Effects of Crew Size on Firefighter Health and Safety

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The Need

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• Threats - Local Department Cuts
• Negotiations / Arbitration
  • Can’t negotiate crew size
  • CAN negotiate Health and Safety
• Industry Standards Linked to Science
  • 1710 (1720)
  • 1500
  • OSHA “2 in – 2 out”
The Paper

• Detail the health and safety risks that firefighters face as they perform their firefighting work;
• Describe the work activities that firefighters must perform during firefighting work in different settings,
• Examine the work environment in which firefighters perform their duties,
• Evaluate the effect of crew size on firefighter health and safety, and
• Provide recommendations for industry standard considerations.
The Abstract

• Firefighters’ safety during fire responses depends on sound policies and procedures that ensure they can do their jobs efficiently and effectively.

• Decisions on vehicle crew size and total effective response force deployment should be based on the best available evidence.

• It is imperative that fire department leaders and political decision makers understand how the fire department resource deployment impacts community safety related to
  • civilian injury and death
  • firefighter injury and death
  • property loss.
The Abstract (cont’d)

• The review examines the effect of emergency response vehicle crew size and total effective response force deployment on firefighters’ health and safety risks, recognizing that firefighter health and safety is necessary to ensure that firefighters can effectively perform their jobs and protect their community.

• We conducted a comprehensive examination of
  • results from multidisciplinary research efforts
  • published data
  • industry standards
  • expert opinion
The Work

• Health and safety risks that firefighters face are multifactorial and often overlap.
• These risks are directly related to the work firefighters perform and their work environment.
• Firefighting personnel conduct interdependent and coordinated activities.
• Conducting these activities simultaneously is the most efficient manner.
• Performing tasks sequentially can limit coordination and delay tasks on the fireground, contributing to rapid fire growth and escalating risk.
The Environment

- Because every fire can present a unique set of conditions, fire department leaders should match the mobile and personnel resources they deploy to the risks they are likely to encounter at the scene.

- Fire growth is the primary factor that drives the need for sufficient available resources to intervene in a structure fire in a timely manner.

- Knowledge of fire dynamics and the associated potential for risk escalation can be used proactively to assist in planning firefighter staffing patterns and fire station locations.
The Research

- UL has conducted several experiments to compare impact of changing fuel loads in residential houses.

- **Findings**: Once living room fires have transitioned to flaming fires, flashover times of less than five minutes may be expected.

- Other experiments show the failure time of wall linings, windows, and interior doors has decreased over time, affecting fire growth and firefighter tactics.

- Also, today’s common engineered I-joist floor system can collapse in less than one-third the time it takes a dimensional lumber floor.
The Impact

- **Fire development and collapse risk** impacts the necessary **firefighter response times and operational timeframes** once on scene.

- Responding crews must be able to **assemble in a timely manner and quickly initiate application of water** on the fire to stop continued risk escalation.

- **Enough firefighters** and equipment must be strategically located to **ensure the minimum acceptable response force** assembly to engage in a fire before substantial risk escalation occurs.
The Effects

• The number of personnel assigned to each emergency response vehicle (crew size) and the number of firefighters deployed to the entire event (ERF) directly influence operational effectiveness.

• Operational effectiveness has a significant effect on firefighter health and safety risks because it influences firefighters’ ability to control fire growth, the risks associated with fire growth, and the amount and pace of work that must be performed to limit additional risk.
Conceptualizing Risk...

and Mitigating Risk
**FR**

**FIREFIGHTING**
- Forcible entry
- Search and rescue
- Life safety
- Water delivery
- Ventilation
- Overhaul/Salvage work
- Utility Control

**Potential RISKS**
- Burn, thermal injury
- Trauma
- Asphyxia
- Structural collapse, blunt force trauma, entrapment
- Cardiac
- Fatigue
  - Decline in situational awareness
  - Impaired cognitive function
  - Decreased ability to evacuate self or others
  - Increased risk for musculoskeletal injury

**INADEQUATE STAFF**
**Effect on Risk**
- Slower job completion
  - More time exposed to heat and other hazardous toxins – occupants and firefighters
- More Fire Growth
  - Increased risk of structural collapse or trauma
  - Intensified environmental hazards – heat, toxins
- Increased cardiac strain and physical workload
  - Less time before fatigued – decreased cognitive function, situational awareness, and physical strength and durability
  - Increased risk of injury or cardiac event
## Primary Factors Mediating Risk

### Environmental

- **Fire/ Fire growth/ Flashover**
- **Toxic environment/ Structural integrity**

- Burn, thermal injury
- Asphyxiation
- Structural collapse, blunt force trauma, entrapment
- Trauma

- Fireground chemical exposure
  - Vapors
  - Particulate

### Firefighter

- **Overstress and Overexertion**
- **Fatigue**

- Cardiac risk
- Musculoskeletal injury
- Hyperthermia

- Impaired cognitive function and decreased situational awareness
- Inability to continue work; less able to rescue self or others
The Conclusions

• Crew sizes and the effective response force sizes recommended in NFPA 1710, should be considered the **minimum** to provide for firefighter health and safety.

• Whenever possible, **additional resources** should be provided to address firefighters’ **physiological stress, limit fire growth, and mitigate occupational exposure** in today’s rapidly evolving fireground.
The Recommendations

- All fire chiefs should use NFPA 1500™ and the performance objectives in NFPA 1710 to ensure adequate resources are deployed to protect communities and to minimize risks to firefighter health and safety.

- Adequate resources, including properly trained firefighters and appropriate vehicles, should be deployed to arrive on scene in an appropriate timeframe to limit fire growth.

- Firefighter health and safety is the ultimate responsibility of the fire chief and city management and adequate personnel are necessary to successfully perform firefighting operations without undue risk to citizens and/or firefighters.
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