Substation - Hazards and Equipment

SWP-152

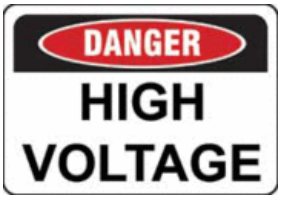
1.0 Purpose

To provide substation information for all workers that are required to enter Yukon Energy Corporation (YEC) substations.

2.0 Substation hazards

2.1 Being alert for hazards at all times is one of the basic concepts of the YEC safety program. This is particularly true when working in the proximity of high voltage facilities.

In order to be alert for substation hazards, all workers need to know what the potential hazards are.



2.2 Electrical Contact -

The electrical current encountered in our everyday activities has enough power to cause injuries. In a substation, electrical contact can be fatal.

There are four main types of electrical injuries:

- electrocution (fatal);
- electric shock;
- burns; and
- falls.

These injuries can happen in various ways:

- direct contact with electrical energy;
- when the electricity arcs (jumps) through a gas (such as air) to a person who is grounded (provides electricity an alternate path to ground);
- thermal burns including flash burns from heat generated by an electric arc and flame burns from materials that catch fire from heating or ignition by electrical currents[1]; and
- muscle contractions, or a startle reaction, can cause a person to fall from height.

[1] High voltage contact burns can burn internal tissues while leaving only very small injuries on the outside of the skin.

2.3 Other Substation Hazards -

- Slips, trips, and falls.
  - Many substations have above grade cable trays and below grade cable trays and conduits.
  - Transformer berms for liquid containment have side wall that are typically above grade.
  - All YEC substations have loose gravel covering the ground grid.
  - There may be tools or equipment left on the ground by workers.
- Other work groups.
- Vehicles or other equipment.
- Weather.
- Inadvertent operation of equipment. I.e., catching a piece of clothing on a breaker handle.

2.4 What can help mitigate these hazards?

- Substation Awareness Training
- Effective work plans
- Job Safety Analysis/tailboard meetings[2] to assess, record, and communicate hazards and barriers.
- Maintain a safe distance from energized electrical equipment.
- Establish safe work areas/zones
- Follow safety legislation, codes, policies, procedures, and guidelines.
- Personal protection equipment.

IF YOU DON'T KNOW – ASK.

3.0 Substation Equipment

This section will describe the more common high voltage electrical equipment in a substation. The majority of high voltage equipment can be operated at the substation; or remotely by the Supervisory Control and Data Acquisition (SCADA) system. Therefore, high voltage equipment can operate without warning in energized substations

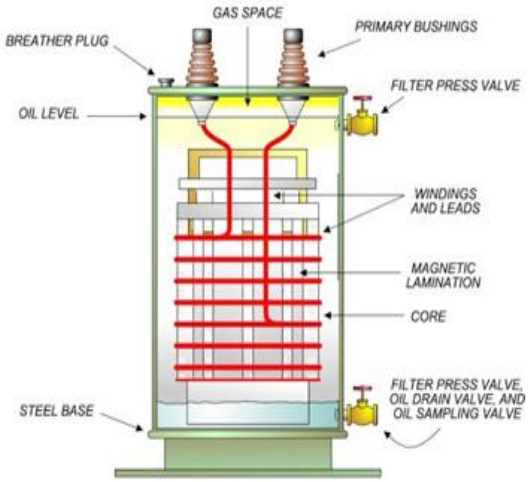
3.1 Power Transformers

A power transformer is a static device for transferring electric energy from one circuit to another by magnetic induction (usually between circuits of different voltages). Generally, power transformers are used to step-up or step-down voltages.
Voltages at the generating source are stepped- up to transmit over long distances then stepped down for delivery to consumers. The voltage transformation occurs in the windings and core inside the transformer. The assembly of core and coils are normally insulated and cooled by immersion in oil (or other suitable liquid) within the enclosed tank.

[2] Other names: Job Hazard Analysis; Field Level Risk Assessment; Toolbox or Tailgate meetings.

Hazards

- High voltages enter and exit the transformer
- Fire hazards exist with oil-filled equipment. An internal fault can cause an extremely hot burning fire that often destroys not only the transformer but also equipment in the immediate vicinity.



3.2 Instrument Transformers

Instrument transformers provide input for the operation of control protection, and energy measuring devices associated with substation equipment. They transform primary voltages and currents to secondary magnitudes applicable to the operation of instruments, meters and protective relaying. Most instrument transformers, though physically smaller than power transformers, are also oil-filled equipment.

Hazards

- High voltages
- Oil-filled and flammable
- Failures can be catastrophic - hurling metal fragments hundreds of yards.

3.3 Circuit Breakers

Circuit breakers of all voltage classes are the most visible of the many types of interrupting devices used on power and distribution systems. The purpose of a power circuit breaker is to interrupt an electrical circuit. The modern breaker interrupts electric current by rapidly removing the ionized gas in the electrical arc path and replacing it with non-ionized oil, air, a vacuum or SF6 gas. Other methods of interrupting an electrical circuit include rapid cooling and elongation of the arc.

Hazards

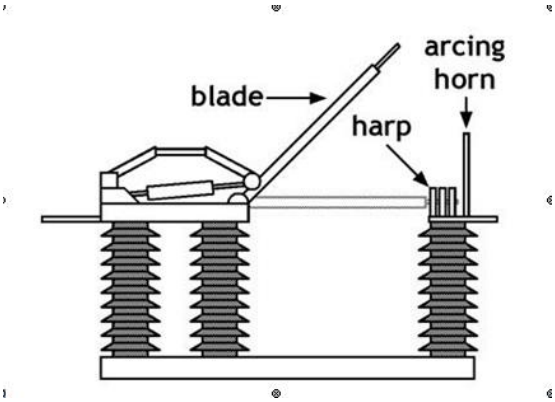
- High voltages
- Oil-filled breakers are flammable
- Decomposed SF6 gas caused by arcing or an internal fault is harmful to breathe or if in contact with the skin. *Do not approach under any circumstances.*
- Can operate with little warning either remotely by SCADA, protective relay operation or by the maintenance crew.

3.4 Disconnect Switches

Disconnect switches are manually or motor-operated means of isolating lines or equipment. They can be locked open and controlled to provide safe access for workmen to other high voltage equipment such as transformers and power circuit breakers. While circuit breakers are used to switch circuits carrying normal or abnormal currents, disconnect switches are used extensively to alter circuit arrangements and to provide electrical isolation for equipment. Disconnect switches range in function from operation with no current flow to certain types of load interruption.

Hazards

- High voltages
- Electric arc can damage eyes
- Can be very loud when operated
- Falling material if equipment fails in operation



3.5 Fuses

High voltage fuses are capable of clearing faults on circuits of limited fault current magnitude. Typical applications include high voltage transformer protection in substations as well as station service and bus potential transformers.

Hazards

- High voltages
- The casings on blown fuses can be damaged by fault current.
- Some fuses drop when blown.

3.6 Substation Bus work

High voltage substation equipment (breakers, transformers) is connected to the substation system by bus work. The bus work is normally 3-phase and separated from ground by support structures and insulators. This current carrying equipment is designed above the ground to allow maintenance on some of the equipment without removal from service. *However, workers must always be aware that bus work over head is energized and very dangerous.*

Electrical connections and bus work are made up of conductors and insulators, supported by suitable structures commonly known as bus pedestals. Pedestals are concrete or steel structures that support substation equipment such as disconnects, aluminum bus, etc. In addition to pedestals, there are also concrete footings and pads used to support large equipment such as power transformers and circuit breakers.

Hazards

- Energized at high voltages
- Very important: STAY ON THE GROUND. Contractors must not work at any elevation without permission from the YEC project manager or person-in-charge.
- Metal ladders and other long metallic objects such as metal tapes are not allowed in PGE substations.
- Extreme care must be taken if operating a vehicle in a switchyard.

3.7 Conductors

Conductors may be made of copper or aluminum in the form of tubing, rod, or cable. Rigid tubing is the more common design. Jumpers, common in rigid bus substations, are flexible cables made from either aluminum or copper. The cable jumpers are suspended by conventional strings of suspension-disk insulators, the same used on high-voltage transmission lines. Jumpers are the high voltage connections from the buswork to the equipment. Steel lattice designed support structure are the most common means of supporting the conductors above ground.

Hazards

- Same as bus work
- Conductor can separate from the bus
- Any conductor that becomes separated from the bus must be considered energized: STAY CLEAR

4.0 Reference documents

- SWP-150; Substation General Safety Rules
- SWP-151; Substation PPE