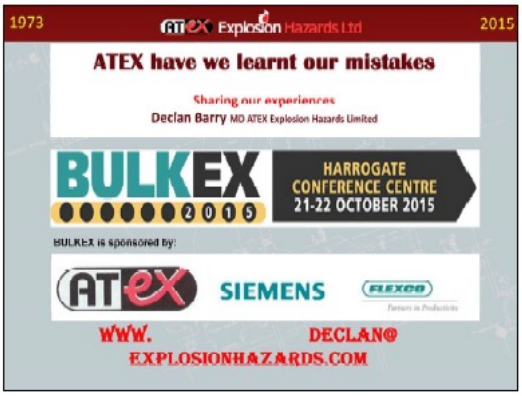
ATEX have we learnt from our mistakes?

ATEX may be relatively new and it has created a great awareness of Explosion safety but the incidents are not just historical. First recorded dust explosion in Italy 1785, the closure of Sonae in 2012 & the Bosley incident 2015 is still a current news item. We need to get the message across of the simple priorities of how to make your plant safe, through examining the incidents from our past. We may identify our hazards, zones, ignition sources, equipment and carry out risk assessments. Is ATEX really a normal part of the materials handling regulatory experience, once the Explosion Protection Document is filed away? Life's experiences, sharing our stories have more impact than regulations.

Welcome back to Harrogate, this time called the MHEA BULKEX2015 Conference

The title of my presentation is:

ATEX have we learnt our mistakes- Sharing our experiences

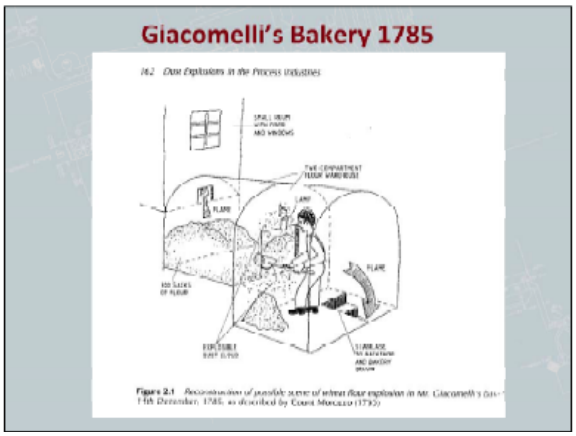


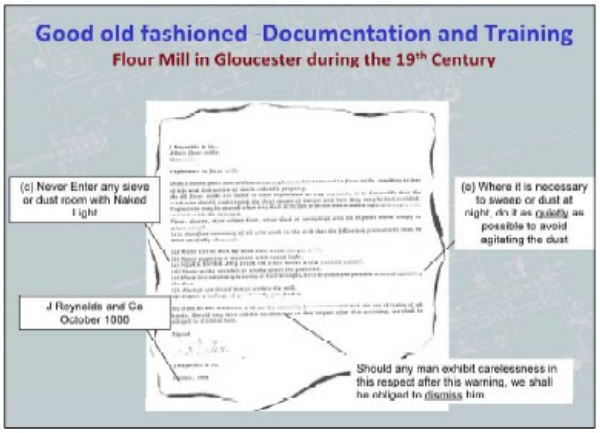
I am Declan Barry MD of ATEX Explosion Hazards Limited based in the UK and Ireland. Explosion Hazards has provided Explosion Safety Solutions to industry for over 42 years

ATEX Group HQ moved into a Canadian Army base in Germany, while ATEX Explosion Hazards Limited UK recently moved offices from Lymm to a bigger premises in Warrington, we are part of an international group of companies around the globe.

Older Experiences:

Some of you may remember when this incident was headline news in Italy 1785. The earliest Dust Explosion recorded. This boy had his face and arms scorched. It blew out the windows and their frames into the street. Another boy saw the flame coming from across the warehouse and jumped off a scaffold and broke his leg. The accident was reported to be due to the dryness of the corn, as there had not been any rain for the last 5 to 6 months in the Piedmont area of Italy. Of course if he had not been shovelling corn dust under a naked light?!.....





An early example of an Explosion Protection Document is J Reynolds & Sons from 1888. They had left a poster on a pillar which was found during its demolition. Never enter any sieve or dusty room with a naked light. Where it is necessary to sweep or dust at night, do it as quietly as possible to avoid agitating the dust. Should any man exhibit carelessness in this respect after this warning, we shall be obliged to dismiss him.

Modern Equivalents:

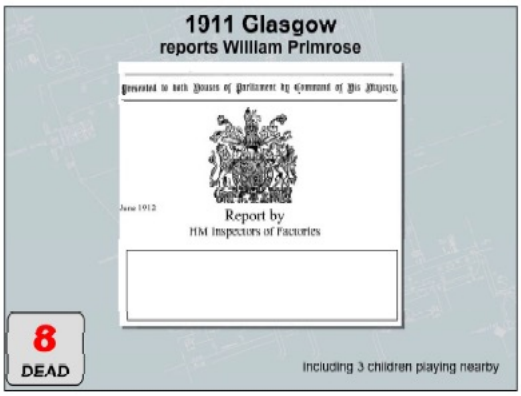
In the late 1970's a similar incident happened inside on the floor of a flat bottomed spray drier. Operator went in to clear out a blockage with his shovel, brush and a halogen light on a stand but the glass lens was broken. Similar to the 1785 incident he saw the flash in the lamp jumped back thought the open door and ran down the gantry realising the flame was followed him, he jumped over the hand rail to the tiled floor below and broke his collar bone, he received no burns.

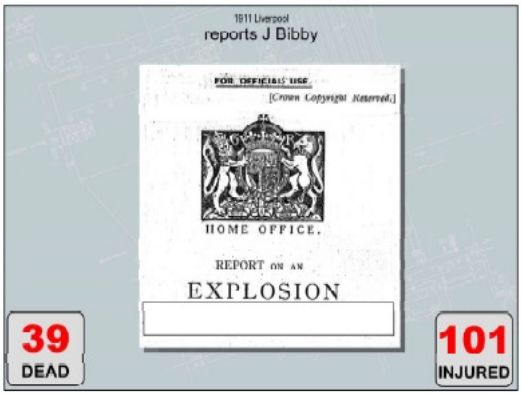
ATEX guidance 137 states that "Only vacuum cleaners containing no ignition sources may be used for flammable dusts". Cleaning processes in which dust is raised into suspension should be avoided. The practice of blowing away deposited dust should be avoided.

On 7 February 2008, an explosion, possibly caused by static electricity igniting fine sugar dust that had become too dry, at a Imperial Sugar refinery Port Wentworth, Georgia, killed 14 people and injured over 42. They had enclosed the bottom of the silo conveyor to prevent spillages, which subsequently blocked and acted as a confined path way for the propagation of the flame throughout the plant. This was the initial explosion path but the consequent fuel was provided by an un-clean plant and operators blowing down their machines with compressed air.

Historical UK reports

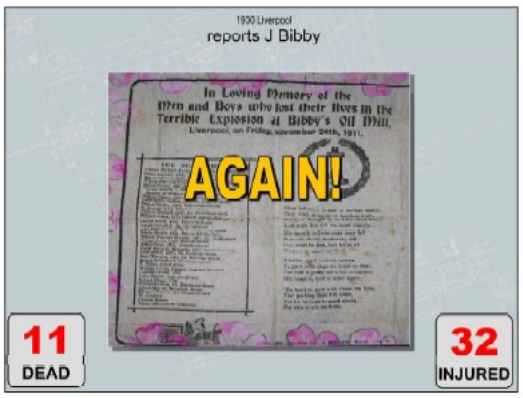
William Primrose and Sons Ltd operated a provender mill in Glasgow which exploded on the 10th Nov 1911, killing 5 people including 3 children playing nearby. Their grinding process was very dusty and had no dust collection system. The room was lit by naked gas lights, and one was on such a long rubber hose that it could be moved around the room. Dust accumulations on the beams were not cleared adequately.





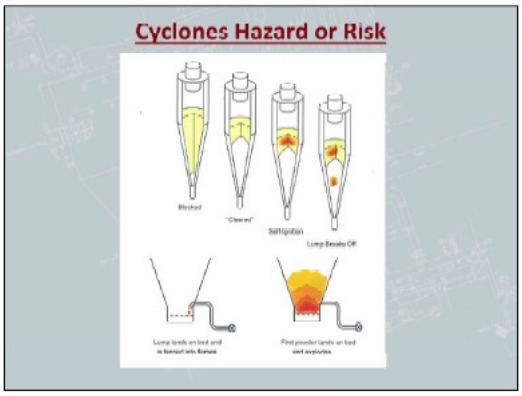
Exactly two weeks after the Glasgow explosion, the premises of J Bibby and Sons in Liverpool experienced the same fate, only this time the toll was 39 dead and 101 injured, figures hard to imagine in factories which today run with such minimal labour. Bibby's were a more go-ahead firm, with electric lighting and a sprinkler system. They handled cotton cake and assorted meals. The machinery was belt driven, and the official report supposes that a dust cloud was formed when a belt broke. The ignition source was not possible to identify with certainty, but matches and electrical equipment were the most likely cause of the spark.

Bibby's managed it again in Liverpool in 1930, when an explosion in the top floor of a silo building killed 11 and injured 32. Rice flour, sunflower seeds and soya bean meal were used in the processes. Self heating of the sunflower seedcake seems to have been the cause of an initial fire, but the heat spread between silos, and initiated an explosion, when hanging dust fell, while an adjacent silo was being emptied. Among the recommendations was 'the provision of recording thermometers on the silos.



NFPA 654 –guidance: Provide access to all hidden areas to permit inspection. Clean dust residues at regular intervals. On February 20, 2003, an explosion and fire damaged the CTA

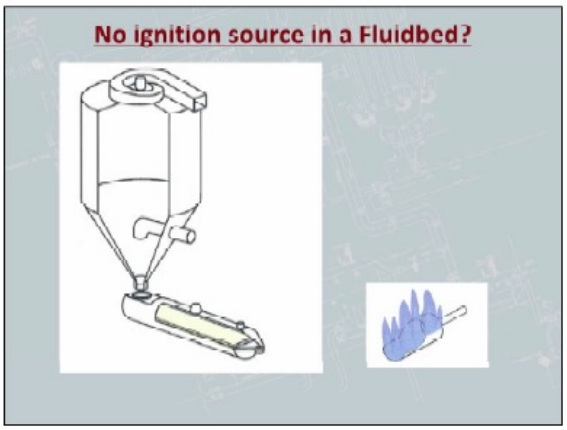
Acoustics manufacturing plant in Corbin, Kentucky, fatally injuring seven workers. The facility produced fibre glass insulation for the automotive industry. CSB investigators have found that the explosion was fuelled by resin dust accumulated in a production area, likely ignited by flames from a malfunctioning oven. The Workers had a clean plant below the false ceiling but the aspiration systems was extracting dust laden vapour into the false ceiling plenum, but the duct work above was not connected to the extract grills and the dust precipitated onto the back of the suspended tiles. An oven explosion disturbed all the dust over head and the extract system drew the flames into the ceiling void above. This caused a catastrophic factory explosion.

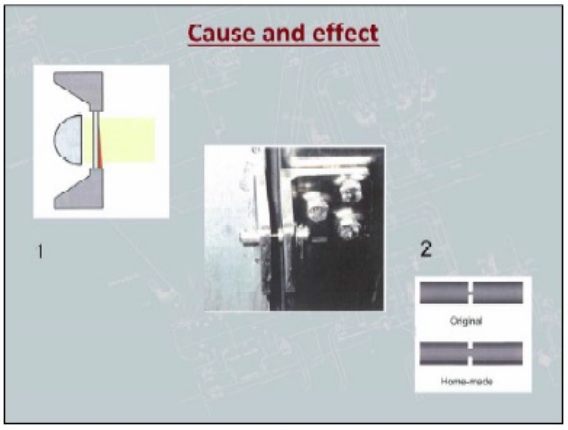


Massachusetts had a Fire in a foundry shell molding machine. This caused a primary explosion in ducts which containing heavy deposits of Phenol formaldehyde resin dust. This resulted in a dust cloud from the ledge dust deposits outside the ducts and a secondary explosion in the plant area.

A Dryer run was stopped because of a badly blocked cyclone. Operator did not clear the cyclone properly and after 6 hours the powder self-ignited. During a subsequent start up lumps broke away to a rotary valve in the fines return & to the integrated Fluidbed which caused a small explosion which over a 25 second period created 3 larger explosions in the drier chamber. 3 out of 16 vent doors opened, socks and cyclone top blew out knocking the plant down for several days, and thankfully there were no injuries.

Flames used to sterilise the sampling equipment. A stainless steel powder scoop was sterilized by spraying it with alcohol and then setting it alight. Because the flame was almost invisible when the operator tried to blow it out and while it was still burning, the scoop was inserted into the socket on the Fluidbed drier setting off a dust explosion.





1. A halogen light was mounted very close to a sight glass in the dryer chamber. Powder gradually built up on the inside of the glass and heated to self ignition temperature. Powder then ignited a dust explosion in the chamber.

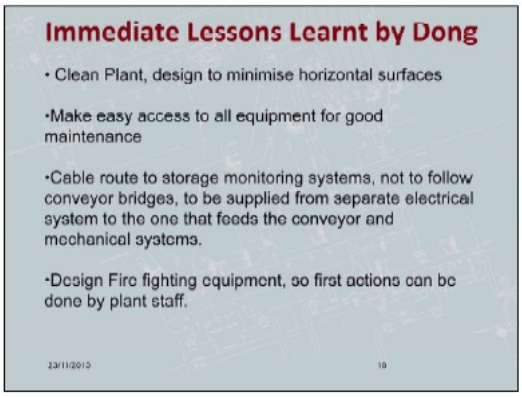
2. A dust explosion took place in a dyer chamber. Only one of the 3 explosion doors opened. The reaction force from the inadequately vented explosion blew the chamber about 300 mm out of the round breaking the welds joining the stringers and the inner skin, The chamber had to be replaced luckily there were no injuries. Shear pins holding two of the three explosion doors were home-made, from turned down ½ inch bolts. These proved to be much too strong and only one door opened. The reason for the use of the stronger shear pins was that when the exhaust fan tripped the over-pressure from the supply fan would often pop one or more of the explosion doors. This created a mess and a hygiene hazard.

A company manufacturing a washing powder had a powder Explosion suppression system installed that had fired, in their opinion spuriously, over 20 times over the previous few years. As the suppression system normally fired on plant start up, they decided to disarm the suppression system during start up! Over the weekend the filters had not been cleaned and the bags had a smouldering fire, which when disturbed by the first hit of the reverse jet filters ignited a dust explosion which destroyed the unprotected filters, propagated into the unprotected cyclone, then into the unprotected chamber. The chamber atomizer jumped to great heights through the roof landing back on top of the chamber roof and the walls of the building were blown out. Fortunately the workers were on their tea break so there were no injuries. At this time there were chemical engineers on staff, 3 different suppression systems on trial with the expertise of their various firms giving advice and an external explosion consultant had issued reports on potential solutions.

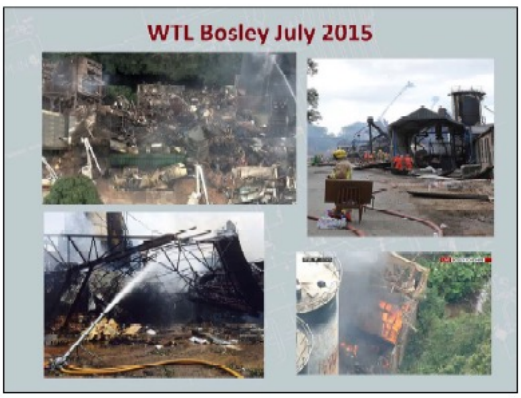
2015 Updates:

Last year I reported on incidents up to 2014, Curtis Furniture Leeds, Explosion in filters flame propagated back in to the factory, Egger Hexham multiple events, a wood burning biomass incinerator June 2013 plus a silo explosion a few weeks ago.

RWE Tilbury, Dong Powers Avedore station Copenhagen were other events and James Jones Timber where the firemen came on site with a high pressure hoses which disturbed the powder and caused an explosion.



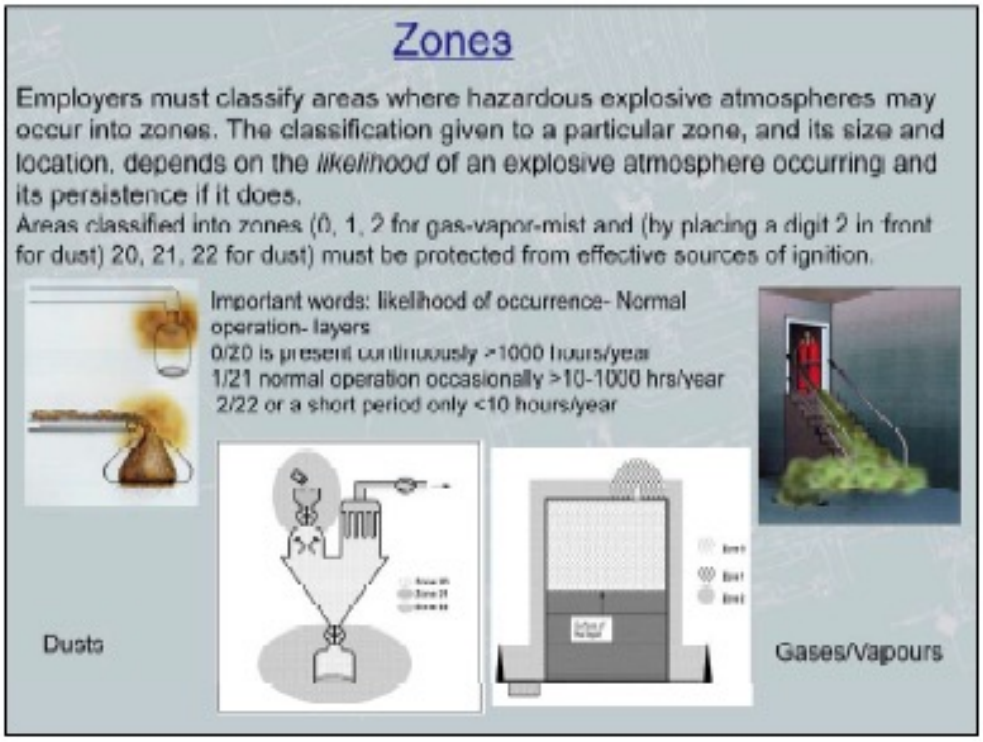
In the recommendations from the most comprehensive Dong report we see the usual suspects. Clean the plant, make access easy for good plant maintenance, specific to that incident where the conveyor dropped a roller and the belt went on fire. Do not route your monitoring systems in the same route as the potential hazard. Co-ordination with your local fire service is essential.



In the UK the most recent tragic event at Boden Wood Flour Mills in Bosley Cheshire this July where the site was also struck by fires in 2010 and 2012. Wood was processed at the plant into a fine powder and the resulting "wood flour", with a consistency like sand, is used to make laminate flooring. Only day's later search teams had found the remaining bodies under the rubble. This highlights the need for closer scrutiny of wood as an explosive dust, especially as the larger power plants convert from coal to wood pellet biomass. The initial reports unqualified are complaints about the cleanliness of the plant, maintenance of the mills.

1. A worker at Adams foods in leek, Staffordshire, suffered facial burns in a powder explosion at the food factory assembly line on August 14th.

2. A collapse and fire at an Omaha plant in the USA which makes supplements for animals has injured at least 10 people and killed at least two. The Omaha Company has been fined at least twice before for safety violations, according to OSHA.



For Dusts at Lower Explosion Level of 30g/m3, if you cannot see the hand on the end of your arm then the atmosphere is explosive.

Ask how many times per year, does this happen in this zone.

Zone 20 inside the mills, pipes, continuously dirty side of the filters >1000 hours per year.

Zone 21 inside dirty filters occasionally, discharge points and their immediate areas 10 to 1000 hours per year.

Zone 22 ventilation points or areas of potential leaks like a bagging plant but only for a very short periods >10 hours per year.

If you are standing in a Zone 20 area and you can't' see your buddy for the dust, then what's going on?..... One of the most important part of the explosion consultants reports is to deal with zoning, yet how many of the previous incidents can be solved with just zoning.

Explosive atmosphere	Zone	Category	Ignition source
Continuous (old >1000hrs /year)	0/20	1	none with rare malfunction
Occasional (old 10-1000hrs /year)	1/21	2	none with malfunction
not likely (old >10hrs /year)	2/22	3	none in normal operation

It is important to choose the correct equipment for the proper Zone or explosive atmosphere.

Here we have a list of ignition sources in ATEX 137. This is all well and good on paper but how do we convey this to the work place?

Standard EN 1127-1

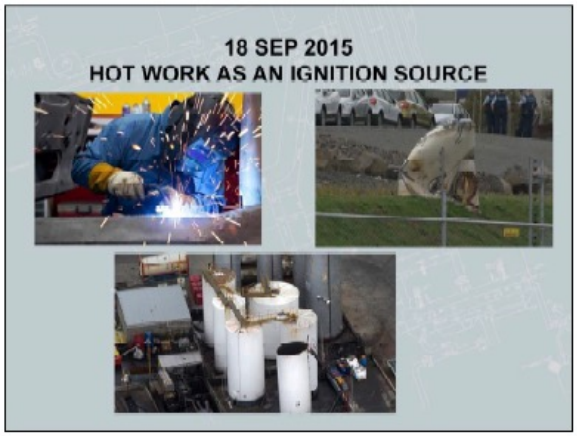
14 types of ignition source:

1. hot surfaces
2. flames and hot gases
3. mechanically generated sparks
4. electrical apparatus
5. stray electrical currents, catrhodic corrosion protection
6. static electricity
7. lightning
8. electromagnetic fields in the frequency range from 9 kHz to 300 GHz
9. electromagnetic radiation in the frquency range from 300 GHz to 3 x 106 GHz or
10. wavelength range from 1000µm to 0.1 µm (optical spectrum)
11. ionising radiation
12. ultrasonics
13. adiabatic compression, shock waves, gas flows
14. Chemical reactions.

In this case we can see that the cause of the explosion may have been welding!

Two contractors were on site, measuring some walkways….One decided to carry out some welding, without permission, causing a tank to explode.

Part of an exploding fuel tank had landed in a nearby yard, as the blast blew out all the windows at this waste disposal site.

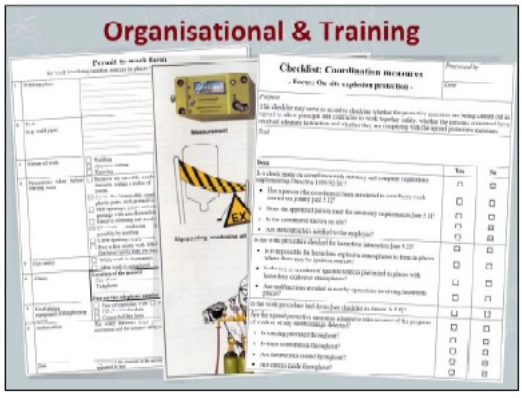


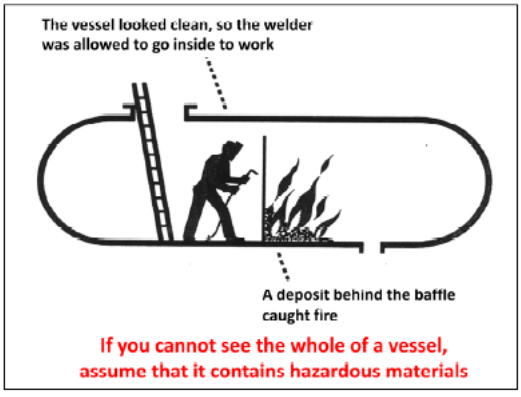
September 23 when two different explosions occurred in a biomass power plant in Borssele, Zeeland, the force of the explosions had ripped off much of the cladding from the side of the building, and several flaps were still hanging loose. Two explosions at a biomass-fired section of a mainly coal-fed plant have left four people injured, as work on dismantling the plant, owned by utility company EPZ, got under way. The explosions reportedly took place during preparations for the plant's closure, scheduled for next January. There are many similar power plants being dismantled in the UK over the next years hopefully without incident.

<u>If there is a potential risk of an explosion at the workplace, this also implies that the work organization must meet certain requirements.</u>

Organizational measures must be taken where technical measures alone cannot ensure and maintain explosion protection at the workplace.

In practice, the work environment can also be made safe by combining technical and organizational measures.





Worker competence: The employer must provide those working in places where explosive atmospheres may occur with sufficient and appropriate training with regard to explosion protection. Are your workers properly trained, this includes management to the highest level.

Worker supervision: In working environments where explosive atmospheres may arise in such quantities as to endanger the safety and health of workers, appropriate supervision during the presence of workers must be ensured, in accordance with the risk assessment, by the use of appropriate technical means. Why in the earlier welding incident was this contractor on site welding when he was only authorised to measure and who was supervising him.

Permit-to-work system: If work liable to cause an explosion is to be carried out in or near a *hazardous place*, it must be authorised by the competent person with responsibility for this function within the establishment. This also applies to activities which may interact with other work to cause hazards. A system of "permits to work" has proved useful in such cases. This may be implemented by means of a permit-to-work form, which all concerned must receive and sign.

In the previous news reports of incidents on our Explosion Hazards website, you will see reports of a welder using an empty fuel drum to use it as a work bench, another cutting an old drum with an angle grinder without investigating the hazard within, decommissioning a cleaned out tank then sending in an operative to cut up the tank walls or pipes within the tank where solvent had leached inside the pipes, causing an explosive vapour during the hot work. Competence is not just about training but should be backed up with experience and responsibility in the relevant industry where the community knowledge (its shared history) builds up, to avoid such incidents. I was recently asked was it OK to cut and weld in a lignite silo while it was still full, by an Engineer who had previously sat beside me at multiple hazop meetings about wood pellets?!

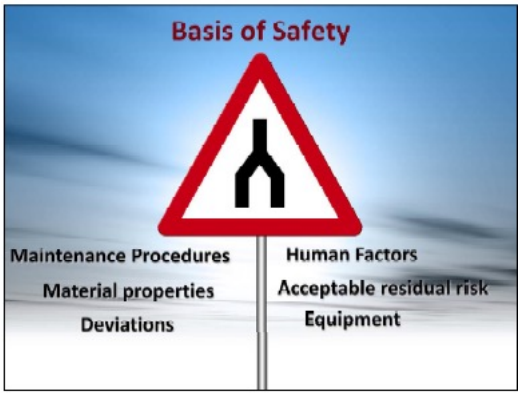
It is important when examining your plant for Explosion Hazards, that you establish your Basis of Safety

Maintenance procedures should be in place to define methods by which equipment and plant can be safely (for the maintenance team and the plant), promptly and economically restored to safe, effective and efficient operating conditions.

Human Factors: Training of maintenance employees should enable tradesmen to undertake maintenance work effectively, so that they themselves are safe and that they do not jeopardise the safety of the plant or the people who work on it.

Material Properties: Identify the Hazard, is it explosive, MIT, MIE, LEL, KST, Pmax, thermal stability,

Acceptable residual risk; Is the risk or danger of an event, despite all the prevention and protection measures applied, acceptable to the organisation's targets for, and approach to safety?



Deviations: Written procedures should be in place which ensures that all modifications are authorised only by competent personnel.

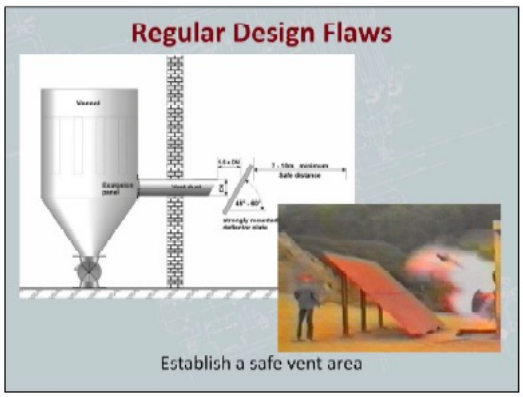
Equipment: Equipment and protective systems in the places where hazardous explosive atmospheres may be present must be chosen in accordance with the categories in Directive 94/9/EC, unless otherwise provided in the explosion protection document, on the basis of the risk assessment.

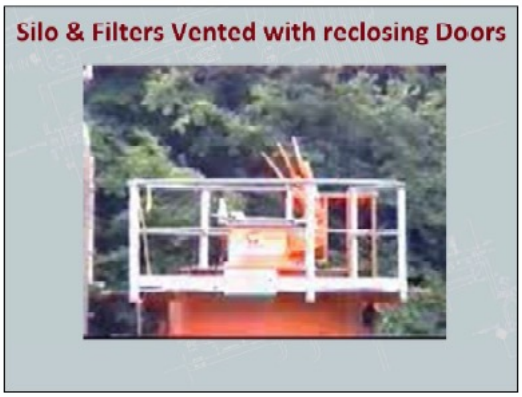
WIDNES chemical firm has fined £80,000 after a 2011 hydrogen explosion

Improvement notice: IN served - r*isk assessment for furnace operations is inadequate for a number of reasons including failure to fully address the risks specific to furnace operations and inappropriate use of "generic" assessment, and failure to consider more reliable control measures in preference to personal protective equipment.* HSE inspector Mhairi Duffy said: "*CatAlloy deals with potentially dangerous substances every day and so it's vital nothing is left to chance when it comes to the safety of its workers*.

Protection

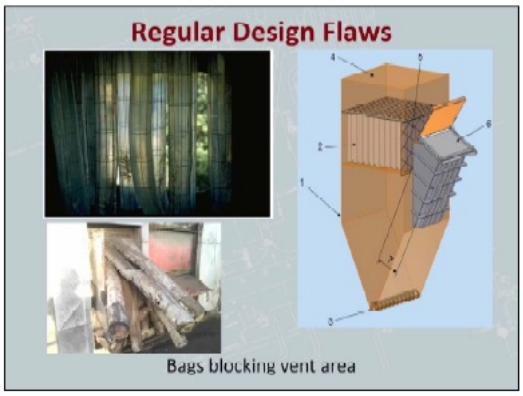
Explosion venting is always the preferred option if you can establish a safe vent area.





Although some modifications can be made to divert the path of dangerous flames they still have practical restrictions which need to be documented and enforced.

A Vented Explosion with self reclosing doors to prevent ingress of air after the event is desirable but expensive.

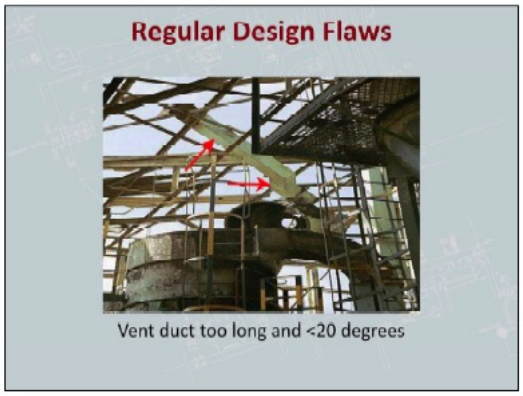


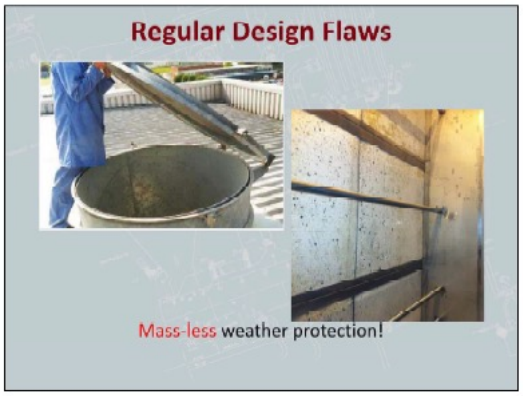
Vented Explosions without self reclosing doors can still have the air influx feeding the original fire and can reduce the effect of e.g. CO2 inerting systems

There are some common design flaws you should check, in any new or existing vent systems. Are the filter bags blocking the natural path of the explosion vent efficiency?

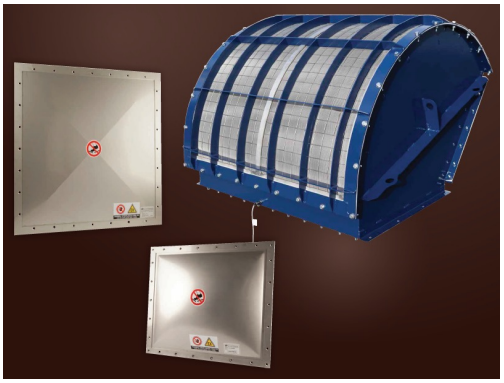
Some filter manufacturers have type tested these arrangements but others have just ignored the restrictions. We have offered, where practical to add a wedge beside the dirty volume of the filter. Although this may increase the dirty volume, it does direct the vent flame vertical, minimising the perpendicular reaction forces and ensuring full unobstructed vent efficiency.

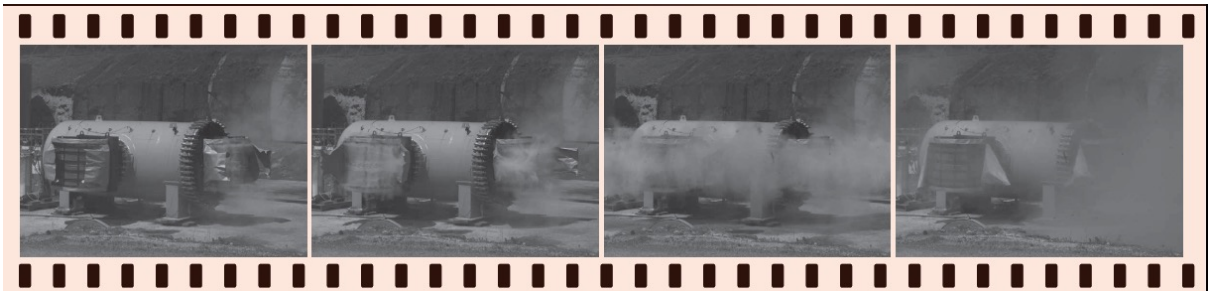
The introduction of explosion vent ducts, to turn the explosion around obstructions or vertically from a normal horizontal path, can create 400% back pressure affecting the vent efficiency or creating dangerous missiles





Low cost rectangular vent panels cost only a few hundred pounds to supply but have to be replaced once fired. Even though you have allowed for vent ducts in the original calculations, many times covers are put on the end of the ducts to prevent ingress of weather or pests. This modification should be done by a competent persons using mass-less covers.





Rectangular vents with the new flameless vents for larger volumes it is a great alternative to explosion venting into a building with-out the dangers of open flame. The important thing to remember is the air is still displaced outside of the flameless vent so if you disturb enough dust outside it may find another ignition source.

Thank you for your attention, do you have any questions?