



STATE MINING AUTHORITY

NITROGEN OXIDES

PREVENTION AND EXPERIENCES IN POLISH MINING INDUSTRY

Luxembourg

23 April 2013



MINING PLANTS SUPERVISED BY THE STATE MINING AUTHORITY

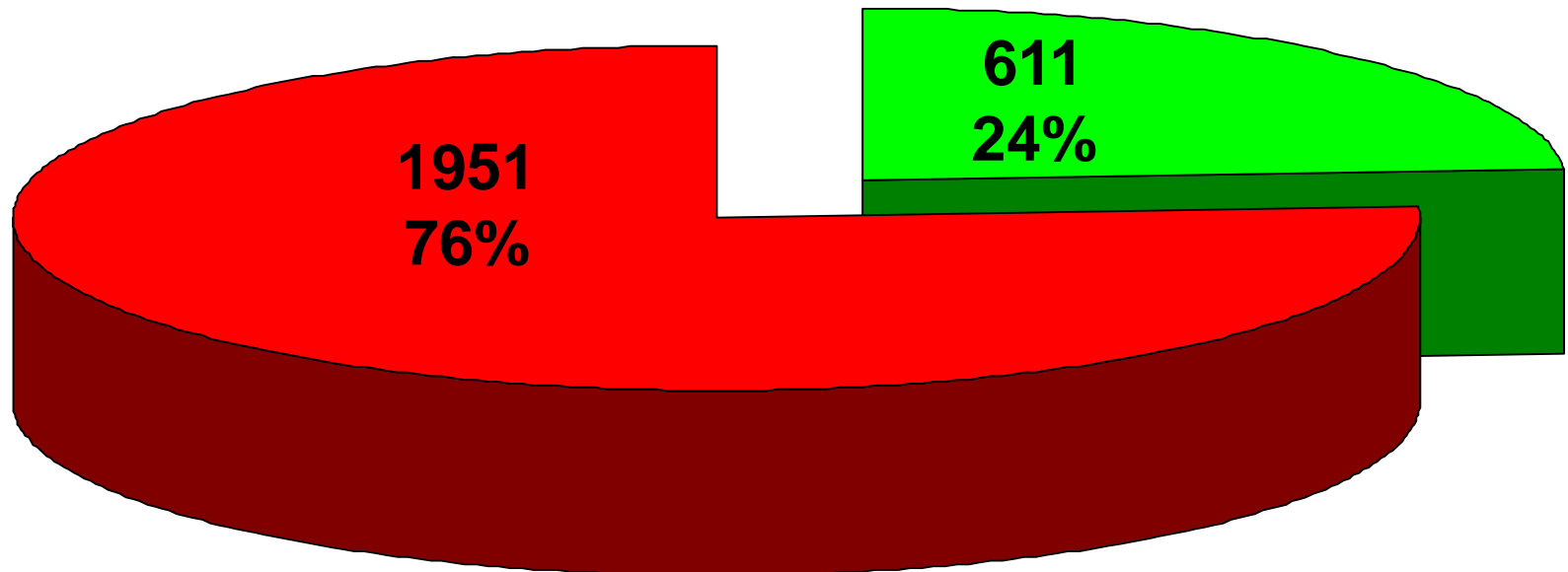
Mining method	No.	Employment [as on 31.12.2012]	Annual output [1000t]
Underground – hard coal	31+1	106 103	79 234
Underground – copper ore	3	12 432	31 725,4
Underground - zinc and lead ore	2	1 186	2 490,8
Surface – lignite	12	12 459	64 276,9
Surface - other basic minerals	77	4 084	-
Mining plants extracting common minerals	6983	19 020	-
Driling	77	4 084	-
Branches – plants conducting geological works	267	6 813	-
Underground works with application of mining techniques	8	1 421	-



OCCUPATIONAL DISEASES IN POLAND IN 2011

Number of cases occupational diseases - 2562

■ Mining and quarrying ■ Other service activities





OCCUPATION DISEASES IN MINING IN 2011

Occupational disease	Number of occurrences occupational diseases	[%]
Pneumoconioses	501	82,0
Occ. impaired hearing	42	6,9
Vibration syndrome	38	6,2
Chronic obstructive bronchitis	4	0,6
Other occ. diseases	26	4,3
Total	611	100



LIST OF MAJOR EXECUTIVE IN THE AREA OF OCCUPATIONAL SAFETY AND HEALTH

Regulation of the Minister of Economy

of 28 June 2002

on the matter of safety and the hygiene of work, the leadership of movement and specialist fire-fighting protection in underground mining institutions

Regulation of the Minister of Labour and Social Policy

of 29 November 2002

on maximum permissible concentration and intensity of agents harmful to health in working environment

Regulation of the Council of Ministers

of 30 June 2009

on occupational diseases



TOXICITY OF NO_x

Nitrogen oxides are one of the more dangerous components of air contaminants. Are considered to be nearly ten times more harmful than carbon monoxide, and several of sulfur dioxide.

No.	Typ of gas	Regulation of the Minister of Labour and Social Policy of 29 November 2002	
		Value (mg/m ³)	
		8-hour TWA	STEL (15-min)
1.	NO	3,5	7
2.	NO₂	0,7	1,5
3.	CO	23	117
4.	SiO₂	1,3	2,7



PERMISSIBLE EXPOSURE LIMIT

No.	Typ of gas	Regulation of the Minister of Economy of 28 June 2002		Regulation of the Minister of Labour and Social Policy of 29 November 2002	
		Value (mg/m ³)		Value (mg/m ³)	
		8-hour TWA	STEL (15-min)	8-hour TWA	STEL (15-min)
1.	NO	5 (2,6 ppm)	10 (5,2 ppm)	3,5 (1,8 ppm)	7 (3,6 ppm)
2.	NO₂	-	-	0,7 (0,36 ppm)	1,5 (0,78 ppm)
Recommendation from SCOEL for NO₂				0,2 (0,1 ppm)	1,91 (1,0 ppm)



SENSORY THRESHOLD AND IRRITATION

Concentration NO₂	Effect of NO₂
560÷940 mg/m³ (300 ÷500 ppm)	Acute pulmonary edema
280÷380 mg/m³ (150 ÷200 ppm)	Fibrinous clot bronchiolitis
94÷190 mg/m³ (50 ÷100 ppm)	Reversible bronchiolitis, pneumonia focal
47÷140 mg/m³ (25 ÷75 ppm)	Bronchitis, bronchopneumonia
0,94 mg/m³ (5 ppm)	Decrease pressure of oxygen in arterial blood
0,3÷0,94 mg/m³ (1,6 ÷5 ppm)	Increase airway resistance
>0,28 mg/m³ (1,5 ppm)	Perception threshold



SOURCES OF NITROGEN OXIDES

The main source of nitrogen oxides in the mining industry:

- Diesel drives for underground mine's vehicles,
- Blasting operations,
- Welding operations.



PERCENTAGE SHARE OF THE EXHAUST GAS COMPONENTS

Fuel ($C_nH_mO_l$) + Air (O_2+N_2)

Combustion

Exhaust gas components [%]

N_2	+	CO_2	+	H_2O	+	O_2	+	CO	+	HC	+	NO_x	+	PM
<72		<15		<10		<1		<1		<0,5		0,5		0,5



REQUIREMENTS RELATING TO DIESEL ENGINES

Polish Standard PN-G-36000:1997 Diesel drives for
underground mine's vehicles - Requirements

CH ₄ content in the air in the induction system	%	0,0	1,0	1,5
CO	ppm	500	1200	1800
NO _x	ppm	750	1000	1000
CH	ppm	200	200	200



RELATIONSHIP BETWEEN NO_x and NO

$$NO_x [ppm] = \frac{NO [ppm]}{0,95}$$



RESULTS OF RESEARCH

- Typ of drive: Ferrit DLZ 110F nr DLZ 09054
- Typ of engine: Zetor 1404 nr *1404-001970*014-110

Marked substance	Date of research	rpm		
		880	1600	2200
CO (ppm)	28.01.2012 r.	155	268	303
	30.01.2013 r.	251	270	285
NO_x (ppm)	28.01.2012 r.	133	389	409
	30.01.2013 r.	245	195	186
CH (ppm)	28.01.2012 r.	25	35	40
	30.01.2013 r.	30	25	20



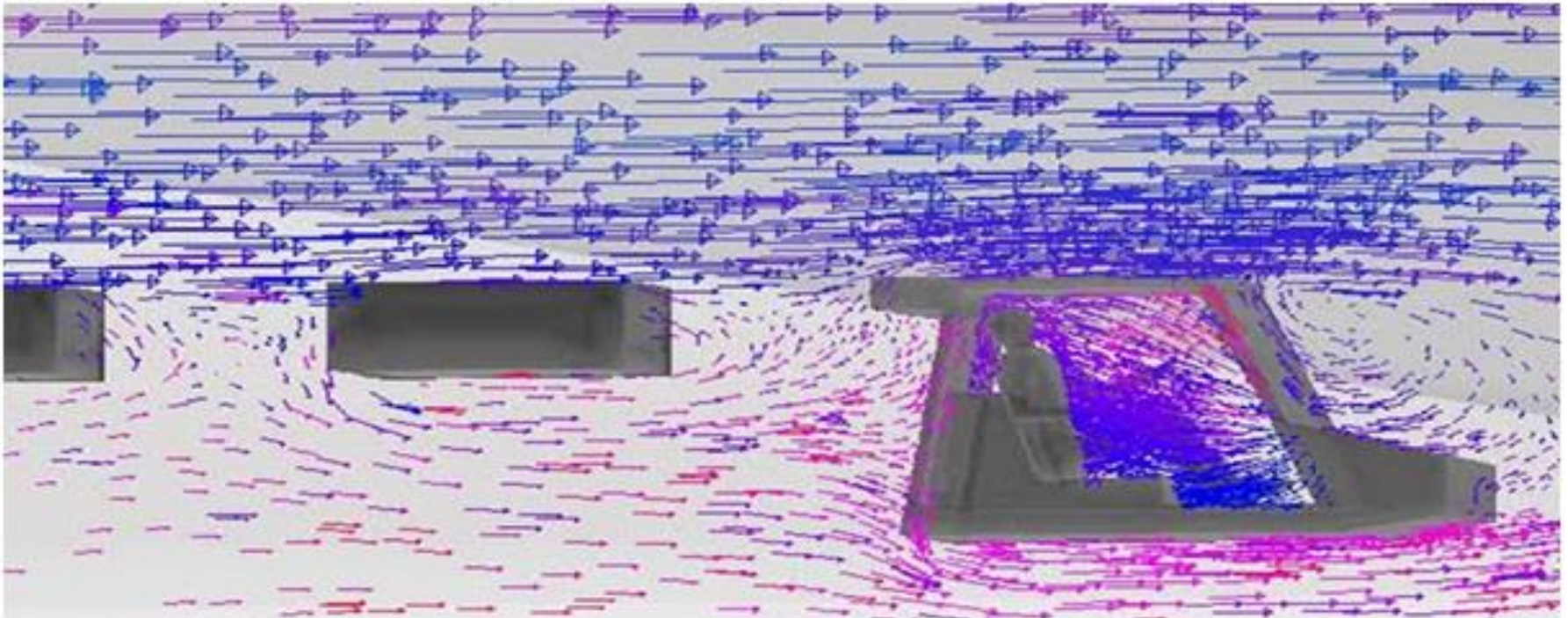
RESULTS OF RESEARCH

- Typ of drive : Ferrit DLZ 110F II nr DLZ 11125
- Typ of engine: Zetor 1404 nr *1404-002258*014-091

Marked substance	Date of research	rpm		
		780	1600	2200
CO (ppm)	14.12.2011 r.	272	330	306
	06.12.2012 r.	194	256	242
NO_x (ppm)	14.12.2011 r.	325	225	196
	06.12.2012 r.	490	327	291



INFLUENCE OF AIR VELOCITY



- Speed drive – 0,30 m/s
- Air velocity – 0,33 m/s



EXPLOSIVES – REQUIREMENTS

- Polish Standard PN-C-86051:1993 Explosives - Permitted ammonites for use in firedamp occurrence – Requirements. (*Metanites*)
- Polish Standard PN-C-86052:1993 Explosives. Dynamites. Requirements.
- Polish Standard PN-C-86053:1993 Explosives - Permitted ammonites for use in coal dust occurrence – Requirements. (*Carbonites*)
- Polish Standard PN-C-86054:1993 Explosives - Permitted dynamites for use in firedamp occurrence – Requirements. (*Barbarytes*)



EXPLOSIVES – REQUIREMENTS

- Polish Standard PN-C-86055:1993 Explosives - Ammonites – Requirements

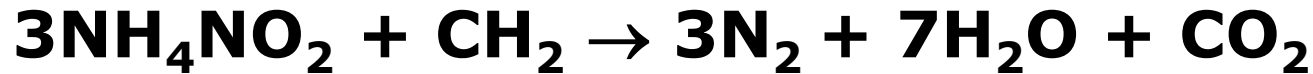
Council Directive 93/15/EEC of 5 April 1993 on the harmonization of the provisions relating to the placing on the market and supervision of explosives for civil uses

- European Standard PN-EN 13631-1:2006 Explosives for civil uses - High explosives - Part 1: Requirements
- European Standard PN-EN 13631-16:2006 Explosives for civil uses - High explosives - Part 16: Detection and measurement of toxic gases



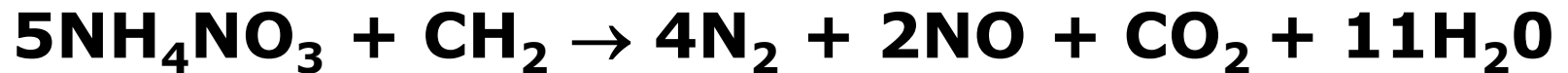
IDEAL AND NON IDEAL EXPLOSIVE REACTION

- The equation for an ideal explosive reaction is as follows:



This is an oxygen balanced explosive reaction that does not generate NOx.

- A non ideal explosive reaction is as follows:



- The nitric oxide combines with oxygen in the atmosphere to produce nitrogen dioxide.





POLISH – REQUIREMENTS

Amount of toxic oxides regulating the approval of the screened explosives to be used in underground mining

Types of toxic oxides	ppm (V/V)	dcm ³ /kg
CO	1350	27
NO _x	800	16



CONCENTRATIONS OF NO_x

Types of explosives	Concentrations of NO _x in post blast fumes	
	ppm (V/V) 0,5kg explosives	dcm ³ /kg
Amonites	550	11,0
Metanites	430	8,6
Carbonites	600	12,0
Barbarytes	380	7,5
Dynamites	560	11,3
ANFO	540	10,9
Emulsion explosives materials	310	6,1



PREVENTIVE MEASURES

- **Air monitoring - ventilation,**
- **Exhaust monitoring,**
- **Engineering controls,**
- **Implementing safe-work procedures,**
- **Inclusion diesel drives at the design stage haulage roads,**
- **Use appropriately selected explosives,**
- **Medical monitoring,**
- **New technical solutions.**



NEW TECHNICAL SOLUTIONS





STATE MINING AUTHORITY

Thank you for your time and attention

Roman Sęsiadek

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the State Mining Authority