Christian Fimpler, Eaton Hazardous Area Communications, Germany, recalls the company’s integrated solution for underground communication at a coal mine in Turkey.

In the light of the advancing automation and new technology used for underground mining, a consistent communication concept is indispensable. Communication is one of the most important factors in a mine; it plays a critical role in ensuring operations and personnel safety. This is even more crucial in the case of coal mines, as many areas within them are considered hazardous due to the risk of explosion caused by the possible presence of explosive gas and dust.

The WL200 system from Eaton/FHF Bergbautechnik GmbH & Co. KG in Mulheim an der Ruhr (Germany) provides the highest grade of explosion protection to ensure constant availability, even with increased gas content in the underground areas. It is also designed for reliable voice communications with syllable intelligibility over the entire system.

Today, machine and control systems are often monitored from a surface control room to provide an overview of the current operating status of the entire mine building. A proven system for human to human speech communication, such as the ‘L111’ loudspeaker system from Eaton/FHF Bergbautechnik, supplies a certain area – an ‘island’ – in the mine building. Eaton’s communication control system facilitates these islands and makes it possible to reach each point...
acoustically from any location in the mine via a central station. In comparison, mine telephones offer the ability to reach any underground location, but only one person can be reached at any given location.

Often, the same message should be sent to all employees or a group of employees in an area. Or the message should be addressed to a person whose location continuously changes, such as the driver of a vehicle. The mine telephone cannot support this requirement.

**Structure of the communication control system**

The communication system consists of one or more dispatcher desk(s) and a main cubicle for controlling its functionality. From the control cubicle on the surface, up to 36 communication lines with up to 40 loudspeaker units can be connected. Both units are located at the surface and connected to the underground stations via Ex-barrier modules. For the main communication in the underground along roadways and in coal faces, a battery buffered loudspeaker unit is used (Figure 1). The underground communication lines are connected by a two-wire twisted pair cable to the surface station.

The dispatcher desk (Figure 2) in the surface control room is equipped with a 10.10 in. capacitive multi-touch screen, which allows users to slide between the different pictures/process diagrams.

The control display offers a free programmable soft PLC with comprehensive interfaces, such as ethernet, USB, CAN, RS-232, RS-485, SmartWire-DT or Profibus-DP/MPI/PPI, to communicate to the main SCADA system from the mine. It is also equipped with a gooseneck microphone and volume-adjustable loudspeaker.

The main control cubicle (Figure 3) on the surface is of modular construction, with a 19 in. rack where the line modules, amplifier modules, tone receivers and barriers are located. Each of the racks support connections for up to 12 modules. Digital input/output cards are connected to transfer the information on each communication line to the main controller, which allows the operator to switch between any specific line in the mine.

Thanks to its modular design, the system can be easily extended and changed to meet mine needs and continuous roadways or drivages by extending the PLC and SCADA software, as well as plugging in new line and barrier modules.

Even though the communication control system is primarily intended to connect loudspeakers and intercoms to a central operator station (or interconnecting the systems when required), a modular design also allows radio and telephone connections to be integrated. Depending on the existing topology, radio systems (e.g. MR90 of the Eaton/FHF Bergbautechnik) can be connected to the line module via a two or four-wire communication connection.

The connection of a local telephone line to a system can be accomplished via a simple, manually operated connection. Converter module 2313 adapts the different signal voltage of PBX and WL200.

**Basic operation mode**

The line modules/interface printed circuit boards (PCBs) can be inserted into the slots of the 19 in. rack in the control cubicle. If numerous lines are to be connected, the control panel can be supplemented by sub-racks.

For the low frequency signals and the speech voltage, each line module includes a speech detection circuit. Assuming this line is switched on at the dispatcher unit, the amplifier is switched on in the receive direction and a ‘busy’ line in the backplane bus of the rack is activated.

This switches the amplifiers of all other connected line cards in the transmission direction, which means ‘who speaks first is heard by all others’. Only the dispatcher is able to interrupt the communication, as priority is assigned to him. The speech detector has a hold time of around 1 sec., so if there is silence for more than this time, the busy line is released and can be occupied by another line card.

**Function: dispatcher is calling one line**

By pressing a soft key on the dispatcher control panel, the corresponding assigned display field on the visualisation lights up.
If desired, an attention signal can be given to the line by pressing the signal button on the control panel. After that, the dispatcher talks to the selected line by use of the gooseneck microphone installed in the panel. The announcement of the dispatcher overrides any existing communication on the loudspeaker line; the control centre has operation priority.

**Function: dispatcher is calling all lines**

By pressing the soft key, ‘call to all’, all connected lines are turned on and connected to one ‘party’ line. The voice communication now can be heard on all lines, as well as in the control room.

**Function: one line wants to be connected with another line**

To achieve this, the call progress is the same, and the operator has to be informed about the request. By additionally switching on the desired line, both (or even more) lines are connected to each other. By switching off the loudspeaker in the control panel, monitoring by the dispatcher can be switched off. The switching of the communication direction is done without intervention of the control centre.

**Function: one line is calling the dispatcher**

If the soft key assigned to a line is switched off (idle state), a line can send its conversation request to the control room by pressing the call button on a LV30 loudspeaker unit twice within 2 sec. If such a sequence is detected, the loudspeaker of the control unit emits a chime tone and the display assigned to the line on the visualisation shows by flashing which line is calling. By turning on the corresponding virtual line, the connection between the calling loudspeaker line and dispatcher is established.

**Function: alarm announcement**

To page automatic alarm messages over the entire system, a free programmable voice module is connected into the dispatcher line. This module can announce up to 64 predefined voice messages via the loudspeaker lines. These different messages are selected by six digital inputs. The voice module can be connected to the gas monitoring system of the mine, as well as to its rescue system. If any scenario occurs in this system, the communication controls will automatically announce the voice messages through all connected lines.

**Conclusion**

Enhancing safety and availability are the central design themes of the company’s new communication control system. It is a cost-effective solution for underground mines due to its easily setup, modular and expandable structure.

The Imbat coal mine in the Soma Manisa area of Turkey decided to install the first system with six loudspeaker lines in its mine. After successful commissioning, Imbat was impressed by the capability and availability of the system. The system was then extended to 14 loudspeaker lines to get it introduced to the entire mine.

“In underground, communication is always important. For communication systems, we want a solution that provides ease of use and simplicity along with reliability under harsh conditions,” said Bülent Başar, Electrical Chief Engineer at Imbat Madencilik A.S.

“That’s why we choose Eaton/FHF Bergbautechnik. Now we have communication inside our mine. During the operation, their solution proved its reliability and ease of use in our underground coal mine.”

It should also be mentioned that, due to continued improvement in development, new technology will soon be implemented in the system. The future outlook will be digital and include wireless connection of the underground loudspeaker system to reduce setup times during the installation, offering more connectivity throughout the entire system.