Step into our TestSafe Time Machine and revisit some of the amazing things that we have done over the years.

Explosion Test on Emergency Airbags

by Les Golder, Senior Electrical Technical Officer, TestSafe Australia

In 1990 Earth Resources Australia Pty Ltd received a NERDDC research grant to investigate the potential use of inflatable airbags for underground mines. This was envisaged as an alternative to semi-permanent stoppings found along the headings for retreat longwall operations, or as a quick means of temporarily sealing an underground 'roadway' in coal mines.

As part of this investigation, TestSafe did experiments to determine whether these airbags could stop an explosion propagating past such temporary barriers.

It has the only facility and expertise in Australia to conduct this type of research.

During an explosion, the airbag could behave in several ways depending on the strength of the explosion. If the explosion was strong enough the airbag would rupture. If the airbag was to be used to suppress such an explosion it would have to contain quenching agents in such a way that they would be effectively distributed by and in front of the explosion. The airbag would have to act as a passive barrier. For a small explosion, i.e. one that produced very little overpressure at the airbag, it might be possible that the airbag would contain the explosion.

At an intermediate strength, the airbag might not rupture but move along the mine roadway allowing the explosion to propogate past this type of barrier. If the inflatable barriers were to be used as an emergency barrier where secondary explosions are a real threat, then the behaviour of these barriers in an explosion needed to be examined.

TestSafe undertook two series of experiments using the 50m explosion gallery. In the first series of experiments undertaken in February 1990, the main objective was to determine the characteristics of the airbag.

The second series of experiments in October 1990 was undertaken to see whether a better distribution method for the suppressant material would improve its suppression capabilities.

The 50m explosion gallery is a 2.4m diameter concrete pipe set in post stressed concrete underground with a concrete floor to roof height of 2.1m. The gallery was instrumented with six flame detectors (designed and built at Londonderry) mounted at locations in the roof directed towards the centre of the gallery. Each unit comprised an infra-red diode mounted behind a Calcium Fluoride lens. The generated voltage from the detector was amplified on the detector board. The amplified signal was passed to a computer interface via individually shielded cables.

Six static pressure transducers were mounted in explosion proof housings in the roof of the gallery.

Two computers were used to generate and record the explosions. This was the first time that we used desktop computers to monitor explosions and everything was high tech and state of the art. The entire scientific community was extremely interested in the ground breaking research that we were conducting, especially the instrumentation. By today's standards the computers were slow but back then this was cutting edge technology.
Computer No.1 was a Sperry PC fitted with a sequencer card and interface unit. The purpose of the computer was fourfold:

- To turn the interior camera light on and then off. This light illuminated the airbag under test during the explosion (delay of 0.1s).
- To trigger computer No. 2 which aquired the data from the sensors during the explosion (delay of 0.2s).
- To start the high speed camera.
- To ignite the detonator thus initiating the explosion (delay of 0.3s).

The second computer was an IBM AT fitted with a DAS16 data acquisition board and interface unit. Data was collected on 16 channels at a sample frequency of 64kHz. The number of samples taken was 204800 and the sample duration was 3.2s. The data collection was initiated by a positive pulse generated in computer No.1.

For each experiment in the gallery, the first 9m was partitioned using a polythene diaphramme. This volume was filled with a flammable mixture of methane in air. Two concentrations were used in this series of experiments, 8.5% and 9% methane in air. The volume air was recirculated through a 150mm diameter pipe where the pure methane was added to the flow. A fan on the wall at approximately 8m continually stirred the volume of air ensuring a well mixed gas volume. The methane concentration was monitored using a hydrocarbon analyser calibrated for methane.
One matchhead detonator (ICI) encapsulated in 6 gm Black Powder was fixed 300mm from the inbye end of the gallery at the centerline prior to filling with methane. This detonator was triggered from the firing circuit through Computer No.1.

It took several weeks to configure the gallery for the first explosion. From the attached pictures you can see all the interested parties around the open end of the gallery waiting for the first test. It should be pointed out here that visitors have never been allowed to stand in this position since this explosion. We hadn't established yet how much pressure was required to inflate the bag so we erred on the side of under inflated. We thought that this would be better than splitting the bag and wasting a lot of time with the important dignitaries patiently waiting for the big event.

Due to technical problems and delays we were not able to have a rehearsal, so this demonstration was to have a totally unexpected result.

What was supposed to happen was either the bag would stop the explosion propagating out of the tunnel or the bag would split and the stone dust that was packed into the pockets in the bag would be dispersed in a 10m radius outside of the tunnel entrance.

What actually happened was that the explosion blew the bag out of the tunnel intact and rotating at high speed. The stone dust was literally thrown out in all directions from a reasonable height and the bag eventually emerging from the cloud to land some 50m away.

There is no fourth photograph because, due to the prevailing wind, the dust cloud then came straight back at the audience

who made a hasty retreat. Several of the dignitaries who had never seen or been close to a full scale explosion before were so enthralled by the occasion that they forgot to move.

For the rest of the day we had three or four visitors doing a reasonable impersonation of snow men.

There were approximately 20 explosions in the first series. We tried every different type of configuration we could derive from single and double bags to stone dust and water as quenching ageants.

The second series of explosions in October were based on the results of the first but we added variations on the suppressants. These included filling half the gallery with high and low expansion water based foam and vermiculite (kitty litter). It is amazing how far you can spread 500 kg of kitty litter when you ignite 60 cubic metres of methane/air behind it.

This was one of many research projects that were conducted on our premises over the years. We enjoyed an excellent reputation nationally and internationally in the scientific community and our work was recognized and published in the worlds leading scientific journals.