

delta-connected system by creating an artificial neutral through the use of a zig-zag or wye-delta grounding transformer, and then applying a high-resistance grounding resistor. This allows the system to remain online with a single fault, yet dramatically reduces the potentially damaging over-voltages associated with ungrounded systems. System reliability and safety are greatly increased compared to ungrounded systems.

When you're converting an industrial distribution network from ungrounded to high-resistance grounded, pay attention to the system capacitance. The inherent line-to-ground capacitance associated with system components determines the magnitude of zero-sequence charging current. The value of this current is required for proper selec-

Locating and repairing the first ground fault is imperative.

tion of high-resistance grounding equipment.

You can calculate the charging current of a system by adding the zero-sequence capacitance or by determining capacitive reactance of all the cable and equipment connected to the system. If actual values aren't available, you can use graphs and approximation equations.

For correct application, the let-through current of the high-resistance grounding equipment should be higher than the capacitive charging current of

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the system. This ensures that fault current will flow through the resistor and not break down system insulation. The installation of a tapped ground resistor unit is recommended when you expect to expand the system in the future or the designer is unsure of the charging current value.

Unfortunately, the last step in the distribution system's design is usually the ground fault protection system. While existing systems can be retrofitted to include high-resistance grounding, it's easier when you consider it from the beginning and incorporate it into the total protection. In either case, all necessary information must be available before starting the design.

The ground fault protection system design should include information such as a complete single-line diagram containing the transformer data, type and size of the interrupters; the type and current rating of the overcurrent devices; the size, type and length of all feeders; and load types (both single- and three-phase) and sizes. Additional information, such as operating modes, interlocking systems and special switching arrangements, will influence the design.

The state of supervision also can be a major factor. Unattended systems may require fully automatic protection integrated via Ethernet or other protocol into a SCADA system, while selective indication may be sufficient for

attended systems where preventive and corrective maintenance is scheduled in weekly or monthly intervals.

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