One Seven® MINING
An innovative system for firefighting and prevention in mining

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ABSTRACT By adding a special foam concentrate and compressed air to water the One Seven MINING system produces compressed air foam, also known as CAF. The foaming agent is a surfactant and not a flammable substance like phenol or polyurethane. The foam has strong penetrating and lasting inhibitory properties. By inundating a mine space with foam it displaces any explosive gases and depletes oxygen contact with the fuel. The MINING 6000 machine is capable to produce up to 6,000 liters foam per minute.

In a 20 days continuous engagement (07/16 – 08/03 2014) a covered mine fire in the Kalın Damar seam, whose development 5.5 months lagged, could be extinguished by using a One Seven MINING 6000 machine and the Class A foam-concentrate AM. A total amount of about 91,000 m³ wet and dry foam was brought into the dammed fire area. The water consumption was 4,200 m³; the foam-concentrate consumption was 6,320 liters.

Finally, it was found that by use of the OS MINING 6000 and the foam-concentrate One Seven AM a fire area could be regained which had to be abandoned using the conventional method (nitrogen inerting).The equipment was recovered and the excavation of the Kalın Damar seam could be continued.

One Seven® MINING: an innovative system for firefighting and prevention in mining

Dr.-Ing. Max Thomas Stöttner

...effective fire fighting systems!

The One Seven® System

one seven®

one seven

Where does the name come from ?

By adding a special foam concentrate and compressed gas to the water, the volume of 1 drop of water expands into 7 foam bubbles.

At the end you get a
CAF = Compressed Air Foam

The One Seven® Foam

one seven®

Properties of the One Seven® AM foam

The result of this process is a micro-cellular, homogeneous foam structure with reproducible properties:

- Excellent foam structure → Important on all sorts of fire
- Large bubble surface → Strong cooling capability (20^0C/s)
- High energy content → High velocity and deep penetration
- Adhesive properties → Cooling the fuel
- Strong wetting Power → Penetration of foam solution into the fuel

The foaming agent is a surfactant (tenside) and not a flammable substance like phenol or polyurethane!!

The One Seven® Foam

one seven®

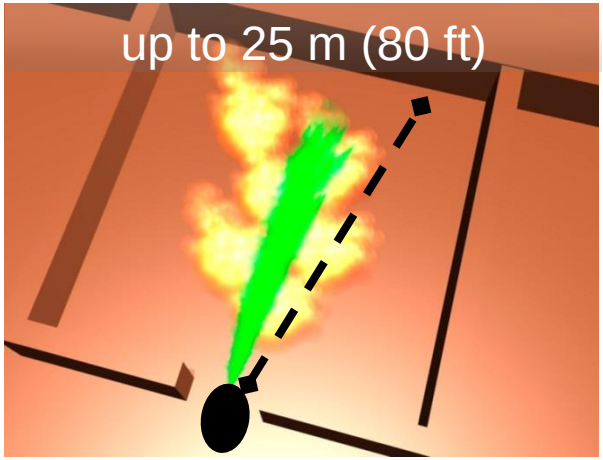
one seven

Videos Foam Discharge

The video shows the resulting throwing distance in a practical demonstration on a 100 m^2 kerosene fire in the UK.

The animation shows the decompression process at the discharge nozzle.

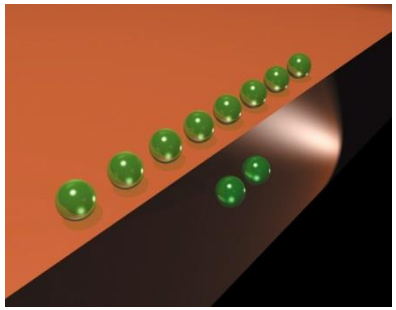
Interior Structural Fire Fighting Process with One Seven®



Due to the high velocity, the One Seven® foam penetrates deeply into the burning room, reaches the fuel and the surrounding structure like walls and ceiling.

Typical throwing distance of a One Seven® handline.

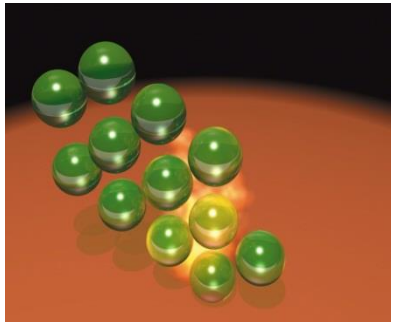
Interior Structural Fire Fighting Process with One Seven®



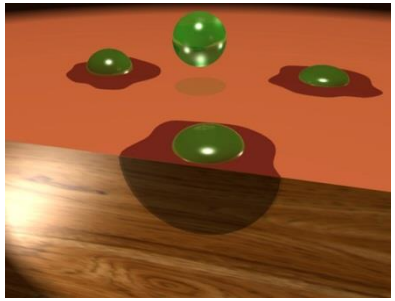
The foam bubbles stick to vertical and horizontal surfaces (like walls, ceilings and furniture) and cool this items within seconds from e.g. 500 degrees Celsius to about 100 degrees Celsius.

The picture shows the result of the adhesive foam properties in a practical demonstration.

Interior Structural Fire Fighting Process with One Seven®



Due to the adhesion on the surfaces the large surface of the foam is exposed to the heat of the fire and the structure. Vaporization happens over a period of over 30 sec.



The water-foam solution which is released out of the foam when bubbles break penetrates into the Class A fuel due to its strong wetting power.

One Seven® MINING 6000

- System developed for use in mines with a ruggedized design for tough job
- Explosion proof system (ATEX I)
- Water and gas to be supplied by installations in the mine
- Operational pressure from 2 bar (29 psi) up to 10 bar (145 psi) either pressed air or nitrogen
- Flows up to 6,000 l (1,585 gal US) of foam per minute
- Usable for prevention as well as fire fighting
- NEW: There is also a MINING 12,000 device available!

One Seven® MINING 6000

- Dimensions (LxWxH): 2,550 x 990 x 1,420 mm
- Weight (dry): 1,550 kg
- Weight (operational): 1,750 kg
- Water consumption: max. 300 l/min @ min. 2 bar (29 psi) and max. 10 bar (145 psi)
- Gas consumption: (Nitrogen or Air) max. 6,000 l/min @ min 2 bar (29 psi) and max. 10 bar (145 psi)
- Foam concentrate: One Seven® Foam Class A (0.3%)
- Foam concentrate tank: 150 l (build-in)
- Foam quality: free adjustable for fire fighting (wet) to preventive foam (dry)
- Life-time of dry foam: about 5 h

One Seven® MINING applications

- The fire and explosion risk in mines remains, because of
  - risk of self-ignition of the materials (e.g. coal, waste)
  - explosive gases and dusts (e.g. methane gas, coal dust)

- One Seven® can be used **preventively** to cover dangerous areas in the goaf, preventing fire damps and dust explosions
- One Seven® can be used for **actual fire suppression** as well on machinery as on the coal itself

- Examples for both, preventive and active firefighting will be given in the subsequent sheets…

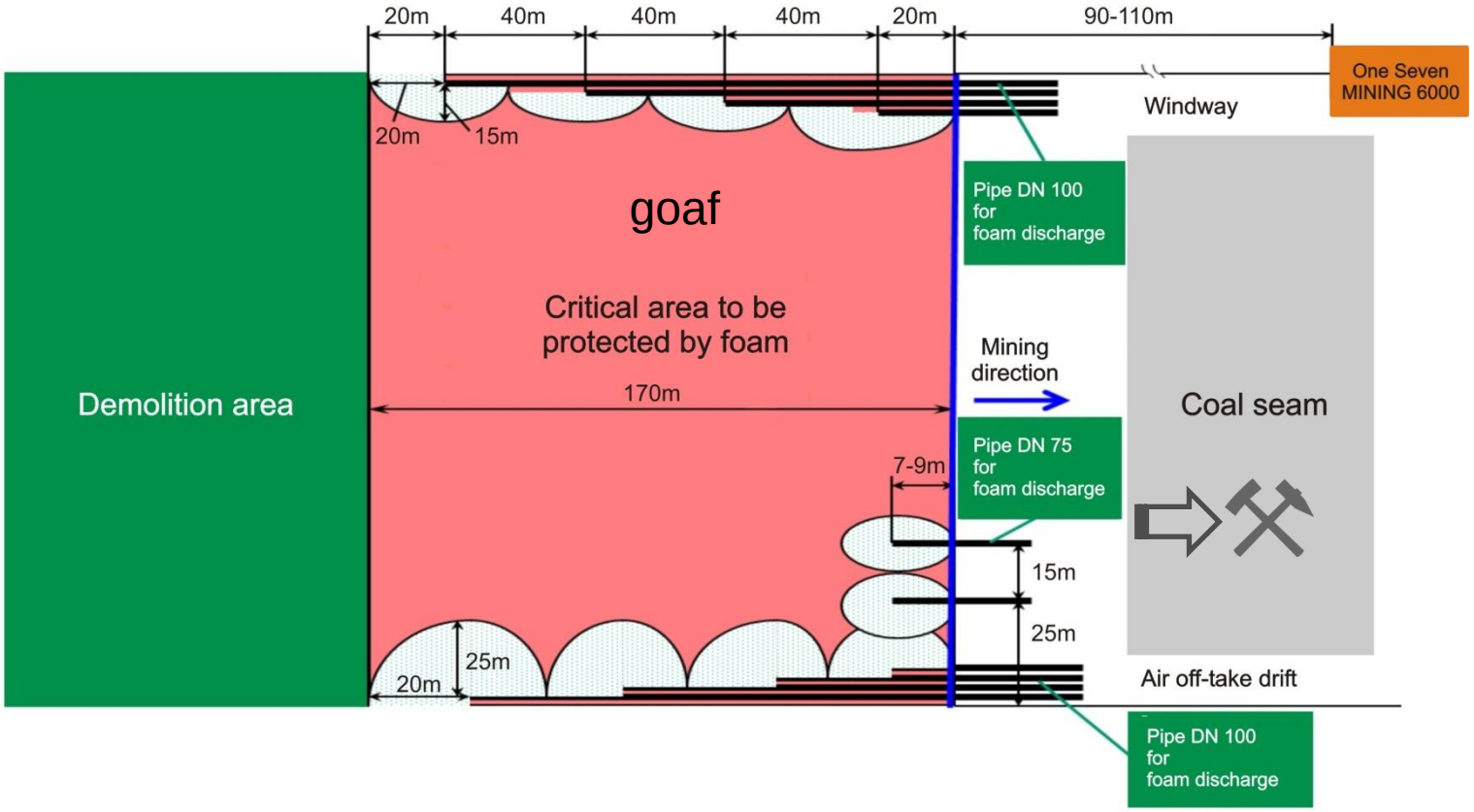
Reference for preventive application: The Czech OKD mines

In order to reduce the oxy-reactivity of the coal the goaf is covered with a rather „dry“ foam.

Areas of freshly broken coal are covered by use of handlines.

One Seven® MINING: Preventive application in a longwall panel

- One Seven® preventive application for a longwall panel



One Seven® MINING: Preventive application

- Application with Dry-Foam

One Seven® MINING: Preventive application, summary

The preventive effects of the One Seven® AM foam are:

- Displacement effect

  By inundating the total space of a gate or the goaf with One Seven® AM foam any explosive gases will be displaced

- Inhibitory effect

  Treating the coal with foam: Reduction of oxygen reactivity of the coal (Tendency of spontaneous combustion)

- Isolating effect

  Avoiding oxygen exposure

- Spark suppression

  No sparks can be created in case of cave-in‘s

CAPEX and OPEX calculation for preventive application

1. Generally: single investment (CAPEX) for the machine unit
   (MINING 6000: €120,000, MINING 12000: €145,000)
   and low operational costs during use e.g. cleaning or exchange of filters
2. Calculation of foam-concentrate costs:
   a) Assumptions: Face length 300 m, seam height 3 m, longwall performance 8 m/d
   A maximum amount of 7200m³/d foam has to be discharged to inundate the goaf
   b) For example use of a One Seven MINING 6000 machine:
   - makes 6000l foam per minute
   - takes 20h to produce and discharge 7200 m³ foam
   - Causes a foam-concentrate consumption of 0,9 l/min (0.3 % of the water demand)
   - 20h consumption is 1080l foam-concentrate

   c) **Daily costs:** ~ 3,- €/l x 1080 l/d = **3240 €/day** for foam-concentrate
3. Additionally: Costs for water (360 m³/d) and pressed air or nitrogen

1st reference for active firefighting: TTK´s Amasra coal mine - Turkey

Amasra: History of the fire

02/08/2014, 8:40 p.m.:
Damming off the Kalın Damar panel

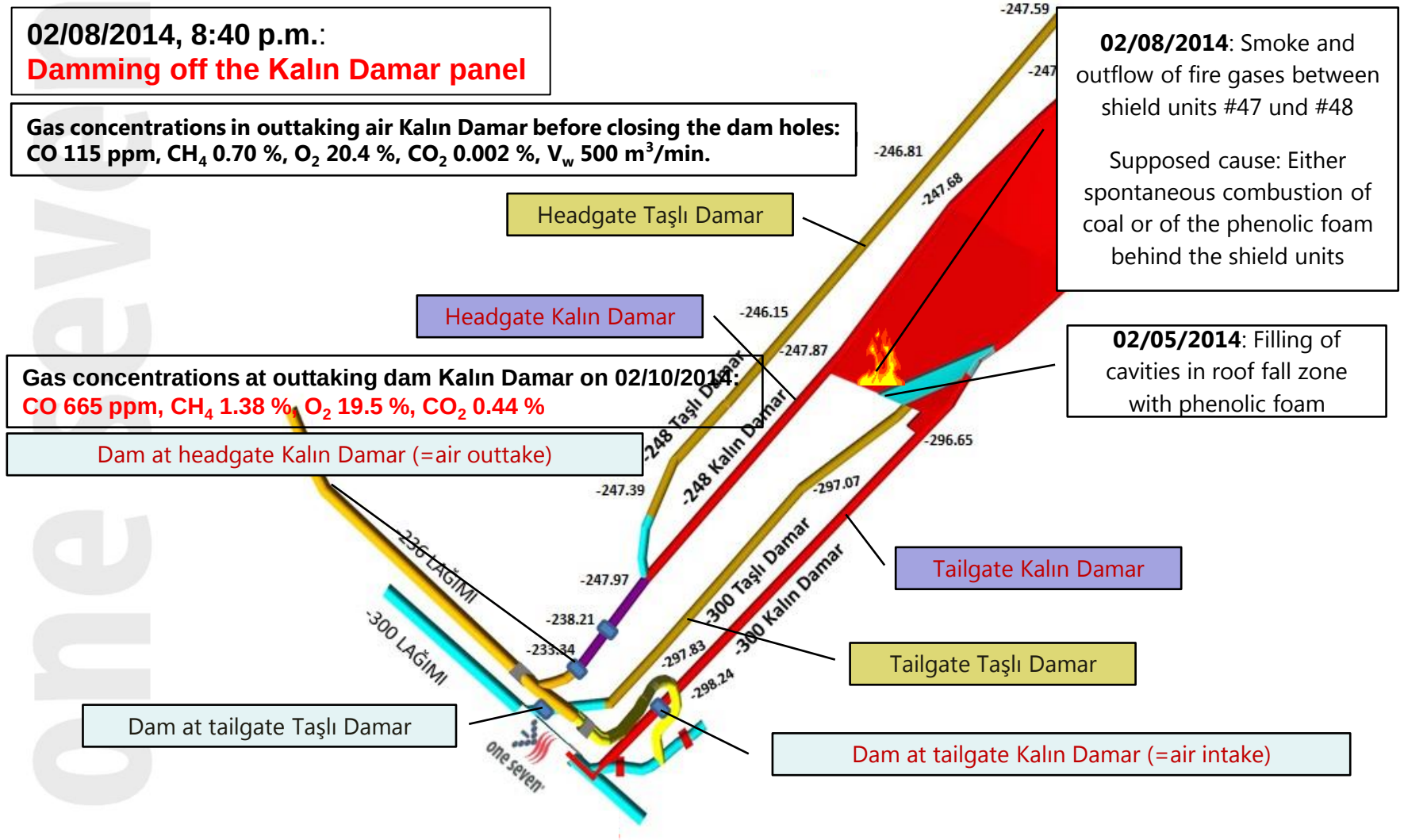
Gas concentrations in outtaking air Kalın Damar before closing the dam holes:
CO 115 ppm, CH_4 0.70 %, O_2 20.4 %, CO_2 0.002 %, V_w 500 m^3/min.

Gas concentrations at outtaking dam Kalın Damar on 02/10/2014:
CO 665 ppm, CH_4 1.38 %, O_2 19.5 %, CO_2 0.44 %

02/08/2014: Smoke and outflow of fire gases between shield units #47 und #48

Supposed cause: Either spontaneous combustion of coal or of the phenolic foam behind the shield units

02/05/2014: Filling of cavities in roof fall zone with phenolic foam



Firefighting in Amasra: Operating in three Phases

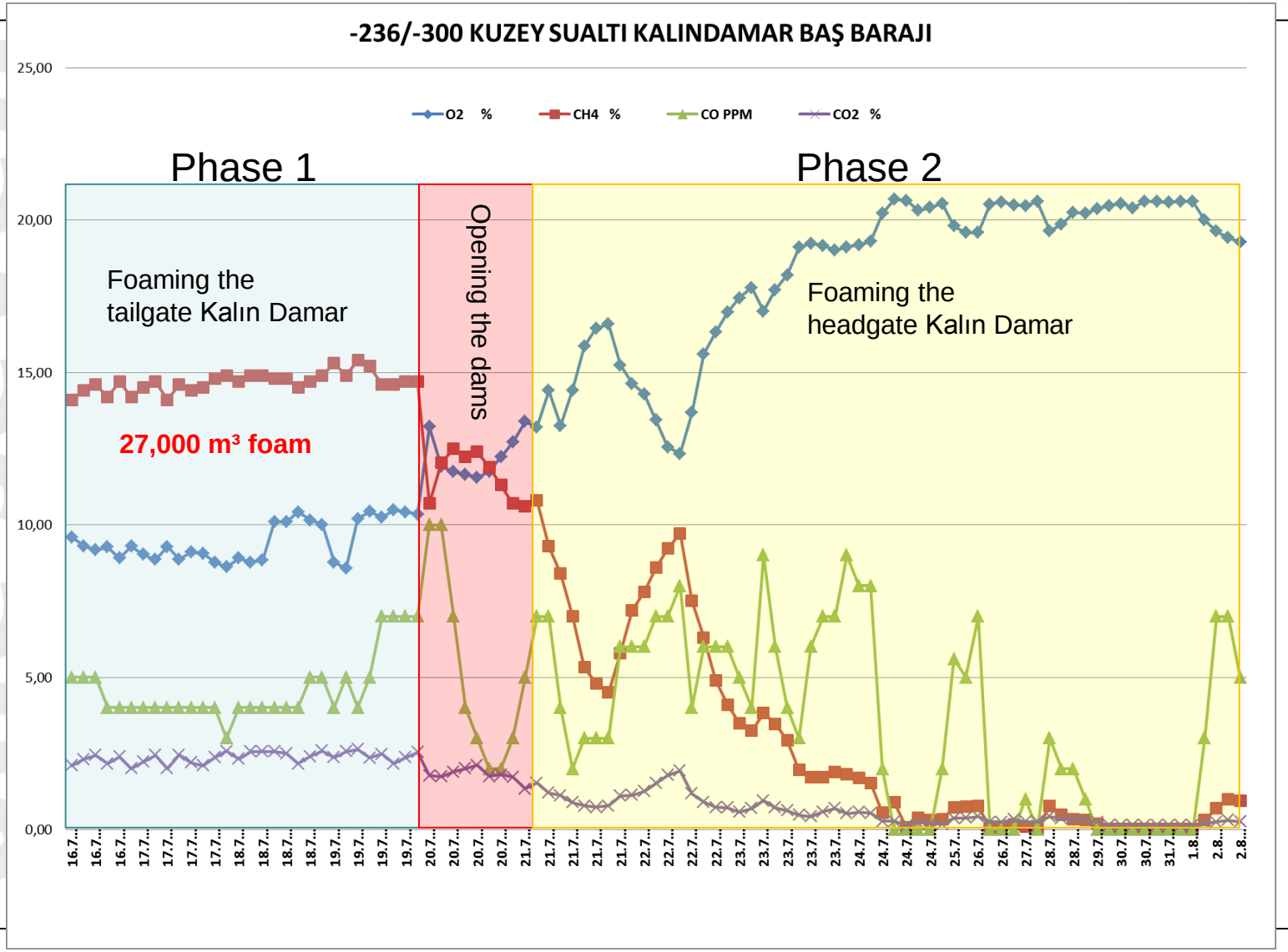
Because the matter is that the longwall face working is in steep formation, the fire-fighting operations have been carried out in **3 phases**:

1. From **07/16 until 07/20** the tail gate gallery was backfilled with foam, which was also the intake airway at the same time, to completely cut off the fire area of the air supply.

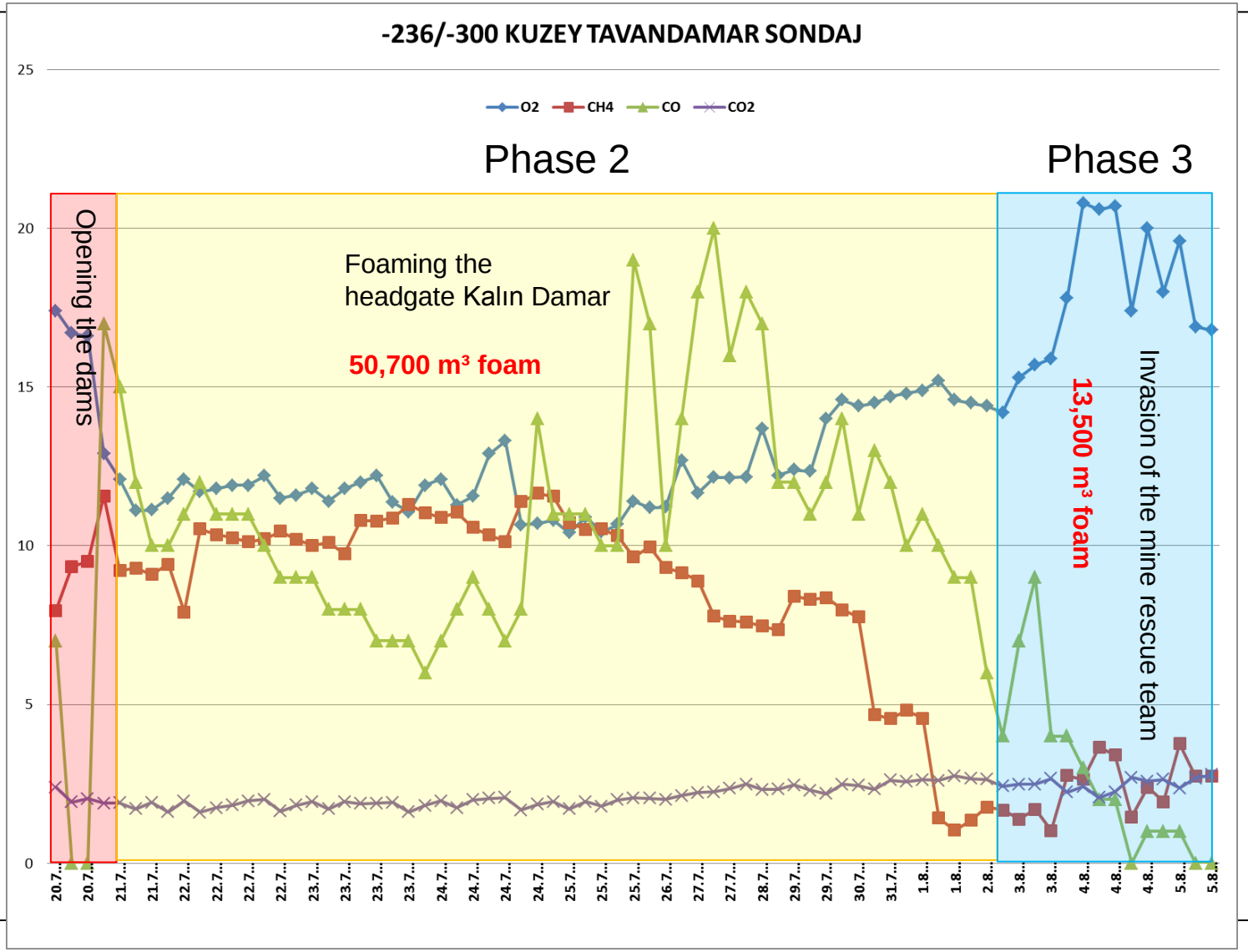
2. After the machine´s removal to the head gate dam the fire area was completely inundated with foam over the head gate gallery from **07/20 until 08/02**, so that

3. **from 08/03** the mine rescue brigade was able to penetrate under auxiliary ventilation and continuous carrying of foam into the fire area.

Gas development during **Phases 1 and 2** at outtaking dam Kalın Damar



Gas development during **Phases 2 and 3** at borehole #2 in Tavan Damar



Amasra firefighting: Impression after opening the dams

Result of Phase 2: The head gate Kalin Damar is inundated with foam, ventilation engineer and assistant

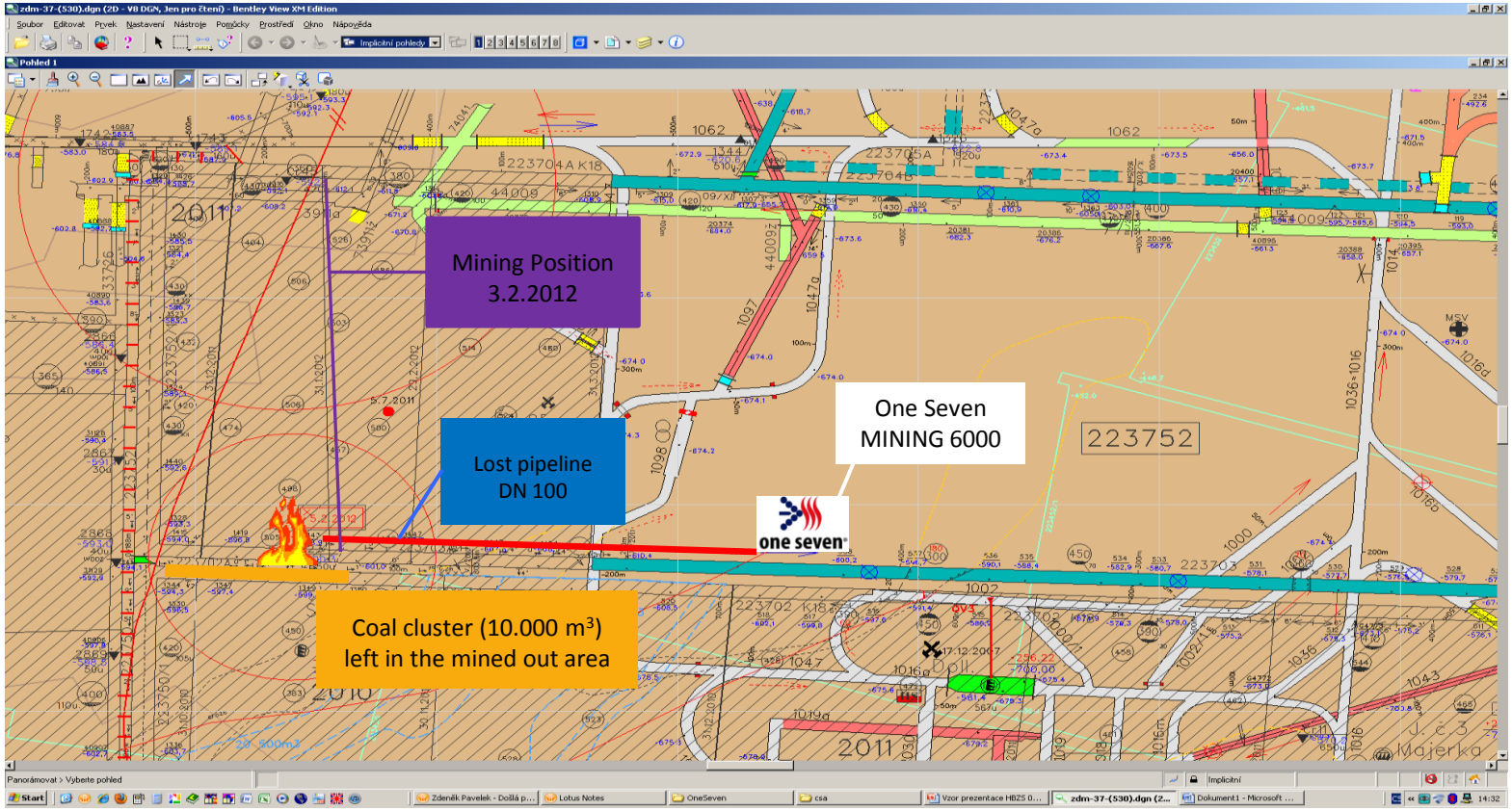
Amasra firefighting: Conclusion

In a **20 days** continuous **engagement** (07/16 – 08/03) a covered mine fire, whose development 5.5 moths lagged, could be extinguished by using a One Seven MINING 6000 machine and the Class A foam concentrate One Seven AM.
A total amount of about **91,000 m³ wet and dry foam** was brought into the dammed fire area. The **water consumption was 4,200 m³**; the consumption of **foam concentrate was 6,320 liters**. This caused **costs for foam concentrate** of about **€ 19,000** at the end.

The longwall equipment was found largely undamaged, which is suggestive of a limiting of the fire in the goaf. The equipment was recovered and prepared for continuing the excavation of the Kalın Damar seam.

2nd reference: Karviná mine, Czech Rep., panel 22 3752 from 02/05 until 02/15/2012

- Consumption of One Seven® Class AM foam was 16,855 Liters (= 10 days contious operation). **Foam costs** of about **45,000 EUR**.



One Seven® MINING: Active firefighting, summary

Extinguishing effects for mining application

•Cooling effect

Temperature reduction by vaporization

•Oxygen depletion effect

Repression of O_2 by foam

•Isolating effect

reduction of air flow by sealing off the goaf and abandoned roads with foam

One Seven® vs Nitrogen Inerting

<u>The disadvantages of Nitrogen Inerting in the mining industry are:</u>

- No fast fire attack possible
  - Complicate preparation, needs time to take effect
- Very expensive
  - Because of preparation, post processing and nitrogen consumption
- Success can not be assured
  - Backfire is possible after renewed contact with oxygen
- Dangerous for the staff. No breathable atmosphere!
- In case of failure: Complete production loss for long time or giving up coal reserves

One Seven® vs Nitrogen Inerting

The advantages of the One Seven® MINING system are:

- Fast attack in case of fire is possible
- One Seven® is a highly efficient fire extinguishing medium
- One Seven® uses minimal volumes of water
- One Seven® uses minimal volumes of foam concentrate
- One Seven® increases firefighters' safety
- One Seven® allows simple manual handling
- One Seven® foam is harmless for the staff
- Also seams prone for self combustion can be worked out safely
- Prevention from long run-off times affected by self combustion

Thank you for your attention!

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...effective fire fighting systems!