FIG UK
FIRE INFORMATION GROUP

18 October 2017

MIND THE GAP IN FIRE INFORMATION

FIRE SAFETY: SOME IMPACTS OF THE LAW OF UNINTENDED CONSEQUENCES

Stewart Kidd

Loss Prevention Consultancy Ltd

The Cobra Effect

The government of the Raj was concerned about the number of venomous cobra snakes in Delhi. They therefore offered a bounty for every dead cobra. Initially this was a successful strategy as large numbers of snakes were killed for the reward. Eventually, however, enterprising persons began to breed cobras for the income. When the government became aware of this, the reward program was scrapped, causing the cobra breeders to set the now-worthless snakes free. As a result, the wild cobra population further increased.

Unintended consequences are a feature of many ill-advised decisions but also arise from unforeseen side-effects resulting from technological change.

The Oops! factor will get you every time…

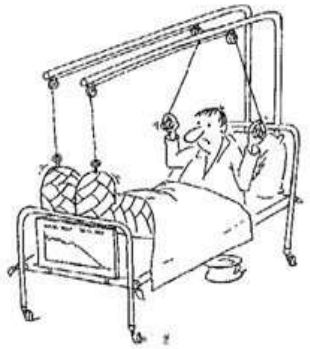
This presentation will review some of the issues which have arisen when new technology was introduced into fire safety and suggests that the lessons which should be learned advise caution when adopting new ideas.

We will consider:

- Asbestos
- Firefighting gases
- Polychlorinated biphenyls
- Insulated (sandwich) panels
- Modern methods of construction
- Photovoltaic panels on roofs
- Wind generation
- New technology
- Social media

We should remember Thomas Midgely Jr:

- Who first added lead to petrol – and gave himself lead poisoning
- Invented CFC's
- After contracting polio, he invented a pulley system to help those with paralysis – and sadly strangled himself to death



The solution to one problem sometimes contains the seeds of a second

The horrific 1881 fire at the Ringtheater, Vienna killed between 620 and 800 people and resulted in the imposition of a new building code specifically for theatres.

Because of poor fire brigade access, this included the need for approaches on at least three sides. Many cities required four.

The code was adopted in most of Europe, new theatres with outward opening doors were built on island sites – and as the fire, ignited by the gas stage lights, escaped through the proscenium arch, fire curtains were universally required.

Six years later in a virtually identical fire, >150 died in the one-year old Theatre Royal, Exeter.

Solution: fire curtains – made of asbestos…

- If you believe some papers, ‘One fibre can kill’!
- The reality is different and ill-health results only from prolonged direct exposure to the fibres.
- The material is so versatile that it was widely used in construction and engineering for more than 150 years although its harmful effects were formally acknowledged in 1930. Asbestos cement was being supplied in the UK until 1999.
- Hundreds of thousands of people have died or been serious injured by asbestos fibres but there is no widely and cheaply available substitute.
- I can find no authoritative studies on the cost/benefits of asbestos in terms of the number of lives saved by its presence v. the number of impaired lives and deaths.

Early firefighting gases – all highly toxic

- Carbon tetrachloride (CTC)
  - Fire grenades containing CTC are still found in the attics of large houses and were intended to be thrown into a fire. The pump action 'Pyrene' extinguishers are still frequently found and sold at car boots – some with original contents!
- Bromochloromethane (CBM) and Methyl Bromide/Bromomethane (MB)
  - Originally developed prior to WW2 – particularly for use in aircraft.
  - Organobromines interfere with the chain reaction at the flame front and were often used in 'fireproofing' materials.
- All are highly toxic. Their effect on animal life is close to that of some war gases such as nerve agents VX, Tabun and Sarin.

1882 Harden 'Star' Fire Grenade

Methyl Bromide

... an interesting comparison

Essex No. 3 Standard Methyl Bromide Extinguisher.

With a view to establishing the relative rapidity of fire extinction using various methods, tests were recently carried out and the following results were obtained:

Three fires each of 2 lbs. wood wool with 3 pints of petrol in a tray 30" × 40" were attacked after burning for 10 secs. by:—

(A) 2 Gallon Foam Extinguisher: When empty fire still burning (80 secs.)

(B) Quart C.T.C. Extinguisher: When empty fire still burning (55 secs.)

(C) No. 3 ESSEX Extinguisher: (contents ½ pint Methyl Bromide) Fire out in 15 secs.

In case it should be assumed that the above figures represent an isolated test we shall be pleased to carry out a similar demonstration at any time.

Methyl Bromide is a stable, colourless and volatile liquid with a boiling point of 4.5° C., which upon release to atmosphere evaporates rapidly to a fire extinguishing gas 3.27 times heavier than air.

Essex Equipment is available in portable or fixed installation form, and in the case of the latter for either manual or automatic operation.

Further details and technical data will be furnished free on request.

Essex No. 5 S.D.V. Methyl Bromide Extinguisher.

The NATIONAL FIRE PROTECTION

Petersham Road, Richmond, Surrey. Telephone: Richmond 2343-3.

1946 Advertisement

Means of Escape
Used to be acceptable in the UK

Some of us will have experienced the joys of the Davey apparatus.

But hard to evacuate more than a couple of people in a reasonable time.

A dormitory of 10 boys used to take 18 minutes.

But where external ‘New York’ escapes are not acceptable what can be done for listed buildings?

In some countries, ‘Controlled Descent Devices’ are still acceptable.

Means of escape: widely acceptable in Europe – but not UK?

New escape technology….

MoE unfit for purpose in GII*dormitory: internal doors could not be upgraded….sprinklers now fitted.

New fire suppression technology

Watermist is now actively being marketed by many companies as an alternative to sprinklers.

Primary advantage is lower water consumption and hence peripheral damage.

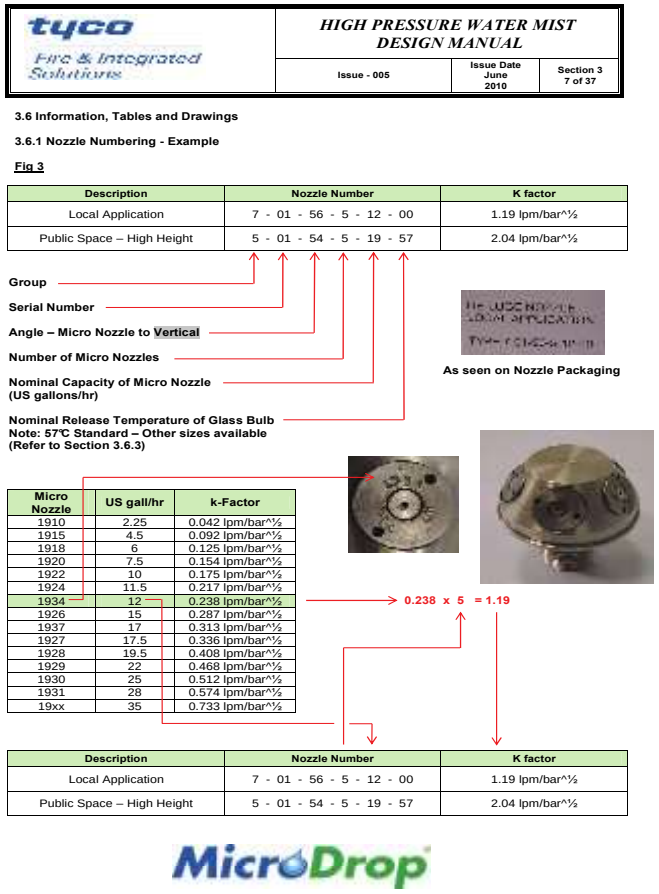
The technology is well understood but there are subtle differences in design and use which require strict adherence to the British Standards: BS 8458 (residential and domestic) and BS 8459 (industrial and commercial).

Third party approval schemes for installers are now available – FIRAS Warrington.

Caution is suggested in respect of systems which claim ‘equivalence’ to the standards.

System design to standards is critical as watermist is less forgiving than sprinklers esp. in water storage.

Very little ‘real fire’ experience so far.



tyco Fire & Integrated Solutions

HIGH PRESSURE WATER MIST DESIGN MANUAL

Issue - 005 | Issue Date June 2010 | Section 3 7 of 37

3.6 Information, Tables and Drawings

3.6.1 Nozzle Numbering - Example

Fig 3

Description	Nozzle Number	K factor
Local Application	7 - 01 - 56 - 5 - 12 - 00	1.19 lpm/bar^½
Public Space – High Height	5 - 01 - 54 - 5 - 19 - 57	2.04 lpm/bar^½

Group

Serial Number

Angle – Micro Nozzle to Vertical

Number of Micro Nozzles

Nominal Capacity of Micro Nozzle (US gallons/hr)

Nominal Release Temperature of Glass Bulb
Note: 57°C Standard – Other sizes available
(Refer to Section 3.6.3)

As seen on Nozzle Packaging

Micro Nozzle	US gall/hr	k-Factor
1910	2.25	0.042 lpm/bar^½
1915	4.5	0.092 lpm/bar^½
1918	6	0.125 lpm/bar^½
1920	7.5	0.154 lpm/bar^½
1922	10	0.175 lpm/bar^½
1924	11.5	0.217 lpm/bar^½
1934	12	0.238 lpm/bar^½
1926	15	0.287 lpm/bar^½
1937	17	0.313 lpm/bar^½
1927	17.5	0.336 lpm/bar^½
1928	19.5	0.408 lpm/bar^½
1929	22	0.468 lpm/bar^½
1930	25	0.512 lpm/bar^½
1931	28	0.574 lpm/bar^½
19xx	35	0.733 lpm/bar^½

0.238 x 5 = 1.19

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MicroDrop

Bromotrifluoromethane (BTM) - Halon 1301

- Probably the most effective total flooding firefighting gas ever invented.
  - Safe discharge in occupied spaces – minimal effects on respiration.
  - Relatively small concentrations to achieve extinction.
  - Cylinders could be located in protected areas.
  - ‘Balls on walls’ provided low cost protection for small rooms.
- BCF/Halon 1211 used for local application and in portables.
- **But: both are Ozone depleters – although smallest by volume**
- Montreal Protocol (1987) required its phasing out worldwide by 2010 – 2000 in EU with removal of existing systems by end 2002. Again no data appears to be available on costs/benefits.
- Some ‘national security’ and aviation exceptions.
- Consequences of ban was huge cost for users – one small utility had to remove and replace > 300 systems and dispose of gas.
- Many systems ‘accidentally discharged’ during removal.

One consequence of the loss of BCF

Safe to use on live electrical equipment as well as other classes of fire

Provision of two portables (foam and CO2) where there is possibility of live electrical equipment

Possible solution: using water wisely

Watermist portable extinguishers have been subject to a di-electric safety tested and are safe for use on equipment up to 35kV. However existing standards do not recognise this benefit.

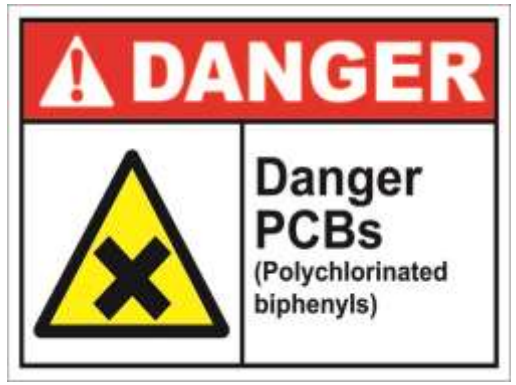
They can also be used on Class “C' fires involving gases (although there is no test available for this).

They offer greater extinguishing power per litre of water. The 6 litre unit, (shown) is rated at: 13A, 21B and 75F. A standard 9 litre water unit is rated at only 21A.

This will allow dry powder units to be relegated to the boiler room and paint store.

Watermist can also replace foam and CO2, although Class F units are probably still better in large kitchens.

Polychlorinated Biphenyls (PCB's)



- Introduced in 1929 as a di-electric and coolant as alternative to flammable oil in larger transformers and capacitors.
- Despite concerns expressed as early as 1936, production of PCB's continued until the late 70's even though by 1970 it was well established that the chemical is highly neurotoxic and has a persistent presence in soil and water.
- Despite this, some countries permit continuing use in 'closed systems'.
- As an example of impact, a container with less than 100 litres of transformer oil contaminated with PCB which suffered damage while being shipped to the UK for incineration resulted in clean up costs in excess of £1.5m following rupture of drum in a shipping container.

New Building Materials

Of all the alternatives to brick and stone, timber is the most attractive to architects (and politicians).

Cross Laminated Timber sections are proposed for the 35 storey Baobab Tower in Paris.

Arup Fire says: “CLT doesn’t need fire protection. The thickness and inherent mass of the wood provides the performance. This gives you an inherent reliability”.

The insurers are less optimistic: ‘Costs of fires in wood frame buildings are six times those of concrete buildings’.

Michael Green Architect, Vancouver

‘New’ Building Materials

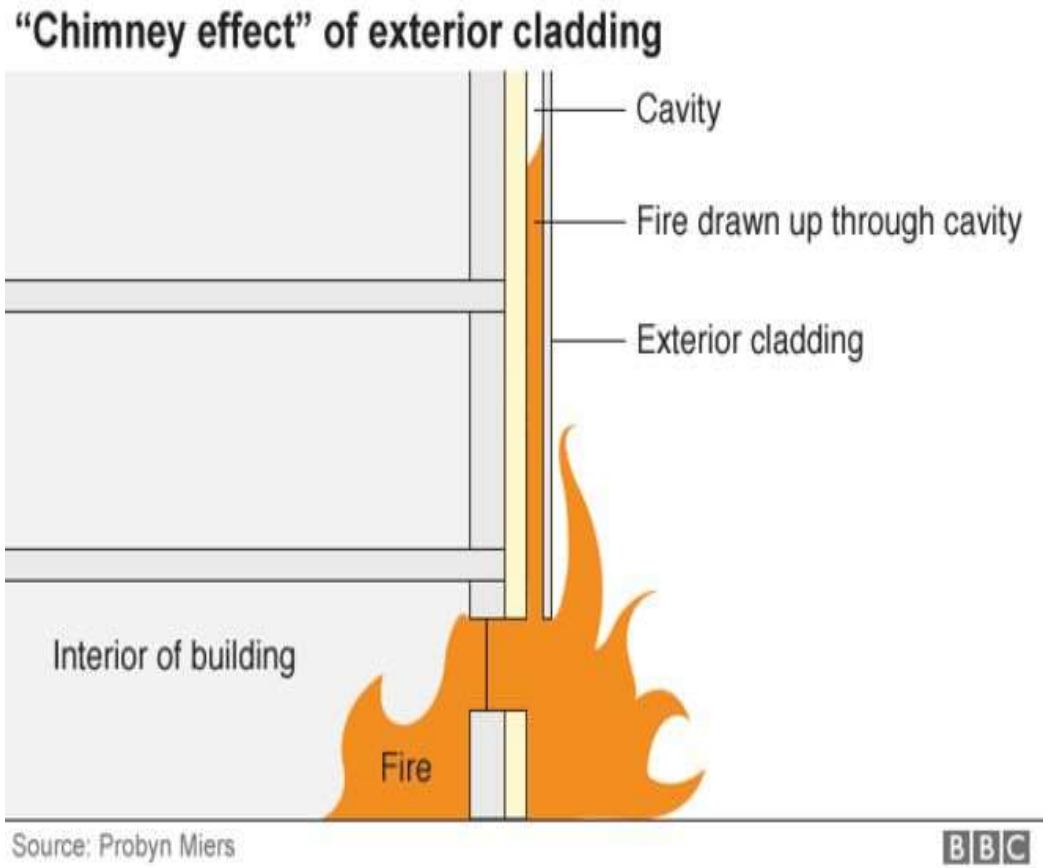
Timber-framed construction:

- Often clad in brick so its presence is hidden.
- Internal fire stopping often defeated by inappropriate intervention after hand-over.
- Fire stopping sometimes incomplete.
- High risk during construction until cladding is complete and internal fire stopping undertaken.

Reclaimed/recycled materials:

- Straw bales.
- Insulating materials including cotton waste, hemp, cellulose fibres.
- Other plastics including HDPE,LDPE, PVC, PE and PET.
- Wool both for structure and insulation.

Energy conservation trumps fire safety…



The 2006 'Decent Homes' programme made it a condition of funding that any upgrades included 'thermal efficiency':

> "When undertaking any work to improve the thermal efficiency of a dwelling, consideration should be given to improving overall energy efficiency aspects, such by installing additional insulation and ventilation, even if the dwelling already meets the minimum insulation requirements".

Some tower blocks were demolished on the grounds that it would be too expensive to meet the new standard.
The Government guide to the 'Decent Homes' programme did not include any reference to fire safety or the need to improve this.

Composite panels (‘sandwich’ panels) and cladding

- Sun Valley Poultry (1993) – a fire which killed two firefighters burnt for three days. Fire spread unnoticed through walls which were lined with ‘sandwich panels’ which had combustible cores. The non-combustible ceiling tiles collapsed when their fixings were damaged by the heat.
- Following this, LPCB developed a standard for non-combustible panels. This rendered some facilities (e.g. cold stores) effectively uninsurable at normal rates and terms.
- In the Arabian Gulf, external cladding panels with a combustible core have been involved in at least 16 high rise, high profile, fires.
- Most notably, the Address Hotel/Apartments on 31 December 2015. The ‘Torch’ block in Dubai has suffered two such fires.
- It’s been estimated* that it will cost USD3.5 billion to replace the affected cladding solely in Dubai.

*Swiss Re: April 2016

Insulation and Engineering Issues

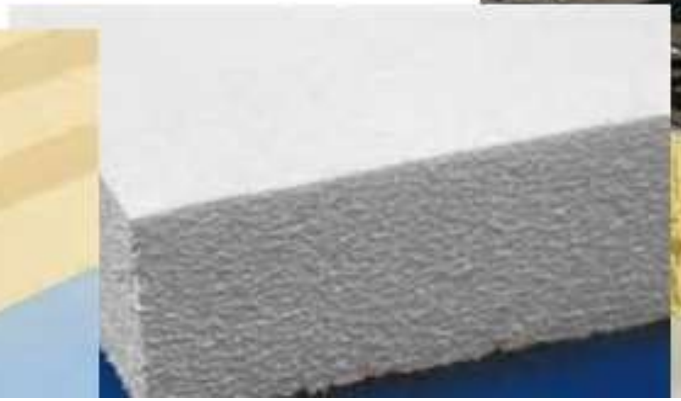
The numerous fires losses globally have occurred involving external combustible wall assemblies, aluminum composite panels (ACP) or insulated metal panels (IMP's). Some of these metal panels are Aluminium Composite Panels which are composed of finished sheet aluminium on the exterior and interior side bonded to insulation material. Both IMP and ACP use polyethylene PE or Polyurethane (PU), Mineral Wool or other insulation core. Some of the features of these fires in buildings with combustible insulation core of external wall assemblies include:

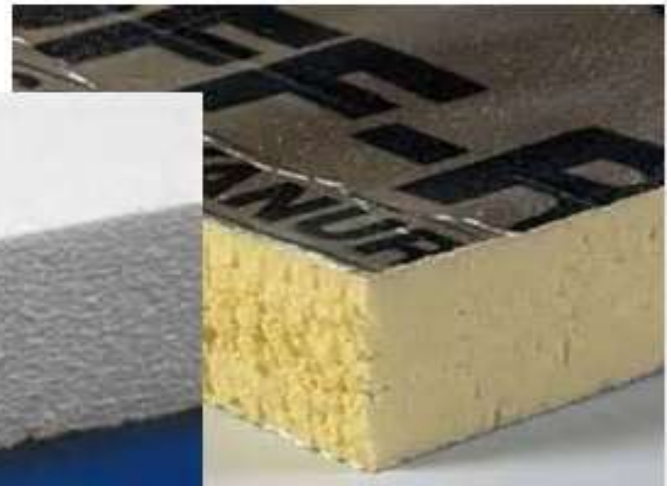
- External ignition source to the façade paneling – light fittings, smoking, BBQ, Fireworks, Hot Work, etc.
- Rapid and full height external fire spread
- Falling debris and pool fires at base from melting insulation material
- Sprinklers reported on some of the incidents have assisted in limiting the internal fire spread

All the buildings involved in similar fires will have conformed to the local building regulations and codes at time of construction or whilst being retrofitted with external cladding on older structures. Following similar fires in the Middle East, the local building codes in the United Arab Emirates were reviewed and amended with revised codes introduced in 2012 for all new structures. This does mean of course that there are a large number of legacy buildings not benefitting from the revised codes in this region. Combustible insulation core panel systems are found in use globally.

Combustible

- Cork
- Modified Phenolic Foam (MPHEN)
- Polyisocyanurate (PIR),
- Polyurethane (PUR),
- Expanded polystyrene (EPS) [Polystyrene foam]
- Extruded polystyrene (XPS)





Non combustible

- Glass wool
- Rockwool or Stone wool
- Foam glass.
- More than 2 hour fire resistance can be achieved

Not just fire issues - inappropriate materials in underground car park?

Polystyrene insulation expanded following flood – what would happen in a fire as a result of fire water run-off? Who will compensate car owners for damage to their vehicles?

‘Modern Methods of Construction’

- The National Trust’s ‘Zero Carbon Footprint’ building:
  - Walls are compressed straw.
  - Insulation is wool bales.
  - Used car tyre foundations.
  - Recycled timber frame and walkways.
  - Internal walls are cob/straw.
  - Heating is via a wood-burner stove.
  - Untreated oak shingles.
  - Exemplar green/low carbon building.
  - Used for education, meetings and yoga classes.

‘Modern Methds of Construction’

- Veolia energy from waste project, Leeds.
- Will burn up 214,000 tonnes of ‘black bin’ waste pa to generate up to 11MW.
- Incinerator operates at 800 – 1000 degrees C.
- Reportedly Europe's largest timber Glulam frame (42m high) and glass/polycarbonate building.
- Will have Europe's largest ‘Living Wall’ > 1,800m2 when planted.
- Believed to be sprinklered but no detailed information available on the building’s fire strategy.
- In summary, a large oven, encapsulated in a timber frame surrounded by combustible waste retained by timber walls.
- The recycling industry does not have the best fire safety management reputation.

Wind generation

- There is a general perception that wind power is ‘safer’ than thermal generation.
- Nacelles contain large volumes of hot oil and hydraulic fluid under pressure as do transformers and PF capacitors in the base of towers.
- Lightning strikes are not unusual. Any defect in bonding and earthing can be catastrophic.
- Nacelles tend to be combustible GRP – even though fire rated materials are available.
- Multiple fatality involving maintenance staff in Holland in 2013. Two more injured in Sept 2017.
- ‘At least 50 fires in wind turbines in Europe each year, 120 worldwide’. (Imperial College)




Photovoltaic panels

- PV panels are now widely found in domestic, commercial and industrial buildings.
- Widely seen as ‘green’, as a source of non- polluting energy, their use has been encouraged by governments and planners.
- They are a source of ignition and a fuel and are also a barrier to rooftop ventilation by fire service.
- They are also a hazard to firefighters as the panels will continue to generate DC power (with current at >1000 amps) in daylight even when the main breaker is pulled.
- Cabling from array to control equipment also remains live.
- BRE have investigated 64 fires in PV arrays

New technology can proceed faster than legislation and codes

- Many of the companies installing PV panels do not appear to have heard of the IEE Wiring Regulations or Part P.
- Anecdotally, there are suggestions that PV is just the latest in a line of entrepreneurial activity which has ranged from double glazing, cavity wall insulation, conservatories and burglar alarms.
- There is no doubt that green though the idea of solar on-site generation might be, there are potential problems for the fire service lurking.
- Meanwhile, the BREEAM scheme continues to ignore the potential impact of fires.

BREEAM®

Do we need more guidelines? These are all avoidable losses

New technology, new dangers?

‘3 blazes a day in tumble dryers’ - LGA

Wales | Wales Politics | North West | North East | Mid | South West | South

Faulty tumble dryer 'likely cause' of Llanrwst fire deaths

1 September 2017 | North West Wales

Near miss from 2-D bulb

Fires in Galaxy phones cost Samsung more than US$ 6 billion

Lithium ion batteries

Social media and fire safety

- The widespread obsession with broadcasting the minutiae of daily life on social media (especially Twitter) has the potential for serious impact on fire safety procedures.
- Imagine a mass evacuation from a supertall building with half the occupants working at a screen while walking down a 30 storey staircase.
- There is anecdotal evidence of delays in evacuation as ‘Tweeting must come first’.
- Office buildings, schools, universities and hospitals are probably especially all at risk.
- Fire training needs to emphasise the need to wait until reaching an assembly area before telling the world how exciting life is.

Can we enforce the rules we already have?

Watching it all come together: 14 May 2013, La Farge, Wisconsin (1)

- Fire in 9-year old building occupied by world's largest dairy cooperative which is principal employer in the town (Pop 750).
- Fire was concealed in roof spaces (light wooden trusses) which were insulated with recycled cotton/denim material. (Temperatures of between -15/30C are common).
- Building was protected by sprinklers - dry in attics and wet in remainder (0.10gpm over 1950 square feet)(.38 lpm over 181m^2)
- 130 Photovoltaic panels were installed on the roof.

Watching it all come together: 14 May 2013, La Farge, Wisconsin (2)

- PV panels prevented vertical ventilation (Usual US practice for this type of structure). Panels were probably generating 70kW at 50v.
- Metal cladding of roof beneath panels deformed as a result of the fire and the local utility found that roof cladding sections were live.
- Roof trusses partially collapsed causing fracture in dry sprinkler range pipes resulting in significant loss of water pressure from public hydrant system.
- Fire demand drained ***all*** of the municipal water supply (101,000 US gallons) (382,000 l) resulting in water shuttle using six tankers being set up from nearby river.

Watching it all come together: 14 May 2013, La Farge, Wisconsin (3)

- Access to roof spaces only became possible when fire self-vented after partial collapse of roof structure.
- La Farge has an all volunteer FD and was forced to call for aid from 10 other FD's.
- 116 fire fighters and 31 appliances responded for a fire which took 18 hours to bring under control.
- Key issues:
  - Impact of PV panels on operations
  - Early failure of lightweight roof trusses
  - Combustibility of cotton insulation
  - Untreated timber contribution to fire load and spread and its early failure.
  - Water consumption and impact on residents
- The NFPA Report said:
- "The use of natural fiber insulating materials is becoming more common as a means of meeting "green building" requirements. The fire service needs to be aware when this type of insulation is used within a building, because potential fire travel in vertical and horizontal spaces will have to be accounted for".
- "Roof access amid PV panels can be difficult, with conduit and other PV system components being located throughout the roof area. PV panels cannot simply be "shut off" during firefighting operations, since they are always producing electrical current".

Summary and conclusions

- History provides ample evidence that unexpected and unanticipated results often follow what appear to be sensible decisions.
- This is especially true for new technology and materials.
- The widespread use of external cladding panels appears, at first sight, to be a sensible practice – the panels are cheap, colourful, easy to install and maintain and because they conceal the surfaces below, ‘fair facing’ which is expensive and requires skill is not required. They also provide additional thermal barriers.
- The consequences of using combustible panels is self- evident and this has created on-going problems for the fire service, building owners and their management companies, architects, construction companies, insurers and governments.

Final thoughts….

Questions and/or thrown objects?

My thanks to AIG Insurance for data on three slides

www. risk-consultant.com