Welcome

to our “e-REW Express”. In our last issue, we introduced the common causes leading to supply interruption and its mitigation measures. In this issue, we will describe another common power quality problem a customer may experience – the voltage dip. We will highlight the causes of voltage dips and various enhancement / mitigation measures you may adopt to safeguard the power supply for important services.

If you have any suggestion, please send an email to us at mail@hkelectric.com or contact our Customer Installation Section at 2887 3455 so that we can further improve our service.

Voltage Dips and its Mitigation Measures

To begin with, let us have a closer look at the definition of a voltage dip based on the European Standard EN 50160.

1. Voltage Dips

A voltage dip is defined as a sudden reduction of the voltage to a value between 90% and 1% of the declared voltage with a voltage recovery after a short period of time. According to EN50160, the duration of a voltage dip may last between 10 ms to 1 minute. In HK Electric system, the duration of voltage dips is usually less than 1 second. In spite of the short duration of voltage dips, they may lead to:

- Memory loss / data errors of computer systems
- Equipment shutdown
- Light flickering
- Motor stalling / stopping.

2. Common Causes

2.1 Supply Cable / Equipment Fault

When there is a fault on a supply cable or equipment, voltage dip will occur in the part of the power supply system affected by the fault until the protective devices are initiated to clear the fault. Thus, apart from supply interruption to those customers who are supplied directly by the faulty cable or equipment, other customers may also experience a voltage dip. In case of a distribution fault, the voltage dip is localized in the affected geographical area but in case of a transmission fault, the voltage dip will be territory-wide and affects more customers.
2.2 Transmission Power Systems Faults Outside Hong Kong Island

Since our supply network is interconnected with other transmission power systems outside Hong Kong Island, customers on Hong Kong Island might also experience momentary voltage dips as a result of faults in the interconnected power system.

2.3 Customers’ Electrical Installations

Voltage dips may be caused by customers’ electrical installations such as:

- High starting current of large motors of refrigerating and air-conditioning plants
- Fault current causing voltage dips in adjacent circuits before the protective device isolates the fault

3. Possible Enhancement / Mitigation Measures

3.1 Plants and Machines

Plants and machines are often susceptible to voltage dips because there are some control devices in the equipment which operate unnecessarily during the voltage dip. It is often possible to identify these “weak links” and effect mitigation on these “weak links” directly so that they will continue to function properly during voltage dip without causing the machine to stall.

Relays, contactors and Programmable Logic Controllers (PLC) are used extensively to control machines and process equipment. However, most of the relays, contactors and some PLC have a low tolerance to voltage dip, and are often “weak links” in the control system. During the voltage dip, the relays, contactors, and PLC may de-energize to cause the associated electrical equipment to shutdown.
Relays, contactors, PLC and other control devices which are sensitive to voltage dip may continue to operate as usual during the voltage dip with the use of suitable voltage dip mitigation devices on their AC input circuits. Various types of mitigation devices are available and described below:

i. **Constant Voltage Transformers**

   Constant Voltage Transformers make use of magnetic saturation characteristics of the transformer core to maintain output voltage magnitude even though a disturbance happens at the input circuit.

ii. **Voltage Dip Proofing Inverters**

   Voltage Dip Proofing Inverters can draw power from a built-in capacitor storage unit and inject back a square AC voltage to the control components.

iii. **Coil Hold-in Devices**

   The Coil Hold-in devices will generate a DC voltage to the existing AC voltage coil, which essentially provides a constant DC current to hold the AC coil.

iv. **Voltage Dip Compensators**

   Voltage Dip Compensators consist of an Ultra-fast static tap-changer that switches from tap to tap a multi tapped step-up transformer to maintain the output voltage to the control components during a voltage dip.

v. **Dynamic Sag Compensators**

   Dynamic Sag Compensators will draw power from the remaining voltage of the voltage dip (or from an extended capacitor storage unit), and then inject a voltage to regulate a sinusoidal output voltage.

3.2 **High Pressure Discharge Lamp (HPDL)**

HPDLs provide a very cost effective way of transforming electricity to light and are extensively used in places where high intensity of light is required over a wide area. However, HPDLs are sensitive to voltage dip and cannot be re-ignited within a short time even after the supply voltage has returned to normal. This may cause interruption to important events and safety problems.
Therefore, for important venues, special consideration should be given to mitigate the effects of voltage dip on HPDLs and/or to use other lamp type (which are less vulnerable to the effect of voltage dip) in lieu of or in combination of HPDLs. The following options may be considered:

i. **Employ Lamps with Double-tube Feature**

The standby arc tube will ignite once the service arc tube extinguishes with approximately 15% of its normal light output instantly.

![Double-tube Feature HPDL](image)

ii. **Employ Hot Re-strike Igniters**

Hot re-strike igniters produce high re-strike voltage to ignite the lamp after voltage dip while the lamp is still hot.

![Hot Re-strike Igniters](image)

iii. **Employ Wide Operating Voltage Electronic Ballasts**

They allow a wide range of input voltage to operate the discharge lamps.

![Wide Operating Voltage Electronic Ballasts](image)

iv. **Employ Voltage Dip Compensators**

Voltage Dip Compensators consist of an Ultra-fast static tap-changer that switches from tap to tap a multi tapped step-up transformer to maintain the output voltage to the lamp during voltage dip.

![Voltage Dip Compensators](image)

v. **Employ Non-HPDL Standby Auxiliary Lamps**

The non-HPDL standby auxiliary lamp (such as Tungsten Halogen) will ignite when the main HPDL is extinguished. Once the discharge lamp successfully ignites, the standby auxiliary lamp will be cut off.

![Induction Lamps](image)

vi. **Non-HPDL Lamps**

For critical lighting applications, install non-HPDL such as tungsten-halogen lamps, induction lamps or fluorescent lamps.

vii. **UPS**

Employ UPS to backup the HPDL.
3.3 **Computer Systems**

Computer and server systems are sensitive to voltage dip which may cause the computer to reset or shutdown. UPS can provide high security of supply for computer systems, as well as isolation to external disturbances including voltage dips. It is recommended that computers and servers which support business operation should be backed up by UPS.

![Computer Systems Backed Up by UPS](image)

3.4 **Air Conditioning Systems**

Chiller plants and their associated equipment of the air-conditioning system are susceptible to voltage dips. A customer should therefore consider specifying his/her air-conditioning system to allow the chiller to ride-through voltage dips or to incorporate automatic re-start functions such that the impact to air-conditioning services will be minimized. These can be achieved by installing voltage dip ride-through devices for control devices and modifying the building management system software as appropriate.

![Air Conditioning Systems](image)

3.5 **Escalators and Lifts**

i. Escalators will require manual reset when they are tripped during voltage dips. The ride-through capability of escalators can be improved by adding appropriate mitigation devices. For adding mitigation devices against voltage dips, please also refer to the latest Code of Practice on the Design and Construction of Lifts and Escalators.

ii. Lifts may be tripped during voltage dips. To minimize inconvenience, lifts should be designed to auto-restart and perform the ‘Homing’ function after supply resumes normal. Further, effective intercom to duty control personnel should be installed inside the lifts for communication with the passengers when the lifts are tripped.

![Escalators](image)

3.6 **The Proper Use of Undervoltage Protective Devices**

i. Undervoltage protective devices should not be installed at main switches or switches affecting supply to more than one customer and/or equipment (as shown in Figure 1).
ii. Whenever undervoltage protective devices are to be used, they should be installed on the load side only, in order to avoid unnecessary tripping to other equipment (as shown in Figure 2).

iii. As a preventive measure against nuisance tripping in the event of momentary voltage dip, a time delay device with suitable setting, such as 1 second should be incorporated provided that the equipment is capable of withstanding the thermal and mechanical stress during and after the voltage dip.

3.7 Power Conditioning Devices

i. Uninterruptible Power Supply (UPS) is an effective means to protect important services from momentary voltage dips. UPS contains energy storage components, which can also maintain voltage level instantly for a predetermined period of time in case of voltage dips/supply voltage fluctuations/interruptions.
ii. A typical voltage stabilizer would maintain the output voltage to within 2% of the normal value even when the mains supply voltage varies by up to 20%. The device would also prevent voltage spikes and other transient voltages from entering into the important services. However, voltage stabilizer does not compensate for complete interruption of main electricity supply and/or severe voltage dip.

iii. A line conditioner contains isolation and filter circuits, which will prevent voltage transients and voltage spikes from entering into the important services. Similar to voltage stabilizers, it cannot provide complete compensation.

Note: The above information is provided for general reference only. Customers should consult a qualified electrical engineer, consultant or contractor for the actual application of these voltage disturbance mitigation methods and measures to their plants and equipment.