Live-line techniques in high voltage overhead transmission line repair

by Patrick O’Halloran, City Power

This short paper covers how live-line (energised) techniques can be utilised to restore supply as quickly as possible in the event that high voltage transmission towers have collapsed.

City Power had to repair two 88 kV high voltage lattice strain transmission towers in Johannesburg recently, which had collapsed due to the theft of metal cross members from the towers. The collapse of these towers caused a power interruption to an entire substation because, since both circuits were affected, no alternative source of supply was available.

Repair project undertaken utilising Live-line techniques to restore power

The repair entailed the replacing of these two towers. New transmission towers can take anywhere between two to four weeks to manufacture depending on their designs and availability. Due to the extent of the outage it was impossible to delay repairs for that length of time. City Power requested help from Quanta Services Africa, a company which specialises in live-line work and has special robot crane trucks for the purpose.

Typically two types of live-line work is commonly undertaken, namely “hot stick” and “bare hand”. The hot stick techniques are traditionally used for tasks such as moving conductors, installing fuses and opening and closing switches. Bare hand work, involving more intricate repairs, entails the use of specially designed protective gear and clothing enabling live-line workers to work at the same electrical potential as the high voltage line up to 765 kV.

The live-line suit consists of a hooded jacket, overalls-style pants, socks and gloves. It is typically made from Nomex material, which is a fire-retardant material,
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Figs. 8 and 9: Foundations being cast in place with the monopole template and earthing.

Figs. 10 and 11: New monopoles being lifted into position between live 88 kV circuits.

Figs. 12 and 13: New monopoles energised and back in service.

Figs. 10 and 11: New monopoles being lifted into position between live 88 kV circuits.

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One high voltage transmission line was restored on the same day that the towers collapsed. Fig. 4 shows the robot arm crane truck holding the live conductors high in the air at the two points where the towers would have been. Two new monopole towers were ordered from Structa Technology which is located in Meyerton. These two locally made towers are designed to withstand 200 kN each.

Although the two robotic arm cranes can hold conductors in the air for extended periods, temporary wooden structures were installed by Quanta Services Africa and stainless steel fibres. This metallic mesh serves as a Faraday cage, which puts the line worker at the same potential as that of the conductor on which he is working. With the metallic mesh clothing bonded to the conductor, the lineman can work protected inside the electrical field.

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Fig. 16: New tower in position with no supply interruptions experienced.

Fig. 17 and 18: Crane lifting the damaged tower off nearby 88 kV transmission lines.

Fig. 19: Quanta Services Africa robotic arm crane trucks holding up the live 88 kV transmission lines.

to hold the live conductors in the air while the new towers were being manufactured, for security and safety reasons.

Once the first 88 kV line was successfully transferred to the temporary wooden poles, the second line could be repaired, lifted up and secured to the wooden poles. Once in place it was energised as well. The concrete foundations for the new steel strain monopoles were then cast in two stages and allowed to cure for the recommend period of seven days to achieve the 20 MPa strength required. The copper-clad steel counter-poise earths were laid before the tower template was concreted in place to prevent theft in the future as it would not be visible after the base foundation was covered again with backfill top soil and compacted.

The new steel monopoles were then assembled and lifted into position and fixed to the new concrete foundation. This involved a high level of caution, observation, communication and skill as the crane had to work between live 88 kV circuits and therefore maintain electrical clearances at all times.

The circuits could then be transferred over one at a time from the wooden temporary poles to the new steel monopoles. This was not done with live lines due to the risk of reducing the electrical clearances which would cause a flash over and the need to make-off the conductors on the new poles once the right sags had been achieved. The power to the substation was not interrupted as one of the lines was always energised and no power interruptions were experienced.

This repair project was successful due to the experienced staff and specialised live-line equipment that Quanta Services Africa operates in South Africa. The project was also professionally overseen by Phambili Merz, a subsidiary of the Mott MacDonald group, to ensure all the technical aspects were complied with. Structa Technology manufactured the steel monopoles for this project in two weeks and this is the huge benefit of having such local manufacturing capabilities available to the industry.

Other projects where live-line techniques have been utilised to carry out the emergency repairs for City Power:

During the Soccer World Cup 2010 Tournament, a freak accident occurred when a vehicle travelling on a highway off-ramp crashed through the Armco barrier and caused extensive damage to an 88 kV transmission line lattice tower. The tower was held in place by the weight of the conductors only. This tower had to be replaced urgently and because of the network loading conditions it could only be replaced under live-line conditions.

During 2012 a car accident caused another 88 kV tower to topple over onto nearby 88 kV transmission lines. The tower foundations were not damaged and a spare lattice tower could be installed in the place of the old tower while the conductors were held up in air by the Quanta Services Africa robotic arm cranes.

Conclusion

The use of new live-line techniques and equipment is critical to ensure that overhead line transmission networks can be restored quickly when disasters occur to prevent extended outages. These emergency repair projects would have been unsuccessful if live-line work methods had not been not utilised.

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