

DISTRIBUTION TRANSFORMER HAZARDS:

ENSURING LINEWORKERS UNDERSTAND POTENTIAL HAZARDS AND TAKE APPROPRIATE PRECAUTIONS

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The distribution transformer is the most commonly used piece of equipment in the power delivery system, and there are virtually millions of them in service across Canada and the United States. Consequently, lineworkers are routinely involved with the following distribution transformer tasks:

- Installing new transformers.
- Installing refurbished or used transformers.
- Removing idle transformers.
- Replacing transformers that are overloaded, under loaded or do not have the capacity for additional load.
- Returning transformers to service that have operated protection features.

Given the number of transformers used by power companies and the various activities lineworkers perform, the exposure to the hazards associated with transformers is elevated.

Over the years, there have been some very serious accidents involving lineworkers and transformers, raising safety concerns among power companies. With systems expanding to meet load growth, fault current levels have significantly increased in many areas. Modern transformers now have lower impedances than the older designs, which can increase the fault current flow. Power companies and lineworkers need to fully understand the potential hazards and take the proper precautions.

TYPICAL HAZARDS

The physical design of distribution transformers places the primary and secondary windings in close proximity to each other. This presents the potential for a primary-to-secondary short from insulation failure, which could result in high voltage coming from the secondary winding. In addition, having a hermetically sealed tank with flammable oil inside presents a hazard for explosion. Transformer-related accidents generally fall into one of the following situations:

- Accidents involving explosions where the lineworker is injured from hot oil, arc temperature, or arc brightness while in the process of reenergizing the transformer.
- Accidents where lineworkers have been injured from being hit by the lid during its removal.
- Accidents where the lineworkers have been injured from back feed through the transformer.
- Accidents where the lineworker is injured from contact with high voltage at the secondary of the transformer.

The majority of the accidents that have occurred have involved some level of catastrophic explosion, which, in turn,

injured the lineworker. The majority of transformer damage comes from lightning storms, and in many cases, the damage is readily visible. The real danger for a lineworker comes when the transformer damage is not visible.

HAZARD MITIGATION

Fortunately, there are several measures that power companies and lineworkers can apply to significantly reduce the hazard. In addition, transformer manufacturers are improving the design of their units to minimize hazards and make it easier for the lineworker to determine if the transformer is faulty.

Experience has shown that lineworkers must be trained to understand and recognize potentially hazardous situations. Having well designed procedures that lineworkers follow significantly reduces the hazard.

The following is a compilation of some key actions from various power company procedures:

- Always wear the appropriate personal protective equipment including fire retardant clothing, hard hats, safety glasses and rubber gloves.
- When performing any close inspections of or repairs to the transformer always deenergize the unit and take precautions from any sources of power including customer generators.
- Prior to re-fusing transformers, make a thorough inspection of the transformer and the surrounding area, looking for indicators such as: animal carcasses, bulged tank or cover, discolored tank, oil leak, burned oil aroma, flashed or broken bushings, any short circuits such as wrapped wires in the secondary or service.
- Prior to re-fusing transformers, test the transformer with an approved instrument such as a Transformer Turns Ratio tester. Some companies require some form of testing on every transformer before they are energized.
- When re-fusing a suspected faulty transformer, position yourself as far away as possible by using an extendable live line tool. Some companies specify maintaining a distance of at least 10 ft. when re-fusing transformers.
- When re-fusing a suspected faulty transformer, always disconnect the customer's load.
- Test the transformer with a smaller test fuse. (Some companies have test fuse tables based on the transformer size and voltage).
- If the transformer blows a fuse and the pressure relieve valve has operated, do not re-fuse and proceed with replacement.
- If the transformer has an auxiliary current limiting fuse that has blown, do not re-fuse; proceed with replacement.



Checking transformer condition (Photo: Hastings)



Maintain proper distance when re-fusing.



In this condition: do not re-fuse

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- Always make sure the neutral is connected first before connecting a transformer and that it is removed last if disconnecting a transformer.
- Do not allow the paralleling of transformers across any point that might be used to isolate a line section, such as switches, disconnects and double dead ends to avoid the possibility of back feed into a cleared line section.
- Always wear rubber gloves when working on the secondary side of a suspected faulty transformer.
- Take precautions when removing the lid from a suspected faulty transformer by operating the pressure relief valve. If it is an older unit without a valve, tie a sling over the lid before loosening the attachments.

Some companies have established step-by-step procedures for investigating transformer problems while others allow the lineworker to access the situation and take precautions they deem necessary within mandatory safety guidelines.

It is recommended that step-by-step procedures be developed as they are good training aids and can serve as a refresher for lineworkers. They also help ensure certain key steps are followed.

MANUFACTURERS' ENHANCEMENTS AND RECOMMENDATIONS

Transformer insulating and cooling oil is an area where there has been considerable effort to produce a product which is more environmentally favorable, with better fire resistant characteristics. Power companies now have options in addition to the standard mineral oil. Manufacturers have also improved the design and quality of the mechanism securing transformer covers.

Internal Fault Detector Corporation has developed a patented device, which is an integral part of the transformer and provides positive identification of an internally-faulted condition. The device, which senses the pressure rise that occurs during internal arcing faults, releases internal pressure and activates an external indicator flag that can easily be seen by the lineworker. When lineworkers encounter a transformer with the fault detector operated, there would be no attempt to re-fuse and the transformer would be replaced. The device is inexpensive and easy to install in new and refurbished transformers, and would be a significant measure in mitigating the hazards to lineworkers.

The majority of manufacturers recommend that auxiliary current limiting fuses be considered for pole-mounted transformers. Current-limiting fuses are used in many underground transformers and have been effective in minimizing the potential for severe explosion.

Some manufacturers recommend that pad mount transformers be installed and maintained so that they do not tilt beyond level by more than 1.5 degrees. If the tilt is beyond this, the fuses might be above the oil level and could present a hazard when operated.

Power companies should review their transformer specifications so that hazard mitigation for lineworkers has been fully evaluated.

ACCIDENT REVIEW

A power company dispatcher received a call from a farmer stating that he had observed a power company employee hanging from a pole near his farm. A line crew was immediately dispatched to the site and upon arrival found a lineman hanging from a transformer pole. Rescue operations were performed, however, the lineman had been dead from electrocution for some time, and could not be revived.

