sales person really needs to understand power. Actually what we should do, is I should give you a very simple course on DC circuits and resistance, because that would teach you to understand more about current.

Lesson 4: Amperage

1000 feet of no. 10 wire has a resistance of approximately 1 ohm per thousand. And the no. 10 wire is the gauge of the wire that we use for our scaffold motors. Here is the ohms law formula. The no. 10 wire has a resistance of 0.9989 ohm per thousand, which is almost 1 ohm. Why is that significant? It is the resistance that causes the loss of voltage. When you multiply the resistance by the amperage, it will tell you what the voltage drop actually is. So, 10amps multiplied by 1 ohm is 10 volts. Now you may say to me, but there is only 500 feet of cord. That's not really true. A person who does not really understand something called network analysis would say that. The power travels from the power source down to the motor, and from motor back to the power source. So it actually has a thousand feet of travel. It's that thousand feet of travel that causes the 1 ohm, which causes the voltage drop that we speak about. That these are only vague approximations, and there are other factors that affect it. For example, when a motor starts, it doesn't draw up amps (17:28). It draws much more because it has to go from 0-1,760 rpms in a split second. It passes a very large amount of current. On a 1ph machine, through a start capacitor, the centrifugal switch switches the start capacitor out of circuit, and it's no longer in a circuit and the more it draws much larger than 10amps. But for a moment in time that motor actually draws something like 20-30amps , depending on a number of things. They may have 2 motors going on. That's why those motors may not start well.