Heat Collectors – will they work?

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Why we use frangible bulb automatic watermist nozzles

- Heat from a fire forms a hot gas layer at ceiling/roof level.
- Automatic nozzles are mounted at ceiling/roof level so as to be ideally positioned to detect the rise in temperature.
- This heat build-up causes one or more frangible bulbs to shatter thereby allowing their respective nozzles to open and discharge watermist.
  - Watermist is delivered to the seat of the fire
  - Only the nozzles in the immediate vicinity of the fire will open.
The Problem

- Hazards where the ceiling/roof is over 5m above the flammable /combustible materials.
- Frangible bulb operation is delayed as hot gas layer takes longer to develop.
- Larger fire develops before frangible bulb operates
- Distance from nozzle to fire may be too great for effective watermist penetration of the fire plume.
- Fire size may exceed the capability of the watermist system.
Will heat collectors work? Have they been tested?
Can we bring automatic nozzles closer to the fire?

- Yes BUT!
- The rising hot air plumes warm the frangible bulbs relatively slowly, as the heat transfer mechanisms are poor.
- So - can we use heat collectors (as a false ceiling)?
- Will they work?
- Have they been tested successfully?
Tyco testing

- Tyco approached by a car manufacturer
- Vehicle test shed
- 16m roof
- Fuel spill hazard
Test arrangement

- 4 nozzles – square array
- 3m centres
- 4.3m height
- 3mm 68° C frangible QR bulbs.
- 9.2 x 9.2 x 7.2m high test enclosure
- 1.5m fire tray offset in the centre of the nozzle array
- Each nozzle fitted into a 900mm diameter, 140° included angle, sheet metal cone with 50mm centre opening for the nozzle.
Plan of test arrangement
Instrumentation

- Thermocouples close to each nozzle
- Sensors on each bulb (to signal operation)
- Thermocouple above the fire tray at nozzle height
- Thermocouples on steelwork near roof level (6.6m)
Test 1- dry test to evaluate detection
15 litres petrol - 1 minute 20 second full burn

<table>
<thead>
<tr>
<th>time</th>
<th>comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.05</td>
<td>Flames steady, rising vertically</td>
</tr>
<tr>
<td>0.15</td>
<td>Temperature at 4.3m above fire 400°C</td>
</tr>
<tr>
<td>0.34</td>
<td>Nozzle no. 2 operated</td>
</tr>
<tr>
<td>0.45</td>
<td>Nozzle no. 1 operated</td>
</tr>
<tr>
<td>0.54</td>
<td>Radiant heat too great for personnel at 6m from the fire</td>
</tr>
<tr>
<td>1.15</td>
<td>Temperature at all four nozzles reach a maximum</td>
</tr>
<tr>
<td>1.23</td>
<td>Nozzle no. 3 operates</td>
</tr>
<tr>
<td>2.30</td>
<td>Roof steel temperature reaches a peak of 83°C</td>
</tr>
<tr>
<td>4.00</td>
<td>Fire burned out</td>
</tr>
</tbody>
</table>
### Test 2 – wet test
40 litres petrol – 2 minutes 50 second full burn

<table>
<thead>
<tr>
<th>time</th>
<th>comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.12</td>
<td>Flames deviating towards nozzles 3 &amp; 4 due to turbulence</td>
</tr>
<tr>
<td>0.16</td>
<td>Flames reaching roof level</td>
</tr>
<tr>
<td>0.25</td>
<td>Nozzle no. 3 operated</td>
</tr>
<tr>
<td>0.30</td>
<td>Nozzle no. 4 operated</td>
</tr>
<tr>
<td>0.43</td>
<td>Reduced burning rate due to nozzle discharge</td>
</tr>
<tr>
<td>1.16</td>
<td>Radiant heat reduced - personnel at 4.5m from the fire</td>
</tr>
<tr>
<td>2.50</td>
<td>Temperature traces show fire declining</td>
</tr>
<tr>
<td>4.00</td>
<td>Water turned off</td>
</tr>
<tr>
<td>4.30</td>
<td>Water turned on again</td>
</tr>
<tr>
<td>6.15</td>
<td>Fire out</td>
</tr>
</tbody>
</table>
Test findings

- Both tests produced rapid detection / nozzle actuation times.
- In test 1 nozzles with the edge of their collectors 0.5m, 0.78, and 1.06m from the edge of the fire tray operated.
- In test 2 the discharge from the first two operating nozzles provided sufficient cooling to prevent further nozzles operating.
- The nozzle with its collector edge offset 1.34m from the fire tray did not operate.
- Test 2 peak steel temperature (projected) – 100°C after 5 minutes.
Conclusions

- The tests showed that automatic nozzles with suitable heat collectors can detect and respond to a fire, with a 1.5m diameter fuel tray, and nozzles 4.3m above and beyond the tray.
- The heat collectors need to be of sufficient size and shape to funnel heat past automatic nozzles.
- The heat collectors do not need to be directly above the fire source.
- Suitable heat collectors can provide effective detection below high ceilings.
- The size of fire and height of heat collector will affect the outcome.