138 kV MAINTENANCE

TR-113556

ABSTRACT

In order to reduce the risk of injury as a result of explosions caused by arcing faults in underground manholes, the Los Angeles Department of Water and Power (LADWP) designed a cover-restraining system that can be retrofitted on existing manholes. The effectiveness of the restraining system in relieving pressure needed to be demonstrated. A test program was developed with the contractors and LADWP. To reproduce the conditions found in the underground network, a precast manhole was installed at IREQ's High Power Laboratory for tests on a l38-kV paper-insulated self contained fluid filled (SCFF) cable with a stop joint. Three tests were performed with a fault current of 4 k_{rms} (30 cycles), 10 k_{rms} (30 cycles) and 20 k_{rms} (8 cycles). The driving voltage was 50 kV for the first and second tests and 40 kV for the third test. A fuse wire was installed in each stop joint in order to trigger an arcing fault in the joint. For each fault test, the voltage, current, pressure, temperature and manhole cover acceleration were recorded and from this data, the cover speed and displacement, arc energy and Joule integral were calculated by numerical processing. High-speed and video cameras captured the ejection of smoke and burning gases and the images were edited to make a short video.

From the collected data and video recordings, it is clear that the restraining system remained in the wide open position as long as the overpressure in the manhole during the arcing fault was high enough. Furthermore, the restraining system remained intact and fell back to its original position in each test. Although the video camera recordings showed flames several meters high for the first two tests, they did not last long enough to burn the pieces of wood placed around the restraining system. The asphalt or sand surrounding the restraining system in the first two tests was completely blown away. Visual inspection of the manhole surroundings after each test also showed that parts of the joint (insulating paper and bakelite) were blown out of the manhole during the test. The section of the joint casing where the fuse wire was installed was completely tom due to the arc-induced pressure build-up; the damage looked similar to that experienced in the LADWP network.

From the pressure recordings, it can be concluded that during the first half-cycle of each test, the arc was mostly confined inside the joint between the cable connector and the joint casing with the ejection of oil and gas under very high pressure through a relatively small opening in the casing. Sometime, during this period, the decomposition gases started to burn with the oxygen available inside the manhole causing the temperature to rise. Following that period, the arc was almost free-burning and the quantity of decomposed gases must have been lower than before the joint exploded. The maximum recorded overpressure values inside the manhole for the first two tests were very si1i1ilar, ~100 kPa

(14.7 psig) while, for the third test, it was test was recorded at 215 kPa (~30 psig).