



NEPRA Alert # 2021-02/ December 18, 2021

### Distribution Transformer Explosion

#### Summary

A fault occurred in a 200kVA distribution transformer. The transformer was shifted to a private workshop for HT connection repair. The transformer was returned to the site after substandard maintenance and placed on a platform at Double Pole Mounted Substation (DPMS). The line staff started connecting transformer without obtaining Permit to Work (PTW). They connected HT/LT jumpers including the total load. One of the linemen called grid staff to get short tripping on the feeder before connecting the links. As the feeder tripped, the linemen connected all three links, after which the linemen called the grid staff to switch ON the feeder. After 12 seconds of restoring the power supply and energizing the transformer, the transformer exploded from the bottom plate and the hot burning oil of the transformer splashed onto the nearby people. Four (4) distribution company employees and sixteen (16) members of the public sustained burn injuries. Later, nine (9) public persons and one (1) distribution company employee passed away and six (06) were hospitalized. Others, however, suffered minor injuries and were discharged on the same day after first aid.



Figure-1: 200kVA Transformer



Figure-2: Transformer Bottom Plate Rupture



Figure-3: HT Side Terminal Connection



Figure-4: HT Side Short-circuited Windings





Figure-5: Tank Sheet and Bottom Plate

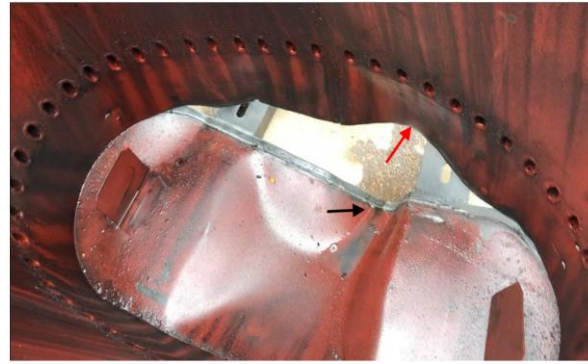


Figure-6: Transformer Tank Internal View

## Findings

1. Employees involved in the activity failed to follow Standard Operating Procedure (SOP), and standard work practices. PTW was not obtained and hazardous electrical energy was not isolated from the grid to ensure Zero Energy State before performing maintenance activity on the transformer. Grid station shift in-charges switching OFF and ON 11kV feeders on the call of a lineman indicates a poor safety culture.
2. The distribution transformer was repaired in a private workshop, where a broken HT terminal was attached manually without soldering, and the connection was wrapped up with a substandard cotton tap and loose insulating paper. The transformer was installed without being tested or certified as fit for use. Also, loose connections in the transformer can cause a spark and overheating. Insulation oil was also contaminated by moisture through substandard repairs.
3. In peak summer during the Eid holidays, the transformer was loaded above 100%. Two of the three HT side windings were short-circuited when energized due to the overloading of the transformer. The transformer oil was already contaminated and the percentage of moisture had been increased from a private workshop, thus affecting its dielectric properties, causing oil temperature to rise, evaporation, and the formation of combustible gasses which expanded violently, causing the transformer tank to bulge rapidly and catch fire within 12 seconds, resulting in a heavy explosion of the transformer. As a result of oil dripping from the transformer, it was observed that the insulating oil in the tank might not be sufficient.
4. After the transformer failed, none of the fuses blew because rora fuses were used for connection purposes, which is a serious failure.
5. The transformer was installed for operation even though the oil leak was discovered after repairs, indicating gross negligence on the part of the field staff. The oil leakage also reduced the level of oil in the tank, caused insulation loss, and ultimately increased the risk of an explosion.
6. The weakest point of the transformer tank was the weld joint in the bottom base plate, a 4mm thick plate that ruptured after explosion. It was found that the welding beads on the bottom base plate of



this transformer tank had an uneven poor bead profile. Since there is no requirement for welding in the specification, welding was done only from the outside, not from the inside.

7. No brochure or maintenance manual was provided with the transformer for operation and maintenance.
8. Serious supervisory lapses were observed in the field. A haphazard and hasty manner was adopted while carrying out maintenance work. The staff failed to predict the level of the risk and took improper decisions.

## Lessons Learned

1. Conduct an extensive awareness program to educate all employees to follow PTW and isolation procedure, and to install transformers according to the SOP in terms of their fitness, application of connections, and loading.
2. The number of authorized workshops should be increased and should have all of the repair facilities required by NTDC specification # DDS-84-2020, including testing facilities for transformer reliability and integrity.
3. Arrange a sufficient quantity of spare distribution transformers for immediate replacement of damaged transformers, as well as to allow authorized workshops to repair and test the damaged transformers properly.
4. Develop and implement SOPs to provide guideline for inspection and corrective/preventive maintenance of under-operation transformers, as well as testing of distribution transformers to improve their integrity and reliability.
5. Include a mandatory requirement in the purchase documents to obtain the “Manufacturer Maintenance Manual” having all details of transformer, its periodic inspection, corrective/preventive maintenance, and testing requirements.
6. A comprehensive study should be carried out periodically to assess the loading position of all distribution transformers and to take subsequent measures, such as augmentation of transformers to prevent overloading and breakdowns.
7. Replace all substandard rora fuses installed on the transformers under operation with fuses of standard size and rating.
8. The welding requirements and strengthening of the base plate of a transformer should be considered in the specification including internal and external welding techniques, welder certification, welding inspection, and quality control.
9. In order to protect consumers and workers, field management should ensure that all electrical requirements, safe work practices, and SOPs are well coordinated and implemented at the site.

