Selected terms used in ”mining telecommunications”

At the beginning of the paper the author pointed out that in many publications which
describe technical solutions applied in telecommunications systems and devices for
underground mines there are terms which belong to the realm of a colloquial rather
than technical language. It often happens that these terms do not have any technical
justification or are even incorrect. In the essential part of the paper the author at-
ttempted to define the basic terms, based on long-term experience and observations.
The following sample incorrect expressions were referred to: “telecommunications
cable for mining” (teletechniczny kabel górniczy), “mining telecommunications
grids” (sieci teletechniczne kopalniane), or the spelling of cable symbols with small
and capital letters. Finally, it was emphasized that telecommunications devices ap-
plicated in mines are, most often, solutions used in other industries too. Therefore the
terms used in mining should be compatible with those that are used in public tele-
communications.

key words: telecommunications in mines, telecommunications mining cables, terms
definitions in telecommunications

1. INTRODUCTION

Some publications about technical solutions for un-
derground mining use commonly known terms, yet
incorrectly. Colloquial terms are widely used too.
They are understandable to miners or telecommu-
cations specialists, however, they are not correct from
the point of view of telecommunications.

The technical environment of an underground mine
specifies untypical requirements (restrictions) to the
manufacturers of telecommunications systems. Yet,
this should not be an excuse to use incorrect terms.
These restrictions are depicted in the definitions of
such products and are presented in Table 1 [1, 6, 7].

<table>
<thead>
<tr>
<th>Restriction</th>
<th>Characteristics</th>
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<tbody>
<tr>
<td>Explosion-proof quality</td>
<td>Underground equipment and underground interfaces of surface-based telecommunications devices, used in coal mines with methane and/or coal dust explosion hazards, should be explosion-proof.</td>
</tr>
<tr>
<td>Protection degree of casings</td>
<td>Due to humidity, salinity and the presence of dust, devices used in excavations should have a minimal protection degree of IP54.</td>
</tr>
<tr>
<td>Structure of excavations</td>
<td>Small lateral sizes of mining excavations (a few meters) with respect to longitudinal ones (up to 20 km), a huge number of grids and power devices in a confined space, extensive excavations with tree-like structures.</td>
</tr>
<tr>
<td>Limited power supply continuity of telecommunications devices which are supplied from an underground power grid</td>
<td>Power supply continuity of underground telecommunications equipment is limited due to the following: planned shut-offs in a power grid (repairs, maintenance, check-ups), unplanned shut-offs caused by proper reactions of electrical power protection and methane measuring equipment, periodical testing of the system of shut-offs, executed by a methane measuring system. Exceeding the alarm threshold of a methane meter installed in the excavation causes an automatic shut-off of electrical energy in the given ventilation area.</td>
</tr>
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As early as in 1970s Prof. Nowicki, in his book „O ściśłość pojęć i kulturę słowa w technice” (Explicit terms and culture of language in technology) [10], discussed some issues related to proper vocabulary use in telecommunications (commonly-understood, "surface" telecommunications). He explained semantic ranges of many terms used in telecommunications at that time. The book was published 36 years ago. Since then, a new generation of telecommunications specialists has emerged in telecommunications departments of mines and companies that produce telecommunications equipment for mines. The author of the paper took an interest in these issues due to long-term experience related to reviewing papers, verifying technical documentation and projects. In these documents technical terms are often misused and the mining jargon is frequent.

2. TELECOMMUNICATIONS (TELETECHNIKA)

The Polish word teletechnika – telecommunications – is often used or, to be more specific, overused in publications and documentations of projects. Most often it can be found in the following expressions:

- “telecommunications cable” (kabel teletechniczny), "telecommunications mining cable" (teletechniczny kabel górniczy), etc.,
- “mining telecommunications grids” (sieci teletechniczne kopalniiane), often with an extra description – "intrinsic safe mining telecommunications grids" (iskrobezpieczne kopalniiane sieci teletechniczne),
- “telecommunications box” (skrzynka teletechniczna).

The word teletechnika and its derivatives come from power engineering, more specifically from local automatics. Monitoring and control of more and more extensive objects was executed with the use of telecommunications technologies for remote measurements and control, called in Polish teletechnika.

The term teletechnika in telecommunications technology is sometimes identified with the branch of technology involved in monitoring and control of distant objects. Thus it is a combination of automatic and data transmission techniques [3], i.e. telemetry.

In Poland the term teletechnika was introduced in 1920s (telecommunications /telekomunikacja was yet an unknown word at that time) to stand for the area in technology engaged in message transmission through cables, in order to differentiate it from ra-
diootechnika and radiotelefonia (radio transmission of messages) [10].

Now teletechnika is a term which signifies a whole spectrum of technical issues with respect to telecommunications technologies. This is a technology domain which deals with practical use of telecommunications. It refers to the issues related to production, design and maintenance of telecommunications grids and systems. Thus teletechnika is a telecommunications technology.

In underground telecommunications grids, in symmetrical cables with copper conductors, over 60% of all subscriber lines are used for audio communications (telephones and alarm communication), while 30% of lines are used for air measurement [2, 14]. Nowadays, it is practically impossible to find separate telecommunications cables (particularly in department local grids) which would be used only for telemetry. Therefore this term should not be used in mining telecommunications.

In 1970s and 1980s, when mines had separate grids for audio communication and for telemetry (e.g. methane measuring grids, mining geophysical grids), the term sieci teletechniczne (telecommunications grids) was used. These were the grids to be used in tele-control and telemetry, etc. Now the term teletechnika should be replaced by telekomunikacja (telecommunications) as in many symmetrical telecommunications cable lines there are subscriber lines for different telecommunications systems. The author used to make that mistake too in his articles and books [8], where the term teletechnika can be found. However in 1990 there was a telecommunications law passed in Poland [16] in which basic telecommunications terms were defined, and it was stipulated to use telekomunikacja instead of teletechnika (for the above application examples).

3. INTRINSICALLY SAFE TELECOMMUNICATIONS CABLES

In § 638 of the decree of the Minister of Economy on occupational health and safety [11] it was stipulated that telecommunications installations in coalbed methane fields should be intrinsically safe. Due to this, in technical documentations the following can be found (below there are English translations of Polish sentences):

1. Documentation of the installation of an intrinsically safe telecommunications cable for mining,
2. Documentation of an intrinsically safe cable bus grid,
3. Documentation of the installation of an intrinsically safe opto-telecommunications cable for mining.

4. Documentation of the extension of an intrinsically safe optical fibre bus grid in a mine.

As far as the second item can be seen as a kind of a mental shortcut, the third and the fourth are unacceptable.

Each copper cable grid (telecommunications installation) will always be safe, unless it has some active elements. Thus naming such a grid (not a line) as intrinsically safe is a misuse. A bus grid is intrinsically safe when symmetrical lines of this grid (in telecommunication cables for mining) have only intrinsically safe devices connected (devices which have an intrinsically safe feature). However, even here it would be necessary to think whether such circuits (with a given kind of terminal) will be intrinsically safe in compliance with PN-EN 50303 or PN-EN 60079-25.

For the tested active device – an element of a mining intrinsically safe telecommunication system (maximal current, voltage, capacity, inductance), notified organizations often determine input and output boundary parameters (e.g. $U_i$, $I_o$, $P_n$, $C_{nn}$, $L_o$, $L_o/R_o$, and $U_i$, $I_i$, $C_i$, $L_i$) for which the developed circuit will be intrinsically safe. Most frequently however, this is determined for lumped parameters: capacity, inductance, representing a 10 km symmetrical line with the conductors diameters of 0.8 mm. Therefore one should not assume a priori that a grid with an unidentified structure and unknown maximal length of subscriber lines, thus with unknown capacity and inductance, is intrinsically safe, unless one identifies active devices to be connected to that grid.

4. INTRINSICALLY SAFE OPTICAL FIBRES

In the case of optical systems (which use optical fibres) the term intrinsic safety may refer only to the electric (electronic) part of an optic transmitter and receiver as well as other electronic devices connected to them. It is vital to remember that in the case of optical fibre devices, the threat-invoking mechanism is the following: the light of an active optical fibre of an electro-optical transmitter (e.g. due to a damaged optical fibre cable) can fall onto an absorber (a grain of coal dust) and heat it up to the temperature which will cause an ignition of the explosive mixture. Thus optical elements are explosion-proof – optically safe.

Explosion-proof versions of the optical parts of systems and devices should be made according to the EN 60079-28 standard which provides three methods to make optical systems [7]:

- op is (inherently safe) – the system is inherently safe due to limited optical power in all light sources used in such systems (150 mW for methane),
- op pr (protected) – the light is confined inside the optical fibre due to extra protection means applied in the optical fibre system along the whole way of the signal, such as, for example, armour or pipes,
- op sh – interlock with optical fibre breakage – the detection of the damaged fibre is used. In the case of such a damage, the transmitter is switched off immediately.

In mines with methane and/or coal dust explosion hazards, the telecommunication installation, made with the use of optical fibres, is not intrinsically safe in its optical part but explosion-proof and optically safe.

In optical fibre systems installed and exploited in Polish mines now, the majority of optical fibre devices have the "op is" feature. The "op pr" and "op sh" features, though could be used by many mining grids exploited in mines, have not caught on so far in the mining optical fibre telecommunications systems.

From a formal and legal point of view, optical fibre telecommunications installations exploited in methane fields do not comply with some stipulations from § 638 of the law [11], which refer to intrinsic safety of these installations (as they are explosion-proof and optically safe, not intrinsically safe).

A similar situation happens (also from a strictly formal point of view) with a stipulation from § 639 of the law [11], which says that it is inadmissible to run intrinsically safe and non-intrinsically safe transmission lines in one cable or wire.

Composite (hybrid) cables of the ImPact intrinsically safe communication system made by Mine Site Technologies (MST), which are adapted to connect underground access points and switches of the grid (named by the Polish distributor HASO Tytyń: switch/access points of an NS40 wireless grid), do not comply with the above stipulation. This is due to the fact that in the core of a composite cable there are copper conductors which are used in intrinsically safe circuits for power supply to linear devices of the

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1 The PN-92/T-05002/A1 standard (with the change A1 introduced on 28.11.1997) Mining telecommunications grids. Cable lines. General requirements and testing kept the term "intrinsically safe line" (for iskrobezpieczny) – defined by the standard from 1987 (BN-87/8984-17/01)

2 Up until the day of passing the law the legislator did not identify a case of using optical fibre cables in underground mines – thus such solutions have no reference in valid regulations.
ImPact system. There are optical fibres too. Optical elements of this system have the "op is" feature, however, they are not intrinsically safe but explosion-proof and optically safe, and the supply circuit is intrinsically safe.

Optical fibre devices and systems can have intrinsically safe circuits but in their electrical parts. This is presented in Fig. 1.

![Diagram](image)

**Fig. 1. Marking devices and terminals in optical fibre teletransmission systems in mines**

Devices which are parts of optical fibre teletransmission systems in mines, presented in Fig. 1, should have the following explosion-proof symbols when used in methane mines:
- active teletransmission element (e.g. multiplexer) – I M1 Ex ia op is I,
- active element of an optical fibre system supplied by an intrinsically safe power supply unit with a fire-proof connection chamber (M2) without a battery, with an ib output, or supplied from intrinsically safe sources (with a battery with an ia output) M1 – I (M2/M1) Ex ia op is I,
- distribution frame – a passive element for which it is enough to have a feature determining the casing protection degree – IP54.

5. MINIMAL PERMISSIBLE DISTANCES FOR TELECOMMUNICATIONS AND POWER CABLES IN EXCAVATIONS

There is no doubt that an optical fibre cable (opto-telecommunications mining cable) is a telecommunications cable. Thus, with respect to this type of telecommunications cables, the following stipulation from the occupational health and safety law (item 7.3.3 of appendix 4 to [11]) is not justified, though often observed by control organizations. The stipulation says that the distances between power cables/wires and telecommunications cables should not be smaller than 30 cm.

This situation often takes places in power switchboards where optical fibre telecommunications cables of a supervision-, control- or monitoring systems are put into fire-proof shields of power distribution boards and other electrical power devices.

It is important to note here that optical fibre dielectric cables (e.g. ADSS self-supporting cables with aramid or kevlar fibres) can be installed on the supports of pylons for 110 kV electrical power lines, close to or even directly in ground wires of these lines.

The biggest number of such optical fibre lines (suspended on 110 kV power lines) were made in 1990s, in co-operation with a local power company (Górnośląski Zakład Energetyczny in Gliwice) to connect the mines of the former coal company Rybnicka Spółka Węglowa S.A. At that time the company took up a concept to construct an ATM optical fibre teletransmission grid that would be common for telecommunications and IT services. About 100 km of optical fibre lines were made. In the mines of another coal company, Jastrzębska Spółka Węglowa, optical
fibre lines are used too and are suspended on the supports of 110 000 V power lines [17, 4].

In these cases, the legislator did not foresee the fast development of telecommunications technologies either. Thus such solutions have no reference in the valid regulations for underground mines in Poland.

6. TELECOMMUNICATIONS MINING CABLES

Telecommunications mining cables are very common in Polish mines. However, in many catalogues or documentations the authors make mistakes in their characteristics and descriptions. Some of these mistakes are discussed below.

In Poland it was agreed that one of the parameters of a conductor in the telecommunications cable (this refers only to single-strand conductors of telecommunications cables, not stranded wires) is its diameter, not its cross-sectional area. In Ukraine it was decided that conductors in the telecommunications cable are identified by their cross-sectional areas, not diameters. In the USA, in turn, the AWG\(^3\) ratio is in use (Fig. 2) [9].

As for power cables in Poland, conductors are characterized by their cross-sectional areas, not diameters. Both these characteristics (diameter, cross-sectional area) are, of course, conventional (interchangeable) parameters; once you know the cross-sectional area, you can determine the diameter. It is important however, to stick to one of these two in documentation and publications.

In telecommunications, a diameter is important while selecting fittings (screw connections, cable connections etc.). It is vital to note here, however, that for telecommunications cables with stranded conductors (e.g. steel and copper ones) one should always give their cross-sectional areas, not diameters.

In electricity, the current-carrying capacity of a conductor is an important issue. It depends on the cross-sectional area of the conductor, therefore this parameter is usually provided. In telecommunications, in turn, the diameter better characterizes the parameters of connections.

The use of small and capital letters in the symbols of telecommunications cables, particularly those used in mining, is justified too and should not be disregarded. In cables installed in excavations and described in documentation, mistakes are usually the following:

- misuse of "L" and "Y", "X" (capital) or "l", "y" and "x" (small),
- wrong understanding when to provide the diameter and when the cross-sectional area of the conductor.

Table 2 below gives the basic differences.

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\(^3\) AWG – American wire gauge – a standardized gauge system for the diameters of wires. This gauge system originated in the number of drawing operations used to produce a given gauge of wire. The more passes, the smaller the diameter. Wires with diameters of 0.8 mm are marked 20 AWG, 0.4 mm – 26 AWG, while a 36 AWG wire has a diameter of 0.005 inches (0.127 mm).
The use of small or capital letters in the symbols of telecommunications cables for underground mines

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Explanation of basic inaccuracies</th>
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| YnTKGMFLY 5x2x0.5 mm²   | • “Yn” PVC flame-retardant sheath – this is an external layer of the cable which plays a double role: the capital letter stands for sheath while the small one – for the external anti-corrosion shield. As the sheath is flame-retardant (unlike the sheath in the next example of a cable), a small “n” was added. Capital letters are used in the characteristics of sheaths and conductor insulation, while small letters – protective shields.  
• Capital “L” is used because the cable has stranded copper and steel conductors (MFL).  
• Capital “Y", used after MFL (in this example, actually, the letter is the last one of the symbol²), identifies the insulation kind of the cable conductor (PVC “Y” – therefore a capital letter is used). The sheath kind (which can be an external shield at the same time) is characterized by the first letters. Such a cable is used for the so called moving connections. |
| YTKGXfly 5x2x0.8 mm³    | • Small “l” means in this case the characteristics of the armour (armour made of coated steel tapes “Ftl”).  
• Small "y", always the last letter of the symbol. It stands for the external shield of the armour (PVC "y").  
• Capital “X”, following the TKG symbol, is always used as it stands for polyethylene insulation. This mistake is the most common in mining documentations. |

7. LEAKY FEEDER AND WIRELESS COMMUNICATION

A concentric radiating conductor with a leaky braid is used in many mines as a line to distribute a radio signal in excavations [6]. Such radio solutions are used, first of all, along transport corridors (suspended monorails, floor-mounted rails and wheel transport) and in shafts. Basic inaccuracies found in texts and documents about such a radio system for mines are related to the following terms:
- an English term "leaky feeder" is translated directly to Polish kabel cieknący,
- "wireless communication", and, in the whole installation of such a telecommunications system, a conductor – in this case it is a radiating conductor, which is the basic teletransmission element for wireless communication, i.e. a line for a high frequency signal.

This inaccuracy, and the necessity to unify the vocabulary, was pointed out by the reviewers of the only book available recently in Poland that discusses thoroughly the issue of radio communication with a radiating conductor in underground excavations [4]. Such a solution should be called radio communications system (not wireless) with a radiating conductor (not leaky feeder).

8. DIRECT (BEZPOŚREDNI)

In mining telecommunications it is possible to find such expressions as "direct connection" or "direct connection in a telecommunications system". They function in Polish valid regulations (§ 639 [9]). Such expressions have their origins in the period when there were local telephone exchanges in mines or local telephones for particular technological processes (e.g. communication in shafts). The connections could function then without human operators or a fallible central exchange of the mine, i.e. they were executed directly.

As the above described solutions do not exist any more, the expression "direct/directly" should not be used in technical documentation or in currently executed modernization projects of telecommunications systems. The records in § 639 (and other related regulations) [9] should be changed immediately.

Nowadays all telecommunications systems in mines function in a different way. In supervision centres of all underground mines in Poland there are digital phones (ISDN) or telephone systems with many programmable and functional buttons. All connections from these phones are commuted in digital central telephone exchanges. There is nothing like a direct connection here. The operator uses a shortcut button to get the required connection more easily and the
connection is always executed by a digital central telephone exchange.

Similarly, there are no "direct" connections in most local shaft communication systems. Old-type MB telephones (e.g. those produced by ZWUS and TELOS) are successively replaced by local telephone exchanges, while connections between particular phones are commuted in commutation fields of the exchanges. An example is a local system for intrinsically safe telephone connections ITS developed by TELVIS [5] which is commonly used in the shafts of many mines. A similar solution for shaft communication is offered by TELOS (SLS System [13]).

In the above cases the following should be differentiated:

- a possibility to program a telephone number and assign a shortcut button to it in an analogue, ISDN or system phone,
- functional possibilities of shortcut buttons in a system phone, from a direct connection in telecommunications (with the use of proper telephone solutions).

Recently, the expression "direct/directly" has generated some negative emotions and misunderstandings. In many tender specifications, in sections describing the installation of new telecommunications systems, the potential suppliers were required to prove that two "relatively independent" telecommunications systems, e.g. a gas measuring and an alarm system, are "directly" connected. This requirement, unfortunately, has not been justified in many cases.

When analyzing the above cases, it is important to note that the expression "direct/directly" refers to a connection which has no intermediary elements and reaches the desired number directly, without an exchange, i.e. without an intermediary commutation process. Thus direct connections refer to stationary connections and local communication (without a commutation process).

The term "direct/directly" should be avoided in the integration of digital telecommunications systems. In telecommunications exchanges or servers all connections from analogue phones, system phones (including the supervisor’s phone) or other phones (terminals) are commuted through the exchange or switch. However, the commonly known English word "switch" should not be used here.

In addition, a connection of two ICT systems (e.g. separate computer networks of two security systems) through a switch or router is not a direct connection. These devices work in the second or third layer of the OSI reference model and play a role of communication nodes. On the basis of the routing process, the information is transferred, in the form of information packages, between separate ICT systems.

9. INDEPENDENT (NIEZALEŻNY)

Another misuse in mining telecommunications is the one of the word "independent". In valid mining regulations (item 8.2, appendix 4 to occupational health and safety law [11]) the term "independent" was characterized quite thoroughly, including its use in electrical power supply to exchanges or supervision units. The requirements concerning the independence of electrical power systems in a mine are unambiguous and precise. As the term "independent" in electrical power supply was defined by regulations, these regulations [16, 11, 12] should also apply to mining telecommunications when the "independence of a given system" is determined. Telecommunications lies in the realm of electricity too.

The misuse is most frequent when talking about alarm systems and all-mine telecommunications systems. How can we speak about independent systems, when we have the following in all mining installations in Poland?:

- "common" system of guaranteed power supply (most often one for both systems),
- usually the same distribution frames (PGI – intrinsically safe and PG – non-intrinsically safe),
- common surface or underground distribution units, ladders, cable canals,
- the same telecommunications lines made with the use of multi-pair mining telecommunications cables,
- common telephones (signalling telephones PST, ZITG, JANTAR).

In this case it is difficult to find any "independence" of these two systems.

It is important to note that the need to build the so called "independent" systems in mining telecommunications is not in accordance with the idea to integrate telecommunications systems. And this idea is, undoubtedly, the objective of modern telecommunications [7, 6].

10. CONCLUSIONS

In the quoted examples the author pointed at several common mistakes in the use of terms and expressions related to "mining telecommunications". These mistakes are common both in the spoken and
written Polish language. Special focus was put on such terms as: telecommunications, intrinsic safety and explosion-proof quality of basic elements of optical fibres, direct connections or independent telecommunications systems and systems with radiating conductors.

Telecommunications devices used in mines are, most often, technological solutions which are applied in other industries too. Therefore the terms used in mining should be compatible with those used in public telecommunications. "Mining telecommunications" is a part of public telecommunications and should use the same terms. Therefore we write "mining telecommunications" in inverted commas to stress that, in fact, such telecommunications does not exist. Its characteristics lie in the use of subscriber devices, teletransmission grids and stationary devices which are adapted to work in specific environmental conditions of an underground coal mine.

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Artykuł został zrecenzowany przez dwóch niezależnych recenzentów.