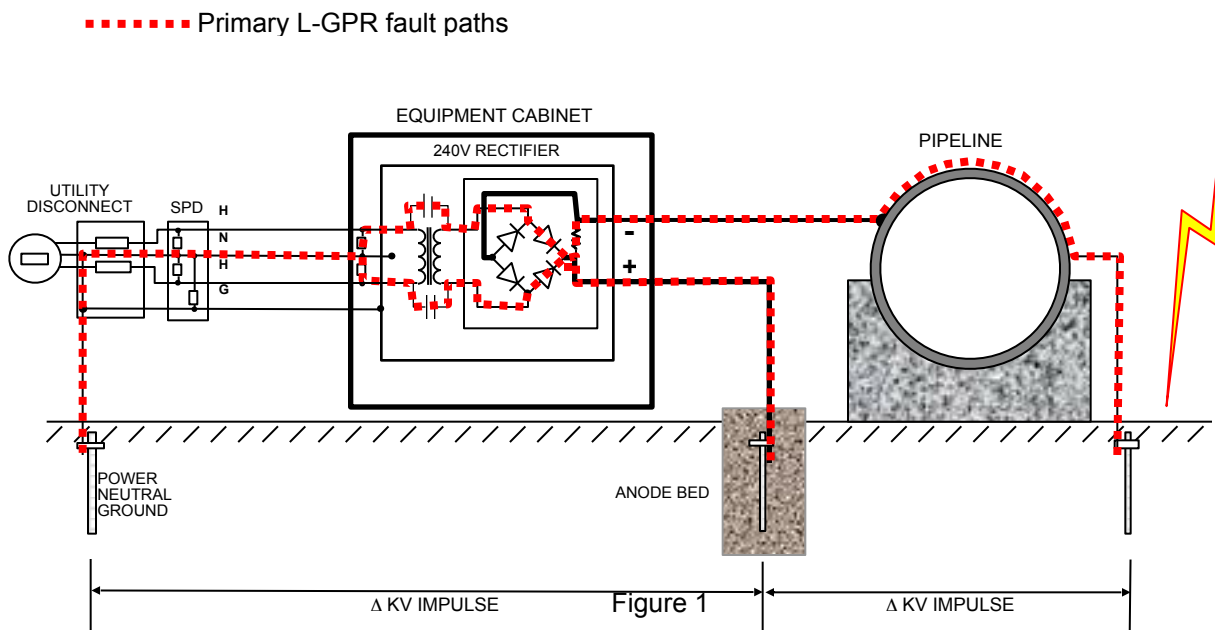


Pipeline Protection: Monitoring, Control & Cathodic Protection Equipment

I. Lightning Threat: Pipeline cathodic protection is exposed to lightning which frequently causes damage to rectifiers, control electronics and communication systems. Cathodic protection systems are particularly exposed to Lightning Ground Potential Rise (L-GPR) since they are in direct contact with the earth bound anode bed and cathode connections to the pipe.

L-GPR is created by a rapid charge injection into the ground when a lightning ground strike occurs. The soil can not instantly dissipate the charge, causing a significant voltage increase at the strike point with respect to other locations. The voltage differences across 10 feet can be tens of thousands of volts for 100 microseconds. At a cathodic protection site the voltage differential between the anode and cathode can expose the rectifier DC outputs to thousands of volts.

Soil conductivity has a significant bearing on L-GPR. Resistive soil (sandy clay, limestone, gravel) inhibits the earth's dissipation of energy; causing a dramatically higher L-GPR. Dehydration of soluble metals in the earth has a similar effect – lower conductivity increases the severity and propagation of L-GPR. “Dry lightning” throughout many regions is a certain prescription for electrical and electronic damage.



In Figure 1 the lightning strike creates a massive charge density at the strike point. The charge radiates in all directions but favors lower resistive paths such as grounding systems, pipes and cathodic protection anodes and cathodes. The dashed lines identify the primary L-GPR fault paths. The pipeline grounding connection provides a low resistive path from the ground to the pipe and through the DC section of the rectifier. The high frequency of the lightning energy passes through the rectifier transformer and causes damage to control electronics and communications systems.

II. AC Threat: Lightning strikes, capacitor bank switching and other utility events can also produce severe transients and surges on the commercial power service. Fatigue and eventual failure of the AC surge protection exposes the cathodic protection system to damaging voltage gradients across modules and components. Power recovery from sags and outages may also produce repetitive transients from sequential attempts to re-establish and balance the service.

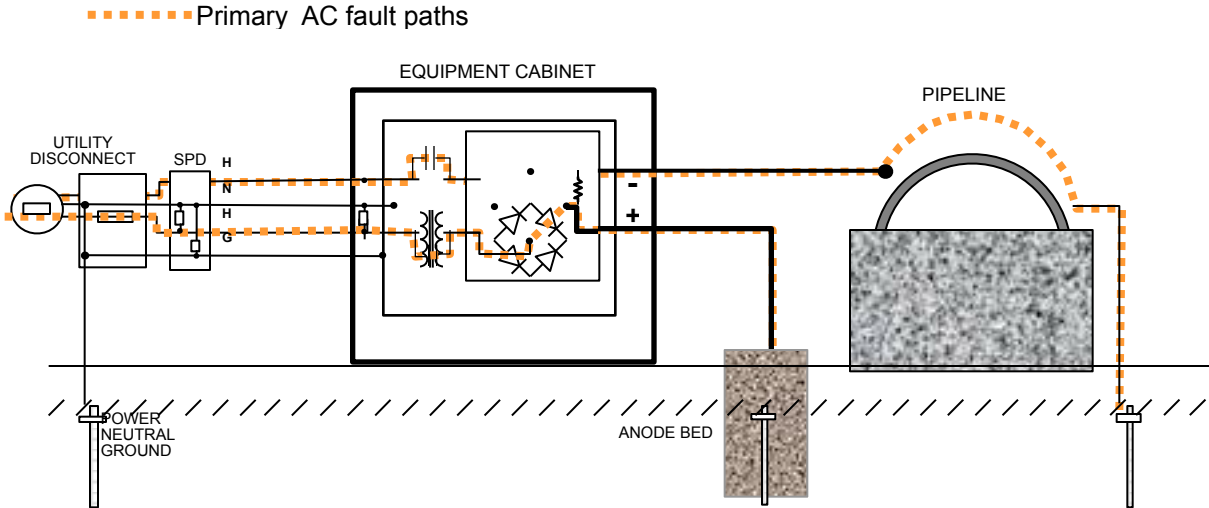


Figure 2

III. Solution: Disconnecting the AC and DC circuits for the duration of the threat eliminates all the potential fault paths. Fault current can not flow across the open circuits and is forced to dissipate in the grounding system. The key is detection of the threat and isolation of the cathodic protection system before the fault occurs. **Lightning Shield** combines detection and isolation capabilities:

- a. Lightning GPR is anticipated by detection of the electric field changes from near-proximity lightning formation or ground strikes from an approaching storm.
- b. Voltage window comparators detect the high speed transients and surges that breach the AC surge protection. Power sags and outages are also detected.

Figure 3 presents the installation of the **Lightning Shield** system.

Detection of an impending threat activates isolation within 15 mSec. Threat detection is continuously active and maintains isolation until the lightning storm passes, or until the commercial power stabilizes, assuring complete protection from power recovery transients. After the threat passes the AC and DC circuits are automatically reconnected. The duration of the isolation will vary, a few seconds for a single power line event or hours for sustained lightning activity.

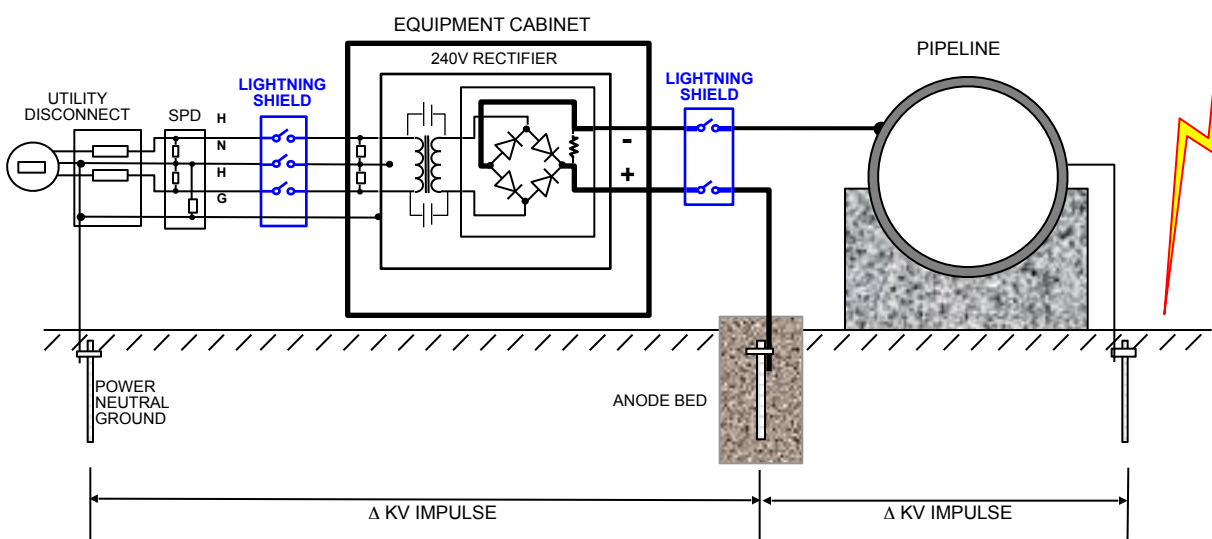
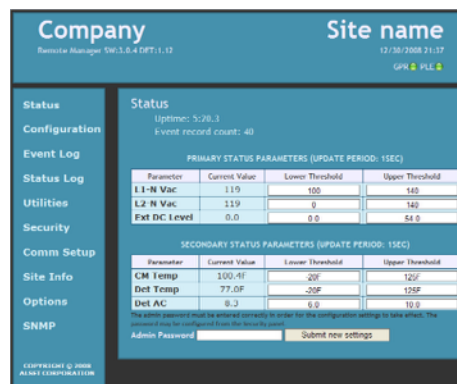


Figure 3

Lightning Shield is user configurable. The L-GPR sensitivity may be set for local soil and storm conditions. The AC voltage comparator thresholds may be set to the power quality requirements for sensitive equipment. Two models are available to accommodate utility breakers rated up to 50 Amps and 200 Amps. A remote management option provides alarm monitoring, event logging and communication via a POTS modem, a 10/100 Ethernet data port or a wireless router. Browser based HTTP and SNMP management interfaces are supported.



Lightning Shield – 240V/50 A



Remote Manager