DEFINITION OF DIFFERENT TERMS USED [1-5]

1. **Auxiliary Ground Electrode:** A ground electrode with certain design or operating constraints. Its primary function may be other than conducting the ground fault current into the earth.

2. **Continuous Enclosure:** A bus enclosure in which the consecutive sections of the housing along the same phase conductor are bonded together to provide an electrically continuous current path throughout the entire enclosure length. Cross-bondings, connecting the other phase enclosures, are made only at the extremities of the installation and at a few selected intermediate points.

3. **DC Offset:** Difference between the symmetrical current wave and the actual current wave during a power system transient condition. Mathematically, the actual fault current can be broken into two parts, a symmetrical alternating component and a unidirectional (dc) component. The unidirectional component can be of either polarity, but will not change polarity, and will decrease at some predetermined rate.

4. **Decrement Factor:** An adjustment factor used in conjunction with the symmetrical ground fault current parameter in safety-oriented grounding calculations. It determines the rms equivalent of the asymmetrical current wave for a given fault duration, t_f, accounting for the effect of initial dc offset and its attenuation during the fault.

5. **Effective Asymmetrical Fault Current:** The rms value of asymmetrical current wave, integrated over the interval of fault duration.

$I_F = D_f \times I_f$

WHERE

I_F is the effective asymmetrical fault current in A

I_f is the rms symmetrical ground fault current in A

D_f is the decrement factor

6. **Enclosure Currents:** Currents that result from the voltages induced in the metallic enclosure by the current(s) flowing in the enclosed conductor(s).

7. **Fault Current Division Factor:** A factor representing the inverse of a ratio of the symmetrical fault current to that portion of the current that flows between the grounding grid and surrounding earth.

$$S_f = \frac{I_g}{3I_o}$$

Where

S_f fault current division factor

Ig the rms symmetrical grid current in A

Io the zero-sequence fault current in A

8. **Gas Insulated Sub-Station (GIS):** A compact, multi component assembly, enclosed in a grounded metallic housing in which the primary insulating medium is a gas, and that normally consists of buses, switchgear, and associated equipment (subassemblies).

9. **Ground:** A conducting connection, whether intentional or accidental, by which an electric circuit or equipment is connected to the earth or to some conducting body of relatively large extent that serves in place of the earth.

10. **Grounded:** A system, circuit, or apparatus provided with a ground(s) for the purposes of establishing a ground return circuit and for maintaining its potential at approximately the potential of earth.

11. **Ground Current:** A current flowing into or out of the earth or its equivalent serving as a ground.

12. **Ground Electrode:** A conductor imbedded in the earth and used for collecting ground current from or dissipating ground current into the earth.

13. **Ground Mat:** A solid metallic plate or a system of closely spaced bare conductors that are connected to and often placed in shallow depths above a ground grid or elsewhere at the earth's surface, in order to obtain an extra protective measure minimizing the danger of the exposure to high step or touch voltages in a critical operating area or places that are frequently used by people. Grounded metal gratings, placed on or above the soil surface, or wire mesh placed directly under the surface material, are common forms of a ground mat.

14. **Ground Potential Rise (GPR):** The maximum electrical potential that a substation grounding grid may attain relative to a distant grounding point assumed to be at the potential of remote earth. This voltage, GPR, is equal to the maximum grid current times the grid resistance.

NOTE: Under normal conditions, the grounded electrical equipment operates at near zero ground potential. That is, the potential of a grounded neutral conductor is nearly identical to the potential of remote earth. During a ground fault the portion of fault current that is conducted by substation grounding grid into the earth causes the rise of the grid potential with respect to remote earth.

15. **Ground Return Circuit:** A circuit in which the earth or an equivalent conducting body is utilized to complete the circuit and allow current circulation from or to its current source.

16. **Grounding Grid:** A system of horizontal ground electrodes that consists of a number of interconnected, bare conductors buried in the earth, providing a common ground for electrical devices or metallic structures, usually in one specific location.

NOTE: Grids buried horizontally near the earth's surface are also effective in controlling the surface potential gradients. A typical grid usually is supplemented by a number of ground rods and may be further connected to auxiliary ground electrodes to lower its resistance with respect to remote earth.

17. **Grounding System:** Comprises all interconnected grounding facilities in a specific area.

18. **Main Ground Bus:** A conductor or system of conductors provided for connecting all designated metallic components of the gas-insulation substation (GIS) to a substation grounding system.

19. **Maximum Grid Current:** A design value of the maximum grid current, defined as follows:

$I_G = Df \times Ig$

WHERE

I_G is the maximum grid current in A

Df is the decrement factor for the entire duration of fault given in second

Ig is the rms symmetrical grid current in A

20. **Mesh Voltage:** The maximum touch voltage within a mesh of a ground grid.

21. **Metal-to-Metal Touch Voltage:** The difference in potential between metallic objects or structures within the substation site that may be bridged by direct hand-to-hand or hand-to-feet contact.

NOTE: The metal-to-metal touch voltage between metallic objects or structures bonded to the ground grid is assumed to be negligible in conventional substations. However, the metal-to-metal touch voltage between metallic objects or structures bonded to the ground grid and metallic objects internal to the substation site, such as an isolated fence, but not bonded to the ground grid may be substantial. In the case of a gas-insulated substation (GIS), the metal-to-metal touch voltage between metallic objects or structures bonded to the ground grid may be substantial because of internal faults or induced currents in the enclosures.

In a conventional substation, the worst touch voltage is usually found to be the potential difference between a hand and the feet at a point of maximum reach distance. However, in the case of a metal-to-metal contact from hand-to-hand or from hand-to-feet, both situations should be investigated for the possible worst reach conditions.

22. **Non Continuous Enclosure:** A bus enclosure with the consecutive sections of the housing of the same phase conductor electrically isolated (or insulated from each other), so that no current can flow beyond each enclosure section.

23. **Primary Ground Electrode:** A ground electrode specifically designed or adapted for discharging the ground fault current into the ground, often in a specific discharge pattern, as required (or implicitly called for) by the grounding system design.

24. **Step Voltage:** The difference in surface potential experienced by a person bridging a distance of 1 m with the feet without contacting any grounded object.

25. **Sub Transient Reactance:**Reactance of a generator at the initiation of a fault. This reactance is used in calculations of the initial symmetrical fault current. The current continuously decreases, but it is assumed to be steady at this value as a first step, lasting approximately 0.05 s after an applied fault.

26. **Surface Material:** A material installed over the soil consisting of, but not limited to, rock or crushed stone, asphalt, or man-made materials. The surfacing material, depending on the resistivity of the material, may significantly impact the body current for touch and step voltages involving the person's feet.

27. **Symmetrical Grid Current:** That portion of the symmetrical ground fault current that flows between the grounding grid and surrounding earth. It may be expressed as

$$I_g = S_f \times I_f$$

where

I_g is the rms symmetrical grid current in A

I_f is the rms symmetrical ground fault current in A

S_f is the fault current division factor

28. **Symmetrical Ground Fault Current:** The maximum rms value of symmetrical fault current after the instant of a ground fault initiation. As such, it represents the rms value of the symmetrical component in

the first half-cycle of a current wave that develops after the instant of fault at time zero. For phase-to-ground faults

$$I_f(0^+) = 3I_0$$

WHERE

$I_f(0^+)$ is the initial rms symmetrical ground fault current

$I_0$is the rms value of zero-sequence symmetrical current that develops immediately after the instant of fault initiation, reflecting the sub transient reactance of rotating machines contributing to the fault.

This rms symmetrical fault current is shown in an abbreviated notation as I_f, or is referred to only as $3I_0$. The underlying reason for the latter notation is that, for purposes of this guide, the initial symmetrical fault current is assumed to remain constant for the entire duration of the fault.

29. **Touch Voltage:** The potential difference between the ground potential rise (GPR) and the surface potential at the point where a person is standing while at the same time having a hand in contact with a grounded structure.

30. **Transferred Voltage:** A special case of the touch voltage where a voltage is transferred into or out of the substation from or to a remote point external to the substation site.

31. **Transient Enclosure Voltage (TEV):** Very fast transient phenomena, which are found on the grounded enclosure of GIS systems. Typically, ground leads are too long (inductive) at the frequencies of interest to effectively prevent the occurrence of TEV. The phenomenon is also known as transient ground rise (TGR) or transient ground potential rise (TGPR).

32. **Very Fast Transient (VFT):** A class of transients generated internally within a gas-insulated substation (GIS) characterized by short duration and very high frequency. VFT is generated by the rapid collapse of voltage during breakdown of the insulating gas, either across the contacts of a switching device or line to ground during a fault. These transients can have rise times in the order of nanoseconds implying a frequency content extending to about 100 MHz. However, dominant oscillation frequencies, which are related to physical lengths of GIS bus, are usually in the 20-40 MHz range.

33. **Very Fast Transients Over Voltage (VFTO):** System over voltages that result from generation of VFT. While VFT is one of the main constituents of VFTO, some lower frequency (≅1 MHz) component may be present as a result of the discharge of lumped capacitance (voltage transformers). Typically, VFTO will not exceed 2.0 per unit, though higher magnitudes are possible in specific instances.

34. **X/R Ratio:** Ratio of the system reactance to resistance. It is indicative of the rate of decay of any dc off-set. A large X/R ratio corresponds to a large time constant and a slow rate of decay.