



## Custom WORM Flexible Temperature Sensor Solution Improves Accuracy and Safety at Ball Mill Mine

The process of extracting copper from raw ore at a large mine in southeastern Arizona involves using crushing rocks with mills with giant rocks (as seen in the photo above). Large ball mills are used in the extraction of copper from large boulders. These mills have large bearings attached to them, which heat up over time due to friction. If the bearing temperatures exceed critical levels, they can become damaged and shut down the entire process. The site originally used I/R sensors but they were unable to get close enough to the bearings to capture accurate ambient temperature readings, increasing the risk of a burn out.

Through a special installation of WORM Flexible Temperature Sensors from Moore Industries (Figure 1), site engineers are now able to more accurately measure the temperature of the bearings to avoid potential damages and shut downs. The installation also eliminated potential safety concerns at the mine.

### Problem Details

The mine harvests copper from one of the largest reserves in the United States. The mine has 448 million tons of proven and probable millable ore, making it the largest in North America. Yearly copper production can range from 500-600 million pounds.

Copper mining involves crushing large pieces of rock that contain copper ore. The process of crushing the rocks separates the copper from the rest of the rock. As the rocks come down a wide conveyor belt, grinding stones the size of small buildings crush the rocks into fine sand. Copper falls into water and the ore turns into slurry, with the copper floating to the surface. The copper can then be collected using chemical processes, dried and sent to a smelter.

The pressure of the heavy ore and the vibrations caused by the grinding process can cause the bearings to overheat. The bearings are cooled down by turning inside an oil tray to lubricate the bearings and prevent friction. However, even lubricated bearings can overheat if not effectively monitored. This can lead to the bearings seizing and stopping the flow of ore. The end result was damaged equipment and costly shutdowns in the mining process. Temperature sensors had been installed to measure the bearings temperature, but the type of sensors used were not effective enough to measure the true temperature of the bearings.

*Figure 1. The WORM Flexible Temperature Sensors created for this installation include a specially-designed copper head that allowed the sensor to touch the bearings and draw heat to get the most accurate temperature readings possible.*



The method used was non-contact I/R sensors (Figure 2). The constant turning of bearings meant that sensors had to be mounted inches from the bearings. Because these sensors were not able to get close enough to the ball bearings, they primarily measured ambient temperature around the bearings. This sensor design inhibited detection of increases in temperature when the bearings began to overheat. The bearings frequently burned out by the time the reading caught up to the rise in actual bearing temperature.

## Solution

Moore Industries' solution was to install the WORM Flexible Temperature Sensor. A specially-designed copper head was designed to ride on the bearings and measure their temperatures more accurately. This meant that an advance warning alarm could sound, alerting workers to add oil to the bearing tray to avoid burn out.

Why was copper selected as the material for the head of the temperature sensor? Copper is particularly effective because it acts as a heat sink, pulling heat from the bearings to the small WORM sensor. This provides faster responses and more accurate readings.

The flexible nature of the WORM and a mounting that could be adapted to the existing installation meant that the sensors could be applied to all of the mills without major redesign of each installation. This lets engineers install them at the perfect angle to touch the side of the bearings and get the most accurate readings possible for an early warning system.

Using the WORM also created a safer environment at the mine as well as saving money by preventing costly interruptions to the flow of the ore. The older I/R sensors were installed in boxes mounted to the floor of the catwalks just a foot above the ball mills. These boxes rose about six inches from the floor and were an extreme safety hazard to all passing employees (Figure 3). Personnel working around the mills walked on these catwalks and were in danger of tripping on these boxes – and potentially having a dangerous fall – or stepping on them and crushing the sensors.

By installing the WORM sensors, the site operators were able to eliminate the dangerous working environment caused by the sensors on the catwalk (Figure 4). They have a flat insulation, which means that they can be installed directly into the floor with a minimal and safer vertical profile.

## End Results

Switching to the WORM sensors helped avoid costly shutdowns caused by ball bearings overheating. In addition, the WORM reduced damages to sensors on the catwalks and lessened the potential for accidents. The site operators are so pleased with the WORM installation that they are expanding their use to the rest of the mine.

In addition, because of the significantly improved temperature readings, ease of installation and lower profile offered by this custom WORM build, Moore Industries is planning on expanding the use of this sensor to other ball mill applications in the future.

**Figure 2.** The older, non-contact I/R sensors which had previously been used at the mine. Because they were unable to get close to the ball bearings, they could only measure the ambient temperature near the bearing.



**Figure 3.** Old I/R sensors at the mine site were mounted in boxes that protruded several inches off of the ground.



**Figure 4.** The installation of the WORM lays flat on the catwalks. This reduces the risk of accidents along with the chance that sensors can be stepped on and crushed.



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