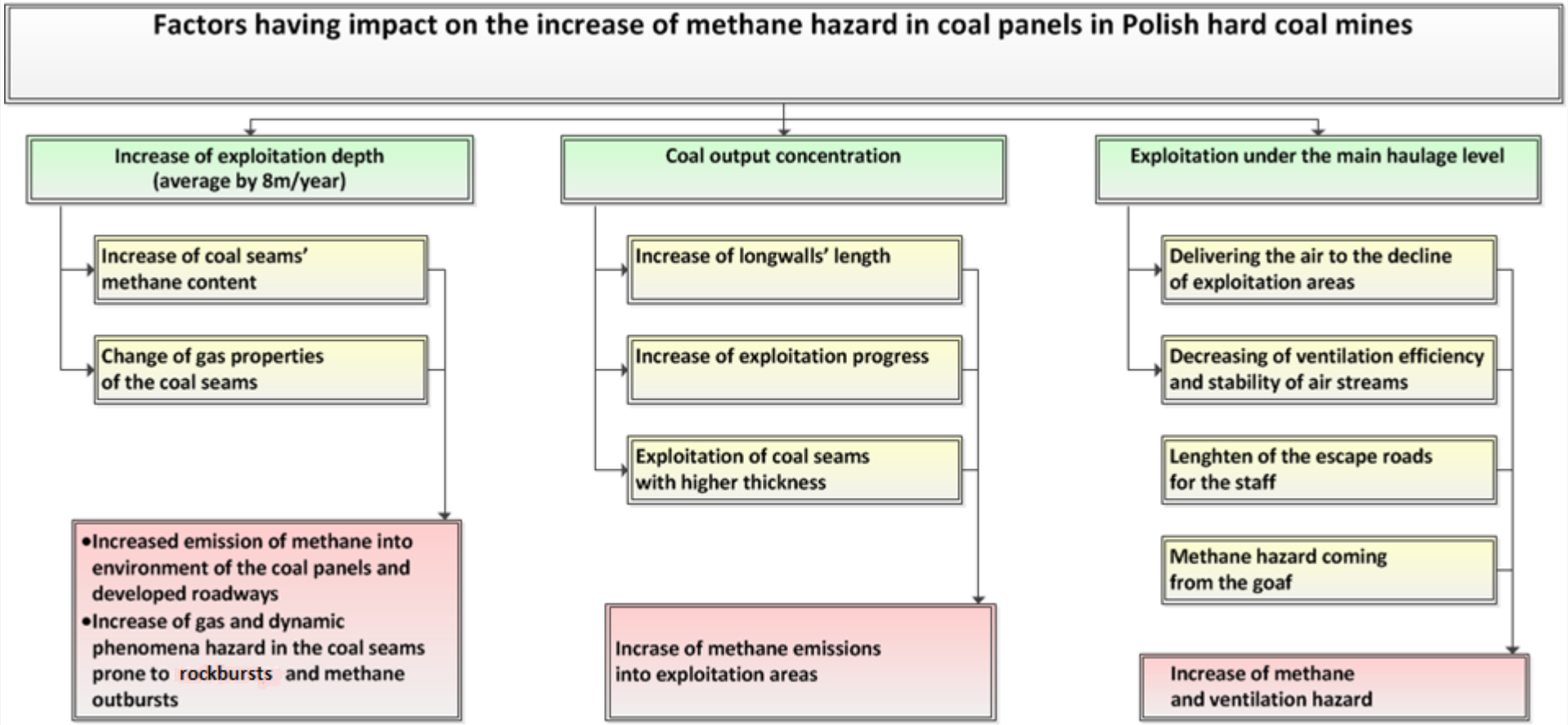
GŁÓWNY INSTYTUT GÓRNICTWA

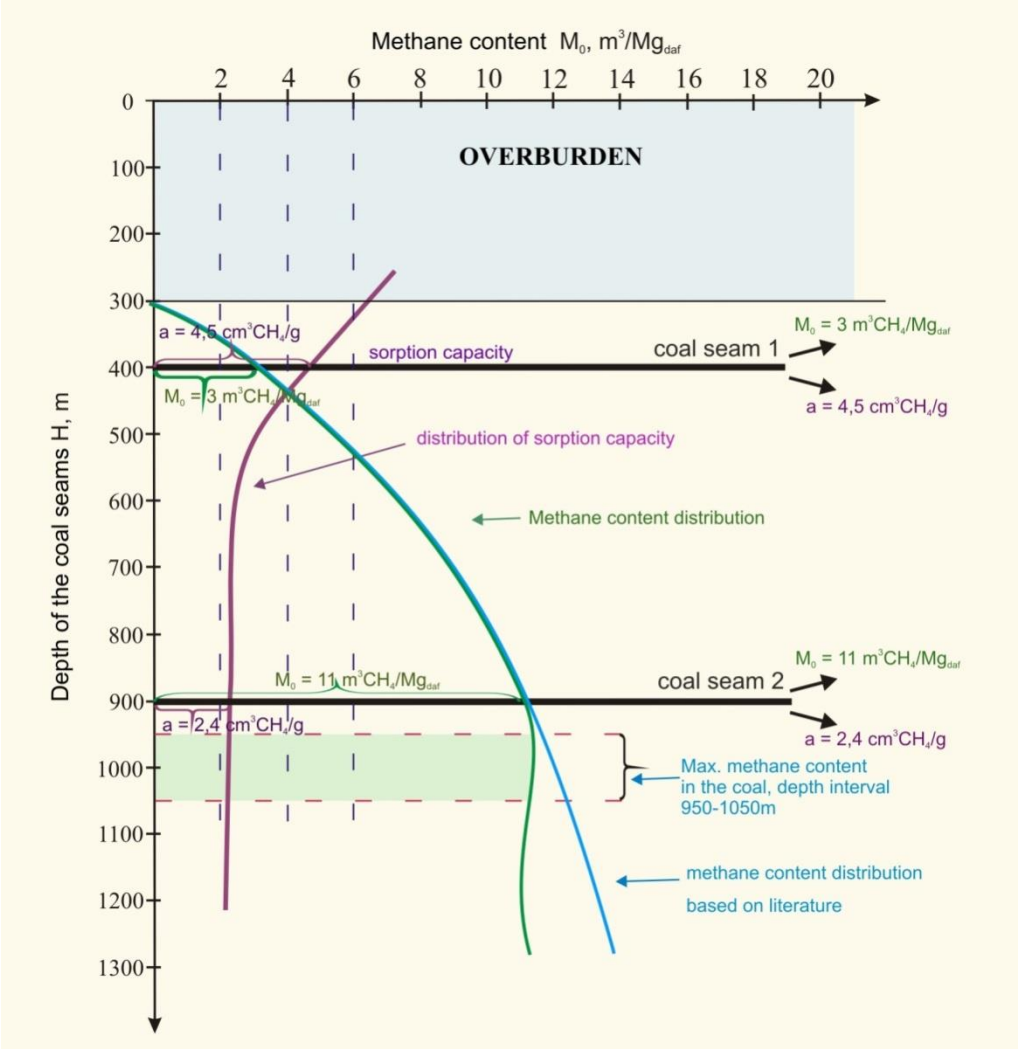
Designing of the Coal Panels with High Concentration of Coal Extraction in a Strongly Gaseous Coalbeds

Henryk Koptoń


Factors having impact on the increase of methane hazard in coal panels in Polish hard coal mines
Increase of exploitation depth (average by 8m/year)
Coal output concentration
Exploitation under the main haulage level
Increase of coal seams' methane content
Change of gas properties of the coal seams
Increase of longwalls' length
Increase of exploitation progress
Exploitation of coal seams with higher thickness
Delivering the air to the decline of exploitation areas
Decreasing of ventilation efficiency and stability of air streams
Lenghten of the escape roads for the staff
Methane hazard coming from the goaf
•Increased emission of methane into environment of the coal panels and developed roadways
•Increase of gas and dynamic phenomena hazard in the coal seams prone to rockbursts and methane outbursts
Incrase of methane emissions into exploitation areas
Increase of methane and ventilation hazard

GIG

Development of methane content and sorption capacity of the coals depending on their depth



Designing of concentrated coal exploitation in the coal panels located in a strongly gaseous deposits should be preceded by calculation of the methane emission forecasts together with ventilation analysis, considering effectiveness of methane drainage, concluding with determination of mining capacity of the longwall.

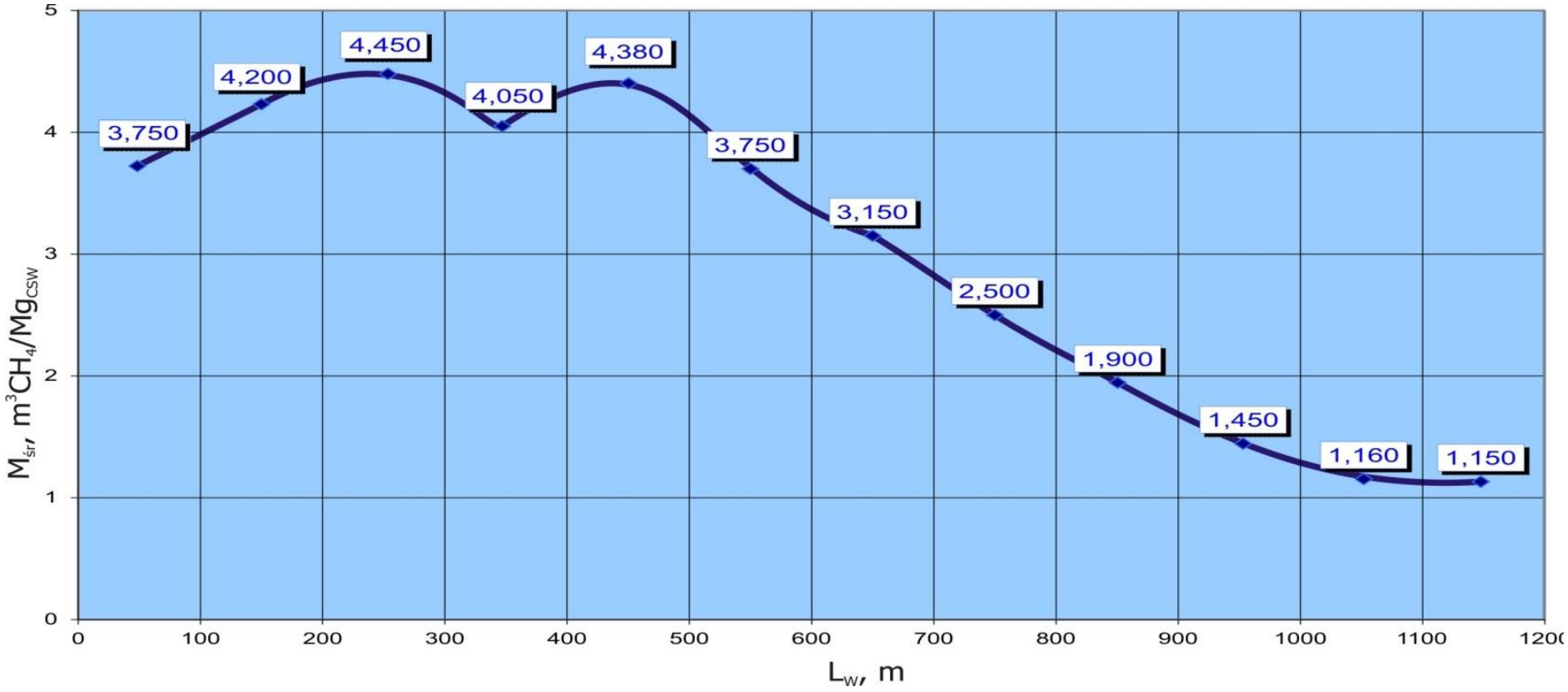
Methane emissions into the environment of the longwall during coal exploitation come from :

- **exploited coal seam,**
- **undermined and overmined coal seams by exploited coal panel, which are within exploitation relaxation zone, having released desorbable methane resources,**
- **goaf after coal exploitation, which are connected with the exploited longwall environment .**

Increase of coal extration concentration, which can be recognized in Polish hard coal mines in the last two decades, was mainly the result of gradual increasing length of the longwalls, besides – introduction of highly efficient coal shearers .

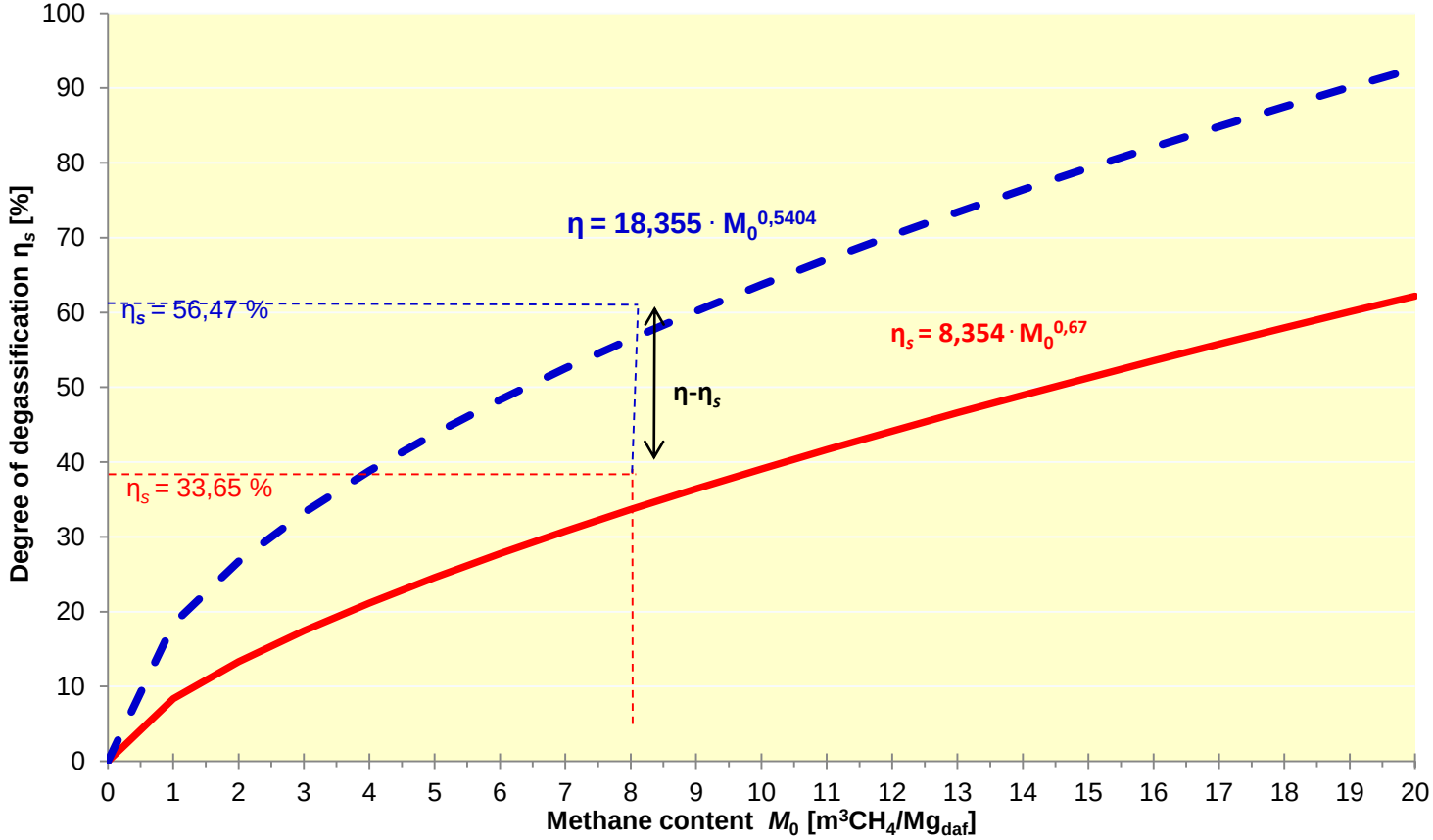
The results of the research conducted by Central Mining Institute confirmed, that in the conditions of increasing coal extraction concentration in the gaseous coal seams the share of methane emissions into the environment of the longwall coming from relaxed undermined and overmined coal seams is increasing .

Distribution of methane content along the designed coal panel



Example of mean methane content $M_{ŚR}$ along the designed coal panel L_w

Degree of degassification the exploited coal seam by the shearer depending on its primary methane content Mo (Krause 2009b)



GIG

Forecasted volume of methane emissions into environment of longwall during coal shearer extraction can be calculated based on the following formula :

$$V_{CH_4} = \frac{L_s \, m_e \, \gamma \, z \, M_o \, \eta_s}{100 \, t} \qquad \textbf{(1)}$$

Where:

L_s – length of the longwall, m;

m_e – heigh of exploited longwall, m;

γ – density of coal, Mg/m^3;

z – shearer cut, m;

M_0 – methane content of exploited seam, m$^3 CH_4/Mg_{daf}$

t – duration of coal extraction cycle, min;

η_s – degree of exploited coal seam degasification – *according to formula (2).*

$$\eta_s = 8{,}354 \cdot M_0^{0{,}67} \qquad \textbf{(2)}$$

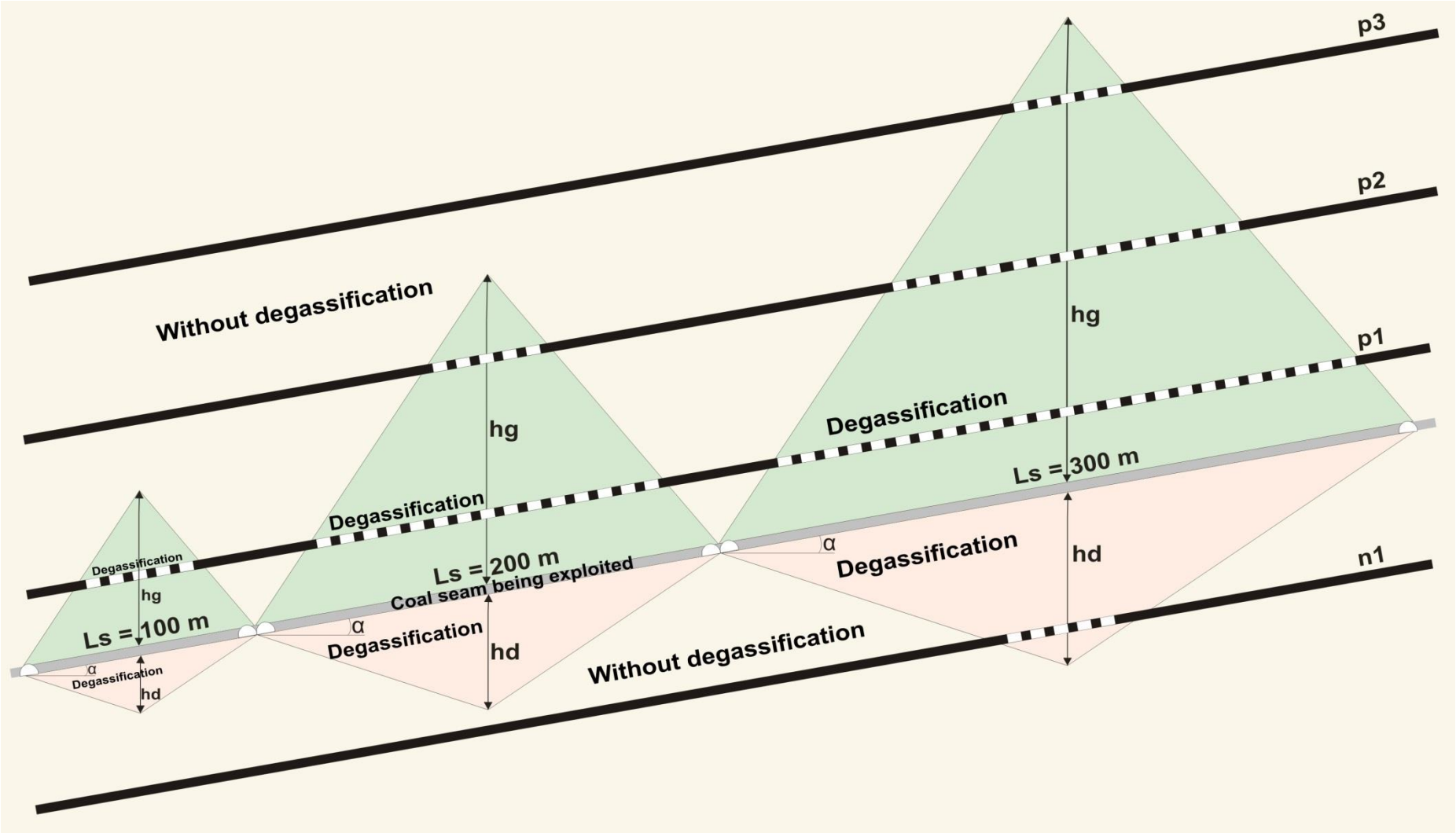
Table below presents calculated values of methane emissions into the environment of the longwall during coal extraction cycle.
Following longwall parameters were assumed :
Longwall length L_s = 250 m, longwall's high m_e = 3 m, cut z = 0.8 m
Primary methane content in the coal seam M_0 = 8 m^3CH_4/Mg daf.
The calculations were conducted for three durations of shearer's mining cycle , i.e. : 80 min, 100 min and 120 min. Value η_s was calculated based on pattern (2), Methane emissions forecasting into longwall environment during coal extraction was calculated based on pattern (1).

Table 1. Forecasts of methane emissions to longwall environment during shearer operation

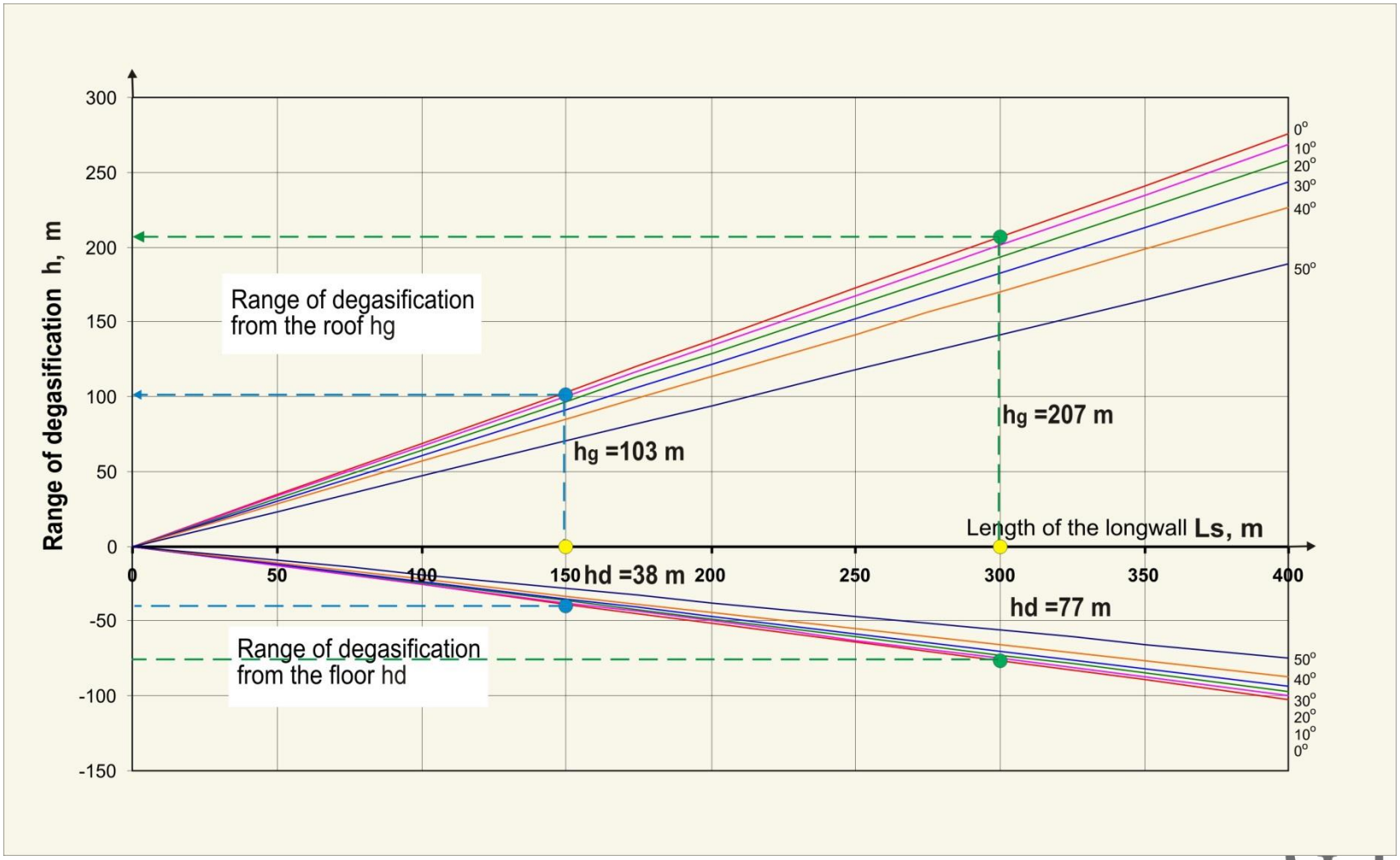
Duration of shearer's mining cycle	Forecasted methane emissions into the environment of longwall during coal extraction (according to pattern 1)
1	2
80 min	V_{CH_4} = 26,25 m^3CH_4/min
100 min	V_{CH_4} = 21,00 m^3CH_4/min
120 min	V_{CH_4} = 17,50 m^3CH_4/min

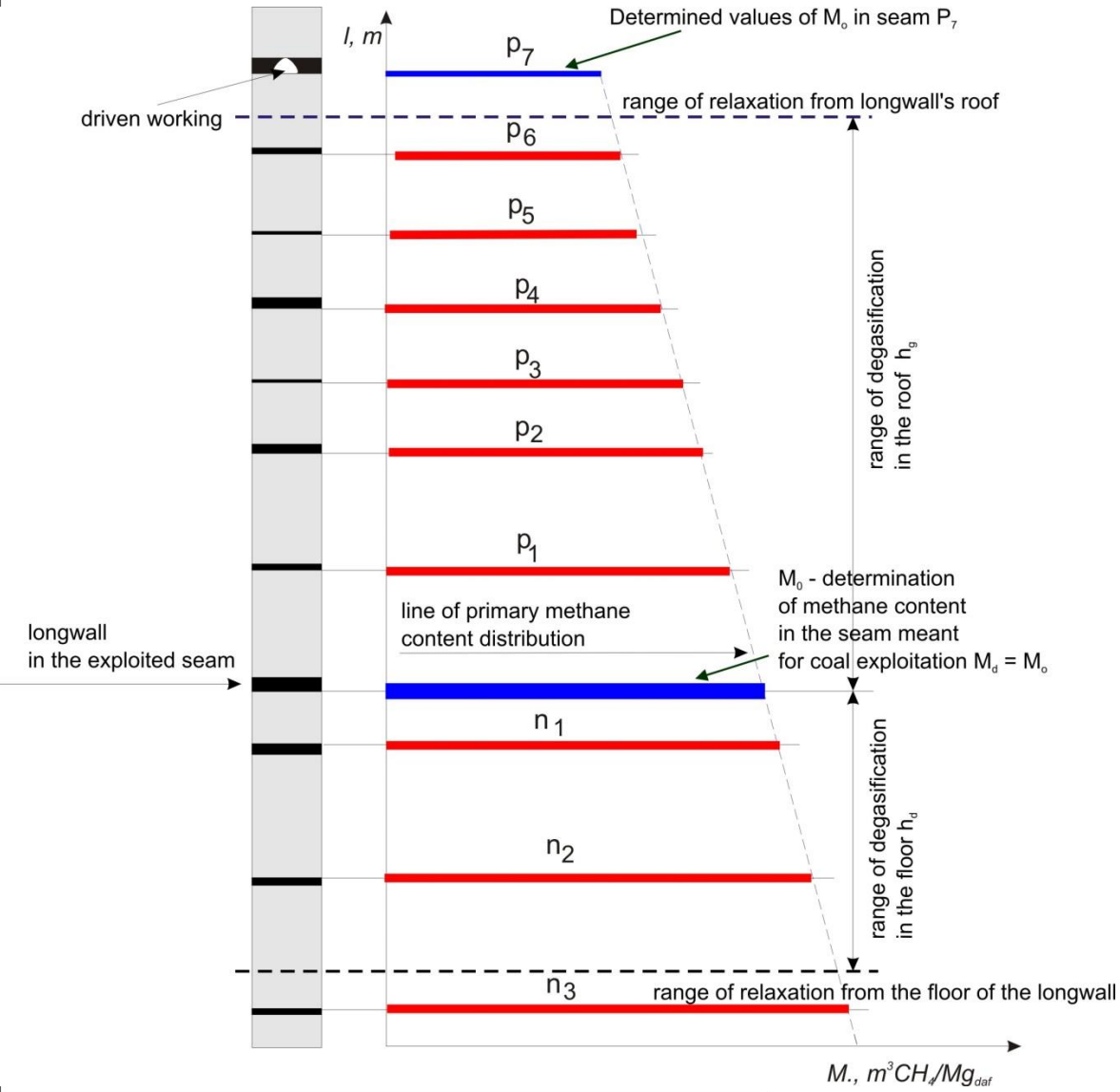
GIG

Vertical cross-section through desorption zones of the longwalls with different lengths



Range of degasification of the overmined and undermined layers depending on longwall's length and its incline (Krause, Łukowicz 2000)





Symulation, Vertical distribution of coal seams' methane content M within the relaxation and degasification zone by operating longwall,

l – distance,

p_1 – p_7 – undermined coal seams,

n_1 i n_3 – overmined coal seams,

Range of degasification:

h_d – in the floor and h_g – in the roof ,

M_0 – determined value of primary methane content in the seams

Methane content values of overmined and undermined coal seams are calculated based on the gradient with 1m change of the depth.

Methane content gradient is calculated based on the pattern (3):

$$g_w = \frac{M_d - M_g}{l_k} \quad , \text{m}^3/\text{Mg}_{csw}/\text{m} \qquad (3)$$

where :

M_g **- primary methane content of the overlying coal seam, m^3/Mg_{daf} ,**

M_d **- primary methane content of the underlying coal seam, m^3/Mg_{daf},**

l_k **- distance between the coal seams is determined based on the difference between their spot heights, m.**

If calculated gradient has positive value it means, that methane content is growing with depth, if it is negative it means that methane content is decreasing with depth. Methane content gradient can be calculated seperately for the overlying or underlying coal seams. Such an attitude is possible due to detailed development of methane content in the parcel of designed coal panel. Primary methane content of each interjacent coal seam can be calculated based on the pattern (4):

$$M_i = g_w \cdot (c_g - c_i) \qquad (4)$$

GIG

Ventilation and methane criteria for designing and conducted longwalls are included in the Regulations for operating the longwalls in the gassy coal seams. Instruction # 17/2004 GIG.

Definition of criteria methane emission (Krause, Łukowicz 2004):

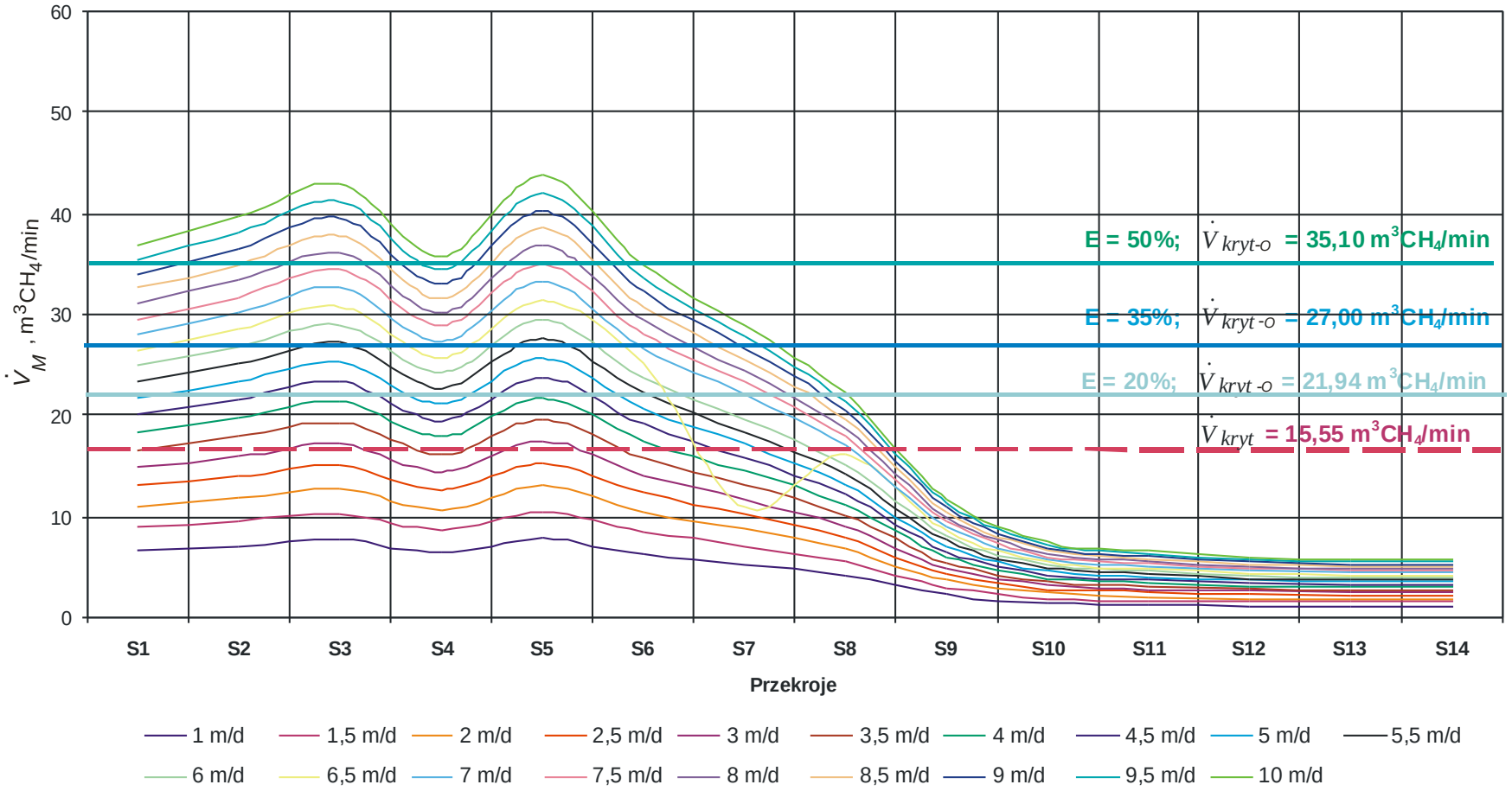
„The criteria methane emission is the absolute methane bearing capacity for which in certain ventilation and methane drainage conditions, in unstable methane emissions, there will not be breaching of admissible methane concentration in the exhaust air stream” .

Value of criteria methane emission is calculated based on the pertterns used for the „U”Type ventilation method and „Y” with refreshing the longwall output.
For the designed coal panels the criteria methane emission is being compared with the forecasting-one.

Calculated value of criteria methane emission :

For designed coal panels must be compared with forecasted absolute methane bearing capacity,
For exploited coal panels must be compared with real absolute methane bearing capacity.

If calculated value of criteria methane emission is smaller than value of forecasted or real methane emission, when assuming daily progress of the longwall, it is necessary then to implement methane drainage or undertake other means, also including reduction of daily progress of the longwall in order to decrease methane emissions into the environment of the exploitation working.



graphical interpretation of the results representing methane bearing capacity of the coal panel 1: V_M - absolute methane bearing capacity S1-S13

GIG

Conclusions

1. Increasing methane saturation of the coal seams along with their depth as well as increase of coal extraction concentration in the mining areas resulted in the increased methane emissions into the environment of exploited coal panels.
2. Dynamic method of absolute methane bearing capacity of the coal panels' forecasting enables calculation of methane emissions with big approximation for te assumed parameters and progress of the longwall. It consitutes input data for the methane and ventilation balance.
3. Forecasting of methane emissions into the environment of longwall from the shearer's coal output, depending on its operational speed allow to design admissible, safe coal output concentration from the longwall after taking into consideration safety regulations.
4. Perfection of applied methods of methane emissions' into environment of the longwall forecasting in the conditions of increasing coal output concentration allows for proper designing the ventilation conditions of the longwall and assuming right prevention in order to provide safety mining conditions.
5. Fulfillment of methane and ventilation criteria at the stage of designing the coal panel is the critical condition to determine both: safe amount of coal output and feasible coal output capacity.

THANK YOU FOR YOUR ATTENTION

Henryk Koptoń hkopton@gig.eu
Central Mining Institute, Poland
Experimental mine „Barbara"
Dept. of Gas Hazard Control