Addressing Electrical Leaks in the Field
Cased Hole Operations

Technical Bulletin Six

The purpose of this technical bulletin is to provide a basic understanding of electrical leaks and to provide a procedure for field personnel to identify the type and location of an electrical leak and if possible keep the wireline unit working.

Although locating electrical leaks can be complicated, the majority of problems can be resolved in the field by a skilled operator using a good quality ohmmeter that reads to 1/10 Ohm. This can save a trip to the service center and allow the wireline unit and crew to finish the job.

Common steps to identify electrical leaks are listed below.

1. Tool String - Step one should be to test the tool string. This is the simplest test and in the field the easiest repair as there are typically spare tools on the wireline unit. If the spare tool works this was likely the problem.
2. Cable Head – If the tool string checks out good the next step is to check for problems in the cable head. This is where the majority of problems related to electrical leaks occur, when it does happen it is typically human error during assembly of the cable head. To check the cable head cut the cable just above the cable head and test the electrical integrity of the head. If the fault is located rebuild the cable head and reattach the tool.
3. Collector (Slip) Rings – Many electrical problems occur in the collector rings, the coaxial cable going from the collector rings to the control panel, and occasionally the control panel. Loose wires, corrosion, wear, pressure washing or steaming the unit, and faulty equipment contribute to these problems. If the leak still exists after testing the cable head, disconnect the collector ring from the cable and test the electrical integrity of the ring through to the panel. If there is a problem here, disconnect the coaxial cable from the collector rings and test the collector ring independently. If the collector ring is good then disconnect the other side of the coaxial cable from the control panel and test the coaxial cable. If the problem is not in the coaxial cable then next test the control panel.

4. Wireline – After disconnecting the wireline from the collector rings: if the electrical problem was not in the collector ring through to the control panel then test the wireline before progressing to the coaxial cable and control panel. The most common areas where wireline problems occur are listed below.
    a. Working part of the cable - Physical damage during rigging up, not using a goose neck, perforating kick back, jumping sheaves, excessive temperature, excessive tension, offset conductor, or broken inner armor, contribute to failures in this part of the cable.
    b. Drum end of the cable – Drum crush, Installation problems and failure at the drum entry hole are common causes of failure.

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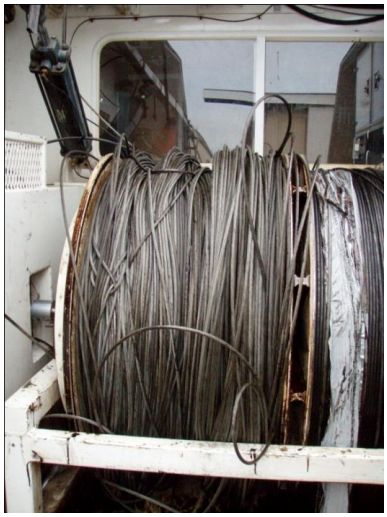
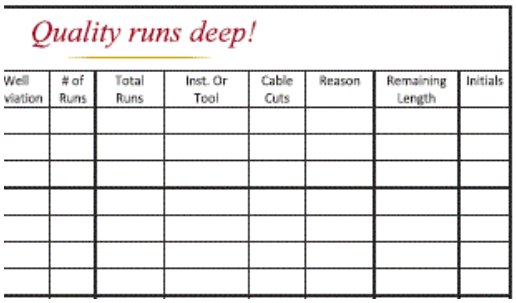
Understanding the typical causes of leaks and shorts will speed up the investigation process. Leaks can occur in many different forms, each having its unique challenges in terms of locating the leak. Listed below are the common leak types. They can all occur in the tool string, cable head, collector rings or in the wireline.

- Dead Short - The conductor is in direct contact with the armor, this is the simplest type of short to locate.
- Intermittent – This is the most difficult type of leak to deal with because it is not always apparent.
- High Resistance – Leaks where the leak resistance is much greater than the conductor resistance can be difficult to locate.
- Wet Leaks – occur when there is moisture in the leak. The presence of salt water complicates wireline leaks because it causes a small voltage generated between the copper conductor and the zinc coating on the armor wire. This potential will create misleading resistance readings and accurate leak location in the field is not possible.
- Multiple Leaks – can occur when a wireline has several leaks. The cable to the right likely has more than one electrical leak.



If the problem is in the Wireline then you need to determine where the leak is relative to the tool, which will determine if it will be possible to repair in the field or not. Although there are several ways to identify electrical leaks in the wireline, there is really only one method that can be used effectively in the field. Regardless of the measurement technique it is critical that the length of the cable is known accurately. This is one of the reasons it is imperative that accurate cable record books be maintained.



The only leak type that can be effectively dealt with in the field is a dead short. So the first thing to do is to determine if you have a dead short. To do so you require a good quality ohmmeter (Fluke) that reads to a minimum of 0.1 Ohms. Using the methodology below you can test to see if you have a dead short.

1. First short your meter leads and record this resistance reading. To eliminate errors due to the resistance of the leads, this lead resistance should be subtracted from all resistance measurements.
2. Disconnect both ends of the cable and ensure the leads are clean.
3. Measure the resistance of the conductor to ground (armor) on the whip end Rw
4. Then reverse the leads and again measure Rw. If the resistance is significantly different with the leads switched then you have a wet leak and precise location in the field is not possible. Proceed to step 7. If the readings are the same proceed to step 5.
5. Measure the resistance of the conductor to ground (armor) on the drum end Rd.
6. If the leak is not wet, use the formula below to determine if you have a dead short. Where Rc is the resistance of the current length of the conductor (from the cable record book). If the value of Rc in the cable record book is questionable then measure the conductor resistance.

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If **(Rd + Rw – Rc) < 300 Ω** then you have a dead short otherwise you have a high resistance leak. If you have a dead short skip section 7 below.

7. If there is a high resistance or wet leak the next step before going to a service center is to unreal several hundred feet of cable and with the Ohm meter attached at the drum end watch the Ohm meter as this loose cable is flexed along the length by hand. This is a crude but sometimes very effective way of leak location as many cable leaks occur within a few hundred feet of the whip end. If the leak is found cut the cable and test. If the leak is still present, the cable must be taken to a service center.

If the resistance is less than 300 Ω than follow these steps to determine the location of the leak.

1. Find the total length (L) of the cable from the cable record book
2. Calculate the length of cable to the leak from the whip end (Lw) using the following formula.

Lw = (Rc + Rw – Rd) x (L / (2 x Rc))

3. Calculate the length of cable to the leak from the drum end (Ld) using the following formula.

Ld = (Rc + Rd – Rw) x (L / (2 x Rc))

The example below demonstrates how to use the formulae:

L = 24,500 ft (7,468 m) For metric use meters in the same formulae
Rc = 68.6 Ω
Rw = 149.4 Ω
Rd = 205.2 Ω

First test to see if it is considered a dead short (Rd + Rw – Rc) = 286.0 Ω **Less than 300 Ω**
Check leak distance from whip end Lw = (68.6 + 149.4 – 205.2) x (24,500 / (2 x 68.6)) = **2,286 ft**
Check leak distance from drum end Ld = (68.6 + 205.2 – 149.4) x (24,500 / (2 x 68.6)) = **22,214 ft**

Once you believe you have located the leak, slack the cable and examine it for physical damage and manually flex the cable while observing the leakage resistance. You should find variations in the ohmmeter reading if you are at the leak. If the leak is located close enough to the whip end that you can spool down and cut off, and you have enough cable remaining to perform the current services then do so. After the short is cut out, test the remaining cable to ensure electrical integrity. Rehead and finish the job.

If the leak is too far away from the whip end to cut out then you will have to take the cable into a service center for inspection. At a service center they are well equipped to deal with all types of leaks. Burning a leak out with a “burn out” box is the fastest way to identify difficult leaks. The service center will also have more sophisticated equipment than an ohm meter to try and locate the exact point of failure. If it is suspected the cable is damaged from mechanical damage or temperature then a burn out box will save time to locate the leak. However, if it is important to determine the cause of the leak, then a burn out box should not be used as it will destroy the area around the leak and likely make it impossible to perform a root cause analysis of the failure. Note as in the picture to the right, damage to both conductor and the armor can result from use of a burn out box.

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