Up on the Roof……Fire Prevention BY David Laks, P. Eng., CFPS, ARM, RRC

Every year there are a significant number of roof fires resulting from installation, neglected maintenance, or housekeeping. This article discusses how the design, installation, and maintenance of roof systems impact the likelihood and severity of roof fires. Case studies will be included to demonstrate how those three elements affect roof fires.

1. **DESIGN:**

Most jurisdictions have minimum design requirements for the fire performance of roofing systems. For example, many require a Class A, B, or C roof rating which is a measure of the exterior fire exposure as determined by external spread of flame on a roof surface.[1]

If the roof assembly has a steel deck and incorporates plastic foam insulation, most codes require a thermal barrier or that the complete assembly must pass an internal fire performance test. This test addresses the contribution of the roof components to "feeding the fire".[2]

Some jurisdictions or insurance companies require roof systems that are Class 1, which can only be granted by FM Global (Factory Mutual). Besides meeting the external flame spread (Class A, B, C), the whole roof assembly is evaluated against more comprehensive tests including: flame spread on the underside of the deck, wind, hail, corrosion/leakage, etc. **All Class 1 roof assemblies are Class A, but not all Class A roof systems meet Class 1 requirements.**

Importance of Roof Classification (case study): On July 5, 2009 a U.S. Navy reservist launched a stolen military flare that ignited a plant roof in Cudahy, WI. This resulted in a property and business interruption loss of $318 million (U.S.), of which $118M was uninsured. Insurance companies and the plant owner (Smithfield Foods) sued the U.S. Navy for negligence and **won** (pending judgement between $51MM and $188MM).

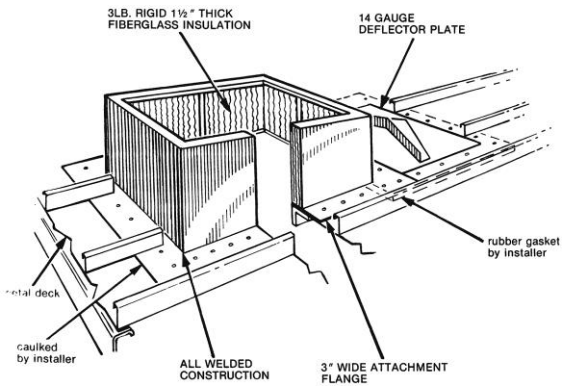
Photo: Milwaukee Business Journal

Design Case Study: Detailing (hot stack)

The photo below shows a hot stack through-roof penetration that was not properly designed (i.e. without non-combustible insulation separating wood support blocking). Over time, the wood blocking dried out and was ignited by the heat from the hot stack.

Photo: Roofing Contractor Magazine

Arrow pointing to wood blocking around hot ductwork



Sample of properly designed hot ductwork flashing

2. **INSTALLATION:**

There are many commercial "flat" roofing systems available. Some of the most popular include BUR (built-up roofs), modified bitumen, single plies (thermoset/thermoplastic), and metal roofs. There are many others, however this article will focus on fire risks related to BURs and torch applied modified bitumen systems

BURs are usually applied in "shingle" fashion using 3-4 plies with felts that are hot asphalt/tar or cold adhesives. They can be finished with a top coat and gravel, or smooth finished (painted). The bitumen (asphalt or coal tar) is heated in kettles and applied with mops or spreaders on the roof.

Images: Frazier Roofing

A heat source such a propane or natural gas is used to heat/liquefy the bitumen in the kettle to proper application temperature. This process also releases flammable vapors. The bitumen can also be heated to its flashpoint so precautions must be employed by properly trained personnel.

Image: US Army News & Information

Typical causes of fires during BUR installation include:

- Ignition of bitumen due to overheating
- Unsupervised operation of gas burners & kettles
- Defective equipment –i.e. gas burners
- Non-observance of safety rules, i.e. kettle near combustible materials too close to building, etc.
- Heat conduction, burning droplets of material coming in contact with combustible building materials; i.e. at perimeters and projections.
- Hot mops spontaneously combusting after use.

Precautions:

- Verify proper condition of kettle, gas burners, etc.
- Kettle should have a close fitting lid (min. 14 gauge) capable of smothering a kettle fire with a quick close valve at the spigot
- Ensure no combustibles or packaging are near the kettle (>20’ away), kettle is on level ground, and >10’ away from the building
- Kettle should be constantly monitored during operation and an appropriate number of fire extinguishers must be on hand (within 20’)
- Kettle operator should be properly trained and aware of the correct working temperature and flashpoint of the material being used. Bitumen should not be heated above the proper working temperature (usually 50° F below the flashpoint)
- The kettle must have a functional, accurate thermometer
- Keep propane cylinders >10’ from the kettle and properly secured
- Maintain a minimum 30 min. fire watch after the kettle burners have been turned off
- Prohibit smoking during roofing operations.

Modified Bitumen Systems can also be classified as BURs. These systems usually have a 1-2 ply base and a smooth or granulated cap sheet. The base sheet (s) can be “peel and stick”, adhered with hot asphalt or cold adhesives, and the cap sheet can also be torch applied.

Clearly, using an open flame for torch applied roofing systems creates unique fire risks and specific precautionary measures must be taken. There are many documented fires that have caused extensive property damage.

Torch Applied Case Study #1: In 2006 in Heflin, AL; "Contractors were working on the roof until late afternoon and the fire broke out shortly after they left for the day." (Alabama News Report). This resulted in the complete loss of the plant and several million dollars in property losses. As the roofers were applying a tie-in of the new torch applied roof system to the existing one, the open flame was likely drawn below the deck where it ignited the wood supports for a metal panel drop ceiling (see below). The fire in this concealed space (below the metal roof deck and above the metal drop ceiling) worked its way, undetected, throughout a large area of the plant. When firefighters arrived on site the fire was so extensive that it was impossible to save the facility.

Wood studs were installed to support the metal panel drop ceiling. The wood studs in the approximately 2' high drop ceiling space, and the lack of fire-stopping, would have contributed to the spread of fire within that space.

Some precautions and recommendations for torch applied roofing:

- Torches should be used according to manufacturer recommendations by trained personnel. They should be verified in proper working condition before use and have the appropriate safety devices, hoses, cylinders, etc.
- Follow the roof system manufacturer installation and safety guidelines.
- Open flame should not come in direct contact with combustible building components. Install a non-combustible material (i.e. peel and stick membrane) over the insulation and around any flashing or projections.
- Extra cautions should be taken around perimeters, projections, and any other roof openings or penetrations.
- Never leave a torch with an open flame unattended.
- Care should be taken around exhaust vents; grease, oil, or lint accumulations should be cleaned up prior to torching.
- Turn off any AC units, fans, or air intakes during work.

- At least one portable fire extinguisher should be within 20' of the torch application.
- Ensure a fire watch is employed for at least two hours after torch work is completed, continually checking for hot spots or signs of smoldering. Check the interior of the building as well.

Image: CTV Southwestern Ontario

Torch Applied Roofing Case #2: A contractor was re-roofing a Dollar Store on March 17, 2011 in Listowel, Ontario. During the installation of a torch-applied roof, a fire started below the metal roof deck. Combustible material and lightweight construction that was not visible fueled the fire which was masked by a drop ceiling. Investigation revealed that the fire may have been burning for up to 40 minutes before 911 was called. These conditions were only discovered when the firefighters started battling the fire. Tragically, as the call was made to vacate the property, the roof collapsed, resulting in two firefighter fatalities.

As a result of this incident, local fire codes were changed to include items related to open flame torches, bitumen kettles, and fire watches.

Potential mitigation strategies to prevent installation fires:

- Fire Department Pre-planning (including construction review)
    - Investigators noted that "decisions should be based not only on what is visible, but what is known about the building from pre-plans"
- Pre-planning Contractor/Pre-construction meeting
    - Ensure proper safety plans & controls are in place
    - Verify that workers are appropriately qualified and safety trained
    - Verify that equipment is in proper working condition.
- During installation
    - Monitor work progress to verify that installation is following proper safety protocols
- Right after installation (Fire Watch)

Codes focus on engineered fire protection systems for buildings and fire resistance of installed roof systems. **More emphasis within the codes needs to be put on ensuring the system is installed safely, with a consideration for fire safety.**

As code changes are being considered, input should be expanded to include fire protection engineers from insurance underwriters as well as brokers, roof consultants, roof manufacturers, roof specifiers, and roof inspectors.

3. MAINTENANCE

According to a 2012NFPA report[3], 'grease related hood/duct system fires cost restaurant owners approximately $50MM USD per year. One in five fires indicated "failure to clean" as a contributing factor.



Images: Jurin Roofing & Hood Filters

Issues with Rooftop Grease:

- Fall hazards
- Damage to many types of roof systems
- Fire hazard
- Environmental contamination

Solutions:

- Regular duct/hood cleaning
- Test duct/hood fire-extinguishing systems per standards (NFPA 96)
- Install and maintain roof top grease collection systems

4. Conclusion

Proper design that includes appropriate consideration of fire safety; installation by qualified installers who follow proper safety procedures; and a regular roof inspection/maintenance program will go a long way toward reducing the likelihood and severity of roof fires.

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[1]Tests consist of exposing the top surface of the roof system to gas flame and measuring the distance of flame propagation. Class A (highest degree of protection) is achieved if the flame spread is ≤6', Class B ≤8', and Class C ≤ 13'. Test methods as outlined in NFPA 256 - Standard Methods of Fire Tests of Roof Coverings. If the deck is combustible, two additional tests may be required: Burning Brand Test and Intermittent Flame Test (flying brand).

[2]Roof assemblies must pass NFPA 276 – Standard Method of Fire Test for Determining the Heat Release Rate of Roofing Assemblies with Combustible Above-deck Roofing Components (2015 Edition)

[3]*Structure fires in eating and drinking establishments*, NFPA (National Fire Protection Association), 2012.