technical bulletin 009

2/2012

Drum Crush

The term "drum crush" refers to a cable electrical failure that occurs as a result of the cable being crushed, smashed or distorted to such an extent that the armor wires press and distort the plastic insulation, and in some cases cut through the insulation and contact the conductor. It is possible to have the conductor insulation distorted to such an extent that it affects the signal transmission characteristics of the cable without an actual electrical short. These failures are caused by cables at high tension being spooled over cable spooled at abnormally low tension, cable installed with an incorrect tension profile or cable that is operated in a manner to cause excessive rotation. For these reasons a more correct term for this type of failure would be "Cable Crush Failure, (CCF)".

CCF never occurs on the whip end of the cable. Typically the failures are found at a minimum of 4 or 5 layers down and more commonly deeper than that. Failures can and often do occur in layers of cable that have never or not recently been off the drum.

An important characteristic of CCF is that the failure frequently does not occur immediately. For a failure to occur the plastic insulation must cold flow under pressure and this can be a slow process. A CCF condition in some cases may have been setup several jobs, days or even weeks before the actual failure does occur. It is this time lag that makes it difficult to always identify the actual cause of the failure.

Factors that can contribute to CCF include:

1. Poor drum cable entry hole.
2. Irregular drum core.
3. Spreading of drum flanges.
4. Incorrect tension profile on initial cable installation.
5. Single break cable installation.
6. Loss of normal cable tension in field operations.
7. Excessive cable rotation.
8. Low or nonuniform cable inner armor coverage.

A further explanation of these failures:

1. A rough or bad angle of the cable entry hole in the drum can result in a CCF from the pressure of all the wraps on the drum. This is a special case and is easily identified.
2. Irregularities in the diameter of the drum core results in irregularities in the spooling pattern which causes pressure points on the cable and distorts its shape. When the cable shape is distorted, it generates gaps in the inner armor permitting easier cold flow of the plastic.
3. When the drum flanges spread there is as much as half of the diameter of the cable on each side of the top layer then there is a situation where the cable can cut in. When this occurs, the cable shape is distorted resulting in easier plastic cold flow.
4. There is no "one size fits all" when it comes to installing a cable on the drum. The correct tension profile that should be used depends on the type of cable, the cable length and expected depth of operations. In general after the bed layer is established the spooling tension is increased each layer for 3 or 4 more layers up to a tension of about 1/3 of the cable breaking strength. This tension is maintained for half the cable length after which the tension is reduced each successive layer. This is just a very general rule and experienced cable servicemen in each area know how to adjust these tensions for best spooling. If too much installation tension is used in shallow hole areas, then the cable will not spool properly at the low tensions in shallow operations. If the installation tension is too low, when installing a cable to be used in deep hole operations, then the problem is more serious as CCF can result. When the installation tension is low, and the spooling tension coming out of the hole is high it can result in a CCF. The failure will typically occur several layers down on the drum and at a cable crossover between wraps or at the flange where the cable moves from one layer to the next.

5. When a cable is spooled on a drum the cable must move over one diameter distance for each wrap. If this move is accomplished at one point in the wrap it is called a single break spooling. All qualified cable spoolers now use the double break spooling method, which moves the cable half a cable diameter midway around each wrap. The single break results in a more severe distortion of the cable armor making it more susceptible to a CCF by overlaying layers.

6. One frequent cause of a CCF resulting from field operations is re-spooling cable back on the drum after loss of normal cable tension. A common cause of loss of cable tension is overrunning the hole bottom. When this occurs it results in several wraps of the cable going back on the drum at low tension, followed by the high tension of cable when pulled off of TD. This problem has become more frequent because of deviated holes, where it is necessary to approach TD very slowly to avoid overrun. The cable can also lose normal tension when any restriction is encountered going in the hole. When this overrun occurs the cable will start back on the drum at lower tension than the subsequent layers. If this tension differential is too great, it sets up a condition for a CCF. As explained above this failure is usually not immediate and therefore if a cable has been overrun it might be saved by bringing it to a cable shop and have a normal tension profile reestablished or by operating the cable in a deeper hole very soon after the previous problem. Any other situation that causes a loss of normal spooling tension coming out of the hole, such as clamping off the cable to correct a spooling problem or clamping off at a side entry sub, can also lead to a CCF. There are some radical operating conditions where the friction in the hole and tool are such that a wide variation of the in and out tension cannot be avoided. In these cases special powered sheave or capstans must be used to reduce the tension differential and to avoid cable crush.

7. One factor in the ability of a cable to withstand cable crush is the “hoop strength” of the armor wires. This is greatly reduced when the outer armor unwinds and becomes loose. If the end of the cable is free to rotate then the outer armor will try to unwind in proportion to the tension on the cable. This is the most frequent cause of failures in pressure cable.

   a. The cable should never be spooled out of the hole at a speed greater than a speed that results in a tension greater than 125% of the static tension at that depth. Higher tensions result in excessive unwinding of the outer armor. Further, going into the hole the speed should never be less than that speed that maintains a tension greater than 75% of static tension. Failure to follow these rules will cause the cable to progressively unwind the outer armor setting up a condition for CCF. When cables are operated outside these limits, the cable should be brought into a cable service center for normalizing (tightening the outer armor) and post-forming when the outer armor becomes loose. Examining the whip end of the cable, if you can easily move the outer armor with your fingernail or a small screw driver, then it is time for service.

   b. Coming out of the hole the cable unwinds and going back in the hole the cable attempts to tighten back up. If a spring centralizer is used going into the hole a swivel head must be used to avoid severe unwinding of the outer armor.

   c. The amount a cable unwinds under free conditions, depends not only on the tension in the cable but also the friction between the armor layers. For this reason seasoned cables with mud and corrosion products between the armor layers will rotate less and are less subject to CCF. New cables, however, rotate very easily and new cable used in high pressure wells, with grease in flow tubes, must be carefully checked for loose outer armor. It would be good practice to have a new pressure cable brought to a service center to have the armor tightened after the first 20 or 30 operations and thereafter when the outer armor becomes loose.

   d. Alloy cables used in sour gas operations, represent a special problem. The alloy armor does not rust or produce corrosion byproducts and these cables are normally used with high pressure grease in the flow tubes, so these cables rotate more freely throughout the life of the cables. These cables MUST be brought into the cable shop regularly for normalizing and post-forming. Good practice for these alloy cables would be to have the armor tightened every 20 operations throughout the life of the cable.

   e. Cables can be forced to unwind when pulled through a tight packer, dragging on any fixed object, run over a sheave wheel that does not have the proper groove or the sheave and truck are not properly aligned. Any forced unwinding of the cable further reduces its resistance to CCF.

8. In the manufacture of Camesa cables careful attention is paid to the inner armor coverage. Coverage is how completely the surrounding inner armor wires cover the plastic core. This coverage is maintained between 98% and 99%. This range of coverage provides the maximum protection to the core to withstand CCF and still provides the necessary gaps to allow the cable to bend. It is also important that the inner armor wires are spaced evenly around the core. At Camesa the inner armor spacing is carefully controlled and inner armor wires are pressed into the core so that this spacing is maintained through the final armoring operation. When a CCF occurs the inner armor coverage should be checked to determine if it was a contributing factor. The inner armor coverage should be checked on a new section of cable as once the cable shape is distorted the coverage cannot be judged.

The cost of cable and more importantly the cost of a cable failure on a job are so great, that the cost of bringing a cable to a service center to have the armor tightened and the proper tension profile reestablished, is minor by comparison. Whenever a cable has encountered any of the conditions described above where a CCF could result, get your truck to a service center before there is a failure.