Hurricane Hazards

- Storm Surge
- Winds
- Heavy Rain
- Tornadoes
- FIRE?
Breezy Point Fire

- October 26: As of 8:00 am, Tropical Storm Watches and Warnings issued by the NOAA National Weather Service were in effect in Florida.

- October 28: Sandy continues moving northeast on a track that takes it parallel to the coasts of Georgia, South Carolina and North Carolina. The storm is still a Category 1 hurricane with peak winds of about 80 mph.

- October 29, 8:00 PM: Sandy’s center comes ashore near Atlantic City, New Jersey. The storm is no longer considered a hurricane but is now classified as a post-tropical nor’easter.

- October 30, 6:00 PM: Breezy Point sees 4-8 feet of water.

- October 30, 11:00 PM: Fire reported to fire department in Breezy Point. Initial reports put the number of homes affected at eight or nine, then 15 before jumping to 50. Single fire truck was able to leave flooded station.

- October 31, 12:00 AM: Fire efforts stalled due to high water. Fire hydrants submerged.

- October 31, 3:34 PM: Fire concluded. 45 hours.
Fire Apparatus
Fire
Flame Dynamics

Flame dimensions

Average flame length

FUEL SURFACE

Flame depth / Flaming Zone

Average flame height
Fire Propagation in extreme weather

![Graph showing the relationship between flame length (ft) and midflame wind speed (mi/h) for different moisture levels. The graph indicates that flame length increases with increasing wind speed and varies with moisture levels: very low, low, moderate, and high.]
Fire Propagation in extreme weather

- Rate of Spread (ch/h)
- Midflame Wind Speed (mi/h)

Lines represent different moisture levels:
- moisture
- very low
- low
- moderate
- high
Wind Driven Fire - Interior
Heat Propagation

- Radiation
- Conduction
- Convection
Residential Fire Propagation

Convection

Radiation
\[
\begin{align*}
    m \frac{dV_x}{dy} &= m \frac{dU_x}{dt} - m \frac{dW_x}{dt} = \frac{1}{2} \rho_s C_D A_p W^2 \frac{W_x}{W} \\
    m \frac{dV_z}{dy} &= m \frac{dU_z}{dt} - m \frac{dW_z}{dt} = \frac{1}{2} \rho_s C_D A_p W^2 \frac{W_z}{W} - mg
\end{align*}
\]
Mitigation Options
# Residential Fire in the Code

<table>
<thead>
<tr>
<th>Exterior Wall Element</th>
<th>Min. Fire Resistant Rating</th>
<th>Minimum Fire Separation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Walls</td>
<td>FRR 1 Hour</td>
<td>&lt; 5 feet</td>
</tr>
<tr>
<td></td>
<td>Not FRR 0 Hours</td>
<td>≥ 5 feet</td>
</tr>
<tr>
<td>Projections</td>
<td>FRR 1 Hour on the underside</td>
<td>≥2 feet to &lt; 5 feet</td>
</tr>
<tr>
<td></td>
<td>Not FRR 0 Hours</td>
<td>≥ 5 feet</td>
</tr>
<tr>
<td>Openings in Walls</td>
<td>Not allowed N/A</td>
<td>&lt; 3 feet</td>
</tr>
<tr>
<td>25% Max wall area</td>
<td>0 hours 3 feet</td>
<td>3 feet</td>
</tr>
<tr>
<td>Unlimited</td>
<td>0 hours 5 feet</td>
<td>5 feet</td>
</tr>
<tr>
<td>Roof</td>
<td>N/A Class A, B, C</td>
<td>3 feet from lot line</td>
</tr>
</tbody>
</table>
WUI

- WUI - Wildland Urban Interface
- Condition, Not Place
- WUI: Areas where homes are built near or among lands prone to wildland fire.
- Conditions include (but are not limited to): the amount, type, and distribution of vegetation; the flammability of the structures (homes, businesses, outbuildings, decks, fences) in the area, and their proximity to fire-prone vegetation and to other combustible structures; weather patterns and general climate conditions; topography; hydrology; average lot size; and road construction.
## WUI vs. Fire during Hurricane

<table>
<thead>
<tr>
<th></th>
<th>WUI</th>
<th>Fire during high wind/high water event</th>
<th>Typical Residential Fire</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vegetation</td>
<td>Dry</td>
<td>Wet</td>
<td>Dry</td>
</tr>
<tr>
<td>Proximity of Homes</td>
<td>Variable</td>
<td>Variable</td>
<td>Variable</td>
</tr>
<tr>
<td>Availability of Fire Fighting</td>
<td>Limited</td>
<td>Limited</td>
<td>Available</td>
</tr>
<tr>
<td>Fire Positive Climate</td>
<td>Positive</td>
<td>Positive</td>
<td>Not Typical</td>
</tr>
<tr>
<td>Increase in Flame Spread</td>
<td>Yes</td>
<td>Yes</td>
<td>Not Typical</td>
</tr>
<tr>
<td>Ability to Evacuate</td>
<td>Limited</td>
<td>Limited</td>
<td>Typically Available</td>
</tr>
</tbody>
</table>
## International WUI Code

### Ignition-Resistant Construction

<table>
<thead>
<tr>
<th>Defensible Space</th>
<th>Moderate Hazard</th>
<th>High Hazard</th>
<th>Extreme Hazard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water Supply</td>
<td>Conforming</td>
<td>Nonconforming</td>
<td>Conforming</td>
</tr>
<tr>
<td>Nonconforming</td>
<td>IR 2</td>
<td>IR 1</td>
<td>IR 2</td>
</tr>
<tr>
<td>Conforming</td>
<td>IR 3</td>
<td>IR 2</td>
<td>IR 1 N.C.</td>
</tr>
</tbody>
</table>

### Fire Hazard Severity

- **Moderate Hazard**
  - Water Supply: Conforming
  - Nonconforming: IR 1

- **High Hazard**
  - Water Supply: Conforming
  - Nonconforming: IR 1

- **Extreme Hazard**
  - Water Supply: Conforming
  - Nonconforming: Not Permitted
## Class 1 Ignition Resistant Construction

<table>
<thead>
<tr>
<th></th>
<th>2012 IRC</th>
<th>2012 WUIC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exterior Wall Element</td>
<td>Min. FRR</td>
<td>Minimum Fire Separation</td>
</tr>
<tr>
<td>Walls</td>
<td>0 Hours</td>
<td>≥ 5 feet</td>
</tr>
<tr>
<td>Projections</td>
<td>0 Hours</td>
<td>≥ 5 feet</td>
</tr>
<tr>
<td>Openings in Walls</td>
<td>0 hours</td>
<td>5 feet</td>
</tr>
<tr>
<td>Roof</td>
<td>Class A, B, C</td>
<td>3 feet from lot line</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Class A</td>
</tr>
</tbody>
</table>
Conclusions

• Fire Risk increased in high wind, high water events
  • Increased by close proximity of Homes
• Current code, 2012 IRC, provides guidelines on fire protection
  • Assumption is that fire fighting is available
  • Limited “defend in place”
• WUI Code a plausible alternative in these situations
  • Consider homes to be risk category I
Questions?
Additional Research

• IRC Flood Provisions vs. Fire Resistance