Cardinal®

Cardinal Scale Manufacturing Co.
Products and Solutions for the Weighing Industry

Applications:

American Scale
Weigh-in-Motion - Mining System

Richard Werth, Owner - American Scale; Paul Erickson, Regional Sales Manager - Cardinal Scale Mfg. Co.; Sharon Werth, Owner - American Scale.

Henderson Mine ore truck discharging ore into the crusher.

Axle and net weight displays and chute status displays at crusher site.

In-Motion Vehicle Weighing Sinks To New Lows

ON THE JOB: The Henderson Mine in Empire, Colorado, a subsidiary of Phelps Dodge, is the largest primary producer of molybdenum in the world. Molybdenum is a gray-white metal used in the production of high-strength steel. The mine, located on the east side of the continental divide high in the Rocky Mountains, sends the molybdenum ore to the mill located on the west side of the divide over a 15-mile long conveyor; the longest in the world. The ore begins its trip to the mill on one of the lowest levels of the mine. Here large underground mining trucks discharge the ore into a crusher where it is crushed then sent to the conveyor for its trip out of the mine and to the mill.

EQUIPMENT USED:

- QWIM Quartz Sensor In-Motion Scale
- 6 SB-500S Remote Weight Displays

With rising molybdenum prices, mine management needed to know just how much ore was being loaded onto the conveyor and how much ore each of the mine's ore trucks was hauling. In the past, educated guesses were made of the amount of ore discharged by each truck but that process, of course, was no longer acceptable. Mark Ramirez, Operations Coordinator at the mine, selected Cardinal Scale's QWIM series of in-motion scale as the foundation of the new truck weighing system. According to Mark, the selection was made based on the ability to install the system in a few days during a routine shutdown for mine maintenance and the minimal excavation of the tunnel floor at the crusher site required for installation of the scale. The quartz-piezo sensors used by the in-motion scale could be installed in 2 inch wide x 2 inch deep cutouts in the tunnel floor thus eliminating the need for time consuming construction of a costly scale foundation.

In addition to the Cardinal QWIM series in-motion scale, the weighing system included six high-intensity LED scoreboards to display the net vehicle weight along with the axle weight of each of the truck's axles. A reader was included to interrogate the truck-mounted transponder to identify the truck being weighed, and computer used to accumulate the weight data,

Applications:

American Scale
Weigh-in-Motion - Mining System

print reports, and transmit the data to the Henderson network. The scale and associated equipment were installed over 5,000 feet below the surface adjacent to the ore crusher.

The in-motion scale uses two sets of Kistler Lineas quartz-piezo sensors which are embedded in the tunnel floor. The sensors consist of a series of quartz discs wired in parallel. As the truck's wheels pass over the sensors, the wheel load is applied to these discs producing a voltage proportional to the load. This voltage is produced through the piezoelectric effect common among some materials. Simply put, the piezoelectric effect is one whereby a voltage is produced across the surface of a non-conducting material when it is mechanically stressed. Conversely, applying a voltage across the surfaces of a material exhibiting this effect will cause the material to distort. The thing that makes quartz unique is its relative consistency over a wide range of temperature compared to other materials.

Using the voltage signals from the quartz-piezo sensors and the speed of the truck, the instrumentation uses a special software algorithm to determine the axle weight. The process is repeated until all of the axles have been weighed. The axle weights are summed to produce the total truck weight.

At the same time the truck is driving across the in-motion scale sensors, a reader is interrogating the truck's on-board transponder to determine the identity of the truck. Once the truck's identity is known, the computer can look up the tare or empty weight associated with that particular truck. Subtracting the tare weight from the gross or total weight of the truck leaves the net weight of the ore that is discharged into the crusher. Each of the axle weights along with the net weight is displayed for the driver on six Cardinal SB500 stainless steel scoreboards using 5-inch tall high-intensity LED displays. The weight data is displayed in increments of 0.01 tons which is equivalent to 20 pounds. Each truck load averages around 160,000 pounds of ore. The second display shown in the photograph shows the driver what chutes are ready for the discharge of ore thus allowing the drive to know where they should go next. The weight data, truck identification, and time and date are entered into a database maintained on the computer and later transmitted to Henderson's data network.

In addition to transmitting the weight data to the Henderson network, the weighing system computer produces a number of special reports for the mine management team. These reports include a statistical report that lists the total and average truck trips by shift for a selected period along with the total and average net weights for the period and the standard deviation of the loads. Another report, the truck ID report, provides a log of weights by truck identification and time and date. Still another report shows the number of trips, average net loads, and total net weight of ore hauled by each truck for any specified period. A report showing production by shift is also available. Armed with this information, the Henderson mine management team can more efficiently plan their production and identify potential problems earlier.

Normally, in-motion vehicle scales are found on our highway system collecting weight information and identifying overweight vehicles. This particular application, however, shows that there are other uses for this type of scale. With the imagination of the Henderson Mine personnel and Cardinal's weighing expertise, in-motion vehicle weighing has sunk to a new a new low.

Climax Molybdenum

Henderson Operations

2/8/2006

Empire, CO

Truck Report 1/23/2006 - 1/24/2006

Truck ID	Date	Shift	No. of Trips	Total Net Weight		Avg. Net Weight
6	01/23/2006	Day	54	87.29		4,713.74
6	01/23/2006	Night	69	86.30		5,954.65
		Average for Truck			**6**	**86.73**
		Standard Deviation Truck			**6**	**15.35**
		Total for Truck			**6**	**10,668.39**
7	01/23/2006	Day	59	87.12		5,140.18
7	01/23/2006	Night	80	83.44		6,675.52
7	01/24/2006	Day	92	81.27		7,476.69
7	01/24/2006	Night	90	91.12		8,200.96
		Average for Truck			**7**	**85.65**
		Standard Deviation Truck			**7**	**11.46**
		Total for Truck			**7**	**27,493.34**
8	01/24/2006	Night	58	77.45		4,492.30
		Average for Truck			**8**	**77.45**
		Standard Deviation Truck			**8**	**13.27**
		Total for Truck			**8**	**4,492.30**
9	01/23/2006	Day	19	74.81		1,421.44
9	01/23/2006	Night	69	81.27		5,607.31
9	01/24/2006	Day	84	79.47		6,675.47
9	01/24/2006	Night	57	83.40		4,753.75
		Average for Truck			**9**	**80.60**
		Standard Deviation Truck			**9**	**11.93**
		Total for Truck			**9**	**18,457.97**

Totals: **61112**
1

Henderson Mine Truck Report