SHOCK PROTECTION

By Nehad El-Sherif, P.E.

Canadian mine operator promotes worker safety with a ground-fault protection device

The answer to pump shock protection was to install an equipment ground-fault protection device.

The entrance to the sump where an employee must work beside a 600-V submersible pump

The U.S Bureau of Labor Statistics attributes a total of 330 worker fatalities to accidental electrocutions in 2011 and 2012 alone. In areas where employees work directly with machinery in wet conditions, the danger of ground faults increases because water conducts electricity. This is a critical safety issue because as little as 50 mA can stop a human heart. In ground fault conditions, workers can be easily injured or killed by electrical shock if their bodies become the shortest path to ground.

Concerned about its workers and proactive about safety, a mining company in Canada looked at its operation to see what could be done.

Preventing Electric Shock

At one of its potash mines, the company uses water to extract deposits that contain potassium in water-soluble form. A pumping station pumps the water used for processing; however, the water must be filtered before it is pumped to the mine, so a filter is used to screen the water intake. Although another filter is installed inside the pumping station, rocks, sand and debris still get into the station. Once a year, a worker must climb into the sump remove the accumulated debris. The sump is dewatered before the employee can enter, and a permanently installed submersible pump is used for this purpose. In this wet environment, an electrical fault in the pump could present a risk of severe electrical shock to the worker.

It has long been best practice in mining to monitor the continuity of ground in electrical equipment, and to use high-resistance grounding that limits the amount of current that can flow in a ground fault. These technologies protect equipment and add safety, but they do not protect workers against the lower-value ground faults that are dangerous to people.

An engineer at the mine had heard about new ground-fault circuit interrupters (GFCIs) for industrial applications. The electrical code requires GFCIs in residential and commercial kitchens and bathrooms. These devices detect a ground fault and quickly interrupt power; however, they are not suitable for industrial use for two reasons: They are rated only for 120- and 240-V installations, and their 6-mA trip level typically is too low for industrial applications. Many industrial electrical systems have normal leakage current greater than 6 mA, in which case a residential GFCI would never leave trip mode and the circuit would never power up.

The engineering team learned that advances in GFCI technology have made it possible to provide sensitive, low-level protection without nuisance tripping at higher voltages. In 2012, UL listed the first GFCI for applications up to 600 V.

Under certain circumstances, the 20-mA trip level of an industrial GFCI can make its use impractical. In those cases, an equipment ground-fault protection device (EGFPD) can be used. EGFPDs offer protection similar to GFCIs but are allowed by UL to have an adjustable trip level (GFCIs have a fixed trip level) and monitoring the equipment ground wire is not required (a mandate for industrial GFCIs). EGFPDs can be adjusted to trip in the range of 6 to 50 mA.

The engineering team chose an EGFPD for their application, because they wanted the ability to adjust the trip threshold to a point where there would be no nuisance tripping that could cause downtime. EGFPDs are rated by UL for equipment protection only, but the engineering team knew that they also would provide personnel protection.

The mine's engineering team supervised the installation of a SB6100 Series Industrial Shock-Block EGFPD made by Littelfuse. Save for the selectable trip setting, it is the same as the Littelfuse industrial GFCI. The team planned to start at the most sensitive and safest setting and increase the trip point until nuisance tripping stopped. To their surprise, the device did not nuisance trip, so the team decided to leave the setting at 6 mA for now and increase it in the future if needed.

Device Installation

Technicians mounted the EGFPD on the wall of the pumping station. They routed a cable from the power distribution panel to one side of the EGFPD and connected the power cable of the submersible pump to the other side.

If the EGFPD senses an electrical fault where significant current is flowing to ground, possibly through a person's body, it will interrupt the power very quickly.

An EGFPD uses the same trip curve as a UL-listed GFCI. The curve requires the device to trip faster at higher ground currents. This provides appropriate shock protection and also minimizes nuisance trips caused by transient currents. At 6 mA, the device should trip in at least 5.6 seconds, and at 300 mA the device should trip in at least 20 milliseconds, although in practice the trip times tend to be faster than UL requirements.

Industrial EGFP and GFCI protection can be applied to submersible pumps in many applications besides solutions mines. Open pit mines make extensive use of high-voltage (480- and 600-V) pumps that frequently are handled by workers when the pumps need repositioning. Water often finds its way into underground mines as well, where pumps are used for dewatering shafts. The use of shock protection devices benefits non-mining applications as well, where submersible pumps are used in municipal water facilities, processing machinery, and with temporary power, such as on construction sites and during cleanup after a natural disaster.

Managers at the mine are pleased that the EGFPD has helped boost safety at the pump by protecting employees from dangerous shock. Another notable benefit is that the device has helped reduce the potential costs related to worker injuries—$7.67 billion alone was paid to Canadian workers for time-loss injuries or fatalities in 2008. PS

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