A parametric study of a longwall district climatic prediction and planning model

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Abstract

This paper reports the results of a series of parametric and correlation studies that have been conducted on a longwall coal district climatic prediction planning model developed at the University of Nottingham. The results of these simulation exercises have been correlated against continuously recorded climatic survey data collected from longwall coal districts at two representative deep UK coal mines. The survey data used was continuously measured to record the climate across the longwall districts during both weekday production periods and weekend non-production periods. An analysis of the measured data was able to establish average dry and wet bulb temperatures, which characterised the climate within the workings during weekday production and weekend non-production periods.

To determine the major contribution that the geothermal properties of the surrounding rock mass have on the heat transfer to the ventilating air stream, as series of climatic simulation and correlation exercises were conducted to establish base data set for these parameters during non-production periods.

A second series of parametric and correlation exercises were conducted on the longwall climatic simulation model to identify the range of values to be taken by the parameters governing the contribution of heat transfer from the installed electrical machinery and cut mineral during the week day production periods.

It is concluded that these exercises were able to identify s base set of values for the model input parameters that enabled the longwall climatic models to satisfactorily replicate the climatic conditions experienced across two representative UK deep mine longwall districts during production and non-production periods.

Key Words: Mine climate, longwall coal mining, climatic modelling

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1 Introduction

A longwall district climatic prediction and planning model has been developed to predict heat and mass transfer across UK deep longwall coal districts. A series of parametric modelling exercises have been undertaken to study the influence that the main input and computational parameters of the model have on the predicted climatic conditions. The results of these simulation exercises have been compared against a series of manual and continuously recorded climatic surveys conducted across two representative UK Coal Ltd longwall coal districts. The intrinsically safe (IS) psychrometric transducers measured and digitally recorded via data loggers, the variation in the dry bulb temperature and humidity at regular 10-minute time intervals over a 10 day period at each survey station [1]. The results of these surveys have been analysed to produce average values of both dry and wet bulb temperatures that are representative of weekday production and weekend non-production periods.
The longwall district climatic model developed at the University of Nottingham may be configured to model either an advance or retreat longwall district. The primary default models, consider only conventional single intake and return roadway configurations, ventilated by a conventional U-type ventilation layouts that are currently predominantly employed within UK deep coal mines However, these base models may be simply adapted to consider multi-entry longwall configurations. The longwall district model was constructed by a combination of two through-flow roadway climatic models and a dedicated longwall face climatic model. The roadway climatic model built upon the results of earlier research [2,3,4] and the face climatic model previously developed at the University of Nottingham [5,6].

The sensitivity exercises conducted have been divided into three major stages:

(1) The validation of the results produced by the single roadway model using continuously recorded climatic survey data obtained from two high production retreating longwall districts at UK Coal Ltd collieries during weekend non-production periods.

The objectives of this exercise are to determine the baseline input data of parameters, such as the rock thermal conductivity and diffusivity, the wetness factor of the roadway and the age of the roadways, by conducting correlation exercises against the logged data when there was no additional production related heat sources present.

(2) The validation of the results produced by single roadway model using the climatic survey data obtained from two high production retreating longwall districts at UK Coal Ltd collieries during weekday production periods.

Following an analysis of the results of the model simulations in the main gate during the weekend non-production period, the focus of the research shifted to conduct parametric model studies to identify the influence of the additional heat sources introduced during a production weekday period. Within the main gate the two major additional heat sources identified were the electrical machinery and the newly cut mineral on the conveyor belt.

(3) The validation of the results produced by the longwall district climatic model using the climatic survey data collected from two high production retreat longwall districts within UK Coal Ltd collieries during the non-production weekend and the weekday production periods.

2 Continuously recorded climatic conditions within a longwall district

Comprehensive climatic surveys were conducted using psychrometric transducers and data loggers to collect a continuous climatic record from a number of longwall districts at UK Coal Ltd. The loggers recorded simultaneously the changes of the dry bulb temperature and the relative humidity over a long period that covered both the production weekday period and a non-production weekend period. The changes and variations in dry bulb temperature and humidity at regular 10-minute time intervals were digitally recorded over a typical ten day period. A schematic of the generic location of the climatic survey stations across a retreat longwall coal district are shown on Figure 1.

In addition to the collection of the continuous climatic records, a number of consecutive manual climatic surveys were undertaken at these locations to confirm the continuously measured the dry and wet bulb temperatures and airflow quantities.

3 The validation of the single roadway main gate model simulations using the climatic survey data recorded in the weekend period

The continuously logged climatic data at the logger locations A and B within the main gate of the longwall coal districts were used to validate the developed single roadway model. During the weekend non-production period the surrounding rock mass was identified as being the predominant heat source. The climatic data collected during this period was employed to evaluate the heat and mass transfers present in a main gate during a weekend period. The heat and mass transfer between the surrounding rocks and the ventilating air stream were primarily influenced by the virgin strata temperature (VST), the wetness of the rock surface, and the rock thermal properties. The continuously logged climatic data recorded over a weekend period makes it possible to determine the input variables of the rock thermal conductivity and diffusivity, the wetness factor and the age of the roadway by conducting a correlation of the simulations with the surveyed climatic data.

3.1 Main gate roadway climatic simulation using base-case input data

The roadway climate model was first applied to the simulation of the main gate (M/G) of T08s longwall district at Maltby colliery, Nottinghamshire. The initial input parameter values were based upon information supplied by the colliery ventilation staff and those available from the literature. This set of parameter values was termed as the base-case input data. The values of the surrounding rock thermal conductivity and diffusivity abstracted from the literature [6,7] that define the ability of a rock to transmit heat, are listed in Table 1. [*A detailed listing of all of the parameter set values will be given in Appendix 1 on* a designated webpage of www.nottingham.ac.uk]

A schematic plan of the T08s longwall district and a cross-section plan of its main gate are shown in Figures 2 and 3, respectively.

Figure 4 illustrates a plot of the predicted and measured dry and wet bulb temperatures and the measured dry and wet bulb temperatures at the inbye measurement location (B) within the M/G.

From an analysis of the results produced by the initial trial simulation using the base-case input data, it may be concluded that the predicted dry and wet bulb temperatures at the inbye measurement station within the M/G did not satisfactorily replicate those measured. The predicted dry bulb temperature was 7.3 °C less the logged one and the wet bulb temperature was 3.2 °C less than the recorded value.

Consequently, it was decided to conduct a serious of sensitivity studies on the following model parameters, (i) the rock conductivity; (ii) the (VST);(iii) the wetness factor of airway, (iv) the age of the roadway, to determine the influence of these factors on the predicted climatic conditions.

3.2 The results of the sensitivity studies

3.2.1 VST against the age of the roadway

The virgin strata temperature (VST) is determined by the geothermal properties of the rock and the surrounding geological structure and the VST value can be established from in situ geothermal measurements. The age of the roadway is an important factor in determining the heat flow between the surrounding rock and the air stream. It is recognised that a freshly cut mass of rock emits greater heat as the maximum potential temperature difference between the rock mass and the ventilating airflow exists at this point, with the flow of heat decreasing as the age of exposure of the rock increases [3].

A number of model simulation runs were conducted using a combination of a range of different input values for the VST and the age of the roadway. The values of the other input parameters were maintained as constant values as defined in the base-case input data set. The resultant predicted dry/wet bulb temperatures at the inbye main gate for these exercises are summarised in Table 2.

3.2.2 The rock conductivity against the age of the roadway

A number of model simulations were conducted employing various combinations of values for the rock conductivity and the age of the roadway. The values of the other input parameters were maintained as constant values as defined in the base-case input data set. The predicted dry and wet bulb temperatures at the inbye main gate are summarised in Table 4.

From an analysis of the simulation results presented in Tables 2 and 3, it is noticeable that among the three parameters studied, the variation in the rock conductivity value produced the biggest change in the heat exchange predicted. The age of the roadway parameter produced a reasonable but less significant influence on the climate simulated.

It was decided to carry out further sensitivity studies using the measured VST value of 41 °C and the actual values of the age of the roadway of 38/14 months. These analyses focused on a study of the effect produced on the predicted temperatures due to variations in the parameters of rock conductivity, rock diffusivity and the wetness factor of airway.

3.3 Sensitivity studies on the parameters of the conductivity, the diffusivity and the wetness factor

3.3.1 The rock conductivity against the rock diffusivity

Further model simulations conducted employing various combinations of the different values for the rock conductivity and the rock diffusivity. The values of other input parameters remained same as the base-case input data. The resultant predicted dry/wet bulb temperatures at the inbye M/G station are summarised in Table 4.

An analysis of the results presented in Table 4 concluded that the combination of a rock conductivity value of 12.0 (W/m°C) and a rock diffusivity value of 0.25 (m^2/sec × 10 $^{-6}$) produced the inbye predicted temperature values that were closest to those measured.

3.3.2 The rock conductivity against the wetness factor

The wetness factor is defined as the ratio of the total rock surface area that is wet. This is an important factor in determining the transfer of the strata heat from the rock to the air stream by convection and by the latent heat of evaporation. It is a dimensionless parameter ranging from 0 (dry) to 1 (wet).

A number of simulations have been completed with the combination of the different values of the rock conductivity and the wetness factor. The values of other input parameters remained same as the base-case input data. The predicted dry/wet bulb temperatures at the inbye location main gate are summarised in Table 5.

From an analysis of the results presented on Table 5 above, it may be concluded that the wetness factor of roadway has a major influence on the predicted inbye dry bulb temperature. It is clearly observed that the predicted dry bulb temperature effectively decreases as the value of the wetness factor increases. This indicates a loss in sensible heat from the air stream would is consumed in the evaporation process.

3.4 Major conclusions from the parametric studies conducted

From an analysis of the above sensitivity studies, the parameters of the rock conductivity, the rock diffusivity, VST, and the wetness factor of were observed to be important factors to the predicted temperatures as ventilation air travelled along the length of the main gate. The parameter of the age of the roadway produced a reasonable influence on the climatic simulation results.

The analysis found that a combination of a value of the rock conductivity of 12.0 W/m°C, a value of the rock diffusivity of 0.25 (m^2/sec × 10^{-6}) and a value of the wetness factor of 0.05 produced predicted temperature values that were closest to those measured. It is noted that the determined rock conductivity value was 6 times higher than the weighted-average of the actual in situ rock values of 2.0 W/m°C, and the determined rock diffusivity was lower than the weighted-average of the in situ rock value of 1.17 m^2/sec × 10^{-6}.

Figure 5 shows a plot of the logged and predicted dry/wet bulb temperatures when using the determined parameter values of the rock conductivity of 12.0

W/m°C, the rock diffusivity of 0.25 (m^2/sec × 10^{-6}), the wetness factor of 0.05, and the remaining parameters of the base-case input data.

3.5 *The model simulation using the determined parameters to the Tail gate of T08s Longwall District, Maltby Colliery*

3.5.1 Tail gate roadway model simulation using the base-case input data

The following section details the results of similar parametric studies conducted on a roadway climate model of the tail gate (T/G) of T08s longwall district over the weekend period, using the base-case input data. [*The details of the parameter input data values of the base-case are given in Appendix 2 on a designated webpage on site* *www.nottingham.ac.uk*] The predicted and the measured dry and wet bulb temperatures at the outbye location of the T/G are plotted in Figure 6.

It can be seen from Figure 6 that the predicted dry bulb temperature at the outbye location of the T/G was not close to the measured value but the predicted wet bulb temperature was close to the measured value.

3.5.2 Tail gate roadway model simulation using the determined parameter input data set

This simulation was conducted using the combination of the value of the rock conductivity of 12.0 W/m°C, the value of the rock diffusivity of 0.25 m^2/sec × 10^{-6} and the value of the wetness factor of 0.05 derived from the M/G validation study reported above. Figure 7 illustrates a plot of the measured and predicted dry and wet bulb temperature profiles.

It was concluded from an examination of the results presented on Figure 7 that both the predicted dry and wet bulb temperatures at the outbye measurement station of the T/G were very close to those measured (within ± 1°C).

4 The M/G roadway climatic simulation and validation during a weekday production period

During a weekday production period additional heat sources are present and consequently potentially more heat exchanges between the airstream during the weekday production period. The two major additional heat sources identified were the electrical machinery and the newly cut minerals on the conveyor belt.

4.1 The roadway model validation during a production period at the main gate of T08s longwall district of Maltby colliery

An examination of the equipment layout within the M/G of T08s longwall district revealed that there was only one unit of the electrical machinery (dinter) located between the logging location A and B, Figure 8. Other M/G electrical equipment, such as the conveyor belt drive, the stage loader and crusher motors were sited out with the surveyed region. It was therefore concluded, that during the production periods the temperature increases recorded between measurement stations A and B would be predominantly due to the heat transfers between the ventilating air stream and the newly cut mineral on the conveyor belt.

A comparison of the temperature increases experienced between measurement stations A and B between the weekend and weekday production periods, would allow the contribution of the heat load added by the conveyed mineral to be quantified. Furthermore, the results from this analysis could be used to validate the heat and mass transfer calculation model of the conveyed minerals encoded within the single roadway climatic computer program.

The single roadway model climate simulations during the production period were undertaken using a range of representative input parameter values for the thermal conductivity of the mineral on the belt, the surface wetness factor of the mineral on the belt and the height of the mineral load on the belt.

4.1.1 Sensitivity study of the conductivity and the wetness factor of the conveyed minerals

A base-case input data of input parameters was firstly constructed for the sensitivity study. [*The details of the base-case input values can be found in Appendix 3 on a designated webpage on site* www.nottingham.ac.uk]

A number of simulations were then conducted using combinations of different representative values of the parameters to represent the conductivity, the surface wetness of the conveyed minerals.

The range of the predicted dry and wet bulb temperatures at the inbye measurement location (B) within the main gate are summarised in Table 6.

An analysis of this data concluded that variations in both the conductivity and surface wetness factor of the conveyed mineral produced large effects on the heat exchange experienced between the ventilating air stream and the surface of the mineral. From a detailed examination of the data presented on Table 6 it is concluded that a combination of a conductivity of 0.35 W/m°C and a wetness factor of 0.4 produced predicted temperatures at the inbye location of the main gate, which were very close to the logged values. The measured dry bulb temperature at the inbye location of the main gate was 33.4°C and the measured wet bulb temperature was 26.1°C.

4.1.2 Parametric studies on the conveyed mineral height

Within the roadway climate model, the conveyed mineral sub-model represents the mineral on the belt as a continuous plane parallel slab, and that the thermal properties and geometrical shape of it remains uniform along the length of the belt. The sensible, latent and radiative heat transfers between the mineral and the air stream are assumed to be controlled by; the time elapsed since the mineral was cut from the face, the relative velocity existing between the air and the mineral, and the projected height of the mineral slab above the conveyor.

A series of climatic simulations were subsequently conducted using a range of representative values of the conveyed mineral height. The conductivity and the wetness of the conveyed minerals were set as 0.35 W/m°C and 0.4, respectively. The values of other remaining input parameters were same as the base-case input data.

The predicted dry and wet bulb temperatures at the inbye measurement station within the M/G are summarised in Table 7.

It can be seen from Table 7 that the conveyed mineral height has a minor influence on the predicted temperatures. It was concluded from a combination of practical observations and the results of the numerical simulations performed that a conveyed mineral height of 200 mm would be employed in future simulations.

In conclusion, the above parametric studies found that the single roadway climatic model was able to satisfactorily predict the climatic conditions within the, provided: (1) the conveyed mineral conductivity = 0.35 W/m°C; (2) the conveyed mineral rock diffusivity $=0.25 \times 10^{-6}$ m^2/sec; (3) the conveyed mineral wetness factor = 0.4; and (4) the conveyed mineral height = 200 mm. The simulation results of using this combination are shown on Figure 9.

5 The validation of longwall district climatic model using the climatic survey data obtained in the production period

The parametric data set established from the sensitivity analyses reported above, were used to conduct a series of correlation exercises were conducted on the district climatic model using the climatic data measured over the weekdat production periods. An analysis of the results from these exercises would determine the range of the various input parameter values.

5.1 The district model simulation in the production period at T08s longwall district of Maltby colliery

The predicted and the measured dry and wet bulb temperatures across the longwall district are given on Table 8 and are plotted in Figure 10. [*The details of the base-case input parameter set determined for the district model may be found in Appendix 4 on a designated webpage on* site www.nottingham.ac.uk]

It can be seen from Figure 10 that the predicted dry bulb temperature at the face outlet was 1.4 °C less than the measured data and the predicted wet bulb temperature at the face outlet was 2.6 °C less than the measured data. The predicted dry bulb temperature at the outbye location of the tail gate was 0.1 °C more than the measured data and the predicted wet bulb temperature at the outbye location of the tail gate was 1.4 °C less than the measured data.

A series of parametric studies were conducted using the longwall climatic model by varying the value electrical equipment utilization factor; 5% (the base-case), 10%, 15% and 20%.

The simulation results of the predicted and the logged dry and wet bulb temperatures for an electrical equipment utilization factor of 20% are plotted on Figure 11.

It can be seen from a comparison of the data presented on Figures 15 & 16 that the district climatic model more accurately predicted the dry and wet bulb temperatures across the whole longwall district when using an electrical equipment utilisation factor 0f 20% rather than 5%.

6 The climatic simulation of 312s Longwall District, Welbeck Colliery

6.1 The climatic simulation of the main gate of 312s Longwall District, Welbeck Colliery

To confirm the general applicability of the results of the parametric analysis performed for Maltby colliery, a second series of climatic simulation exercises were performed using the single roadway model to the gate roads of a longwall coal face at a second colliery, Welbeck colliery, UK Coal Ltd. The rock mass surrounding the main gate of 312s longwall district had an in situ measured VST of 33.3 °C. A schematic plan of the 312s longwall district and a cross-section plan of its main gate are shown in Figures 12 and 13, respectively.

6.1.1 M/G Roadway climatic model simulation for the weekend non-production period

The roadway model simulation of the main gate of 312s longwall district during a non-production weekend period was first conducted using an equivalent base-case input data set determined from the literature. The rock conductivity and diffusivity values used are listed in Table 9. [*The detail of the base case input data set may be found in Appendix 5 on a designated webpage of site* www.nottingham.ac.uk]

The measured and predicted dry/wet bulb temperatures at the inbye location of the main gate of 312s longwall district are plotted on Figure 14.

From an analysis of the data presented on Figure 14 it was concluded that both the predicted dry and wet bulb temperatures at the inbye location of the main gate were not close to those measured. The predicted dry bulb temperature was 8.4 °C less the logged one and the wet bulb temperature was 3.5 °C less than the recorded value.

6.1.2 M/G roadway model simulation using the determined parameter input data set

A simulation was conducted using the combination of parameter values determined for Maltby colliery T08s longwall; rock conductivity of 12.0 W/m°C, the rock diffusivity of 0.25 $m^2/sec \times 10^{-6}$ and a wetness factor of 0.05. The resultant predicted and the measured dry and wet bulb temperatures, which are plotted on Figure 15.

It can be seen from Figure 15 that the predicted wet bulb temperature at the inbye location of the main gate was in line with the measured one and the predicted dry bulb temperature was very close to the measured ones.

The analysis concluded that the roadway model could satisfactorily predict and simulate the climatic conditions during the weekend period by using the observed parameter values of the rock conductivity of 12.0 W/m°C, the value of the rock diffusivity of 0.25 ($m^2/sec \times 10^{-6}$), the value of the wetness factor of 0.05 and the other base–case parameter values. It was further concluded that the single roadway climate model may be applied for different inlet climatic situations of either with higher or lower dry and bulb temperatures and also be applied to the roadways having different VST values (33.3 °C or 41 °C).

6.1.3 The validation of the roadway climatic model for 312s M/G during a weekday production period

It was decided to carry out the further exercise to the single roadway model during the production period using the determined parameters of the conveyed minerals to Welbeck colliery. The main gate of the 312s longwall district of Welbeck colliery had different geothermal properties of the rock comparing to the Maltby geothermal properties. The surrounding rock of the main gate of 312s longwall district had a measured VST of 33.3 °C.

The measured and predicted dry and wet bulb temperatures at the inbye location of the main gate are plotted on Figure 16.

It can be seen from Figure 16 that the predicted wet bulb temperature at the inbye location of the 312s M/G during the production period was very close to the measured value. However, the predicted dry bulb temperature was 2.3 °C less than the measured value.

A comparative analysis of the climatic simulation results derived for the two from colliery longwalls, concluded that the roadway climatic model was able to adequately simulate the climatic conditions during production periods when the parameter sets derived for the Maltby colliery longwall were employed.

6.2 The district climatic simulation for 312s longwall district of Welbeck colliery during a production period

A further series of climatic simulation exercises were conducted for 312s lonqwall district, Welbeck colliery. [*The details of the input data values of the parameters for the district model at 312s longwall district are listed in Appendix 6 on a designated webpage on site* www.nottingham.ac.uk] The results of the surveyed and predicted dry and wet bulb temperatures are plotted on Figure 17.

It can be seen from Figure 17 that the predicted wet bulb temperature closely mirrors that measured across the whole district. However, the predicted dry bulb temperature at inbye M/G measurement station was 1.9 °C less than that measured. The district climatic model predicts that the dry bulb would decrease as the air travels along the T/G. However, the manual climatic survey indicted that there was a dry bulb temperature increase in the ventilating air flowed outbye along the T/G. It was concluded that this manual survey measurement may have been made in an unrepresentative roadway location

7 Conclusions

The sensitivity exercises for the single roadway model and the district model demonstrated the significance of certain parameters, their impact on the prediction results of the ventilation air stream across a longwall district under varies climatic and geothermal conditions.

The single roadway climatic model was examined and analysed by using the climatic survey data obtained from two high production retreating longwall districts at UK Coal Ltd collieries during the weekend period. The parameters of the thermal conductivity, wetness factor, and ages of the roadway were studied.

The analysis found that a combination of a value of the rock conductivity of 12.0 W/m°C, a value of the rock diffusivity of 0.25 ($m^2/sec \times 10^{-6}$) and a value of the wetness factor of 0.05 might produce the predicted temperature results that were close to the logged ones during the weekend period. The single roadway model may not only be applied to different inlet climatic situations of either with higher dry/bulb temperatures (34.4°C/24.3°C) or with lower dry/bulb temperatures (24.8°C/15.3°C) and but also may be applied to the roadway having different geothermal properties of VST values (33.3 °C or 41 °C).

Sensitivity studies on the roadway model simulations during the production weekday period were conducted. The analysis of the simulation results from two collieries found that the roadway model may predict the climatic conditions that were close to the measured data by using the values of the selected parameters of: (1) the conveyed mineral conductivity of 0.35 W/m°C; (2) the conveyed mineral rock diffusivity =0.25 $\times 10^{-6}$ m^2/sec; (3) the conveyed mineral wetness factor of 0.4; and (4) the conveyed mineral height of 200 mm. The model may be applied to different inlet climatic situations from two collieries and can be applied to the roadway having different geothermal properties of VST values (33.3 °C or 41 °C).

Built upon the establishment from the sensitivity analyses of the roadway climatic model during both the weekend period and the production period, sensitivity exercises of the district model demonstrated that the model might predict dry and wet bulb temperatures that were close to the measured one across the longwall district when using 20% of the electrical equipment utilization factor.

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Figures

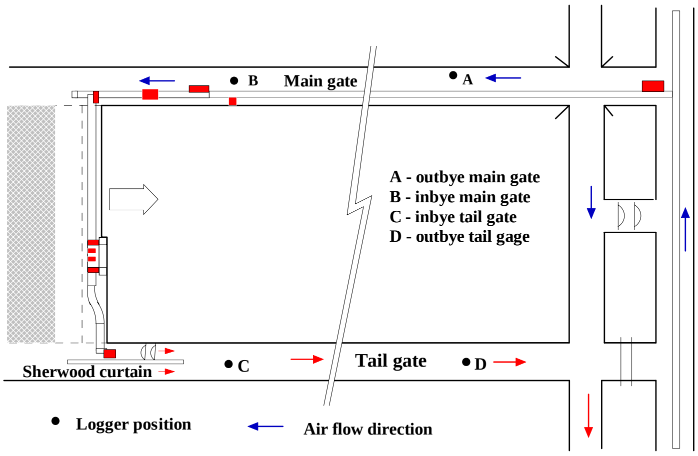

Figure 1 Generic location of climatic survey station on a schematic plan of a conventional retreat longwall coal district

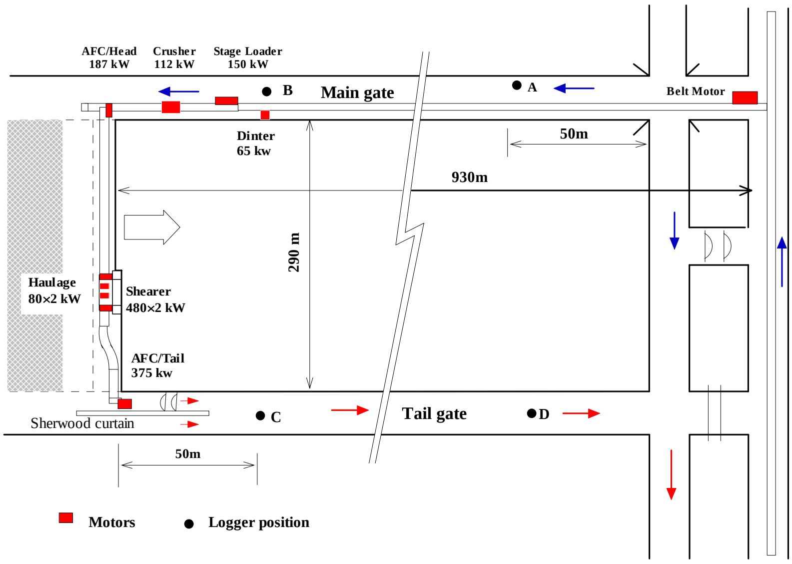

Figure 2 Schematic layout plan of T08s longwall district, Maltby colliery

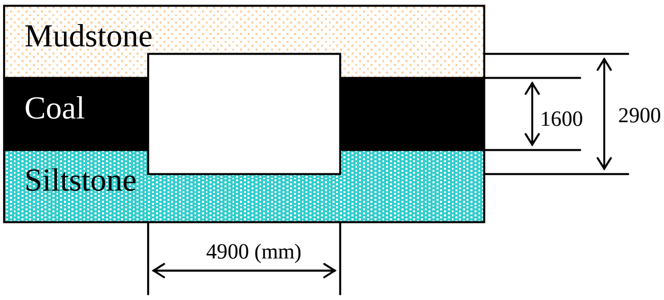

Figure 3 The M/G roadway section profile of T08s longwall district, Maltby colliery

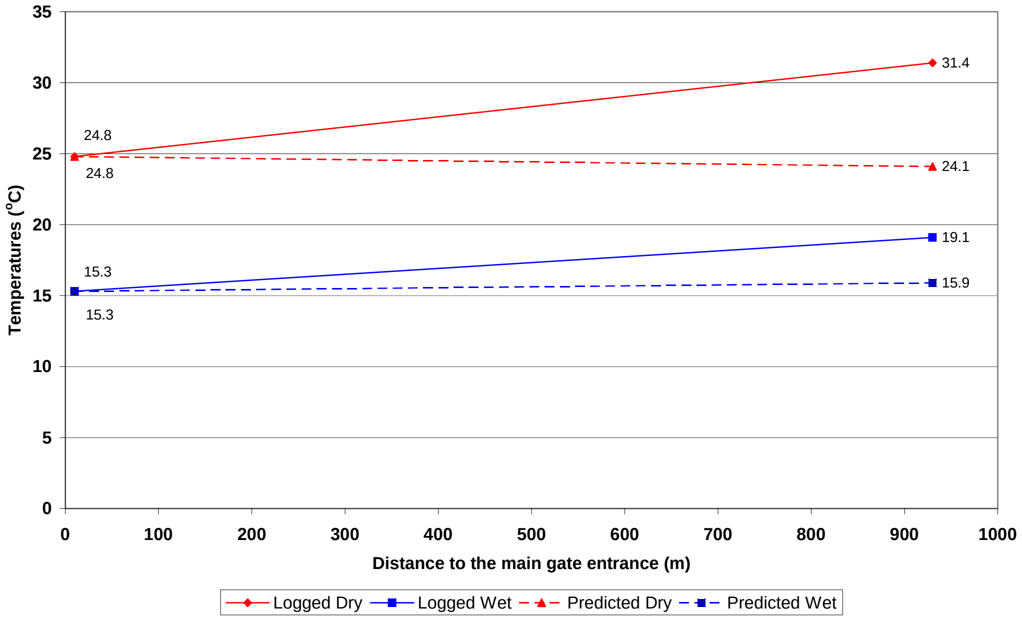

Figure 4 The measured and predicted temperature profiles along the M/G roadway using the baseline data set.

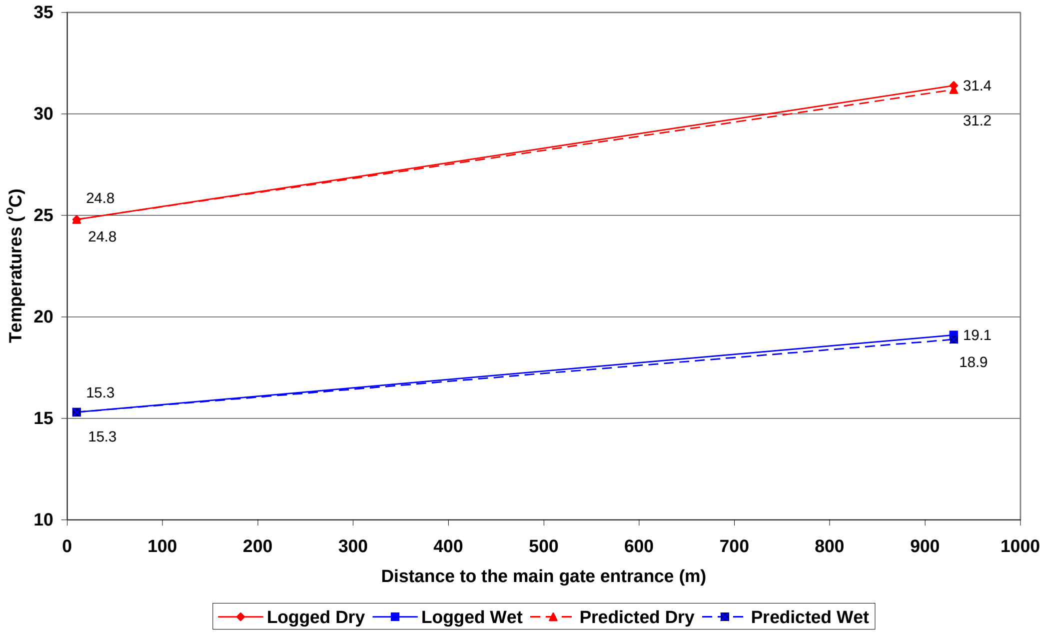

Figure 5 The measured and predicted temperature profiles along the M/G roadway

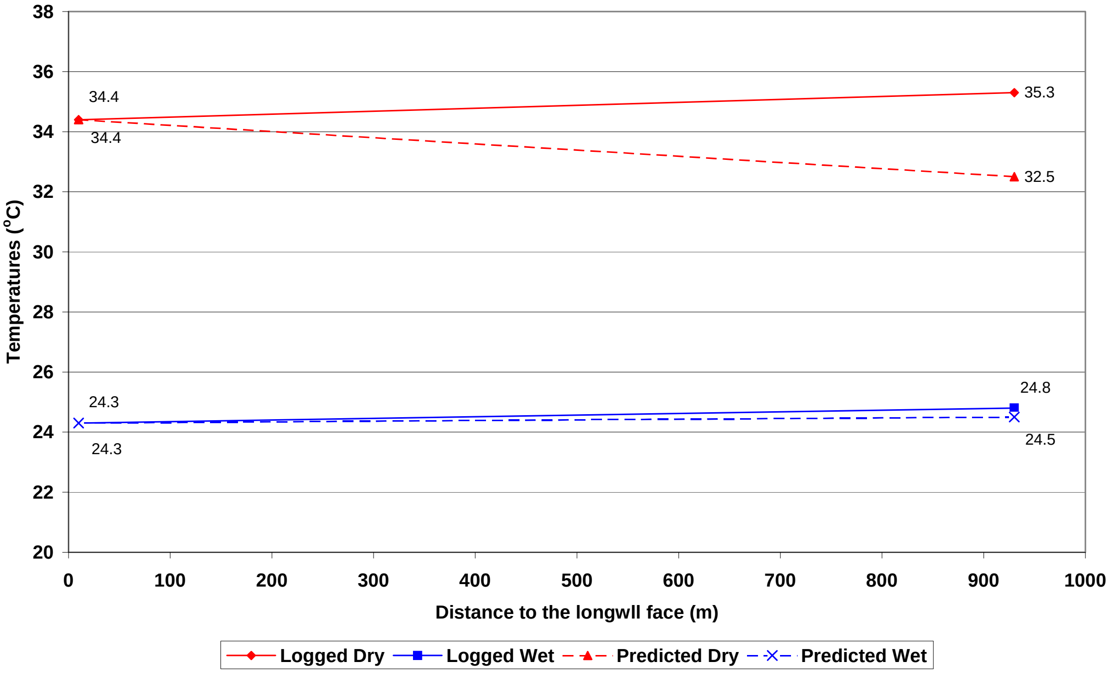

Figure 6 The measured and the predicted temperature profiles along the tail gate roadway

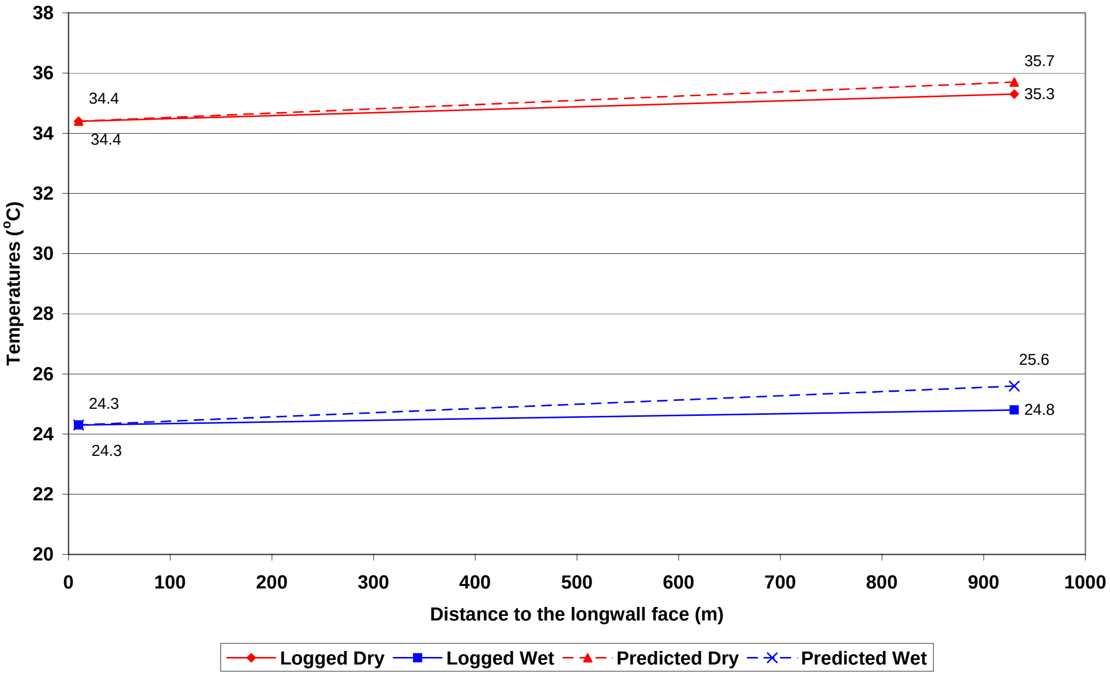

Figure 7 The measured and predicted temperature profiles

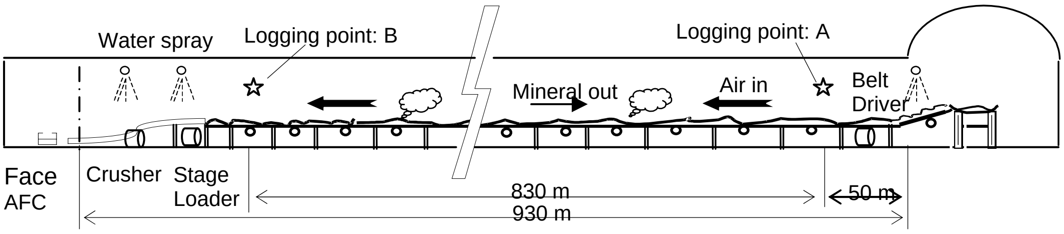

Figure 8 Schematic layout of T08s M/G roadway

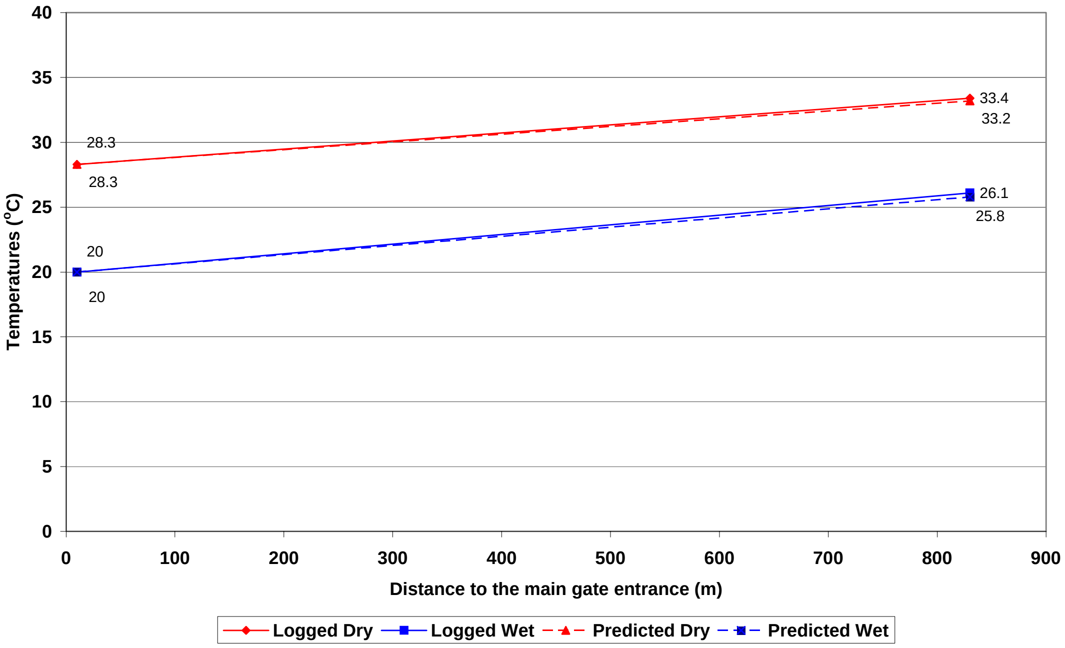

Figure 9 The measured and predicted temperature profiles in the M/G roadway during the production period

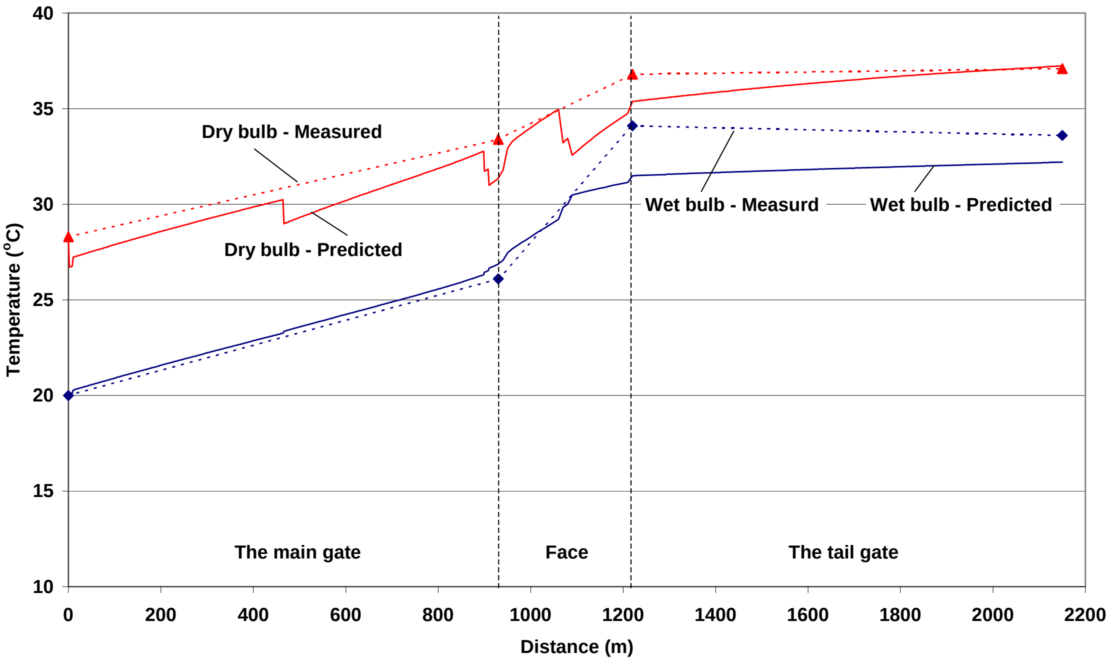

Figure 10 The predicted and the measured dry and wet bulb temperatures across the district during a weekday production period

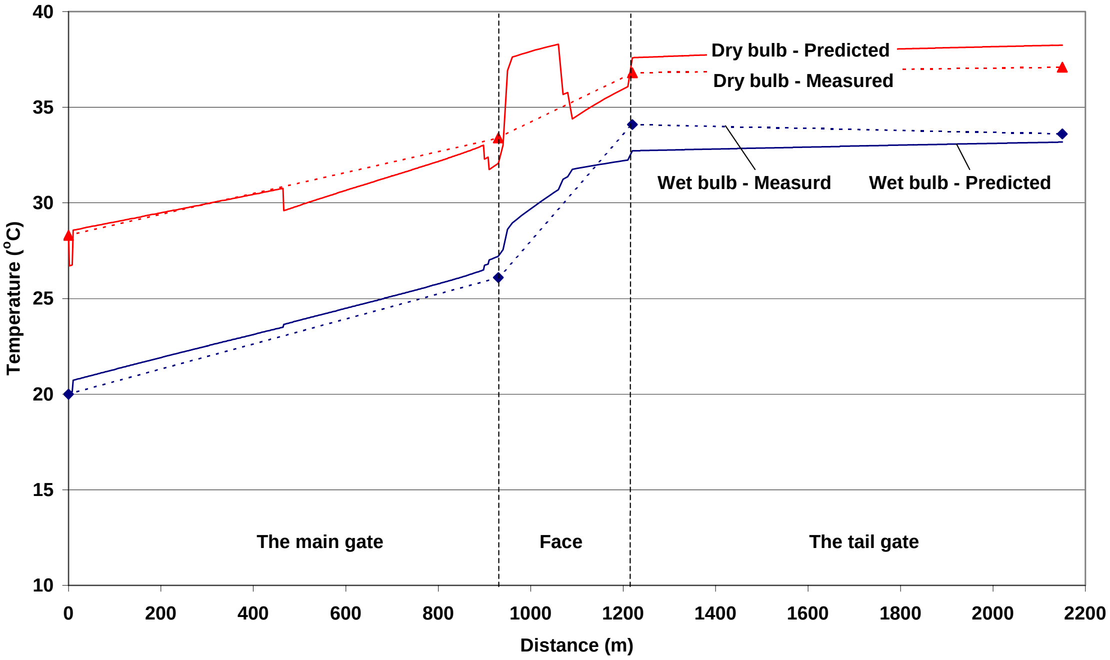

Figure 11 The predicted and the measured dry and wet bulb temperatures across the longwall district

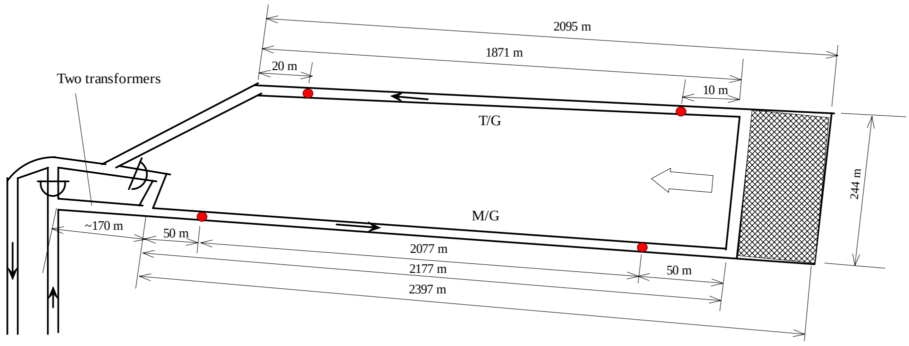

Figure 12 Schematic of the layout of 312s longwall district, Welbeck colliery

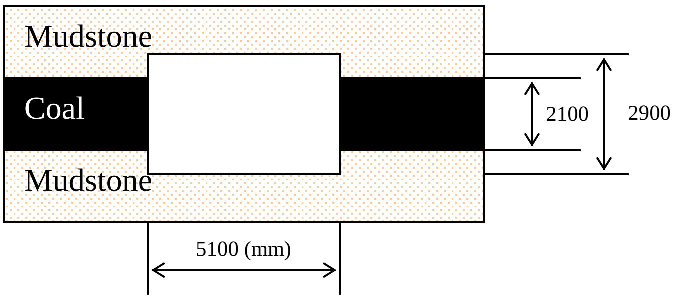

Figure 13 The main gate roadway section profile or 312s gate roads, Welbeck colliery

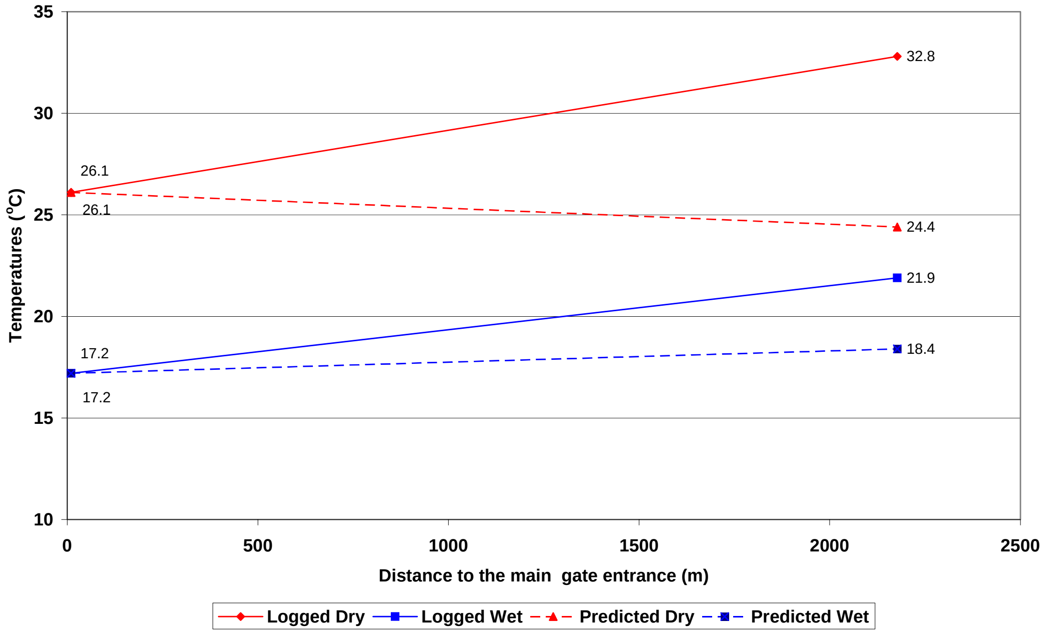

Figure 14 The measured and predicted temperature profiles along 312s main gate roadway

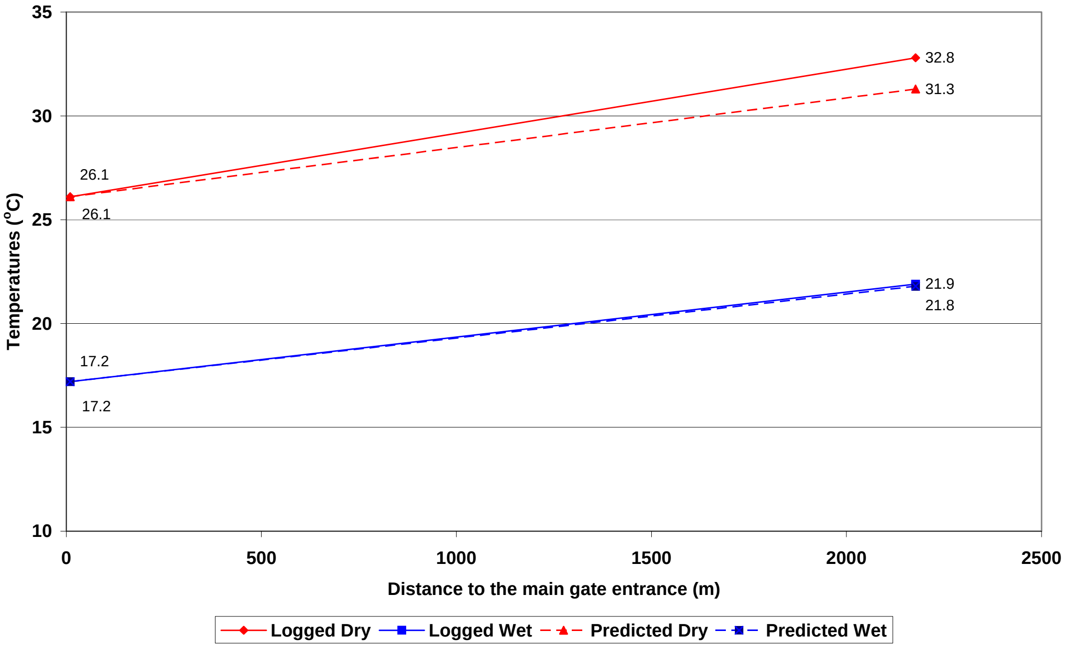

Figure 15 The measured and predicted temperatures profiles along 312s M/G roadway.

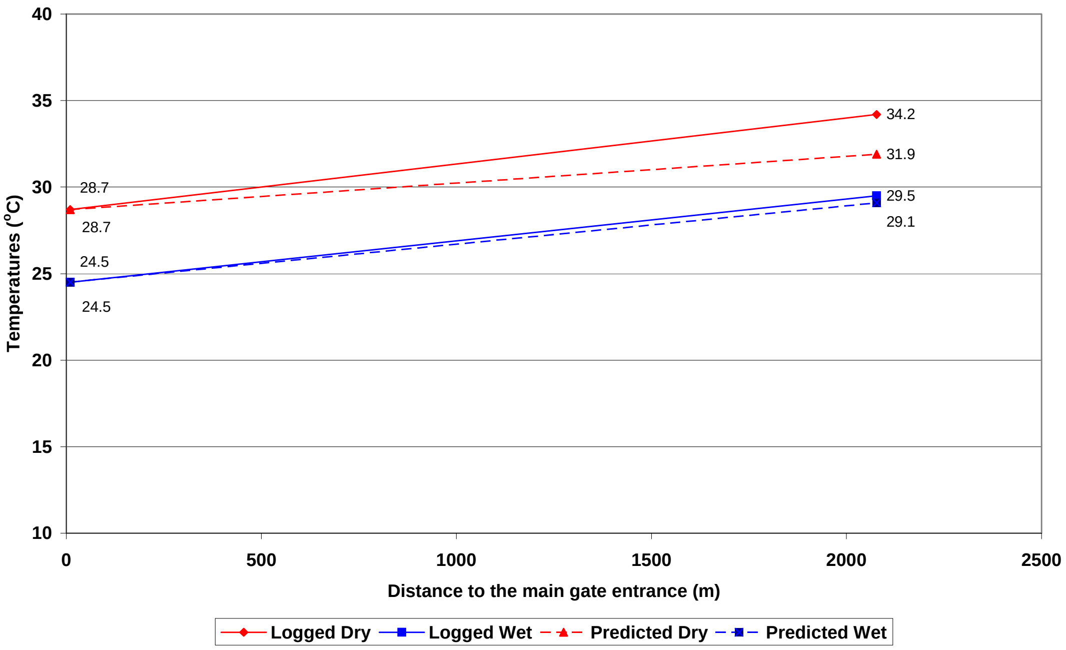

Figure 16 The predicted and the measured dry and wet bulb temperature profiles along 312s M/G roadway

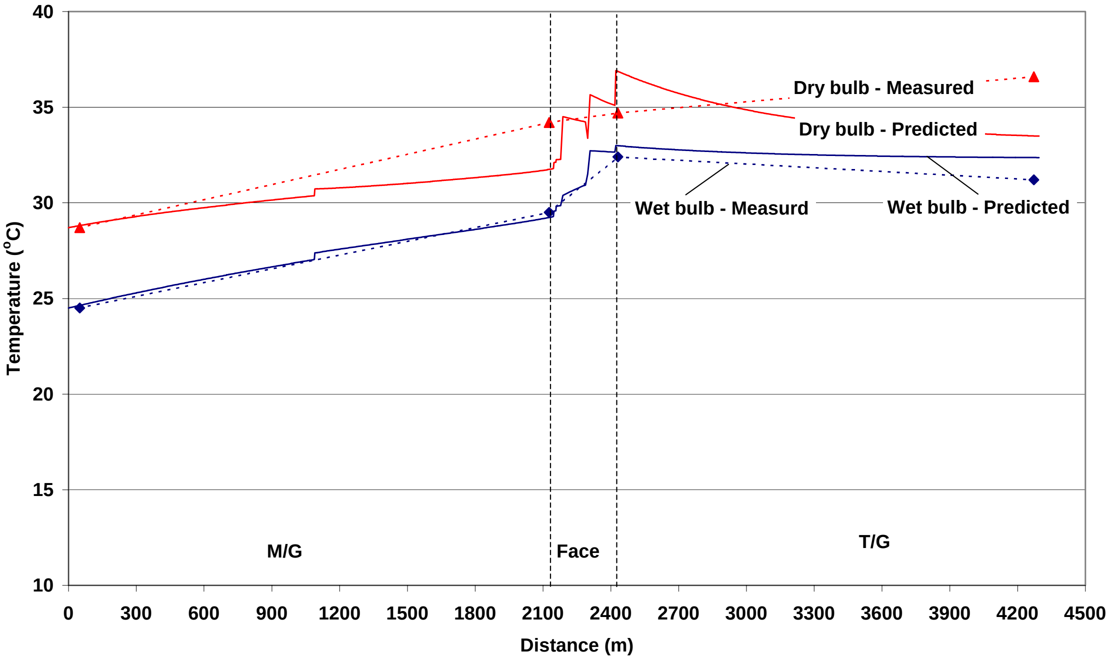

Figure 17 The measured and predicted temperature profiles across 312s longwall district during a production period

Tables

Table 1 The base-line rock conductivity and diffusivity values used in the climate prediction program [5,7]

Description	Thermal Conductivity W/m°C	Thermal Diffusivity $m^2/sec \times 10^{-6}$
Coal	0.35	0.25#
Mudstone	2.24	1.39
Siltstone	2.56*	1.39

* A value for sandy shale.

\# After Tuck (1986).

Table 2 The predicted dry and wet bulb temperature at the inbye M/G measurement station using combinations of different values for the VST and age of the roadway

Age of outbye station (A)/ Age of the inbye station (B) (months)	VST			
	41.0 (°C)		60.0 (°C)	
	Dry bulb temperature (°C)	Wet bulb temperature (°C)	Dry bulb temperature (°C)	Wet bulb temperature (°C)
8/1	25.1	16.3	27.7	17.4
22/1	24.6	16.1	26.7	17.0
43.5/22.5	24.1	15.9	25.7	16.6
100/79	23.8	15.8	25.2	16.4

Table 3 The predicted dry and wet bulb temperature at the inbye M/G measurement station using combinations of different values for the rock conductivity and the age of the roadway

Age of outbye main gate/ Age of the inbye main gate (months)	Conductivity (W/m°C)			
	4.0		8.0	
	Dry bulb (°C)	Wet bulb (°C)	Dry bulb (°C)	Wet bulb (°C)
8/1	27.1	17.2	30.1	18.5
22/1	26.3	16.9	29.0	18.0
43.5/22.5	25.4	16.5	27.6	17.4
100/79	24.9	16.3	26.8	17.1

Table 4 The predicted dry/wet bulb temperature at the inbye M/G measurement station using combinations of different values for the rock conductivity and diffusivity

Conductivity (W/m°C)	Rock diffusivity ($m^2/sec \times 10^{-6}$)					
	0.25 (coal)		4.0		8.0	
	Dry bulb (°C)	Wet bulb (°C)	Dry bulb (°C)	Wet bulb (°C)	Dry bulb (°C)	Wet bulb (°C)
2	24.7	16.2	23.8	15.8	23.7	15.7
4	26.4	16.9	24.9	16.3	24.6	16.2
6	27.9	17.6	25.8	16.7	25.5	16.5
8	29.2	18.1	26.7	17.0	26.3	16.9
10	30.3	18.6	27.5	17.4	27.1	17.2
12	31.2	18.9	28.3	17.7	27.8	17.5
14	32.0	19.3	28.9	18.0	28.4	17.8

Table 5 Summary of the predicted dry/wet bulb temperature at the inbye M/G measurement station using different combinations of values for the rock conductivity and the wetness factor

Wetness factor	Conductivity (W/m°C)					
	2.0		6.0		12.0	
	Dry bulb (°C)	Wet bulb (°C)	Dry bulb (°C)	Wet bulb (°C)	Dry bulb (°C)	Wet bulb (°C)
0.01	26.4	16.1	29.6	17.3	32.9	18.6
0.05	24.7	16.2	27.9	17.6	31.2	18.9
0.10	23.0	16.3	26.1	17.8	29.5	19.4
0.15	21.6	16.3	24.8	17.9	28.1	19.7
0.20	20.6	16.4	23.6	18.1	27.0	20.0
0.25	19.8	16.4	22.8	18.2	26.0	20.1
0.30	19.1	16.4	22.0	18.3	25.3	20.5

Table 6 The predicted dry and wet bulb temperature at the inbye M/G measurement station using combinations of different values for the conductivity and surface wetness factor for the conveyed mineral

Conductivity (W/m°C)	The wetness of the conveyed minerals											
	0.05		0.1		0.2		0.3		0.4		0.5	
	Dry bulb (°C)	Wet bulb (°C)	Dry bulb (°C)	Wet bulb (°C)	Dry bulb (°C)	Wet bulb (°C)	Dry bulb (°C)	Wet bulb (°C)	Dry bulb (°C)	Wet bulb (°C)	Dry bulb (°C)	Wet bulb (°C)
0.10	33.5	22.8	33.0	22.9	32.0	23.1	31.2	23.3	30.1	23.4	29.8	23.6
0.35	35.9	23.8	35.4	24.0	34.6	24.6	33.8	25.0	33.1	25.4	32.5	25.8
0.5	36.5	24.1	36.1	24.4	35.3	25.1	34.6	25.7	33.9	26.2	33.4	26.7
1.0	37.5	24.6	37.2	25.2	36.6	26.2	36.0	27.1	35.6	27.9	35.1	28.6
2.0	38.2	25.1	38.0	25.9	37.6	27.4	37.2	28.6	36.9	29.7	36.6	30.6
4.0	38.6	25.5	38.4	26.6	38.3	28.5	38.1	30.1	37.9	31.3	37.8	32.4
8.0	38.8	25.8	38.8	27.2	38.7	29.4	38.6	31.1	38.6	32.6	38.6	33.7
12.0	38.9	26.0	38.9	27.5	38.9	29.8	38.9	31.7	38.9	33.1	38.9	34.3

Table 7 The predicted temperatures at the inbye M/G measurement station

The conveyed mineral height (mm)	Dry bulb (°C)	Wet bulb (°C)
50	30.0	25.2
100	33.1	25.4
150	33.2	25.6
200	33.2	25.8

Table 8 The predicted and the measured dry and wet bulb temperatures across the longwall district during a weekday production period.

Location	The measured temperatures		The predicted temperatures	
	Dry bulb (°C)	Wet bulb (°C)	Dry bulb (°C)	Wet bulb (°C)
M/G outbye	28.3	20.0	28.3	20.0
Face inlet	33.4	26.1	31.4	26.1
Face outlet	36.8	34.1	35.4	31.5
T/G outbye	37.1	33.6	37.2	32.2

Table 9 The base-line rock conductivity and diffusivity values used in the climate prediction program [5,7].

Description	Thermal Conductivity W/m°C	Thermal Diffusivity $m^2/sec \times 10^{-6}$
Coal	0.35	0.25#
Mudstone	2.24	1.39

After Tuck (1986).

NOTE: It is proposed to post the following series of Appendices on a web page to be constructed on site:

www.nottingham.ac.uk

Appendix 1 Details of the input parameter values for the roadway climate model during weekend period at main gate of T08s Longwall District, Maltby Colliery

	Name of the parameter	The value selected	Units	Calculations and remarks
1	**Main Gate:**			
2	Element Length	2	m	
3	Airway Length	930	m	
4	Airway Area	14.2	m^2	4.9 × 2.9
5	Airway Perimeter	15.6	m	(4.9 + 2.9) × 2
6	Wetness factor of airway	0.05		The roadway was dry.
7				
8	Roadway friction factor	0.012	kg/m^3	
9	Depth outbye	1040	m	
10	Depth inbye	1038	m	
11	Age outbye	43.5	months	17/11/02 – 27/03/99 = 43.5
12	Age inbye	22.5	months	17/11/02 –27/01/01 =22.5
13				
14	VST	41.0	°C	
15	VST depth	1040	m	
16	Geothermal step	30	m/°C	
17	Rock Conductivity	2.0	W/m°C	Mudstone = 2.24 Coal = 0.35, Siltstone = 2.56 0.35×(3/15.6) + 2.24×(6.4/15.6) + 2.56×(6.2/15.6) = 2.0
18	Rock diffusivity	1.17×10^{-6}	m^2/sec	Mudstone = 1.39 Coal = 0.25, Siltstone = 1.39 0.25×(3/15.6) + 1.39×(6.4/15.6) + 1.39×(6.2/15.6) = 1.17
19				
20	Air dry bulb temperature	24.8	°C	Measured at the location A (outbye main gate)
21	Air wet bulb temperature	15.3	°C	Measured
22	Absolute Pressure	110.93	kPa	Estimated
23	Quantity entering main gate	43	m^3/s	Measured
24				
25	No. of water pools	1		
26	Water pool position	50	m	Ambient temperature
27	Water surface area	1.0	m^2	
28	Water temp.	30	°C	

Appendix 2 Details of the input parameter values of the roadway climate model during weekend period at tail gate of T08s Longwall District, Maltby Colliery

	Name of the parameter	The value selected	Units	Calculations and remarks
1	**Tail Gate:**			
2	Element Length	2	m	
3	Airway Length	930	m	
4	Airway Area	12.2	m^2	
5	Airway Perimeter	14.2	m	
6	Wetness factor of airway	0.05		
7				
8	Roadway friction factor	0.012	kg/m^3	
9	Depth outbye	1040	m	
10	Depth inbye	1038	m	
11	Age outbye	39.5	Months	17/11/02 – 4/09/99 = 39.5
12	Age inbye	29.5	Months	17/11/02 – 03/06/00 =29.5
13				
14	VST	41.0	°C	
15	VST depth	1040	m	
16	Geothermal step	30	m/C°	
17	Rock Conductivity	1.96	W/m°C	Mudstone = 2.24 Coal = 0.35, Siltstone = 2.56 $0.35\times(3/14.2) + 2.24\times(5.7/14.2) + 2.56\times(5.5/14.2) = 2.00$
18	Rock diffusivity	1.15×10^{-6}	m^2/sec	After M. Tuck Mudstone = 1.39 Coal = 0.25, Siltstone = 1.39 $0.25\times(3/14.2) + 1.39\times(11.2/14.2) =1.15$
19				
20	Air dry bulb temperature	34.4	°C	Measured
21	Air wet bulb temperature	24.3	°C	Measured
22	Absolute Pressure	110.93	kPa	
23	Quantity entering main gate	43	m^3/s	Measured
24				
25	No. of water pools	1		
26	Water pool position	50	m	Ambient temperature
27	Water surface area	1.0	m^2	
28	Water temp.	30	°C	

Appendix 3 Details of the input parameter values of the roadway climate model during production period at main gate of T08s Longwall District, Maltby Colliery

	Name of the parameter	The value selected	Units	Calculations and remarks
1	**Main Gate:**			
2	Element Length	2	m	
3	Airway Length	830	m	The actual length = 930 m. The distance between the two logging points = 830 m
4	Airway Area	14.2	m^2	
5	Airway Perimeter	15.6	m	
6	Wetness factor of airway	0.05		The roadway was dry.
7				
8	Roadway friction factor	0.012	kg/m^3	
9	Depth outbye	1040	m	
10	Depth inbye	1038	m	
11	Age outbye	43.5	Months	17/11/02 – 27/03/99 = 43.5
12	Age inbye	22.5	Months	17/11/02 –27/01/01 =22.5
13				
14	VST	41.0	°C	
15	VST depth	1040	m	
16	Geothermal step	30	m/°C	
17	Rock Conductivity	12.0	W/m°C	The weighted average = 12.0
18	Rock diffusivity	0.25 $\times 10^{-6}$	m^2/sec	The weighted average = 0.25
19				
20	Air dry bulb temperature	28.3	°C	Measured
21	Air wet bulb temperature	20.0	°C	Measured
22	Absolute Pressure	110.93	kPa	
23	Quantity entering main gate	43	m^3/s	Measured
24				
25	No. of water pools	1		
26	Water pool position	50	m	Ambient temperature
27	Water surface area	2.0	m^2	
28	Water temp.	30	°C	
29	No. of conveyors	1		
30	Antitropal/homotropal	Antitropal		Antitropal: conveyor belt travels in an opposite direction to the airflow direction.
31	Conveyor Belt	on	on/off	Belt is running or not
32	Belt speed	2.89	m/s	
33	Belt capacity	1000	t/h	
34	Start position	0	m	
35	End position	830	m	The actual length = 930 m. The distance between the two logging points = 830 m

36	Belt width	1219	mm	48” conveyor
37	Conductivity of conveyed materials	0.35	W/m°C	
38	Diffusivity of conveyed materials	0.25×10^{-6}	m^2/sec	
39	The wetness factor of transported materials	0.1		
40	Material Height	100	mm	
41	The age of materials	5.0	mins	((930/2.89) + (290/1.28))/2 (m/s) = 548/2 = 274s = 4.56 minutes after the cutting. Take 5 min.

Appendix 4 Details of the input parameter values of the district climate model during production period at T08s Longwall District, Maltby Colliery

	Name of the parameter	The value selected	Units	Calculations and remarks
1	**Main Gate:**			
2	Element Length	2	m	
3	Airway Length	930	m	
4	Airway Area	14.2	m^2	
5	Airway Perimeter	15.6	m	
6	Wetness factor of airway	0.05		The roadway was dry.
7				
8	Roadway friction factor	0.012	kg/m^3	
9	Depth outbye	1040	m	
10	Depth inbye	1038	m	
11	Age outbye	43.5	Months	17/11/02 – 27/03/99 = 43.5
12	Age inbye	22.5	Months	17/11/02 –27/01/01 =22.5
13				
14	VST	41.0	°C	
15	VST depth	1040	m	
16	Geothermal step	30	m/°C	
17	Rock Conductivity	12.0	W/m°C	The weighted average = 12.0
18	Rock diffusivity	0.25×10^{-6}	m^2/sec	The weighted average = 0.25
19				
20	Air dry bulb temperature	28.3	°C	Measured
21	Air wet bulb temperature	20.0	°C	Measured
22	Absolute Pressure	110.93	kPa	
23	Quantity entering main gate	43	m^3/s	Measured
24				
25	No. of water pools	1		
26	Water pool position	50	m	Ambient temperature
27	Water surface area	2.0	m^2	
28	Water temp.	30	°C	
29	No. of conveyors	1		
30	Antitropal/homotropal	Antitropal		Antitropal: conveyor belt travels in an opposite direction to the airflow direction.
31	Conveyor Belt	on	on/off	Belt is running or not
32	Belt speed	2.89	m/s	
33	Belt capacity	1000	t/h	
34	Start position	0	m	
35	End position	930	m	
36	Belt width	1219	mm	
37	Conductivity of conveyed materials	12.0	W/m°C	Used the rock conductivity in situ
38	Diffusivity of conveyed materials	0.25×10^{-6}	m^2/sec	Used the rock diffusivity in situ

39	The wetness factor of transported materials	0.4		
40	Material Height	200	mm	
41	The age of materials	5.0	mins	((930 /2.89) + (290/1.28))/2 (m/s) = 548/2 = 274s = 4.56 minutes after the cutting
42				
43	No. of water sprays	4		
44	1st spray Status	on	On/Off	M/G conveyor dirve
45	Spray Position	2	m	Just inside the M/G entrance
46	Flow rate	0.17	l/s	10 l/min = 0.17 l/s
47	Water temp.	28	°C	
48	Percentage of airflow effected	20	%	
49	Factor of merit	0.45		
50				
51	2nd spray Status	on	On/Off	Dinter,
52	Spray Position	930/s =465	m	Located in the middle of the M/G
53	Flow rate	0.17	l/s	10 l/min = 0.17 l/s
54	Water temp.	35	°C	
55	Percentage of airflow effected	20	%	
56	Factor of merit	0.45		
57				
58	3rd spray Status	on	On/Off	Stage loader
59	Spray Position	900	m	30 m to the face line
60	Flow rate	0.17	l/s	10 l/min = 0.17 l/s
61	Water temp.	35	°C	
62	Percentage of airflow effected	20	%	
63	Factor of merit	0.45		
64				
65	4th spray Status	on	On/Off	Crusher
66	Spray Position	910	m	20 m to the face line
67	Flow rate	0.08	l/s	5 l/min = 0.08 l/s
68	Water temp.	35	°C	
69	Percentage of airflow effected	20	%	
70	Factor of merit	0.45		
71				
72	No. of electrical spot sources	4		
73				
74	1st spot sources status	on	On/Off	The conveyor drive
75	Position	10	m	10 m inside the gate entrance
76	Nominal power loading	250×2 = 500	kW	
77	Heat output	5	%	Percentage of the nominal power given off as heat
78				
79	2nd spot sources status	on	On/Off	Dinter
80	Position	930/2= 465	m	In the middle of the M/G
81	Nominal power loading	65	kW	

82	Heat output	5	%	Percentage of the nominal power given off as heat
83				
84	3rd spot sources status	on	On/Off	Stage loader
85	Position	900	m	30 m to the face line
86	Nominal power loading	150	kW	
87	Heat output	5	%	Percentage of the nominal power given off as heat
88				
89	4th spot sources status	on	On/Off	Crusher
90	Position	910	m	20 m to the face line
91	Nominal power loading	112	kW	
92	Heat output	5	%	
93				
94	**Longwall Face:**			
95	Conductivity of face roof	12.0	w/m°C	
96	Conductivity of face wall	12.0	w/m°C	
97	Conductivity of face floor	12.0	w/m°C	
98	Diffusivity of face roof	0.25×10^{-6}	m^2/s	
99	Diffusivity of face wall	0.25×10^{-6}	m^2/s	
100	Diffusivity of face floor	0.25×10^{-6}	m^2/s	
101	Rock VST	41	°C	
102	Geothermal gradient	30	m/°C	
103				
104	Face length	290	m	
105	Depth intake	1040	m	
106	Depth return	1040	m	
107	Ventilation width	4.0	m	Estimated
108	Extracted height	1.6	m	The coal seam hight
109				
110	Ventilation type	0	0/1	0 = antitropal; 1 = homotropal
111	Wetness factor	0.1		Assuming wetter than the M/G
112	Friction factor	0.05		Typical condition, coal on conveyor
113	Advance per shear	0.71	m	
114	Time per shear	1.0	hour	45 ~ 70 minutes

115	Shearer position from intake	290/2 =145	m	Assuming at the middle of the face
116				
117	Direction of cut (0/1)	1	0/1	0 = from intake to return; 1 = from return to intake
118	Chain speed of AFC conveyor belt	1.28	m/s	77m/min
119	Standing time	3	hours	
120	Ripping debris on the AFC	0	0/1	0 = there is no ripping debris on AFC
121				
122	No. of spot sources	4		
123				
124	1st spot sources position	1	m	AFC motor at the main gate side, 187kW, the location 1 m to the start line
125	Heat output	187 × 5% = 9.4	kW	187 × 30 % kW of power given off as sensible heat
126				
127	2nd spot sources position	145	m	Shearer, 480×2 kW, middle of the face
128	Heat output	(480×2) × 5%=48	kW	(480×2)× 30 % kW of power given off as sensible heat
129				
130	3rd spot sources position	147	m	Haulage, 2m to the Shearer motor
131	Heat output	80 × 2 × 5% = 8.0	kW	(80×2) × 30 % kW of power given off as sensible heat
132				
133	4th spot sources position	289	m	AFC motor at the tail gate side, 375kW, the location 1 m to the finish line
134	Heat output	375 × 5% =18.8	kW	375 × 30 % kW of power given off as sensible heat
135				
136	No. of sprays	2		
137	1st Spray Position	139	m	The rear cutting drum. Shearer length = 12.2 m 145 – 12.2/2 = 139 m
138	Flow rate	6.67/2 =3.35	l/s	Total face water usage = 400 l/min = 6.67 l/s

139	Water temp.	40	°C	The water coming out the machine was warmer than the ambient air temp.
140				
141	2nd Spray Position	151	m	The front cutting drum. Shearer length = 12.2 m 145 + 12.2/2 = 151 m
142	Flow rate	6.67/2 =3.35	l/s	Total face water usage = 400 l/min
143	Water temp.	40	°C	The water coming out the machine was warmer than the ambient air temp.
144				
145	**Tail Gate:**			
146	Element Length	2	m	
147	Airway Length	930	m	
148	Airway Area	12.2	m^2	4.2 × 2.9 = 12.2
149	Airway Perimeter	14.2	m	(4.2 +2.9) ×2 = 14.2
150	Wetness factor of airway	0.05		
151				
152	Roadway friction factor	0.012	kg/m^3	
153	Depth outbye	1040.0	m	
154	Depth inbye	1038.0	m	
155	Age outbye	39.5	Months	
156	Age inbye	29.5	Months	
157				
158	VST	41.0	°C	
159	VST depth	1040.0	m	
160	Geothermal step	30	m/°C	
161	Rock Conductivity	12.0	W/m°C	
162	Rock diffusivity	0.25×10^{-6}	m^2/sec	
163				
164	No. of water pools	1		

165	Water pool position	220	m	Ambient temperature
166	Water surface area	2	m^2	

Appendix 5 Details of the input parameter values of the roadway climate model during weekend period at main gate of 312s Longwall District, Welbeck Colliery

	Name of the parameter	The value selected	Units	Calculations and remarks
1	**Main Gate:**			
2	Element Length	2	m	
3	Airway Length	2077	m	The actual length = 2177 m. The distance between the two logging points = 2077 m
4	Airway Area	14.3	m^2	5.1× 2.8 = 14.3
5	Airway Perimeter	15.8	m	
6	Wetness factor of airway	0.01		Both the M/G and the T/G were very dry.
7				
8	Roadway friction factor	0.012	kg/m^3	
9	Depth outbye	842	m	
10	Depth inbye	842	m	
11	Age outbye	18	Months	From Nov.01-29Apr 03 = 18
12	Age inbye	6	Months	It took: 2177/(15×25) = 6
13				
14	VST	33.3	°C	31 – 33.3
15	VST depth	842	m	
16	Geothermal step	30	m/°C	
17	Rock Conductivity	12.0	W/m°C	The selected weighted average = 12.0
18	Rock diffusivity	0.25×10^{-6}	m^2/sec	The selected weighted average = 0.25
19				
20	Air dry bulb temperature	28.7	°C	Measured at outbye M/G. The ave. temp. of 4 hrs in 5/5/2003
21	Air wet bulb temperature	24.5	°C	Measured
22	Absolute Pressure	106.10	kPa	Assume: surface fan pressure = 5.0 kPa.
23	Quantity entering main gate	29.5	m^3/s	Measured
24				
25	No. of water pools	1		
26	Water pool position	50	m	Ambient temperature
27	Water surface area	1.0	m^2	
28	Water temp.	30	°C	
29	No. of conveyors	1		
30	Antitropal/homotropal	Antitropal		Antitropal: conveyor belt travels in an opposite direction to the airflow direction.
31	Conveyor Belt	on	on/off	Belt is running or not
32	Belt speed	2.89	m/s	
33	Belt capacity	1000	t/h	
34	Start position	0	m	

35	End position	2077	m	The actual length = 2177 m. The distance between the two logging points = 2077 m
36	Belt width	1219	mm	48” conveyor (assumed)
37	Conductivity of conveyed materials	0.35	W/m°C	Used the rock conductivity in situ
38	Diffusivity of conveyed materials	0.25×10^{-6}	m^2/sec	Used the rock diffusivity in situ
39	The wetness factor of transported materials	0.4		
40	Material Height	200	mm	
41	The age of materials	7.7	mins	(((2077 +50)/2.89) + (244/1.28))/2 (m/s) = 926/2 = 463s = 7.7 minutes after the cutting.

Appendix 6 Details of the input parameter values of the district climate model during production period at 312s Longwall District, Welbeck Colliery

	Name of the parameter	The value selected	Units	Calculations and remarks
1	**Main Gate:**			
2	Element Length	2	m	
3	Airway Length	2177	m	
4	Airway Area	14.3	m^2	5.1× 2.8 = 14.3
5	Airway Perimeter	15.8	m	
6	Wetness factor of airway	0.01		Both the M/G and the T/G were very dry.
7				
8	Roadway friction factor	0.012	kg/m^3	
9	Depth outbye	842	m	
10	Depth inbye	842	m	
11	Age outbye	18	Months	From Nov.01-29Apr 03 = 18
12	Age inbye	12	Months	It took: 2177/(15 (m/day) × 25 (days/month)) = 6 months From May 03 - May 02 = 12 months
13				
14	VST	33.3	°C	31 ~ 33.3 (technical guess)
15	VST depth	842	m	
16	Geothermal step	30	m/°C	
17	Rock Conductivity	12.0	W/m°C	The selected weighted average = 12.0
18	Rock diffusivity	0.25×10^{-6}	m^2/sec	The selected weighted average = 0.25
19				
20	Air dry bulb temperature	28.7	°C	Logged; the mean values of the peak value of every shift during five working days.
21	Air wet bulb temperature	24.5	°C	Measured; the mean values of the peak value of every shift during five working days.
22	Absolute Pressure	106.10	kPa	Assume: surface fan pressure = 5.0 kPa.
23	Quantity entering main gate	29.5	m^3/s	Measured
24				
25	No. of water pools	1		
26	Water pool position	50	m	Ambient temperature
27	Water surface area	1.0	m^2	
28	Water temp.	30	°C	
29	No. of conveyors	1		
30	Antitropal/homotropal	Antitropal		Antitropal: conveyor belt travels in an opposite direction to the airflow direction.
31	Conveyor Belt	on	on/off	Belt is running or not
32	Belt speed	2.89	m/s	
33	Belt capacity	1000	t/h	

34	Start position	0	m	
35	End position	2177	m	
36	Belt width	1219	mm	48” conveyor (assumed)
37	Conductivity of conveyed materials	0.35	W/m°C	
38	Diffusivity of conveyed materials	0.25×10^{-6}	m^2/sec	
39	The wetness factor of transported materials	0.4		
40	Material Height	200	mm	
41	The age of materials	7.7	mins	(((2077 +50)/2.89) + (244/1.28))/2 (m/s) = 926/2 = 463s = 7.7 minutes after the cutting.
42				
43	No. of water sprays	3		
44				
45				
46	1st spray Status	on	On/Off	Dinter,
47	Spray Position	2177/s =1089	m	Located in the middle of the M/G
48	Flow rate	0.17	l/s	10~15 l/min = 0.17 l/s
49	Water temp.	30	°C	
50	Percentage of airflow effected	20	%	
51	Factor of merit	0.45		
52				
53	2nd spray Status	on	On/Off	Stage loader
54	Spray Position	2147	m	30 m to the face line
55	Flow rate	0.17	l/s	10 l/min = 0.17 l/s
56	Water temp.	30	°C	
57	Percentage of airflow effected	20	%	
58	Factor of merit	0.45		
59				
60	3rd spray Status	on	On/Off	Crusher
61	Spray Position	2157	m	20 m to the face line
62	Flow rate	0.08	l/s	5 l/min = 0.08 l/s
63	Water temp.	30	°C	
64	Percentage of airflow effected	20	%	
65	Factor of merit	0.45		
66				
67	No. of electrical spot sources	4		
68				
69	1st spot sources status	off	On/Off	The conveyor drive; outside the calculation zone of the M/G
70	Position	10	m	10 m inside the gate entrance
71	Nominal power loading	250×2= 500	kW	
72	Heat output	5	%	Percentage of the nominal power given off as heat
73				
74	2nd spot sources status	on	On/Off	Dinter

75	Position	2177/2= 1089	m	In the middle of the M/G
76	Nominal power loading	194	kW	2×65 HP = 194 kW
77	Heat output	20	%	Percentage of the nominal power given off as heat
78				
79	3rd spot sources status	on	On/Off	Stage loader
80	Position	2147	m	30 m to the face line
81	Nominal power loading	150	kW	200 HP = 150 kW
82	Heat output	20	%	Percentage of the nominal power given off as heat
83				
84	4th spot sources status	on	On/Off	Crusher
85	Position	2157	m	20 m to the face line
86	Nominal power loading	112	kW	200 HP = 150 kW
87	Heat output	20	%	
88				
89	**Longwall Face:**			
90	Conductivity of face roof	12.0	w/m°C	
91	Conductivity of face wall	12.0	w/m°C	
92	Conductivity of face floor	12.0	w/m°C	
93	Diffusivity of face roof	0.25×10^{-6}	m^2/s	
94	Diffusivity of face wall	0.25×10^{-6}	m^2/s	
95	Diffusivity of face floor	0.25×10^{-6}	m^2/s	
96	Rock VST	33.3	°C	
97	Geothermal gradient	30	m/°C	
98				
99	Face length	244	m	
100	Depth intake	842	m	
101	Depth return	842	m	
102	Ventilation width	4.0	m	Estimated
103	Extracted height	2.1	m	The coal seam height
104				
105	Ventilation type	0	0/1	0 = antitropal; 1 = homotropal
106	Wetness factor	0.1		Assuming wetter than the M/G
107	Friction factor	0.05		Typical condition, coal on conveyor
108	Advance per shear	0.71	m	Measured
109	Time per shear	0.8	hour	45 ~ 70 minutes

110	Shearer position from intake	244/2 =122	m	Assuming at the middle of the face
111				
112	Direction of cut (0/1)	1	0/1	0 = from intake to return; 1 = from return to intake
113	Chain speed of AFC conveyor belt	1.28	m/s	77m/min
114	Standing time	3	hours	
115	Ripping debris on the AFC	0	0/1	0 = there is no ripping debris on AFC
116				
117	No. of spot sources	3		
118				
119	1st spot sources position	1	m	AFC motor at the main gate side, 500HP, the location 1 m to the start line
120	Heat output	373 × 20% = 75	kW	500 ×0.7457× 20 % kW of power given off as sensible heat
121				
122	2nd spot sources position	122	m	Shearer, 946 HP = 705 kW, middle of the face
123	Heat output	705 × 20%=141	kW	705 × 20 % kW of power given off as sensible heat
124				
125	3rd spot sources position	243	m	AFC motor at the tail gate side, 500 HP = 373 kW, the location 1 m to the finish line
126	Heat output	372 × 20% =75	kW	373 × 20 % kW of power given off as sensible heat
127				
128	No. of sprays	2		
129	1st Spray Position	116	m	The rear cutting drum. Shearer length = 12.2 m 122 – 12.2/2 = 116 m
130	Flow rate	6.67/2 =3.35	l/s	Total face water usage = 400 l/min = 6.67 l/s
131	Water temp.	40	°C	The water coming out the machine was warmer than the ambient air temp.
132				
133	2nd Spray Position	128	m	The front cutting drum. Shearer length = 12.2 m 122 + 12.2/2 = 128 m

134	Flow rate	6.67/2 =3.35	l/s	Total face water usage = 400 l/min
135	Water temp.	40	°C	The water coming out the machine was warmer than the ambient air temp.
136				
137	**Tail Gate:**			
138	Element Length	2	m	
139	Airway Length	1871	m	
140	Airway Area	14.3	m^2	$5.1 \times 2.8 = 14.3$
141	Airway Perimeter	15.8	m	$(5.1+2.8) \times 2 = 15.8$
142	Wetness factor of airway	0.01		Very Dry
143				
144	Roadway friction factor	0.012	kg/m^3	
145	Depth outbye	842	m	
146	Depth inbye	842	m	
147	Age outbye	21.0	Months	5/2003 – 8/2001 = 21
148	Age inbye	16	Months	It took: 1871/(15 (m/day) × 25 (days/month)) = 5 months 21 – 5 = 16 months
149				
150	VST	33.3	°C	
151	VST depth	842	m	
152	Geothermal step	30	m/°C	
153	Rock Conductivity	12.0	W/m°C	
154	Rock diffusivity	0.25×10^{-6}	m^2/sec	
155				
156	No. of water pools	1		
157	Water pool position	220	m	Ambient temperature
158	Water surface area	1	m^2	