Technology News

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Development of a Research Facility To Improve Mine Hoisting and Ore Pass Safety

Objective

Construct a research facility to test sensor technology and engineering controls and to increase awareness of the proper functioning of mine hoists. Improve safety and prevent injuries and fatalities related to vertical movement of personnel and materials in mine shafts and ore passes.

Background

Mine hoisting and control of material flow in ore and waste passes are the most important and potentially the most hazardous operations in underground mining. In addition to providing access to the network of openings used to recover an underground mineral resource, ore and waste passes serve as escapeways in emergencies and allow vertical movement of miners and materials. Hoist and elevator systems and ore pass chutes for underground metal/nonmetal mines must meet the requirements specified in the Code of Federal Regulations (CFR), Parts 57 and 75. The Mine Safety and Health Administration (MSHA) has requested new safeguards and design criteria for hoists and ore passes. However, equipment suppliers and mining companies cannot justify the costs nor interrupt production to develop and test safer technology for vertical haulageways.

Approach

A hoist and ore pass facility was designed and constructed to permit testing of safety features and sensor and design technology in a controlled setting. Studies of equipment safety features and MSHA accident statistics suggested that research should be focused on—

(1) Shaft conveyance monitoring to provide better operational data and warnings of potentially dangerous situations to operators, inspectors, and maintenance personnel and

(2) Ore pass design criteria that might lead to structural improvements for chutes and gates and better detection of and remediation measures for ore pass blockages.

Results

Progress to date has resulted in completion of a state-of-the-art hoisting and ore pass research facility in which safety features and operational characteristics related to mine hoists and ore passes can be evaluated. Figure 1 shows the configuration of the simulated mine shaft and ore pass. The hoist tower simulates a headframe, and an 18-ft-deep concrete section simulates a "shaft." The ore pass is simulated by wood or steel liners of varying cross-sections. Ore is initially loaded through a ground-level grizzly into a below-ground chute and loading cartridge, and then into the skip. The loading cartridge is equipped with balancing load cells to monitor the net weight of material in the cartridge prior to its discharge into the skip. Output from these cells, as well as loading gate position sensors, control skip loading functions. The skip hoists the ore to the top of the headframe, where it is dumped into a hopper connected to the ore pass.

The hoist room components include a winding drum and motor-gearbox interface with a capacity of 500 ft of 3/8-in diam wire rope with 500-to 1000-lb hoisting capacity. Operation of the hoisting motor and ore pass system is controlled by a programmable controller and HMI software. Loading chutes and gate position, ore levels and loads, conveyance net weight and position, and speed and wire rope tension can all be viewed from process graphics screens on an operator consol (figure 2). A conventional Lilly controller provides backup in the event of conveyance overspeed and overtravel.

Conveyance-mounted sensors and real-time data acquisition and transmitting devices that monitor hoist position and speed, conveyance load, rope tension, and shaft guide misalignment are currently being tested. A *position sensor* mounted on the conveyance eliminates the need to correct the position of the conveyance because of rope stretch. A *flex-cable load sensor* mounted just

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above the conveyance protects against *slack and tight rope*. A third sensor monitors *misalignment* of the shaft guides. These measurements are taken in real time and transmitted via wireless equipment from the conveyance to the hoist room.

Current work in ore pass design includes measurements of static and dynamic forces on chutes and gates from simulated loads. Results to date indicate that the dynamic forces caused by impact loads on chute gates, (i.e., release of hang-ups) may be much higher than previously thought.

Patent Status

The U.S. Dept. of Energy and NIOSH have applied (min-9603) for a patent entitled "Cable Load Sensing Device."

For More Information

Report of Investigations 9637, "Development of a Mine Shaft and Ore Pass Research Facility" by M.J. Beus and T.M. Ruff, is available from the authors. Call (509) 354-8064 or (509) 354-8053.

NIOSH is seeking cooperators to assist in further tests of mine hoist and ore pass technology to improve mining safety. Additional information can be obtained by contacting Elaine Cullen, Technology Transfer officer, NIOSH, Spokane Research Laboratory, Spokane, WA 99207 at (509) 354-8057.

To receive additional information about mining issues or other occupational safety and health problems, call **1-800-35-NIOSH (1-800-356-4674)**, or visit the NIOSH Home Page on the World Wide Web at http://www.cdc.gov/niosh/homepage.html.

As of October 1996 the safety and health research functions of the former U.S. Bureau of Mines are now located in the National Institute for Occupational Safety and Health (NIOSH).

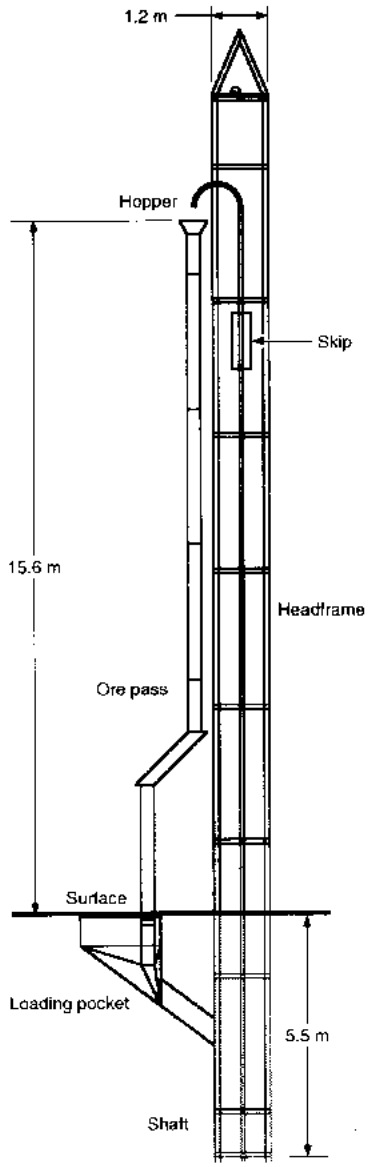

Figure 1.—Closed-Loop Hoisting System.

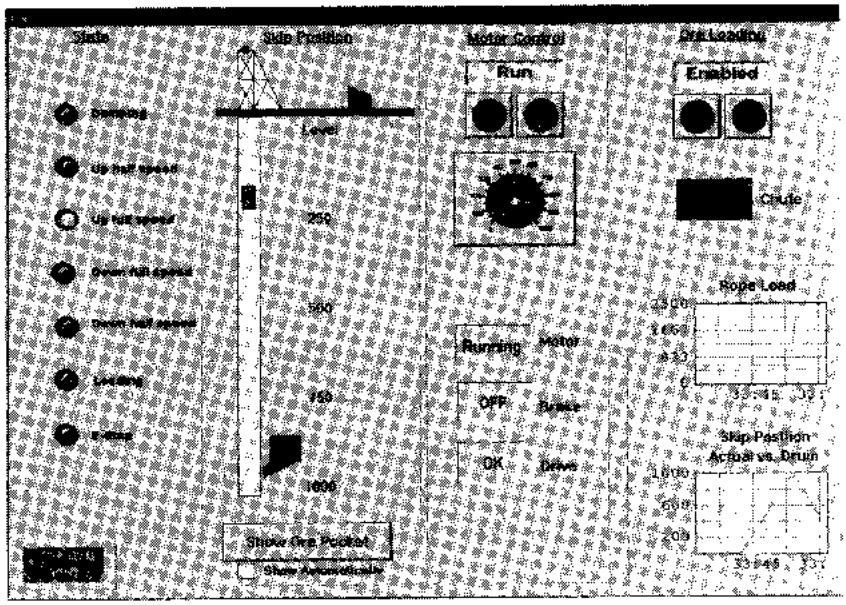

Figure 2.—Process Graphic Screen.