Knock Out
Background

Difficult to break impact glass

Time consuming

Hazard for Firefighters
What We Learned
Impact Glass

Laminated Glass Construction

Glass

PVB layer

Glass
A device/tool capable of effectively clearing hurricane-rated impact windows:

**KNOCK OUT**

market: handheld tool | intended user: firefighters | intended buyer: fire stations

<table>
<thead>
<tr>
<th>CUSTOMER NEED</th>
<th>PRODUCT ATTRIBUTE</th>
<th>ENGINEERING SPECIFICATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>A device/tool that clears a window quickly</td>
<td>Time</td>
<td>&lt; 45s</td>
</tr>
<tr>
<td>Can be used safely near open flames</td>
<td>Flammability</td>
<td>Non Flamable</td>
</tr>
<tr>
<td>A device/tool that can fits within existing fire department budgets</td>
<td>Price</td>
<td>&lt; $150</td>
</tr>
<tr>
<td>Can be carried with ease</td>
<td>Form (weight,size)</td>
<td>&lt; 15lbs &lt; 4 x 4 x 12 in</td>
</tr>
<tr>
<td>Feedback response when in use</td>
<td>Notification system</td>
<td>Yes (Visible)</td>
</tr>
</tbody>
</table>
How Quickly Can We Cool The Glass?

Concentrated $N_2$

Thermocouple

Liquid nitrogen sprayed on a single point

-95°C

Temperature [°C]

Time [s]
Can We Break Through?

With $N_2$

Without $N_2$
Can We Break Through?

With $N_2$

Without $N_2$
Next Steps

User testing with firemen to understand:

- What form is easiest for firemen to carry and transport

Need to test on a window frame to understand:

- How the window framing affect the impact glass?
- Can we effectively distribute the nitrogen along the frame?
Sources

https://apps.usfa.fema.gov/registry/summary

https://www.weathershield.com/Products/Hurricane-Impact

https://www.firehouse.com/operations-training/article/10513783/hurricane-windows-and-their-effects-on-firefighting-operations