BEST PRACTICES

Bleeder Systems

Internal Airflow Paths

Internal Airflow Paths

Internal airflow paths of the bleeder system are the interconnected openings within the worked-out area in which pillars have been wholly or partially extracted, excluding bleeder entries.

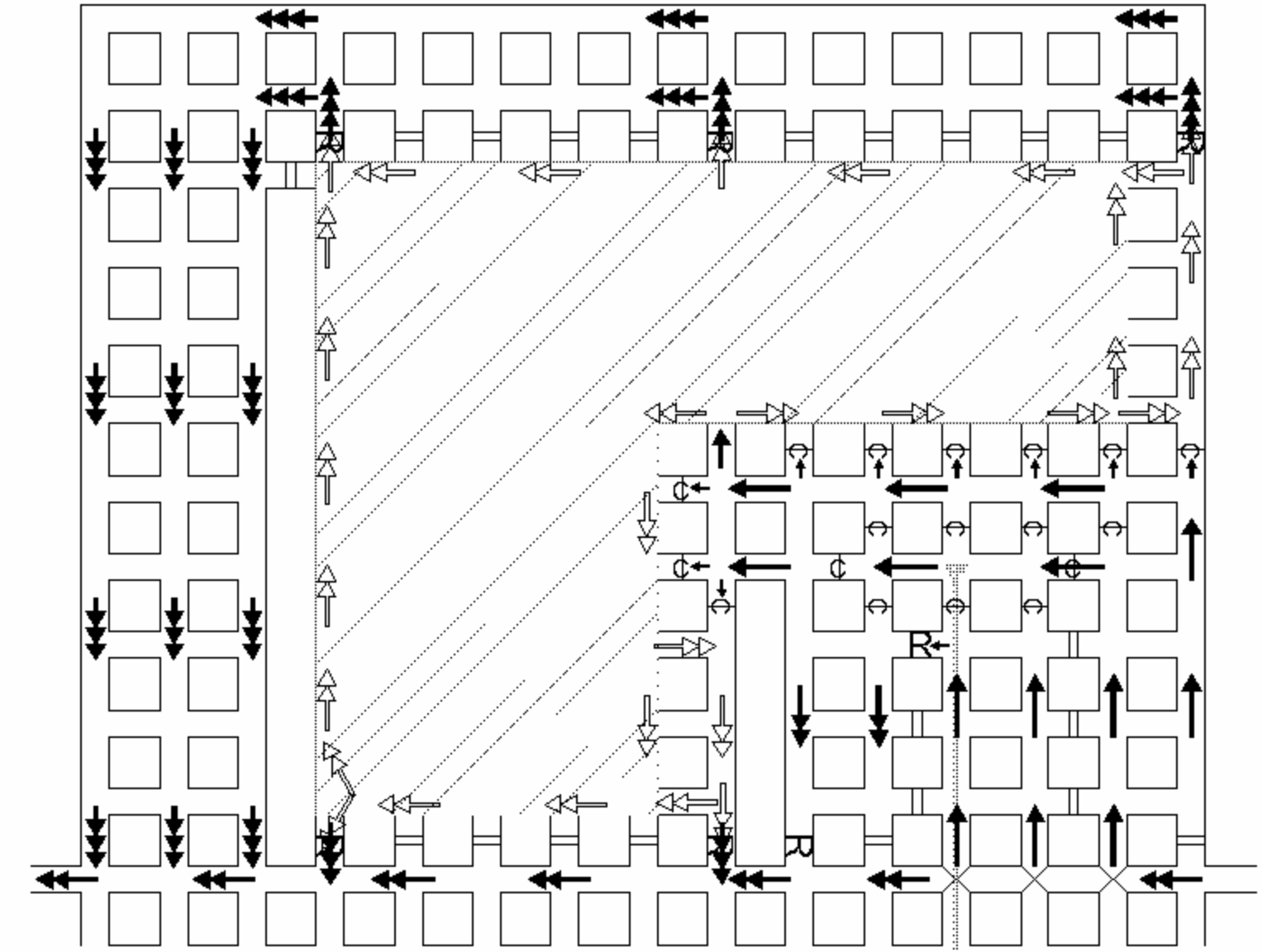
Primary Internal Airflow Paths

Primary internal airflow paths are those interconnected openings (entries or open areas along the caved material) through which airflow within the worked-out area of the bleeder system is designed to be coursed, and which are necessary, to continuously dilute and move methane-air mixtures and other gases, dusts, and fumes from the worked-out area away from the active workings.

Primary Internal Airflow Paths

Two simplistic diagrams and videos were developed and posted to demonstrate airflow through what are considered typical primary airflow paths through worked-out areas where the typical strata response to full extraction (compaction) prevails in the caved area.

Room-and-Pillar Flow-Through with Bleeder Entries



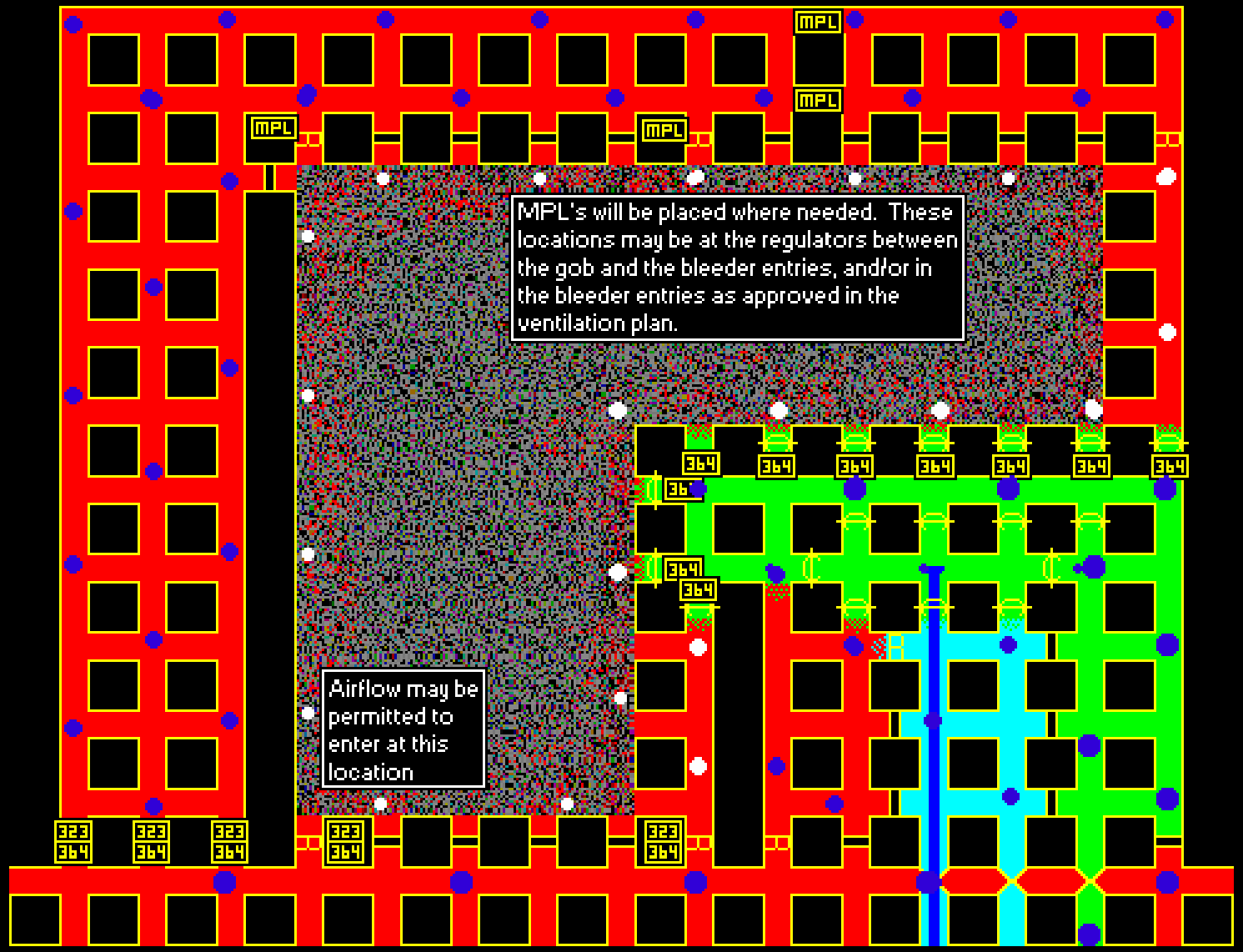
Intake Airflow

Primary Internal Airflow Paths

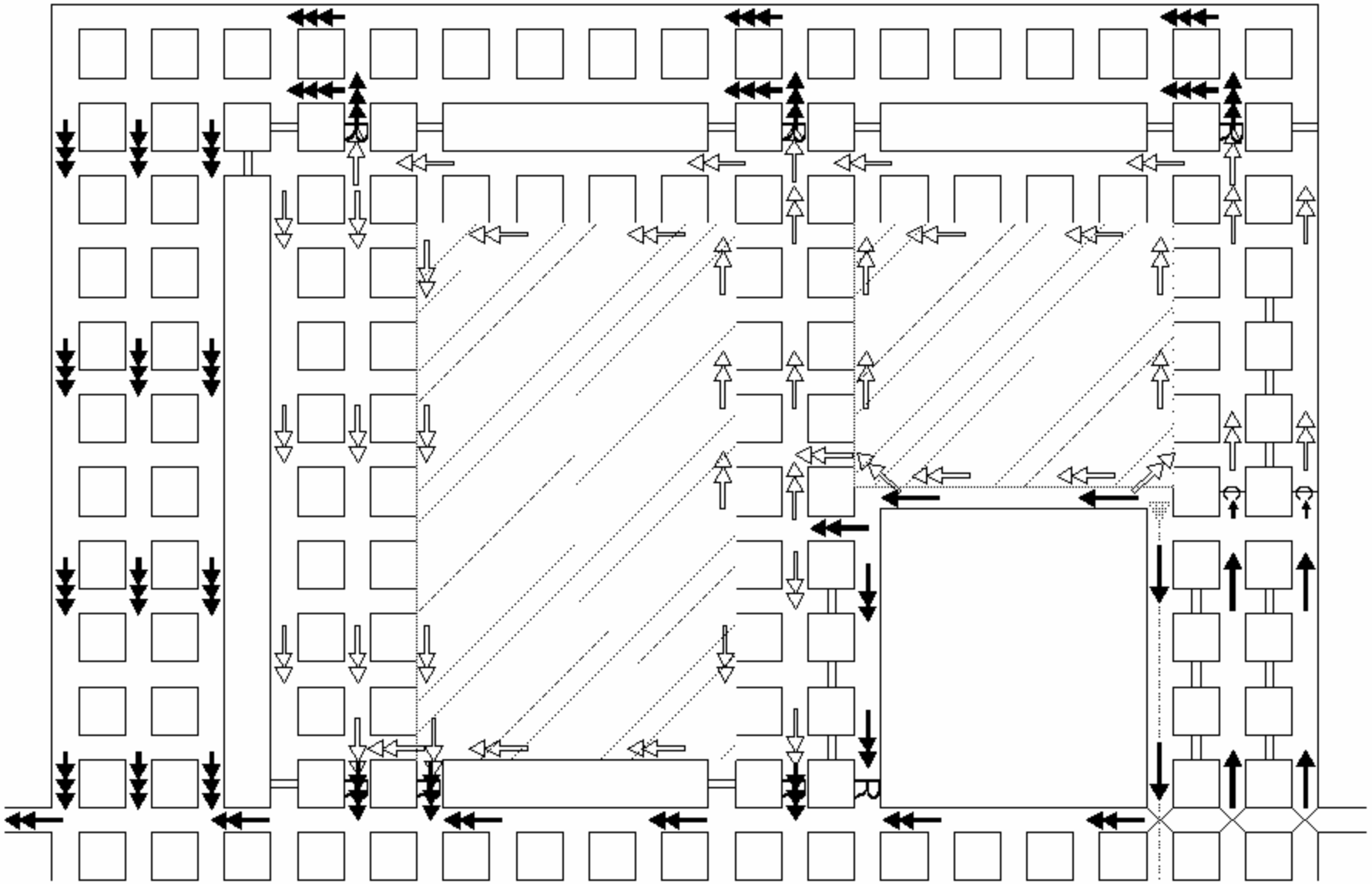
Return Airflow

Bleeder Airflow

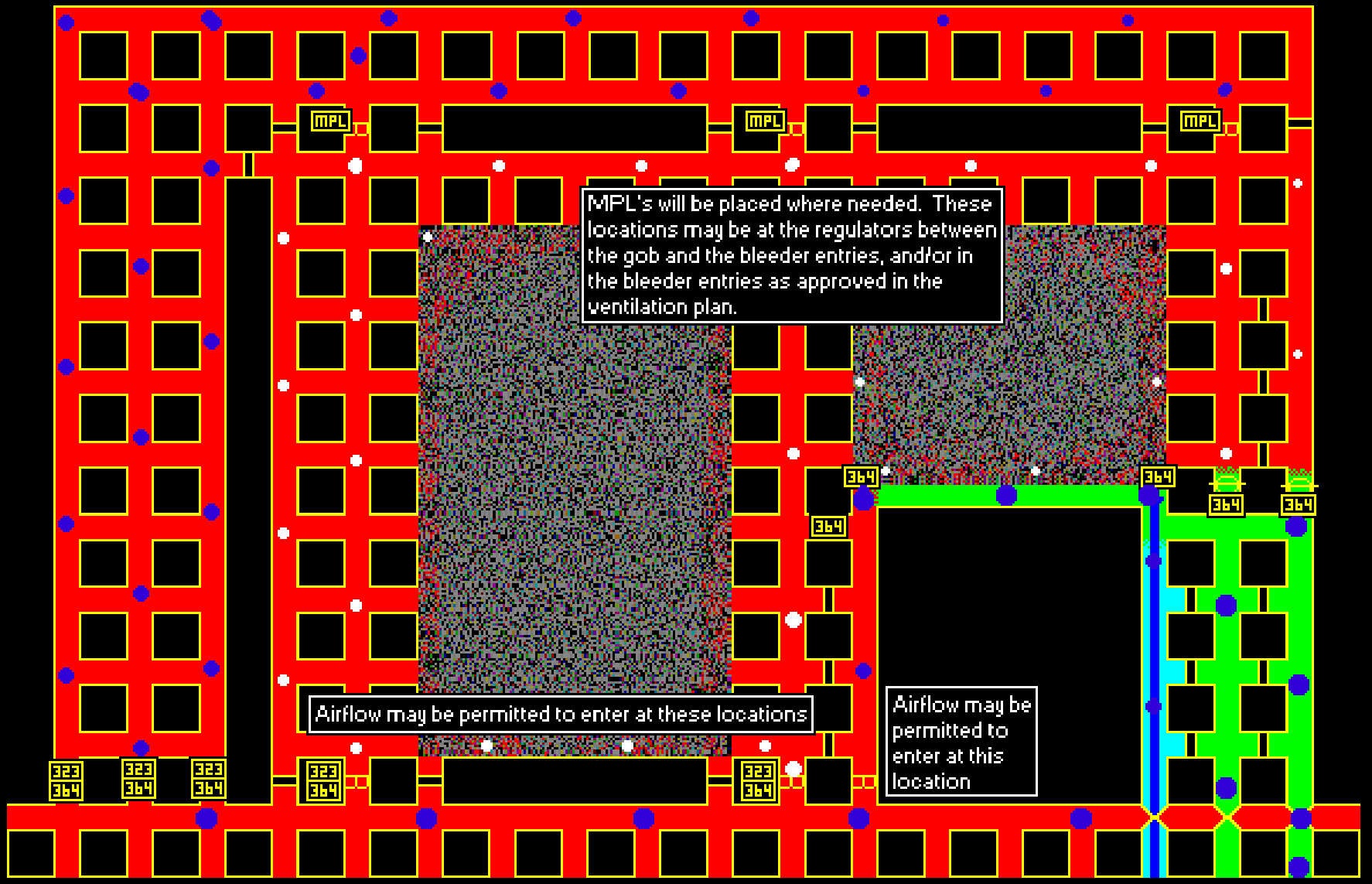
Room-and-Pillar Flow-Through With Bleeder Entries

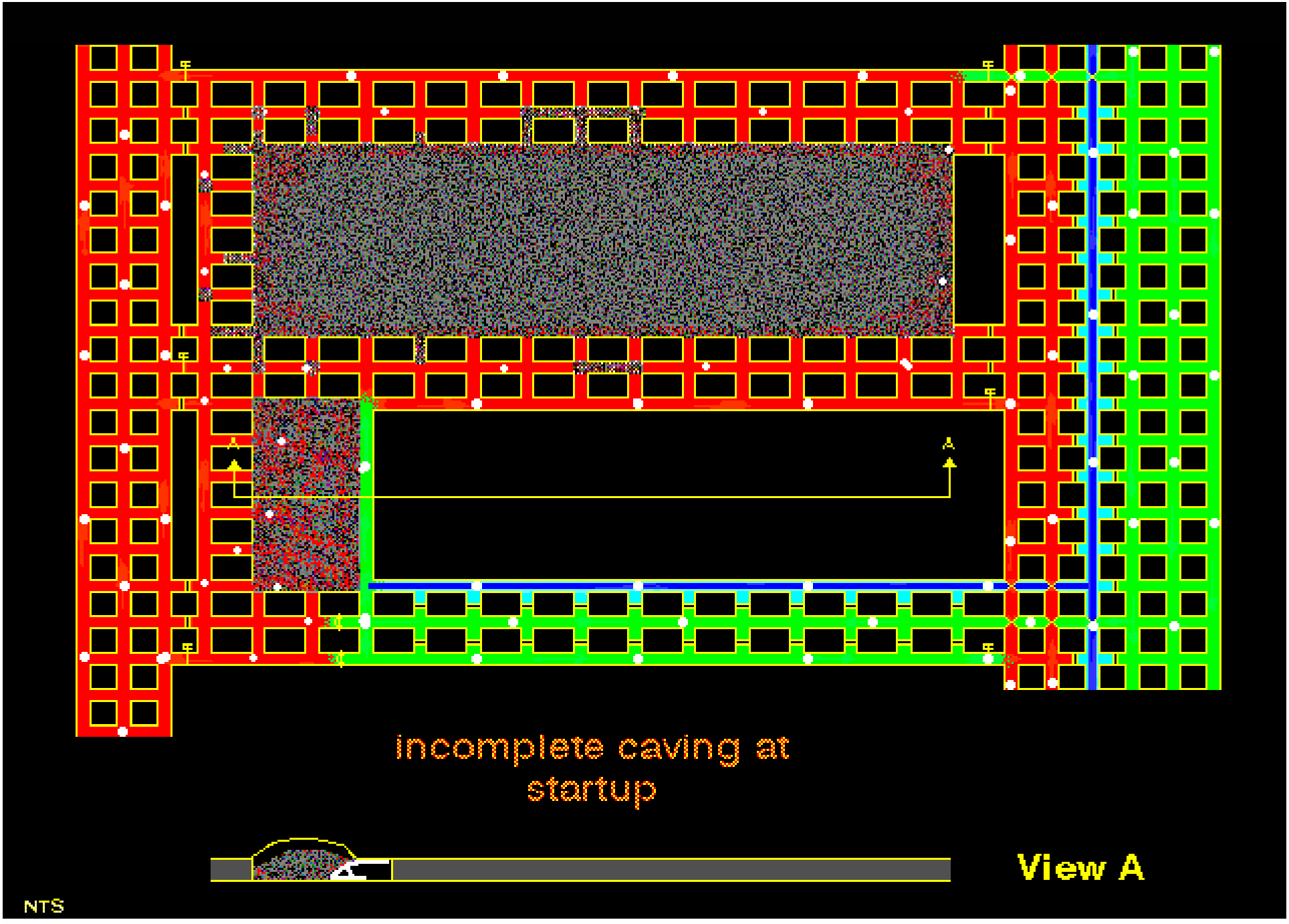


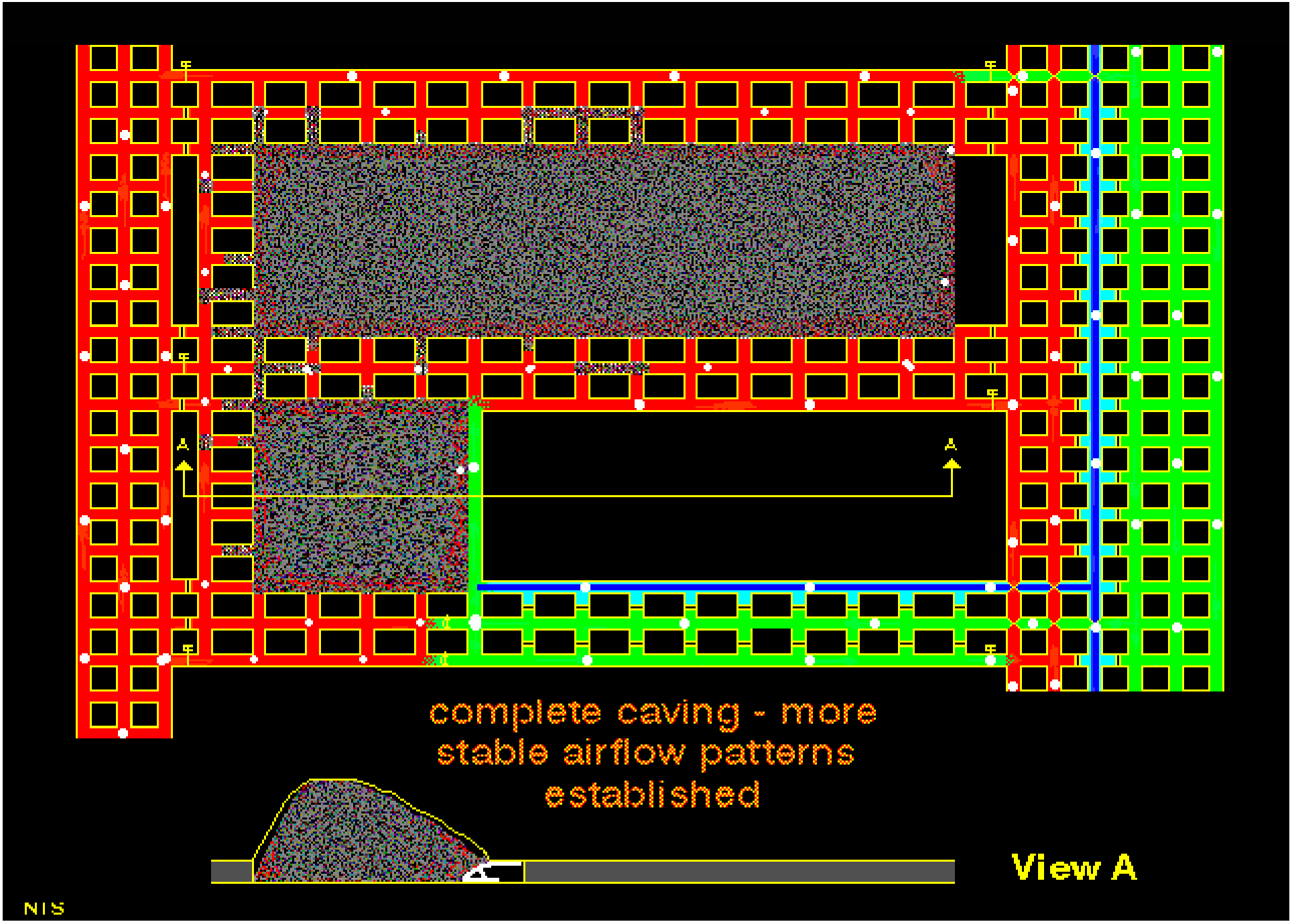
Longwall Flow-Through with Bleeder Entries

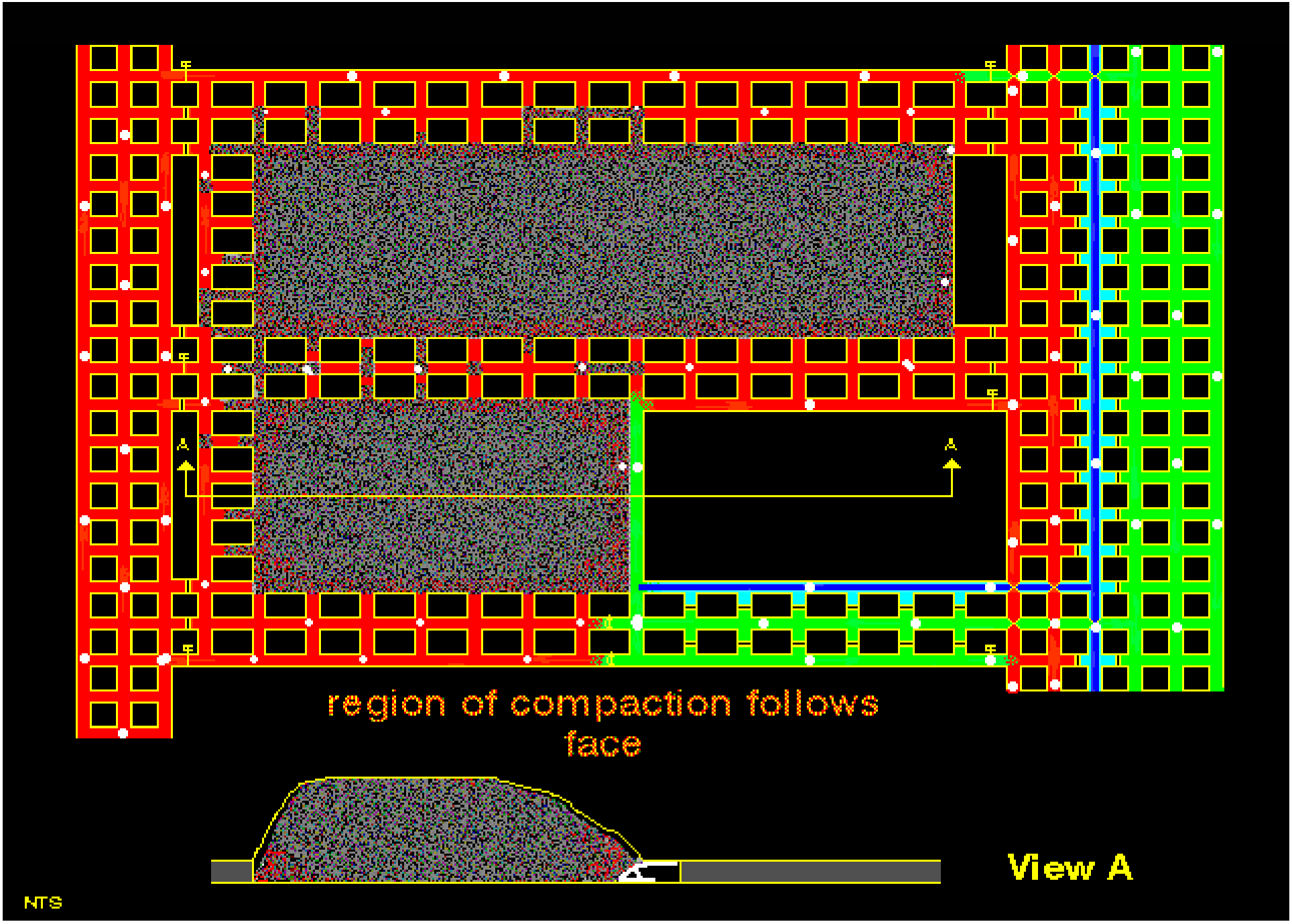


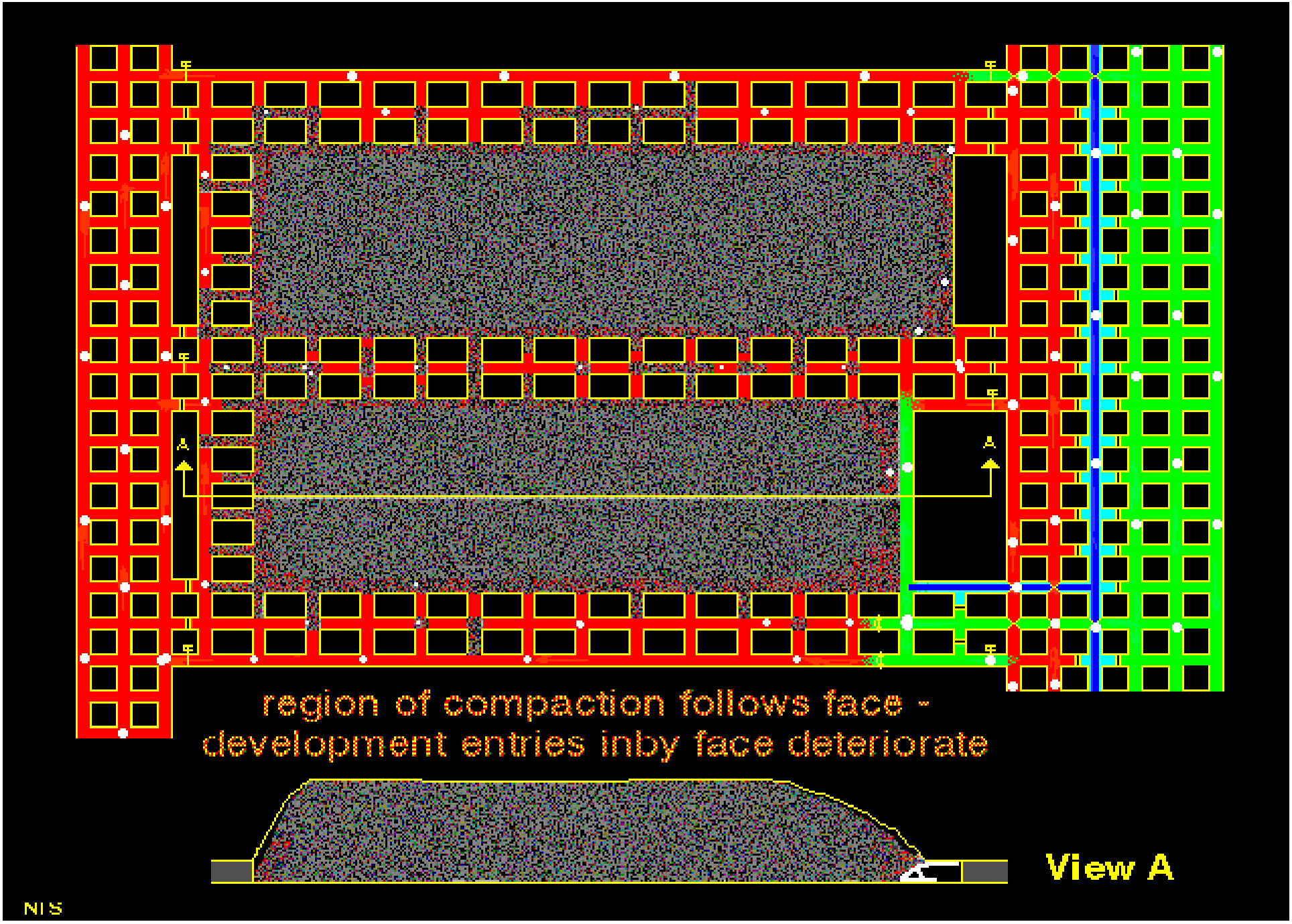
Longwall Flow-Through With Bleeder Entries




incomplete caving at
startup
View A
NTS


A
A
complete caving - more
stable airflow patterns
established
View A
NTS

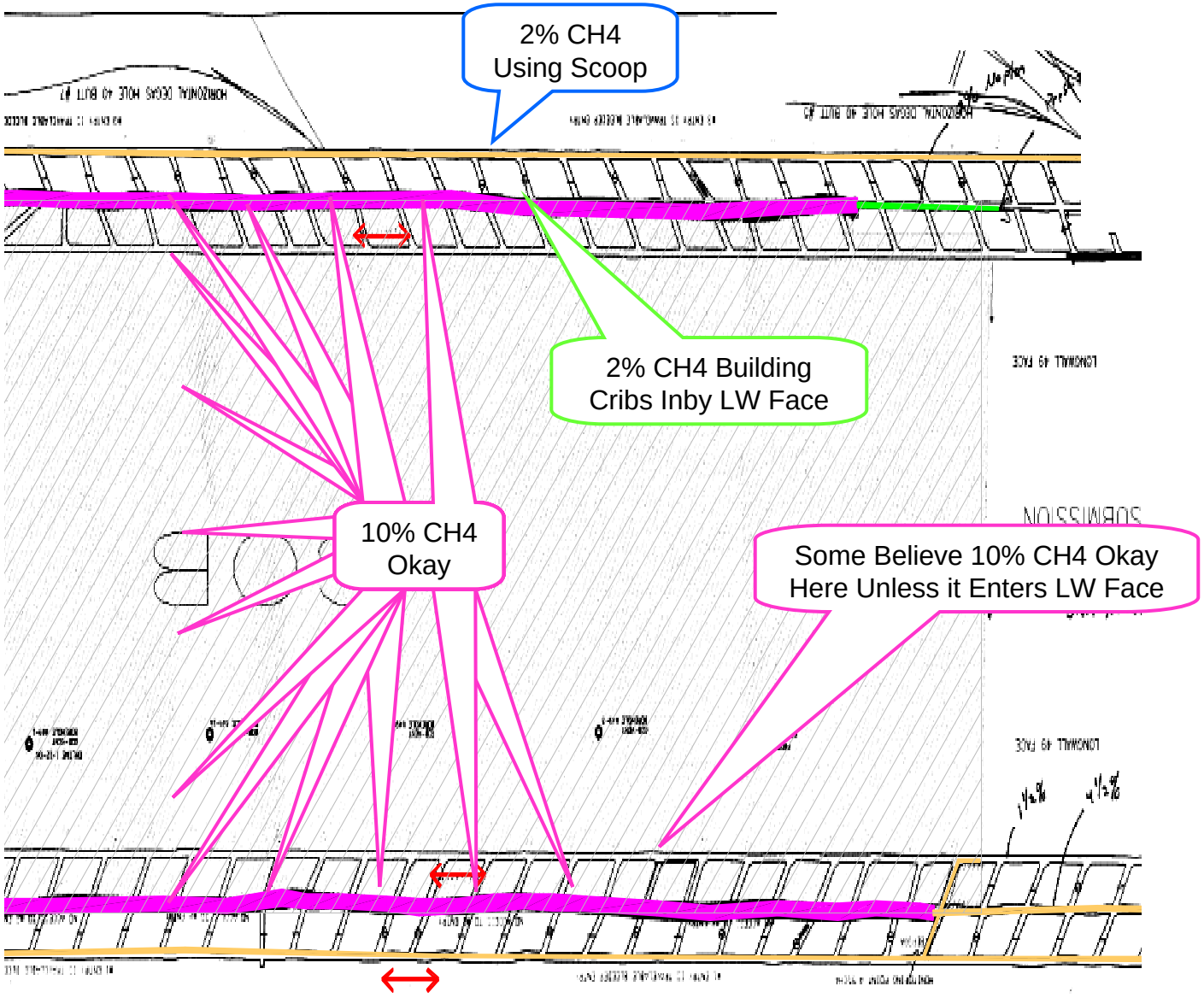

A
A
region of compaction follows face
View A
NTS


A
A
region of compaction follows face -
development entries inby face deteriorate
View A
NTS

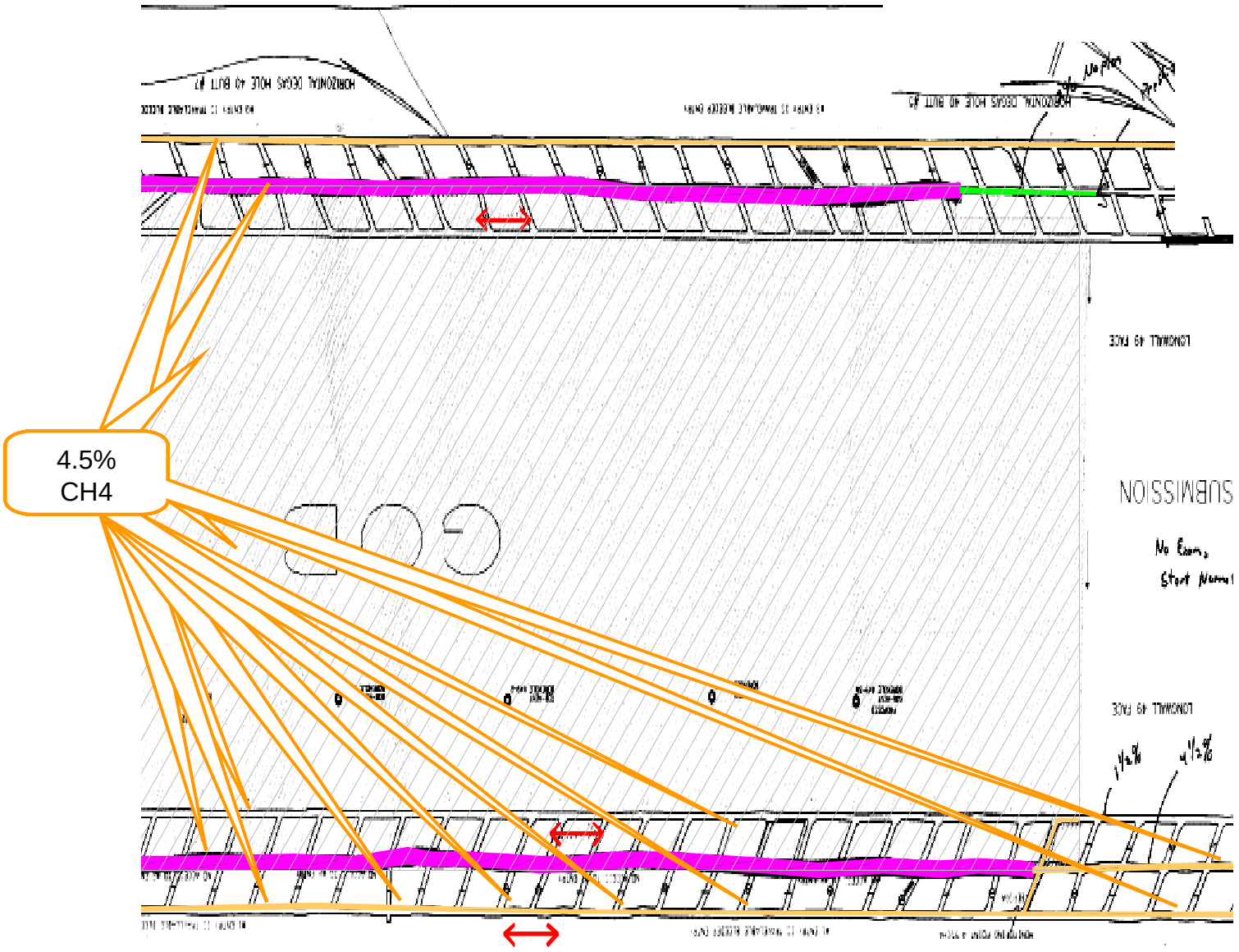
Understand the Potential

- Gas Accumulations – Tiger by the Tail?

  - What Do You Expect, It's in the Gob!!!
    - Considerations
      - Accumulated volume
      - Location of active workings
      - Primary airflow paths
      - Ignition sources
      - Unintentional changes – movement of contaminants

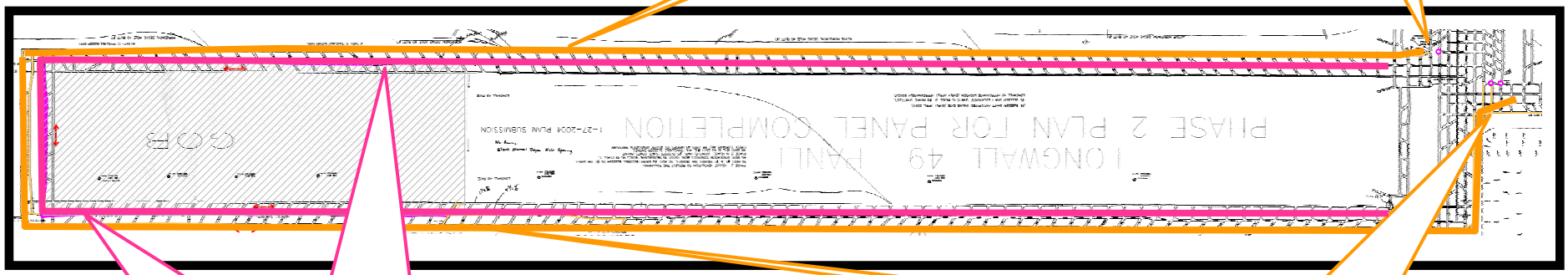


One Philosophy – Presented by an Interested Party but not MSHA



One Philosophy – Presented by an Interested Party but not MSHA

Bleeder Entry on
Both Sides of Panel



4.5% CH4 Bleeder Air Until
Meets Another Split of Air

10% CH4 Okay Area
Grows as Panel Retreats

4.5% CH4 Bleeder Air Until
Meets Another Split of Air

One Philosophy – Presented by an Interested Party but not MSHA

Understand the Potential

- Gas Accumulations – Tiger by the Tail?

  - What You Can't See Can't Hurt You … Can It?
    - Past experiences

1968, Fatal Mine Explosion

There were 99 miners underground when an explosion occurred. Forces from the explosion destroyed two mine fans, a manhoist and nearby surface buildings. Mine fires and several additional explosions interfered with and eventually prevented rescue and recovery efforts. Only 21 miners escaped to the surface – 78 perished. The mine was sealed at its surface openings.

There were many factors which resulted in the conditions that existed prior to the explosion. An ineffective bleeder system was among those factors.

The bleeder system for an abandoned gob area was not effective. Bleeder entries were caved tight and air could not be forced through and around the gob area by the mine ventilating system. Only a small portion of the vast abandoned gob area was ventilated. These unventilated areas became a reservoir of fuel for the propagation of the explosions.

1984, Fatal Mine Explosion

The failure to maintain an effective bleeder system for a longwall gob area allowed an explosive methane-air mixture to accumulate in adjacent entries. Prior to the explosion, water was allowed to accumulate in the longwall gob area and bleeder entries. This water accumulation, together with stoppings constructed in the two connecting entries (cut-throughs), blocked or severely restricted the airflow in the bleeder system and in the adjacent entries.

Investigators concluded the explosive methane-air mixture was ignited by normal operation of a non-permissible, battery-powered locomotive in the adjacent entries.

Three miners died as a result of the explosion. Eleven miners located on an adjacent section were exposed to heat, smoke, dust, and forces but survived the explosion. Four of these miners suffered severe burns.

1989, Fatal Mine Explosion

The failure to maintain air flow in its proper course, volume, and direction to dilute, render harmless, and carry away explosive gases allowed the accumulation of an explosive methane-air mixture. Changes in ventilation had occurred during the mining of the longwall panel. These changes caused a fragile balance to exist in the longwall flow-through bleeder system with bleeder entries. The combination of changes permitted methane to accumulate in open areas of the gob near the longwall headgate.

The removal of a stopping caused the accumulated explosive methane-air mixture to flow toward and into the longwall recovery area. The explosive methane-air mixture was ignited. An explosion occurred that fatally injured miners. Ten miners died from the explosion. Four other miners escaped despite being exposed to high concentrations of carbon monoxide and smoke.

Elevated methane concentrations had previously been detected on the longwall recovery face on more than one occasion. The methane was removed by installing curtains, but the source and cause of the methane accumulation was not investigated.

1992, Fatal Mine Explosion

The wrap-around bleeder system ventilating a room and pillar gob was not examined or maintained. The bleeder system became ineffective to continuously move methane-air mixtures away from the active faces. Methane accumulated in the bleeder entry and gob.

Removal of and/or failure to maintain permanent and temporary ventilation controls on the active working section allowed the accumulated methane to migrate from the pillared area into active areas where it was ignited.

An explosion resulted. Eight miners died from the explosion.

1992, Mine Explosion

An inadequate flow-through main-to-main bleeder system permitted explosive methane-air mixtures to accumulate in an open area of a room and pillar gob near the active face. An explosion occurred when a roof fall in the gob near the face area ignited the explosive methane accumulation.

Flame from the explosion exited the gob, entered the active workings in the face area and extended outby for approximately four crosscuts from the face. Five miners were burned on the working section. Permanent ventilation controls that were not constructed in a durable manner were damaged.

Investigation revealed a special bleeder connector design specified in the ventilation plan was not followed. Access to important bleeder connectors was not provided. Prior to the explosion, methane was detected in the face area and section return.

The explosion occurred as a result of methane accumulations in the gob due to an inadequate bleeder system and management's failure to properly examine the bleeder system to determine its effectiveness. Ventilation changes were made to address the condition before mining resumed.

1993, Mine Explosion

An ineffective flow-through main-to-main bleeder system permitted explosive methane-air mixtures to accumulate in an open area of a room and pillar gob near the active face. A roof fall in the gob ignited the explosive accumulation, causing an explosion. Miners were not injured.

Section ventilation controls, as well as permanent ventilation controls outby the section and inby the back of the gob, sustained substantial damage. The extent of flame from the explosion extended inby the gob for a distance and into the adjacent intake air course. Wooden cribs were found smoldering in the open entries adjacent to the caved material in the pillared area on the back side of the gob.

1993, Fatal Mine Explosion

Ventilation controls were removed from a permanent stopping line required to direct airflow to worked-out areas. Ventilation of a room and pillar gob by the wrap-around bleeder system was affected. Insufficient ventilation permitted methane from the pillared area to migrate into active areas where it accumulated in a roof cavity.

The explosive methane-air mixture in the roof cavity was ignited, causing an explosion. One miner died from the explosion.

1997, Mine Explosion

A mine fire in the gate entries and edge of a longwall gob was believed to be extinguished. Mining began in the adjacent longwall panel and progressed outby the location of the fire area. Ventilation changes were subsequently made that affected airflow direction in the tailgate entries. Mining continued.

Increased CO concentrations were detected by AMS sensors located near the bleeder entries inby the tailgate of the longwall panel and at the longwall regulator at the mouth. Minutes later, miners near the longwall face felt two gusts of air and their ears pop. No miners were on the longwall face.

An explosive methane-air mixture that had accumulated in the gob inby the tailgate side of the longwall face had been ignited and an explosion occurred. Elevated concentrations of carbon monoxide exited from the gob through the tailgate bleeder connector. Heat damage to equipment on the longwall face occurred. No miners were injured.

An underground investigation later determined the explosion originated at a location in the gob near the original fire area.

1997, Mine Explosion

An explosion occurred when a flammable methane-air mixture was ignited in the gob by a roof fall behind the longwall shields near the tailgate. An orange glow was seen in the tailgate entry and behind several shields near the tailgate. A miner on the face near the tailgate felt heat and saw smoke coming from behind the shields as he exited the face. Another miner on the longwall face near the tailgate was singed by the heat.

A second ignition occurred after the miners left the tailgate side of the face. Ventilation changes were made on the headgate side to increase ventilation.

Two additional explosions occurred after the ventilation change. Explosion forces destroyed stoppings located outby the face in the tailgtate entries.

1998, Mine Explosion

Operational problems developed when the methane encountered exceeded the original wrap-around bleeder system design estimates. Excessive concentrations of methane and/or hydrocarbon vapors had been progressively detected in the bleeder system, which sporadically delayed coal production. Changes in the bleeder system were implemented to reduce or control these concentrations.

Shortly before the accident, a regulator in the headgate was adjusted to direct more airflow into the bleeder to lower the methane concentration at the bleeder/return mixing points.

Most likely, a falling rock in the gob caused an ignition of methane that resulted in a low level explosion and subsequent fire in the tailgate side of the gob near the face. Miners on the longwall face were knocked down. A miner on his knees at the tailgate of the longwall face felt heat go over him immediately after the first gust of air passed him. From the tailgate entry just outby the longwall face, miners soon afterward observed an orange-reddish glow pulse in and out, moving from approximately 15 feet inby the shields to 100 feet inby the shields.

The mine was evacuated and sealed. A lengthy mine rescue airlock operation ensued to recover the mine. After the fire, significant improvement was made in the capacity of the bleeder system.

2000, Fatal Mine Explosion

An ineffective flow-through bleeder system with multiple bleeder entries did not control and distribute air passing through the worked-out area in a manner which continuously diluted and moved methane-air mixtures and other gases, dusts, and fumes from the worked-out area away from active workings and into a return air course or to the surface of the mine.

An investigation identified the following factors that impacted the bleeder system's effectiveness at controlling and diluting the air passing through the worked-out area: a limited mine ventilating potential; the configuration and distribution of airflow in the bleeder system and worked-out area; and temporary controls installed within the worked-out area which restricted airflow through the pillared area.

As production increased and the pillared area expanded, methane liberation increased and airflow paths changed within the worked-out area. These changing conditions resulted in reduced airflow and elevated methane concentrations within the worked-out area at locations containing potential ignition sources and within close proximity to the active longwall face. An explosive concentration of methane-air mixtures and/or other gases, dusts and fumes accumulated in the worked-out area within 250 feet of the working longwall face.

Most likely, a roof fall in the headgate fringe area of the gob ignited a small pocket of methane and other gaseous hydrocarbons. The flame traveled inby to a methane accumulation in the back of the gob, resulting in an explosion and fire. The explosion interrupted ventilation of the gob and prevented methane removal from the gob. Miners were injured as a result of the explosion.

Miners attempted to extinguish the fire on the longwall face. Subsequent explosions occurred. Two miners died from the subsequent explosions. Following recovery of the victims by mine rescue personnel, the mine was sealed.

Production was not resumed in the mine.

BEST PRACTICES

Bleeder Systems

Internal Airflow Paths