

# ***BHSEA Meeting, 9<sup>th</sup> November 2009***

## ***DSEAR with a BANG***

**(Presentation by Roy Smith, Managing Director, Denios Ltd.)**



Roy Smith surrounded by the paraphernalia of his 'Big Bang'!

In keeping with the early part of November, this presentation was intended to go “**with a bang**” and Roy did not disappoint us, as ear defenders were the recommended PPE during the next hour or so! He was also our first speaker to come equipped with his own explosion-proof safety enclosure! Roy started with a brief introduction to the Dangerous Substances Explosive Atmosphere Regulations 2002 and placed them in the context of related requirements for Risk Assessment, Welfare, PPE and COSHH. He emphasised, with particular reference to Explosions, the additional legal sanction posed by the Corporate Manslaughter Act in serious incidents. However, he voiced the opinion that the more recent Health and Safety Act would probably have more impact over a wider range and greater number of lower level offences because of the increased fines in Magistrates Courts up to £20,000 and prison terms up to 12 months. It was also not appreciated widely, that the Water Resources Act, with penalties of up to a £20,000 fine and/or 2-year prison sentence, was an additional sanction in the context of DSEAR. This was a distinct possibility if an explosion or fire resulted in pollution of neighbouring watercourses!

He went on to say that the basic requirements of DSEAR were for employers (and self-employed persons, who are considered to be Employers under DSEAR) to assess risks from dangerous substances and eliminate, or reduce them. This process involves implementing control measures, introducing risk mitigation and preparing incident and response planning. Importantly, they also have to identify places where explosive atmospheres may occur (the ‘ATEX’ requirements). As with all other regulation, the provision of information, instruction and training for employees is a vital necessity.

Roy then went on to deal with the effects of water pollution in more detail. He quoted the Sandoz Chemical Company fire near Basle in 1986, during which a cocktail of about 30 tonnes of very toxic chemicals were washed into the River Rhine by the firefighting! This polluted 20 kms of the Rhine and killed all the fish, before flowing 200 kms through four countries into the North Sea. It is considered that this pushed back pollution control by ten years in the area and showed how the consequences of a fire can have disastrous effects. He added that this single incident gave birth to the foundation of the DENIOS Group!



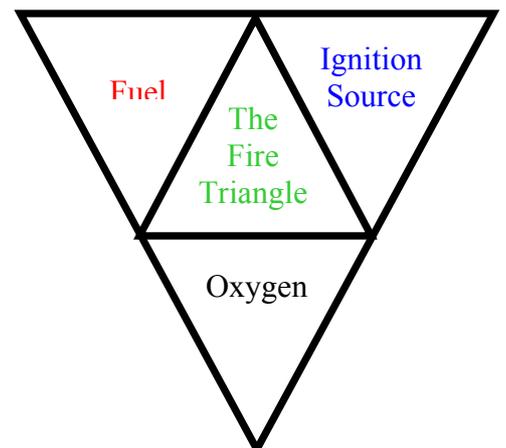
**David Hughes passes water sample fit for drinking!**

He illustrated how a small drop of water could be easily detected in a beaker of water with an audience test to distinguish between one contaminated and one uncontaminated sample. BHSEA Member David Hughes had no difficulty with this trial! Roy added that 1 litre of oil makes 1 million litres of water unusable as drinking water and described how apparently innocuous spillages from lawnmowers or chainsaws could contaminate ground and

the water for many years! Such pollution is a criminal offence under the Water Resources Act 1991 and, he cautioned alarmingly, serious spillages attracting large clear-up costs might not be covered by insurance if the storage was deficient!

The **Environment Agency Pollution Prevention Guidelines (PPG26)** gives good guidance on chemical storage, with a calculator to estimate the size of sumps or bunds relative to the size of primary containers to prevent contamination of drains, boreholes or watercourses. This calculator requires that the sump must hold 110% of the contents of the largest container OR 25% of the total volume stored, where there are more than four containers. One exception to this rule is for Agro-chemicals when the sump must hold 185% of the largest container! PPG26 also specifies the corrosion resistance of the sumps, with regard to the nature of the chemical being stored. For instance, Roy said, solvents should be stored over galvanised steel, whereas acids/alkalis required polyethylene containers.

Roy then addressed the matter of Fires and Explosions, which he said cost an average of £100,000 each for the 200 primary fires occurring each year. He reminded us of the principles incorporated into the Fire/Danger Triangle and went on to address their significance. Common Ignition sources were Hot Surfaces, Naked Open Flame, Static-Electrical Discharge, and Mechanical or Electrical Sparks. One source that was often missed is Exothermic Reaction, which is often uncontrolled. He added that static electricity generated on certain



types of man-made fibres in personal clothing or workwear could also be a source of ignition that was overlooked in risk assessments.

Regarding the Fuel element, Roy addressed significant safety parameters of flammable liquids, which were a significant cause of fires and which divided into these three primary categories: -

**A. R10 – Flammable Liquids**

Liquids with a Flashpoint  $\geq 21^{\circ}\text{C}$  and  $\leq 55^{\circ}\text{C}$ , which support combustion when tested at  $55^{\circ}\text{C}$ .

**B. (F) R11 R15 R17 – Highly Flammable Liquids**

Liquids with a Flash Point  $< 21^{\circ}\text{C}$  but are not classified as Extremely Flammable

**C. (F+) R12 – Extremely Flammable Liquids**

Liquids with a Flash Point  $< 21^{\circ}\text{C}$  and with a boiling point  $\leq 35^{\circ}\text{C}$

**Flashpoint** is defined as the Lowest Temperature at which vapours are given off in such quantities that, when mixed with air, combine to form a flammable mixture. Some examples are: -

Diesel	<b>55°C</b>	Petroleum Ether 40-60°	-
			<b>30°C</b>
Alcohol	<b>12°C</b>	Turpentine substitute	<b>38°C</b>
95 Octane	-	(Bottle not marked	
Petrol	<b>40°C</b>	flammable)	

The next critical Safety Parameter is the Auto Ignition Temperature. If the surface temperature of a flammable substance rises above the Auto Ignition Temperature, then the vapour pressure of the flammable substance becomes so high that the arising gas-air mixture self-ignites without external assistance. The table below gives examples for the selected liquids: -

	<b>Auto Ignition</b>	Flash Point		<b>Auto Ignition</b>	Flash Point
Diesel	<b>260°C</b>	55°C	Petroleum Ether 40-60°	<b>250°C</b>	-
					30°C
Alcohol	<b>420°C</b>	12°C	Turpentine substitute	<b>210°C</b>	38°C
95 Octane	<b>450°C</b>	-	(Bottle not marked		
Petrol		40°C	flammable)		

Roy commented that it was interesting to note that the one liquid that was not marked flammable was the liquid with the **lowest Auto Ignition Temperature**. However, most people's perceptions of the danger from this substance would **suggest** that Turpentine was **not** the most dangerous liquid in a room heated by a fire with a potential temperature of **1100 °C!**

Roy then examined what happens, when the equilibrium of the fire triangle is altered, by looking at the effect of introducing industrial gases into confined spaces. Most of these gases have a density greater than 1.28 g/litre at 25°C and 1 bar pressure, so that they sink to the deepest accessible level and slowly replace the normal breathable air mixture. Whilst this is beneficial for fire prevention, if it happens to be Carbon Dioxide (CO<sub>2</sub>), because it is also odourless there is a real risk of asphyxiation! On the other hand, in the case of Ammonia (NH<sub>3</sub>), which is only detectable in high concentrations, not only is there risk of suffocation, there is the added risk of an explosion (Lower explosion limit 15% concentration, Upper explosion limit 28%). To illustrate the point, Roy placed lighted candles on these steps in an open-top box, into which he introduced CO<sub>2</sub> that sank to the bottom and extinguished the lowest flames.



**Introduction of additional gases**

The solution to this problem is to install built-in gas warning detectors, or to use portable instruments AND train workers! Failure to ensure this has recently resulted in a double fatality in a basement from Carbon Monoxide poisoning!



**A mobile explosive gas hazard!**

Another situation that often occurs on building sites is where multitrade working is happening and a worker on upper stories may be using solvents, whilst on the ground floor, 'hot-work' like welding is taking place. Although both workers may be working to adequate risk assessments independently, when their work is carried out simultaneously in the same building the original control measures will not be acceptable. This is because the heavier than air solvents will permeate to the ground floor and create an explosive mixture in the area around the welding torch. This situation needs to be prevented by increased awareness on the part of individuals to the potential hazards around them, better training but, predominately, by the person controlling the overall programme on site, especially when priorities may be subject to last-minute changes from day-to-day! Roy demonstrated this effect very nicely by pouring ether down this tube, towards the naked flame at the bottom to produce another satisfying, but safe, BANG at the top as the flame tracked nicely upwards! He quoted a recent example of this effect in Lincolnshire, where a LPG leakage tracked over 1 mile along an irrigation ditch to a tractor being used on clearance work, which caused an explosion.

Roy went on to describe how the contents of gas canisters like Camping Gaz expanded to 27½ times their volume to produce very explosive mixtures in buildings. A similar risk was also present, he explained, with less obvious sources of 'fuel' when their

surface area was increased in contact with an ignition source. He quoted an interesting example of an old “Constellation” vacuum cleaner that was spherical in shape and hovered on a cushion of air. The bearings on this model were worn and had been liberally dosed with the well-known aerosol lubricant WD40. Unfortunately the user had not appreciated that the propellant in the can was LPG and the vacuum motor ignited the gas on start-up! In addition, a lubricant with an ignition between 21°C and 55°C will begin to burn, even at room temperature, because its surface area is increased as an aerosol. So it is essential to turn off all ignition sources when using combustible liquids and to store them in a safe and secure manner away from all sources of ignition. This effectively turns a can of WD40 into a *flamethrower* although, in the interests of avoiding a libel suit, Roy would like to point out that other combustibles are also available! It is also important to beware of other ignition sources like the motors in hair driers when using hair sprays! The Secretary pointed out that some apparently innocent household appliances, like block storage heaters, could have core temperatures over 320°C, which reacted with turpentine and paint fumes drifting through houses as painting was done!

The same problem can occur if combustible solids and paste-like liquids come into contact with hot surfaces, when the surface temperature exceeds the ignition temperature of the substance. The answer is good housekeeping! Similarly, if combustible dusts are present, good risk assessment should address elimination of the dust at source, elimination hot surfaces, use of ATEX electrical machinery, effective cleaning regimes, or an appropriate combination of all of these measures.

Another source of fire from increased surface area arises if materials like fine steel wool and electrical storage batteries are disposed of in the same waste container. There is often as much as 7% of the energy left in a spent battery, which is enough to



**Contact between battery and steel wool**

ignite steel wool, as Roy showed in this demonstration.

As in so many other examples, the answer to this type of fire lies in good planning of waste disposal to provide adequate separation of materials. Modern environmental protection requirements also demand the same standards, so the incentives to implement all the correct control measures are complementary!

The widespread use of compressed air lines for cleaning machinery is also a means of creating increased surface areas of fuel sources adjacent to hot surfaces, in addition to

creating aerosols that present an entirely different COSHH risk! Even Alcohol hand cleanser, Roy commented, is flammable yet was not always marked as 'flammable'!

The next hazard that Roy spoke about was the problem of Oxygen (O<sub>2</sub>) enrichment, which can often happen unnoticed near processes such as welding from leaking pipes or valves. Many years ago there was the tragic case in the Swan Hunter shipyard where O<sub>2</sub> pipes were left under pressure overnight and exploded as work was started again the next day. Roy explained that our atmosphere contains 21% Oxygen and with an increased proportion of just 3% to 24%, the speed of combustion doubles. It is essential, therefore, to control all processes using Oxygen very tightly to prevent enrichment and ignition from hot surfaces, naked open flame; static-electrical discharge; mechanical or electrical sparks.

Roy continued with a demonstration of several attempts to ignite varying quantities of Petroleum Ether in a 500 ml. conical flask, first 2, then 5, 10, 20 and, finally, 30 drops to illustrate how the % volume of liquid affects its explosive potential. Two drops proved to be too 'lean' a mixture, whereas 5 drops provided an ideal formula for a big bang. At the other extreme, 30 drops did not support an explosion, but it did provide enough fuel to present a serious fire risk. This series of tests proved that two drops were below the **Lower Explosive Limit**, the 30 drops were above the **Upper Explosive Limit** and the other quantities presented an explosion risk! Roy went on to say that 20 ml. of combustible liquid evaporates to a 205-litre drum of ignitable mixture, so that drums had to be cleaned extremely carefully before they could be considered safe. Relating to work practice, supposedly empty drums should be rinsed out with water and then taken to the waste disposal but empty vessels, he warned, that are not completely cleaned of combustible liquids can be assumed to contain explosive atmospheres. Therefore it is not safe to subject them to welding, grinding, or use of cut-off wheels.

Coming back to the risk from combustible Dusts, Roy identified Coal flour, wood, food grains, sugar, certain metals and synthetic organic chemicals as the main culprits. He said that if dust was disturbed and came into contact with an ignition source there is a risk from a serious explosion caused by particles < 0.5 mm. Very often, he added, a Primary Dust Explosion occurs, which disturbs more dust into the atmosphere that, in turn, fuels an even larger explosion! In the course of a risk assessment, any **explosive atmosphere** above a quantity of **10 Cu litres** should be considered highly dangerous. Independent of the number of persons employed, an explosion protection document should be issued to all persons and in-addition, all persons should be made fully aware of the potential of Explosion and Danger.

Roy then went on to destroy some complacent myths about the effectiveness, or otherwise, about storing flammables in the workplace. The old BS476 for single skin cabinets provided 30 minutes delay protection – in theory. In practice, it was really only about 2 – 3 minutes for a daily usage quantity of up to 50 litres. So, if you rely on a cabinet that has been in your building for some years, you may be in for a shock if you have a fire! Roy outlined the new HSE position on storage in cabinets, but said that this is still subject to significant improvement by the new EN-BS 14470 pt1 Fire

Cabinets, where the *actual* protection is 30-90 minutes and up to 250 litres can be stored in any one cabinet. The cabinet includes standard design features, including auto-close vents, auto-close and lock doors and fusible links and are standard design features in the DENIOS range.

Roy concluded with a reference to the imminent EU standard for External Cages, which required 90 minutes fire protection between the stored materials and the occupied building. It is common to see existing external cages fixed directly to the building.

In conclusion, Roy mentioned a replacement for Halon produced by the 3M Company, called Novec 1230, which had the added advantage that it could be used in occupied areas.

All members of the audience were provided with a Denios Hazmat Manual and product catalogues that provided excellent back-up to the solutions demonstrated by Roy in his presentation. And there were no reports of hearing loss by any members of the audience!

Ed Friend closed the meeting and thanked Roy for a truly amazing presentation, which was reflected by hearty the round of applause from the members.