

# IO33 APPLICATION: AREA OF ORIGIN



Mike Ross – Fire Investigator

M.Sc., B.Sc., C.F.Sc

Office of the Fire Marshal

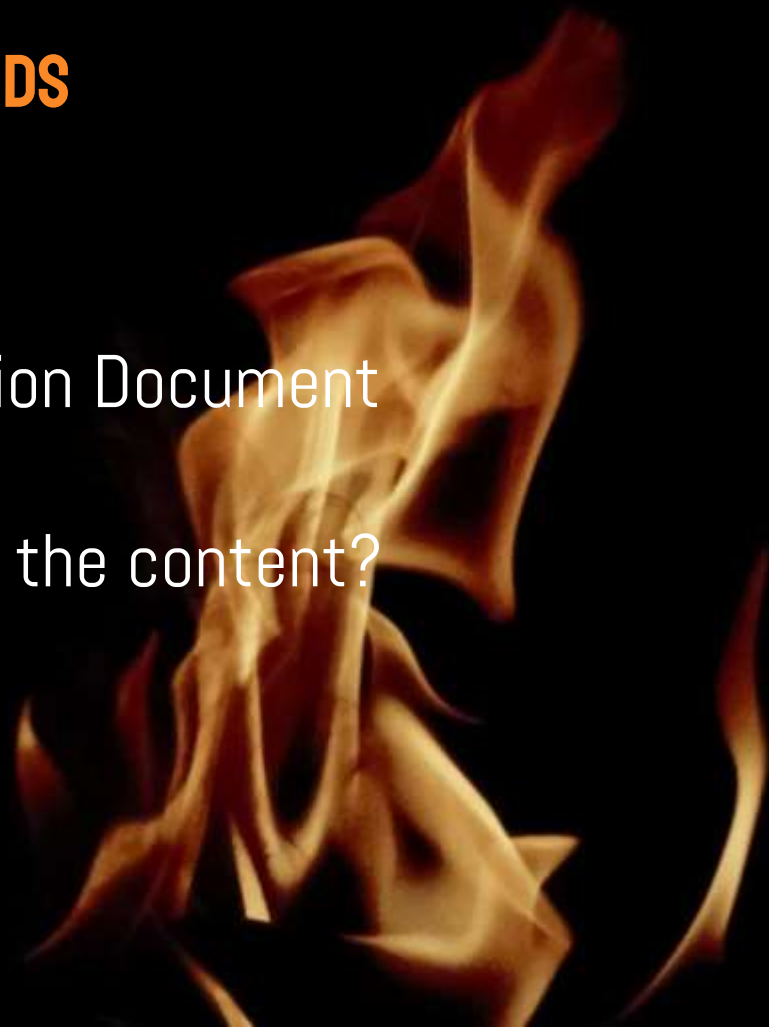
Jason Williams CFEI, CCFI-A

Fire Investigator

Belleville Fire & Emergency Services

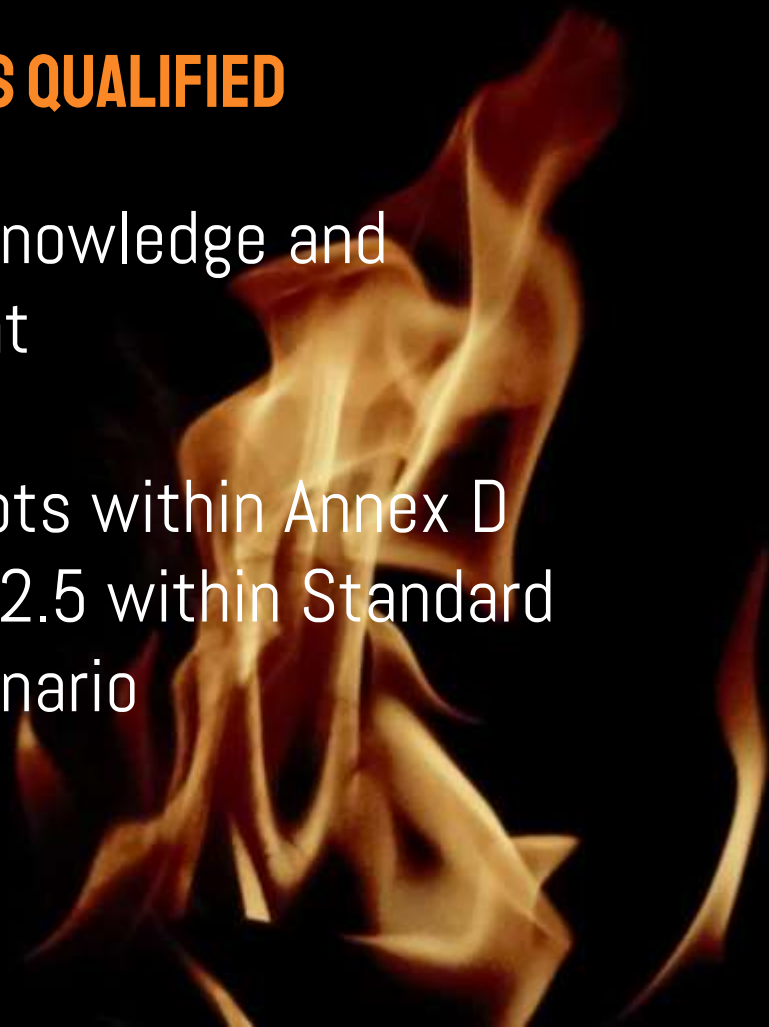
## CURRENT TRENDS

- Certified vs Qualified
- You possess the Certification Document
- Are you qualified to answer the content?



## NFPA 1033 CERTIFIED VS QUALIFIED

- Proficiency testing is the knowledge and application of the document
- NFPA 1321
- Read the terms and concepts within Annex D
- Framework for 4.2.4 and 4.2.5 within Standard and apply to your given scenario



# IO33 OLD (2014) VS NEW(2022)

**4.2.4** Interpret fire patterns, given standard equipment and tools and some structural or content remains, so that each individual pattern is evaluated with respect to the burning characteristics of the material involved and in context and relationship with all patterns observed and the mechanisms of heat transfer that led to the formation of the pattern.

**(A) Requisite Knowledge.** Fire dynamics, fire development, and the interrelationship of heat release rate, form, and ignitability of materials.

**(B) Requisite Skills.** Ability to interpret the effects of burning characteristics on different types of materials.

**4.2.5** Interpret and analyze fire patterns, given standard equipment and tools and some structural or content remains, so that fire development is determined, methods and effects of suppression are evaluated, false origin area patterns are recognized, and all areas of origin are correctly identified.

**(A) Requisite Knowledge.** Fire behavior and spread based on fire chemistry, fire dynamics, and physics, fire suppression effects, building construction.

**(B) Requisite Skills.** Ability to interpret variations of fire patterns on different materials with consideration given to heat release rate, form, and ignitability; distinguish impact of different types of fuel loads; evaluate fuel trails; and analyze and synthesize information.

**Δ 4.2.4** Interpret and analyze fire patterns, given standard equipment and tools and some structural or content remains, so that each pattern is identified and analyzed with respect to the burning characteristics of the material involved, the stage of fire development, the effects of ventilation within the context of the scene, the relationship with all patterns observed, and the understanding of the methods of heat transfer that led to the formation of the patterns identified and analyzed, and the sequence in which the patterns were produced is determined.

**(A) Requisite Knowledge.** Fire dynamics, including stages of fire development; methods of heat transfer; compartment fire development; the interrelationship of heat release rate (HRR), form, and ignitability of materials; and the impact and effects of ventilation on the creation of the fire patterns.

**(B) Requisite Skills.** Ability to interpret and analyze the effects of burning characteristics of the fuel involved and the effects of ventilation on different types of materials.

**4.2.5** Interpret and analyze fire patterns, given standard equipment and tools and some structural or content remains, so that fire development, fire spread, and the sequence in which fire patterns were developed (i.e., sequential pattern analysis) are determined; methods and effects of suppression are analyzed; fire patterns and effects indicating a hypothetical area or areas of origin are recognized and tested; false or refuted hypothetical areas of origin are eliminated; and all fire patterns are tested against the data, such that the area(s) of origin is correctly identified.

**(A) Requisite Knowledge.** Fire development and spread based on fire chemistry, fire dynamics including compartment fire development, fire spread, fire suppression effects, building construction, electricity and electrical systems, and fuel gas systems.

**(B) Requisite Skills.** Ability to analyze variations of fire patterns on different materials with consideration given to HRR, form, ignitability of the fuels involved, and the effects of ventilation; ability to understand the impact of different types of fuel packages on pattern creation; and ability to analyze and correlate information.



- 6 general areas of expert testimony where the reliability and validity of the underlying methodologies employed in determining the fire's origin or cause is either unknown, has been shown to be unreliable or is a clear violation of the scientific method. These include conclusions based on:

1. *Suspicious Burn Patterns;*
2. *Misidentification of the Area of Origin;*
3. *Misidentification of Multiple Areas of Origin;*
4. *Unconfirmed Accelerant Detecting Canines Alerts;*
5. *Unsupported Elimination of Electrical Appliances; and*
6. *Negative Corpus.*



Source: Bieber, P. (2016) *Anatomy of a Wrongful Event Analysis in Fire Investigations*. ISFI

## Contesting the Origin

- **Area of origin** is the room or area where the fire began.
- The origin of a fire is the most important hypotheses that an investigator develops.
- There are times if multiple origins are suspected that this is potential evidence of an incendiary fire, however, several requirements must be met.
- **Proof of Wrong Origin – Case Falls Apart**



# FIRE PATTERNS: FRIEND OR FOE



# FIRE PATTERNS IN CONTEXT

## SUBJECT MATTER IN THE DEVELOPMENT OF A FIRE PATTERN

1. Physical Chemistry of Fires
2. Heat transfer
3. Ignition
4. Flame-spread/Smoulder Waves
5. Heat Release/Burning Rate
6. Fire Plumes
7. Combustion Products/Toxicity



00:01:45



**ATF**

# **FIRE PATTERNS IN CONTEXT**

## **FIRE PATTERNS ANALYSIS OCCURS IN THE CONTEXT OTHER DATA:**

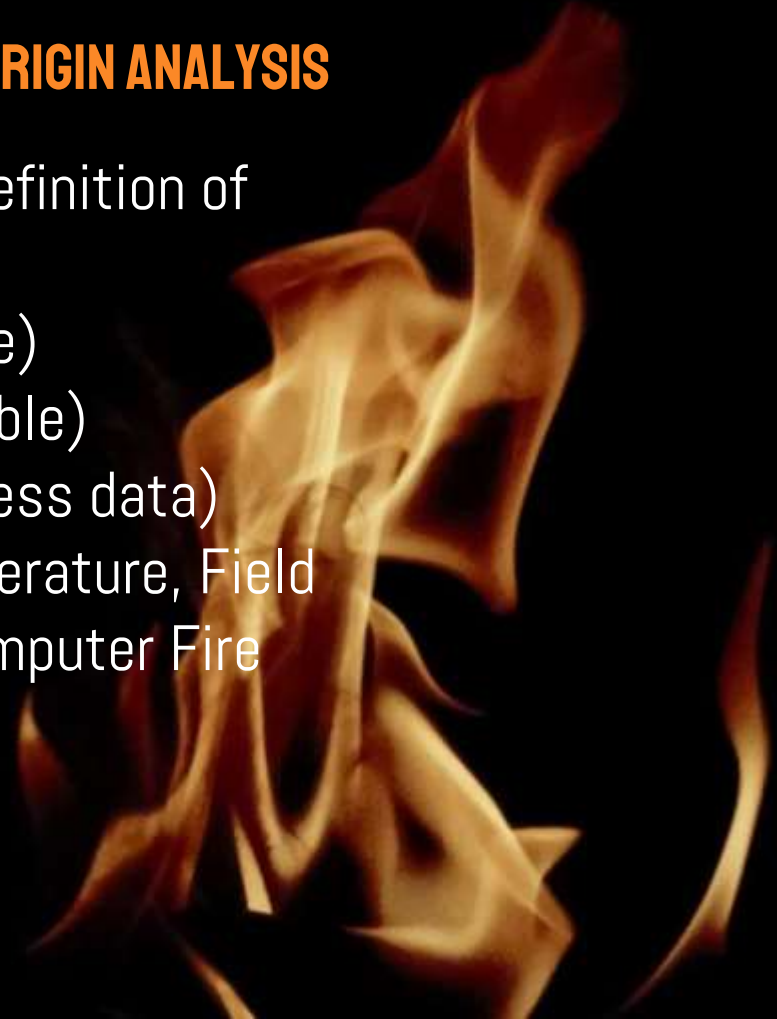
- Additional patterns
- Building construction
- Fuel characteristics
- Witness statements
- Fire Dynamics Analysis
- Time Interval Analysis





## CORE CURRICULUM AREA OF ORIGIN ANALYSIS

1. Fire Dynamic Fundamentals (see definition of fire dynamics)
2. Enclosure Fire Dynamics (next slide)
3. Fire Protection Systems (if applicable)
4. Interaction of fire and people (witness data)
5. Validation from Big 5 (Scientific Literature, Field Testing, Empirical Correlations, Computer Fire Models, Full Scale Laboratory



# FIRE PROTECTION SYSTEMS FOR ORIGIN ANALYSIS























## TO BE COMPLIANT WITH IO33

### QUANTITATIVE ANALYSIS OF A FIRE IN A ROOM

- Utilizing the terms and concepts discussed in Appendix D
- Most area of origin errors occur on the front end (data analysis for what is possible)



## 2 MAJOR QUESTIONS FOR AN ENCLOSURE FIRE

1. How does the fire impact on the compartment?
2. How does the compartment impact the fire?



# STANDARDS OF CARE

## NFPA 92I APPLICATIONS

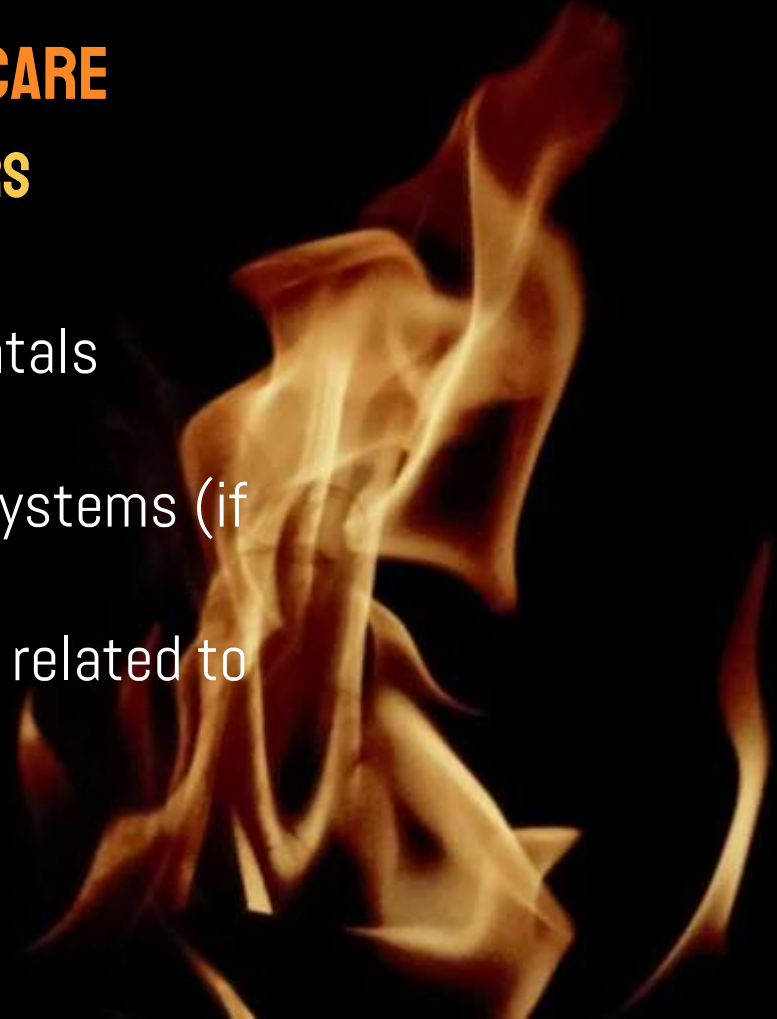
- Fire Patterns
- Witness Information
- Fire Dynamics
- Timelines
- 18.2.1 and 18.2.1.1



# STANDARDS OF CARE

## IO33 STANDARD FOR FIRE INVESTIGATORS

- ANALYSIS (biggest change)
- 4.2.4 and 4.2.5 for the fundamentals
- Incorporation of timelines
- Incorporation of fire protection systems (if applicable)
- Annex D for Terms and Concepts related to Compartment Fires



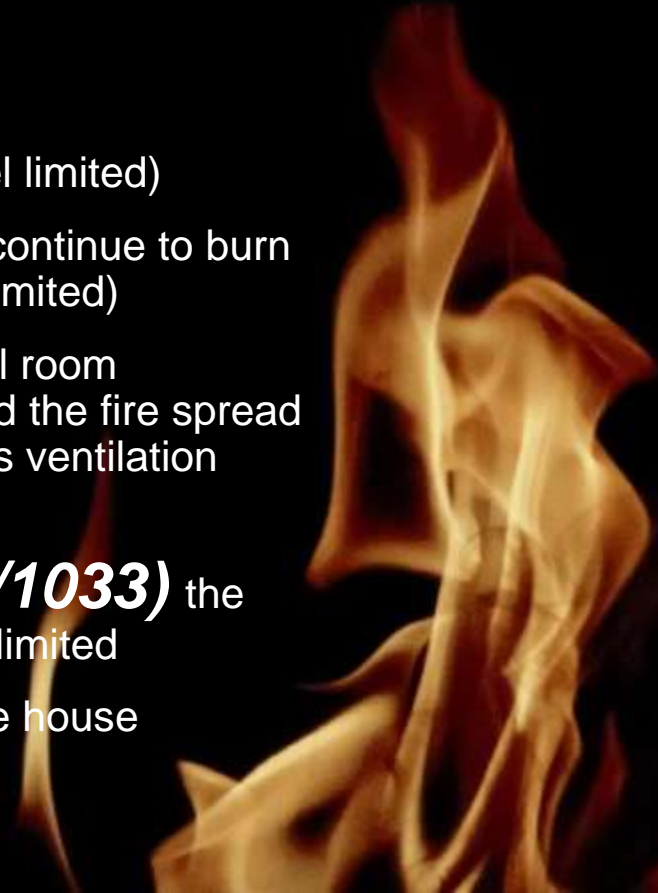


# FIRE BEHAVIOUR IN AN ENCLOSURE

1. Fire burns insolation without involving other items (fuel limited)
2. Inadequate ventilation the fire may self-extinguish or continue to burn at a slow rate dictated by available oxygen (ventilation limited)
3. Sufficient fuel and ventilation the fire progresses to full room involvement where all exposed surfaces are burning and the fire spread to adjacent compartments or atmosphere (entire room is ventilation limited)

\*With 3 given ***sufficient time (NFPA 921/1033)*** the entire enclosure, house, etc may transition back to fuel limited

\* Apply definition of flammable range to enclosure or the house depending on fire's magnitude



# FIRE BEHAVIOUR IN AN ENCLOSURE



00:01:45



**ATF**

# FACTORS EFFECTING AREA OF ORIGIN DETERMINATION

## I. INITIAL FIRE SIZE AND LOCATION

- Definition of Area of Origin
- Initial fire size may range from a couple articles of clothing (80-200kW)
- Full size Sofa
- Specified fire power (kW) in a Geographic Location (by definition area of origin and fuel to evaluate)



Single item vs Room

# FACTORS EFFECTING AREA OF ORIGIN DETERMINATION

## 2. FUEL ANALYSIS

- Type (state of matter)
- Amount (total mass available or residual)
- Position (Centre of Room, X,Y,Z Axis)
- Orientation (Horizontal vs Vertical)
- Spacing (Proximity to Other Materials)
- Surface Area(s) of Fuel Packages





# FACTORS EFFECTING AREA OF ORIGIN DETERMINATION

## 3. GEOMETRY OF THE ENCLOSURE/ROOM

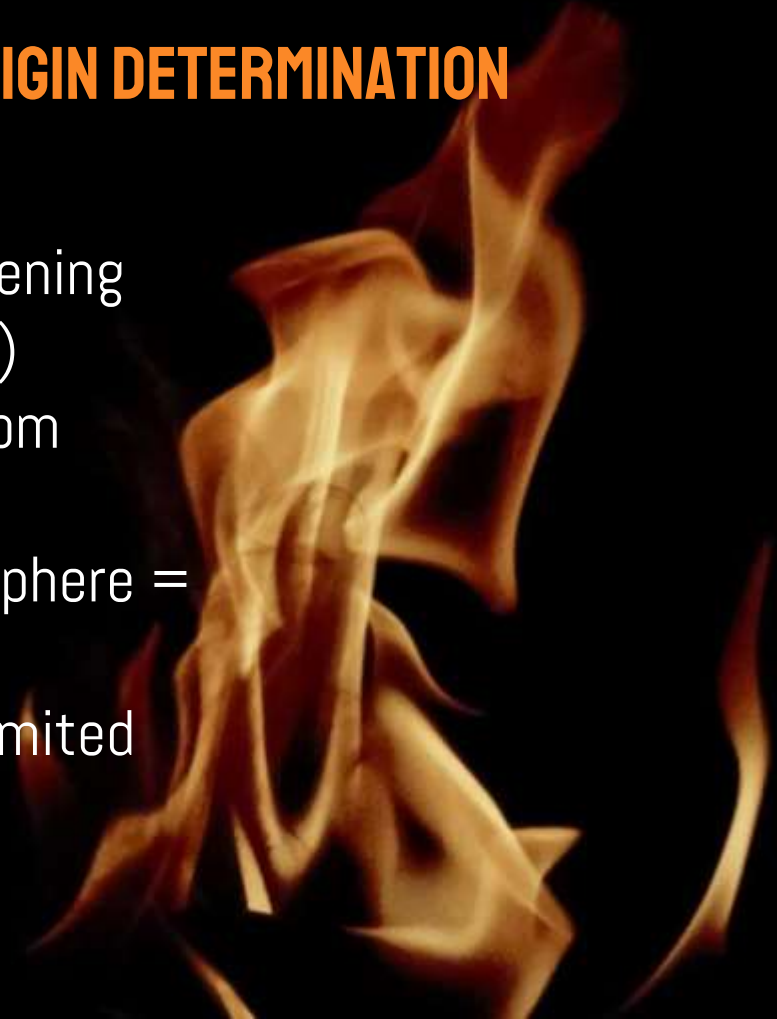
- Traditional Square Room with ~ 8 foot Ceiling
- Loft/Half Storey (Triangle)
- Compartment with lower ceiling or potential for elevated fuel load (z-axis)



# FACTORS EFFECTING AREA OF ORIGIN DETERMINATION

## 4. LOCATION AND SIZE OF THE OPENINGS

- Traditional Door size vs Large Opening
- Upper vs Lower (Window vs Door)
- Friction affecting entrainment from attached compartment
- No friction if opening is to atmosphere = greater velocity of airflow
- Affects the Fuel vs Ventilation Limited Profiles and their application



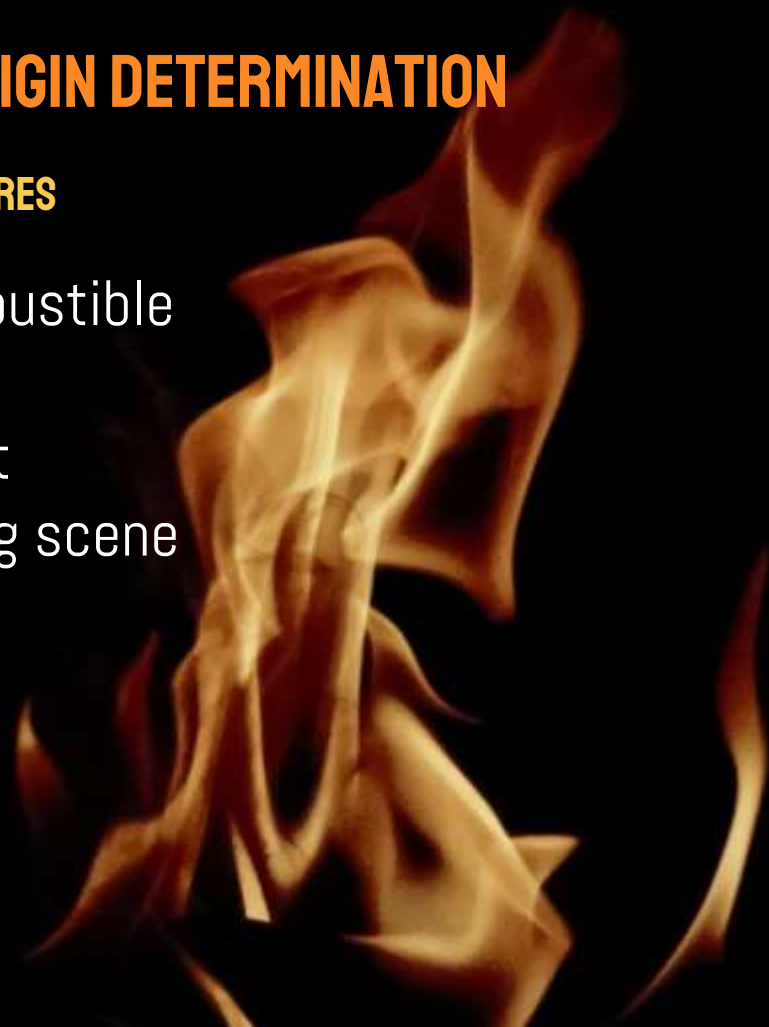
## LOCATION AND SIZE OF THE OPENINGS



# FACTORS EFFECTING AREA OF ORIGIN DETERMINATION

## 5. MATERIAL PROPERTIES OF THE BOUNDARY ENCLOSURES

- Wall and ceiling linings of a combustible finish
- Key in misinterpreting data is not collecting this type of data during scene survey





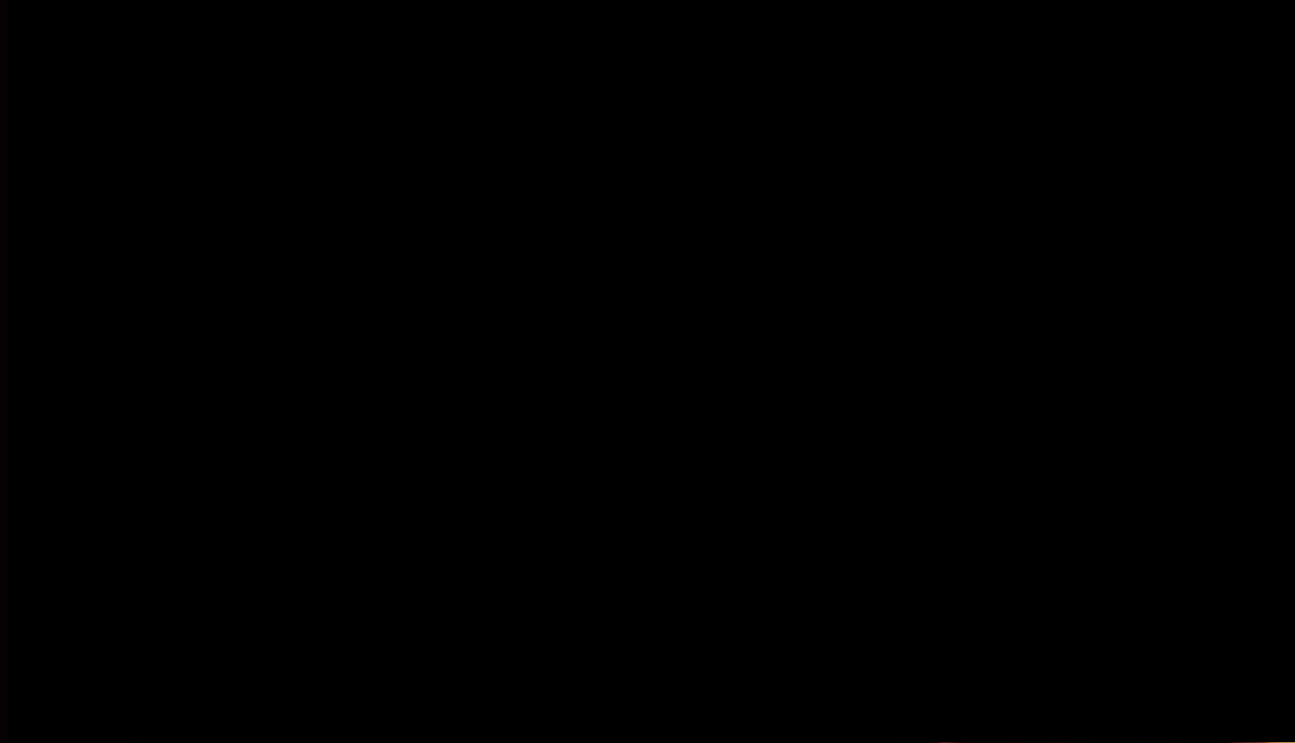
# FACTORS EFFECTING AREA OF ORIGIN DETERMINATION



# FACTORS EFFECTING AREA OF ORIGIN DETERMINATION



# FACTORS EFFECTING AREA OF ORIGIN DETERMINATION



# Problem Solving Utilizing Methodology

## Three Problems:

- 1) Area of Fire Origin
  - 2) Fuel Load (with required HRR) to support development of Fire
  - 3) Ignition Sequence (First Fuel Ignited / Ignition Source)
- Investigator shall ensure that domain relevant data is collected and analyzed (through inductive and deductive reasoning). Hypothesis are formed and tested (falsification process) and if possible final hypothesis is selected.





# Investigative Data Analysis- NFPA 1033 Application

- Incident Location
- Occupant Activity
- Fire Service Response and Suppression Activities
- Involved Agencies
- Origin Determination
- Cause Determination- Including FFPE Choudry Analysis
- Fire Models – Smoke Alarm Activation and Vent/Temp Profiles
- Public Fire Safety Issues/ Comp. Fire Safety Effectiveness Model:
  - A) Smoke Alarms
  - B) Fire Ground Effectiveness



## Incident Location- 95 Gainsborough Drive, City of Toronto



# Occupant Information

## Occupants of Dwelling

- 1) Jana JANSONS (D)- Home owner, Mother of Arija and Grandmother of Kai
- 2) Arija (Celeste) JANSONS – Surviving Occupant
- 3) Kai ARCE (D)
- 4) Jade JACOBIS (26 Years)- Discover of Fire, Friend of Arija renting room
- 5) Amanda FREIMANIS (D)- Friend of Arija renting room
- 6) Matthew ZDYBAL (D)- Contractor performing work and Friend of Arija



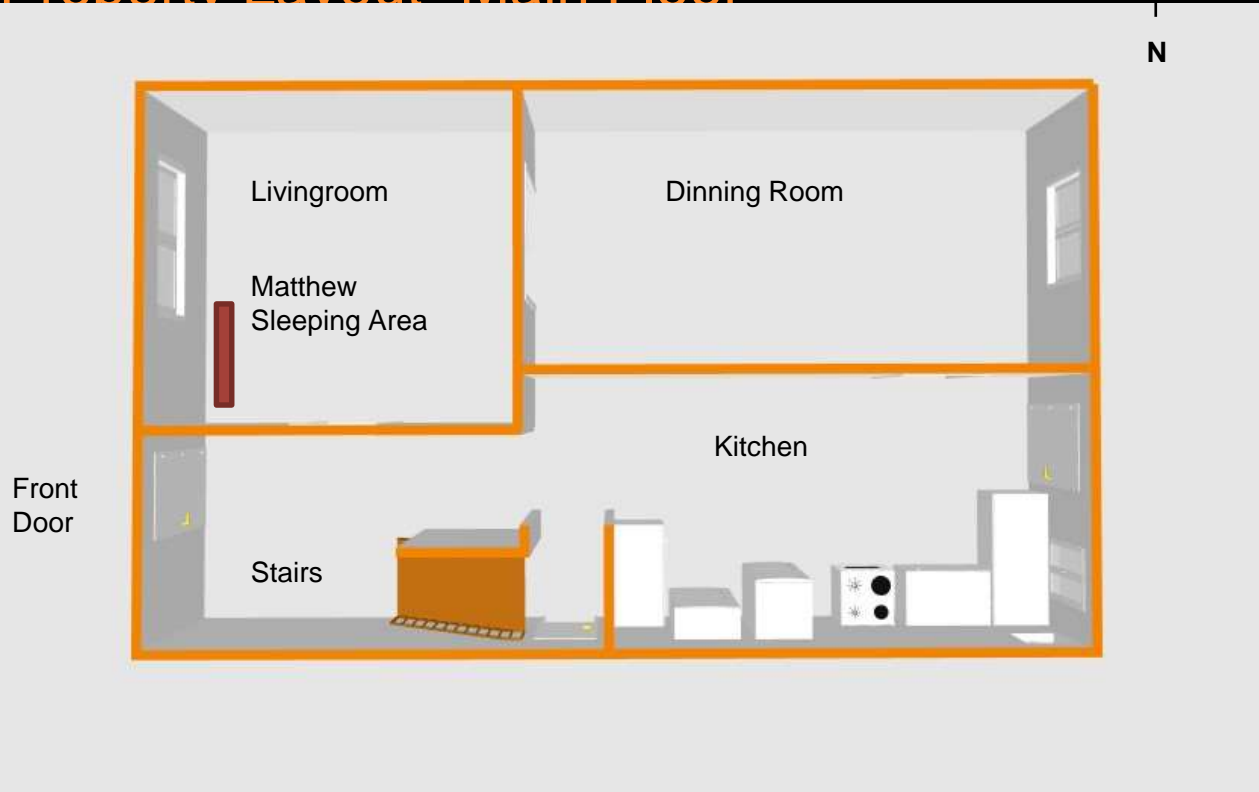
# Investigative Data Collection

- Working on kitchen renovations day prior to fire
- Removed section of ceiling and were painting
- Removed kitchen light fixture to replace and encountered knob and tube wiring
- Going to call electrician next day
- Kai and Jana went to bed
- Arija, Jade and Matthew were up until between 1-3am having bonfire then went to bed

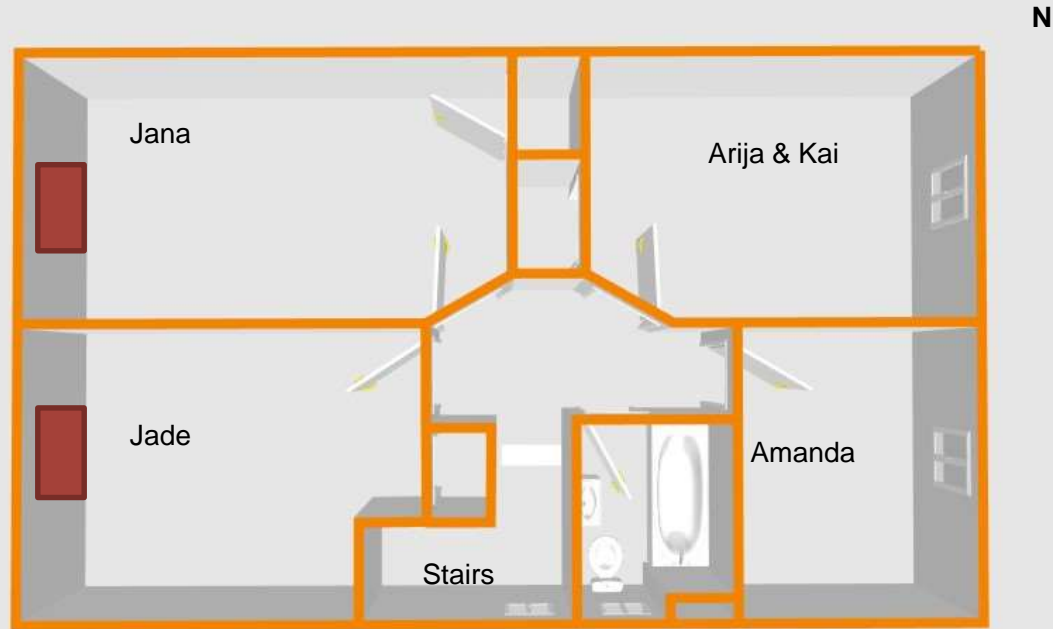




## Property Layout- Main Floor



## Property Layout-Second Floor

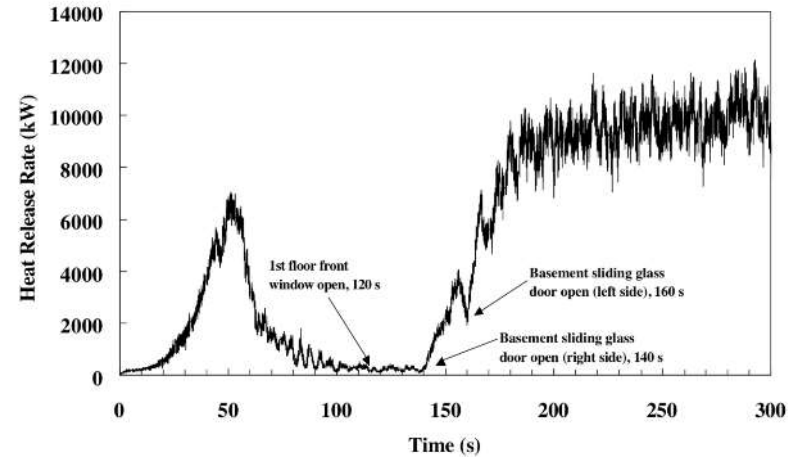


# Fire Development-Time Line Analysis (Effects on Fire Pattern Development)

Event	Date	Time	Event	Time Pre/Post
911 Call	1/29/21	4:36:23	0	00:00:00
Arrival of Fire Service P227	1/29/21	4:42:09	0	00:05:46
P226 second truck in	1/29/21	4:42:52	0	00:06:29
Fast Attack-victims 2nd floor	1/29/21	4:43:26	0	00:07:03
P226-Hydrant #1 Frozen	1/29/21	4:46:05	0	00:09:42
P226-Hydrant #2 Frozen	1/29/21	4:50:24	0	00:14:01
P226-Hydrant #3 Water Flowing	1/29/21	4:52:24	0	00:16:01
P227-Low Water	1/29/21	4:54:07	0	00:17:44
P227-No Water	1/29/21	4:57:11	0	00:20:48
Mayday Called	1/29/21	5:02:31	0	00:26:08
P226 Crew 3 Mayday Called	1/29/21	5:03:08	0	00:26:45
Victim located 2nd floor N/W	1/29/21	5:07:29	0	00:31:06
C32-All Crews Retreat	1/29/21	5:11:29	0	00:35:06
C22-Victim Removed	1/29/21	5:40:14	0	01:03:51
P322-Victim Removed 2nd Floor	1/29/21	5:51:17	0	01:14:54
T333-Victim located and removed	1/29/21	6:58:46	0	02:22:23

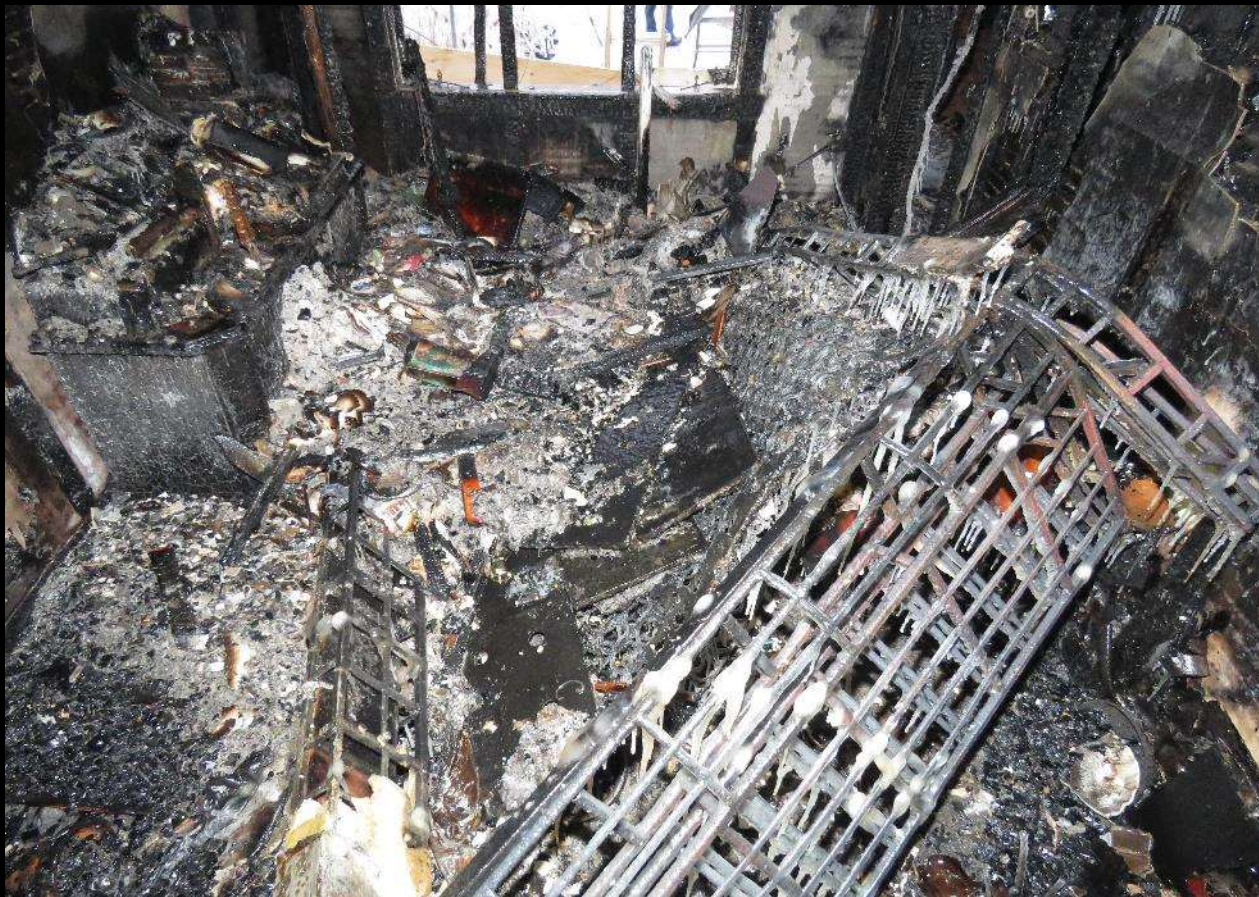


# VENTILATION IMPACT ON FIRE PATTERN ANALYSIS AND DEVELOPMENT (CONTEXT)













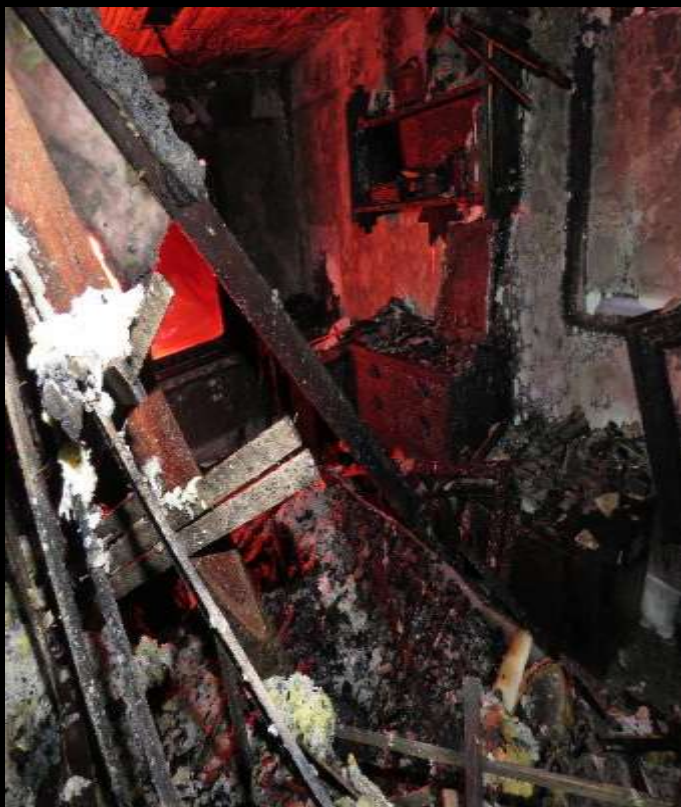












## OFM Fire Investigation-Origin Determination (Location/Orientation of Fire)





# OFM Fire Investigation- Origin Determination



# Fire Dynamics/Fire Spread

- The fire spread from the area of origin (which consisted of electrical branch circuitry and combustible timber framing and sheathing materials) within a confined ceiling cavity. The fire was ventilation limited in the early stages of development due to the limited amount of available oxygen to support the fire within the ceiling cavity. The fire entrained oxygen into it through the voids between the ceiling joists from the areas of the north and south exterior walls of the structure (as a function of their placement and orientation). The fire spread laterally with the positioning of the fuel load, namely the timber 2x8" ceiling joist (north to south) and breached the ceiling cavity at the north end of the dining room, under the north enclosing wall of the north/east second floor bedroom (location of Persons 2-6).
- The fire also spread laterally to the south, and into the kitchen compartment as a function of the removal of a section of the ceiling materials earlier in the day to facilitate the renovation work which was taking place. The removal of the ceiling material allowed for the fire to entrain oxygen into the ceiling cavity (though the spacing in the floor joists) as well for the fire to first vent into the kitchen compartment which is supported by security video obtained during the course of the investigation.





# OFM Fire Investigation-Cause Determination

## Electrical Failure of Dining Room Light Assembly





## OFM Fire Investigation-Cause Determination

### Electrical Failure of Dining Room Light Assembly



# Major Fire Investigation – Public Fire Safety Office of the Fire Marshal

- The FPPA mandates that every municipality in the Province of Ontario establish a program which includes public education with respect to fire safety and certain components of fire prevention, and provide such other fire protection services as it determines necessary in accordance with its needs and circumstances. This is regularly done by the analysis of the fire safety risk assessment which should be performed by the fire service in the community in which they serve. The fire service commonly refers to these elements as the *Three Lines of Defence*.
- **The *Three Lines of Defence* are the following:**
  - Public Safety Education
  - Fire Safety Standards and Enforcement
  - Emergency Response



# Public Fire Safety – Detection Smoke Alarms

- 1) During the scene examination and excavation process no working smoke alarms were located within the dwelling
- 2) A single Kiddie brand (Modell #I90609A) Ionization battery operated smoke alarm was located in the basement level of the dwelling. The smoke alarm had been removed from the mount on the ceiling, and the battery was dead.



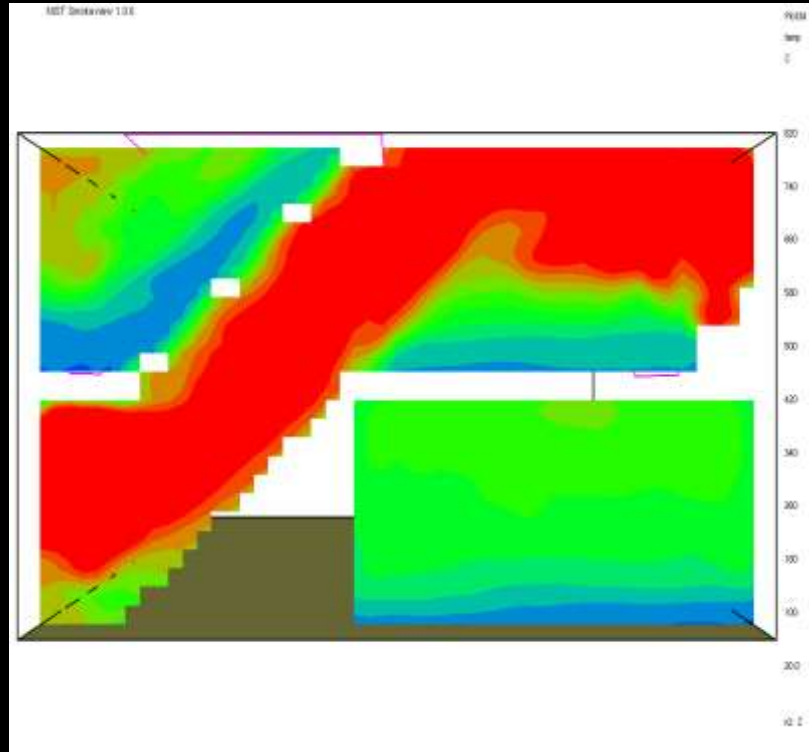
# NIST- Research involving Ventilation/Suppression Activities

- Based on a review of NIOSH investigation reports from the past 15 years, it is clear that fires with rapidly developing or changing flow paths are a significant hazard to the fire service. The development of (or changes to) a flow path could be caused by the failure of a component of the structure, such as a door, window, or portion of a ceiling, wall, or floor. Environmental conditions such as wind can generate hazardous thermal conditions within a flow path. Uncoordinated ventilation procedures can also be the cause of increased thermal hazards within a flow path. The experiment where the line was delayed following the ventilation of the basement generated conditions representative of these types of dramatic change in the exhaust portion of the flow path.
- Fire suppression efforts should be coordinated with interior operations and ventilation procedures to reduce thermal hazards related to flow paths within a structure. Ongoing research by NIST, Underwriters Laboratories (UL), and others has demonstrated that applying water from the exterior into the fire area of a structure (typically prior to the start of interior operations) can significantly improve the safety of firefighters by reducing the thermal hazard from the fire and reducing the potential for developing high velocity hot gas flows within the structure



## FLOW PATH MODEL

This exemplar fire model is one of many which have been utilized to speak to the role of ventilation and the creation of unilateral and bilateral vent openings during the course of fire suppression tactics. The ventilation of a structure (which contains a ventilation limited fire) must be analyzed and in conjunction with the application of water as the rapid entrainment of oxygen into a compartment (containing pre-heated fuel) can allow the fire to develop rapidly within the structure.





# Fire Model Slice File- Entrainment Vector Analysis 95 Gainsborough Road



# FDS Fire Model- 95 Gainsborough Road

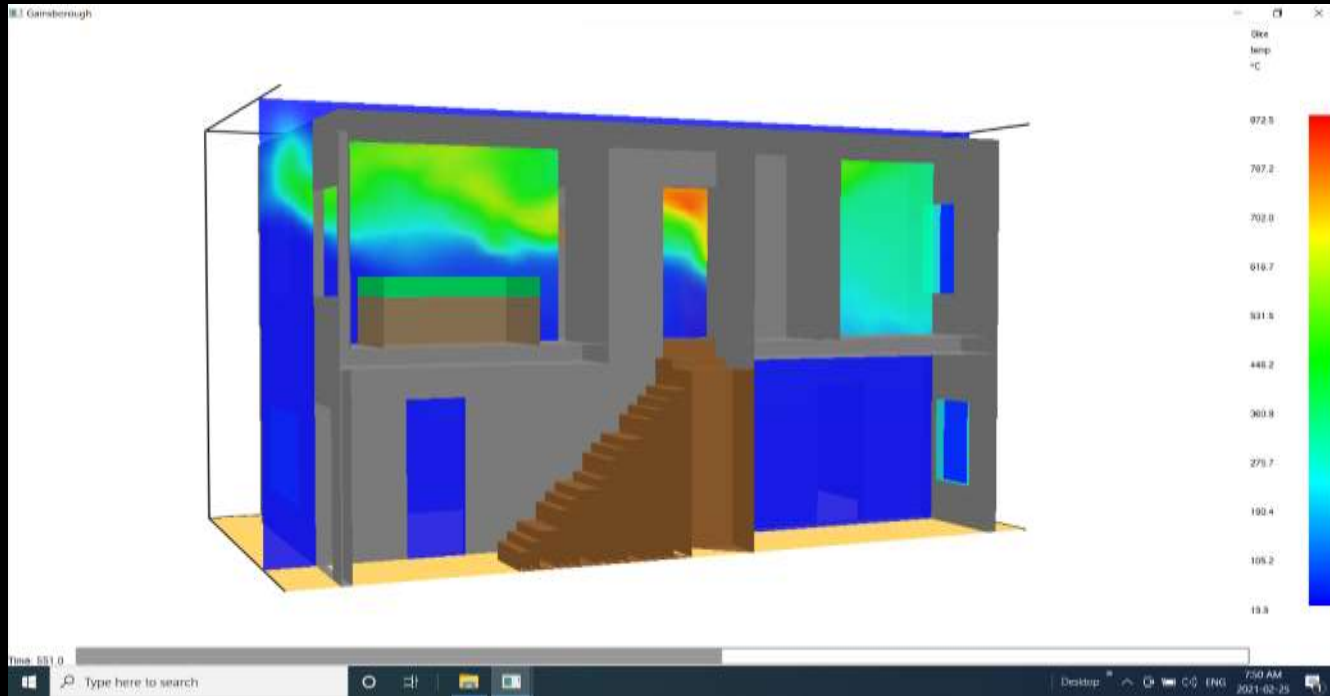


# Smoke Alarm Activation Data

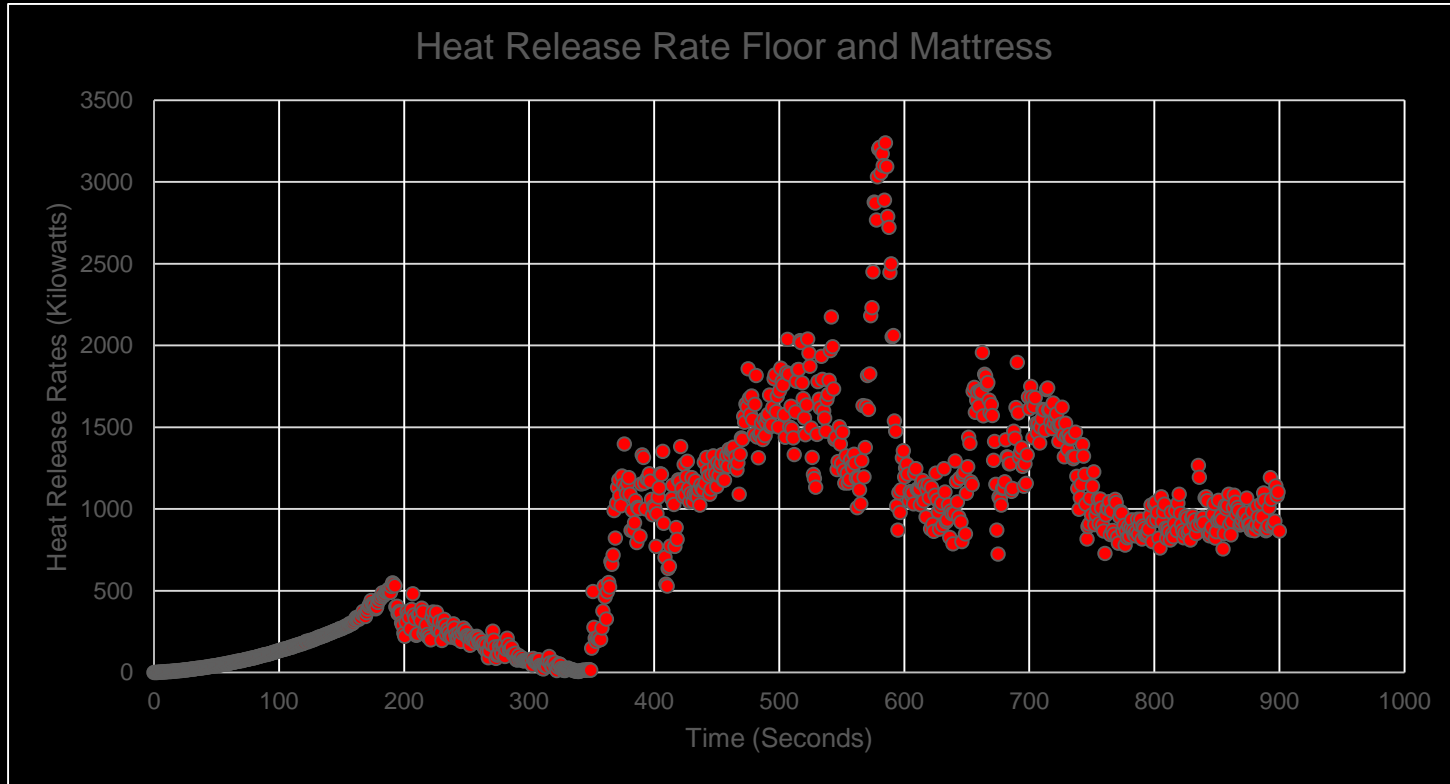
DEVC Name	Units	Threshold	Fire Type	Detector Type	Alarm Threshold Plus or Minus		time - MIN	time - MAX
		[%]			[OD/m]	[OD/m]	[sec]	[sec]
2ndFloorHallway	1/m	80% ▾	Flaming ▾	Photoelectric ▾	0.106	0.039	32	3
Bedroom S/W	1/m	80% ▾	Flaming ▾	Photoelectric ▾	0.106	0.039	121	12
Bedroom N/W	1/m	80% ▾	Flaming ▾	Photoelectric ▾	0.106	0.039	121	12
#N/A	#N/A	80% ▾	Flaming ▾	Photoelectric ▾	0.106	0.039	#N/A	#N/A
#N/A	#N/A	80% ▾	Flaming ▾	Photoelectric ▾	0.106	0.039	#N/A	#N/A
#N/A	#N/A	80% ▾	Flaming ▾	Photoelectric ▾	0.106	0.039	#N/A	#N/A
#N/A	#N/A	80% ▾	Flaming ▾	Photoelectric ▾	0.106	0.039	#N/A	#N/A
#N/A	#N/A	80% ▾	Flaming ▾	Photoelectric ▾	0.106	0.039	#N/A	#N/A
#N/A	#N/A	80% ▾	Flaming ▾	Photoelectric ▾	0.106	0.039	#N/A	#N/A
#N/A	#N/A	80% ▾	Flaming ▾	Photoelectric ▾	0.106	0.039	#N/A	#N/A
#N/A	#N/A	80% ▾	Flaming ▾	Photoelectric ▾	0.106	0.039	#N/A	#N/A



# Fire Model-Slice File / Temperature Profile with Conservative HRR



# Heat Release Rate Curve- Fire Development





# Investigation Summary

- The area of fire origin hypothesis was considered, tested and isolated as the center of the dining room ceiling.
- The ignition sequence hypothesis which was considered, tested and isolated in this incident was the ignition of the stranded copper electrical conductors (living room light fixture) by means of an electrical failure within the area of fire origin.
- The cause of the fire has been classified as: ***Accidental.***



# THANK YOU

Mike Ross  
Fire Investigator  
Office of the Fire Marshal  
[Michael.d.ross@ontario.ca](mailto:Michael.d.ross@ontario.ca)

Jason Williams  
Fire Investigator  
Belleville Fire and Emergency Services  
[jwilliams@belleville.ca](mailto:jwilliams@belleville.ca)  
(613)921-8129

