Zipf, Richard K. (Karl) (CDC/NIOSH/PRL)

From: Zdzislaw Dyduch [z.dyduch@gig.katowice.pl]
Sent: Monday, March 12, 2007 5:40 AM
To: Zipf, Richard K. (Karl) (CDC/NIOSH/PRL)
Subject: Re: Draft report on seals

Dear Karl,

First of all, please forgive my late reply caused by my absence at work.

I've read your guidelines with interest and pleasure. I think they are comprehensive and reasonable. Below, there are a few remarks that came to my mind while reading the text.

1. It seems the choice of 50 m as the detonation run-up distance is a very conservative assumption. I don't know how different the cross-sections of your mine tunnels are, but may be it would be more appropriate to use L/D ratio to define the run-up distance instead of the length alone, as is was formulated by the authors you mentioned in the report.

2. Apart from the test No. 1397 we registered another detonation in a dust/air mixture. I'm attaching the wave diagram of the test No. 2399 where the explosion was initiated at the closed end of our 400 m underground entry. Although in the test we used grain dust its explosibility parameters (pmax, Kst) were quite similar to typical coal. We used 10 bar pressure sensors so they failed to register initial peak pressure but I believe the rest of the curve is correct. Comparing to your 4.4 MPa design pulse, the width of initial peak is similar but the pressure reminding behind the peak was higher in our test.

3. As you probably already know, FLACS is not designed for very strong explosions. In FLACS the SIMPLE numerical method is used. The method was designed for subsonic, incompressible flows so basically you should expect smearing of steep pressure pulses. How strong the effect is manifested depends also on how fine grids you used. More appropriate for your purposes would be so called 'shock capturing' methods.

4. Among the parameters affecting the explosion strength I would add the complexity of the geometry of the sealed area. Almost all experimental tests were done in straight tunnels, the simplest possible geometries. In real cases the interconnected straight sections form geometries that, together with random locations of explosion initiation, can produce explosions developing in different directions and then further interacting one with another. The interactions may lead to unpredictable pressure rise. For example, I'm not sure that explosion initiation at the closed end will produce the strongest pressure effects. In your FLACS simulations, have you tried to ignite methane at different locations, not only at the points A, B and C?

5. It would be much easier to compare results obtained with FLACS and AutoReaGas if time axes had the same range

Thank you for sending me the guidelines that helped me better understand the problem of sealing abandoned mining areas.

Best regards, also to Mike Sapko and Jurgen Brune

Zdzich
= = = = = = Original message = = = = = = =

>Dear Zdzislaw,
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>I hope all is well with you since our meeting last September. Jurgen
>Brune and I have been very busy completing our report on seals.
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>Attached is a copy of the NIOSH draft report entitled, "Explosion
>Pressure Design Criteria for New Seals in U.S. Coal Mines." I thought
>you might be interested in having a draft copy.
>
>This report addresses two critical issues: 1) what explosion pressures

>can develop during an explosion within a sealed area?, and 2) what are
>appropriate design criteria for seals that will withstand these
>pressures?
>
>Based on fundamental knowledge of explosion chemistry and physics and
>knowledge about sealed areas in mines, NIOSH engineers recommend a
>three-tiered explosion pressure design criteria for seals in coal mines.
>1) For unmonitored seals where there is a possibility of
>methane-air detonation behind the seal, the recommended design pulse
>rises to 4.4 MPa (640 psi) and then falls to the 800 kPa (120 psi)
>constant volume explosion overpressure.
>2) For unmonitored seals with little likelihood of detonation, a
>less severe design pulse that simply rises to the 800 kPa (120 psi)
>constant volume explosion overpressure, but without the initial spike,
>may be employed.
>3) For monitored seals where the amount of potentially explosive
>methane-air is strictly limited and controlled, engineers can use a 345
>kPa (50 psi) design pulse if monitoring can assure 1) that the maximum
>length of explosive mix behind a seal does not exceed 5 m (15 ft) and
>2) that the volume of explosive mix does not exceed 40% of the total
>sealed volume.
>
>Based on these explosion pressure loads, NIOSH engineers used a dynamic
>computer modeling program and other methods to determine minimum seal
>thickness to resist these explosion pressure loads. The analyses show
>that resisting the worst case 4.4 MPa (640 psi) design pulse is
>reasonable using modern materials. For example, a 6.1 m (20 ft) entry
>that is 1.5 m (60 in) high requires a 0.9 m (36 in) concrete seal,
>whereas a 2.4 m (96 in) high seam would require a 1.2 (48 in) concrete
>seal.
>
>The report also provides an alternative to these worst-case scenarios,
>if the atmosphere behind the seals is monitored and inerted, as is done
>in many mines abroad. In that case, seals to withstand a pressure of
>345 kPa (50 psi) may be adequate.
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>If you have any thoughts on the report, please let me know.
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>All the best,
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>Karl Zipf
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