Fire Investigations

- The purpose of a fire investigation is to determine:
  - What was the origin of the fire?
  - What was the cause of the fire?
  - Was it accidental or intentionally set?
  - If life was lost, what contributed to the death?

Entities Involved in Fire Investigations

- Company investigators
- Insurance investigators
- State/central/Local Government Investigators

Accidental Fire Cause

- Accidental fires involve all those for which the proven cause does not involve a deliberate human act to ignite or spread fire into an area where the fire should not be.
- For example, in a legal setting, a trash fire might be spread by a sudden gust of wind.
- The spread of fire was accidental even though the initial fire was deliberate.

Natural Fire Cause

- Natural fire causes involve fires caused without direct human intervention, such as lightning, earthquake, wind, and the like.

Incendiary Fire Cause

- The incendiary fire is one deliberately ignited under circumstances in which the person knows that the fire should not be ignited.

Undetermined Fire Cause

- Whenever the cause cannot be proven, the proper classification is undetermined.

Types of Evidence

- There are basically three types of evidence, all of which in some manner relate to fire investigations.
- They are demonstrative evidence, documentary evidence, and testimonial evidence.

Demonstrative Evidence

- Consists of tangible items as distinguished from testimony of witnesses about the items.
- Can derive a relevant firsthand impression by seeing, touching, smelling, or hearing the evidence.
- Demonstrative evidence should be authenticated through witness identification (i.e., recognition testimony) or by establishing a chain of custody (an unbroken chain of possession from the taking of the item from the fire scene to the exhibiting of the item)

Photographs/Illustrative Forms of Evidence

- Among the most frequently utilized types of illustrative demonstrative evidence are maps, sketches, diagrams, and models. They are generally admissible on the basis of testimony that they are substantially accurate representations of what the witness is endeavoring to describe.

Samples

- Chain of custody is especially important regarding samples.
- To ensure admissibility of a sample an unbroken chain of possession should be established.

Documentary Evidence

- Documentary evidence is any evidence in written form.
- May include business records such as sales receipts, inventory lists, invoices, bank records, including checks and deposit slips; insurance policies; personal items such as diaries, calendars, telephone records; fire department records such as the fire investigator's report, the investigator's notes, the fire incident report, witness statement reduced to writing; or any law enforcement agency reports, including investigation reports, police officer operational reports, fire or police department dispatcher logs; division of motor vehicle records; written transcripts of audio- or videotape recordings.

Testimonial Evidence

- Testimonial evidence is that given by a competent live witness speaking under oath or affirmation.
- Investigators are frequently called on to give testimonial evidence regarding the nature, scope, conduct, and results of their investigation. It is incumbent on all witnesses to respond completely and honestly to all questions.

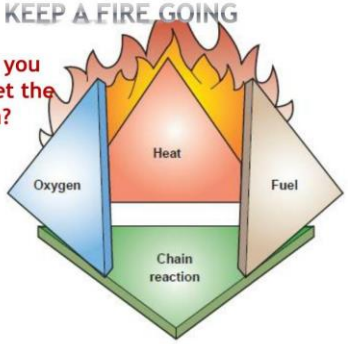
INTERPRETING DATA

- Forensic Science
  - Often uses graphs to help people understand the data and conclusions
- Develop conclusions based on the data
  - Deaths, Injuries, Property Damage
  - Accidental vs. Intentional
- Graph the data to support your conclusions
  - Support your choice for the type of graph

HOW DOES A FIRE BURN?

COMPONENTS NEEDED TO START AND KEEP A FIRE GOING

How do you interpret the diagram?



FACTORS FOR BURNING

Fuel + O_2 ⇛ Heat + CO_2 + H_2O

To react with oxygen, most accelerants must be in the gaseous state.

- Terms
  - Accelerant = material to start or maintain a fire
  - Flash Point = lowest temperature where there is enough heat to change from liquid to gas
  - Ignition Temperature = temperature that allows a fuel to burn and continue burning
  - Heat of combustion - heat generated in a combustion reaction

INTERPRETING THE TABLE

- Comparing fuels (accelerants)
  - Which will be the easiest to ignite?

Accelerant	Flash Point (°C)	Ignition Temperature °C
Acetone	-20	465
Gasoline	-46	257
Kerosene	52-96	257
Mineral spirits	40-43	245
Turpentine	32-46	253

IMPORTANT TERMS

- Combustible
- Non-flammable
- Accelerant
- Exothermic
- Heat
- Flash point
- Ignition Temperature
- Heat of combustion
- Vaporization
- Solid/liquid/gas
- Pyrolysis
- Arson
- Hydrocarbon
- Conduction
- Radiation
- Convection

FUNCTION OF FIRE INVESTIGATION

- Fire category

Category	Description
Natural	A fire caused by acts of nature: a lightning strike or intense sunlight
Accidental	A fire that was unintentional and explainable; causes may include faulty wiring, malfunctioning appliances, or human carelessness
Undetermined	The cause of the fire is unknown and cannot be identified
Deliberate	A fire that was intentionally set (Not all deliberate fires are arson. For example, a campfire might spread out of control.)

- Point of origin
- Pattern of fire spread

DIFFICULT TO ANALYZE ARSON

(i) These crimes are carried out at the convenience of the perpetrator and are often "well-planned" to hide crucial evidences

(ii) Inability to collect crucial/useful evidence due to the accompanied destruction of the crime scene

(iii) volatile evidences are hard to collect and preserve.

THE FIRE SCENE INVESTIGATION

A
- Starts as soon as the fire has been extinguished.

R
- Most arsons are started with petroleum-based accelerants.

S
- Does not require a search warrant.

O
- Focus on finding the fire's origin

N

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ARSON = INTENTIONAL FIRES

Did You Know?

The bedroom is the most common point of origin for intentionally set fires in the home. In public places, such as schools or offices, bathrooms are the most common point of origin.

Did You Know?

There appears to be a growing link between arson and illegal drug activity. Preliminary results of a new study by the National Fire Protection Association suggest that between 20 and 25 percent of reported arson cases in major American cities are drug related.

Did You Know?

Arsonists often escape punishment. Only 16 percent of arson offenses lead to arrest, and only 2 percent of those arrested are convicted.

FIRE INVESTIGATION BASICS

- Work from the least damaged areas to the most heavily damaged areas.
- Document with notes, photographs, and videos.
- Collect evidence (accelerant samples, fire items, and other crime scene evidence.)
- Interview witnesses
- Determine the point of origin.
- Determine the heat source(s).
- Hypothesize the reasons for the fire.

Havana – Laurel Street Practice Burn Photographs

What clues might a fire investigator gain from this photograph?

Photos provided by Brock Brooks & the Havana Fire Department

Havana – Laurel Street Practice Burn Photographs

Photos provided by Brock Brooks & the Havana Fire Department

Practice Burn Photographs

A fire started in the kitchen area does not take long before it is a ball of flame reaching quickly to the ceiling.

Fires can easily double in size every 60 seconds, meaning there is little time to extinguish a fire before escape should be your primary goal if trapped.

Fire fighters look on as the fire spreads across a room.

The house is nearly completely consumed.

Source: http://www.ci.east-grand-forks.mn.us/fire/gallery/burn/burn.htm

ACCIDENT OR ARSON?

- **Accidental Nature**
  - Heating System
  - Electrical appliances
  - Lightning
  - Children playing with matches
  - Smoking
- **Non-Accident**
  - Odors – Gas, kerosene, or other accelerants
  - Furnishing – Removal of personal objects and valuables
  - Clothing – Check debris for buttons, zippers, etc
  - Locked windows, blocked doors
  - Two or more points of origin
  - Look for inverted v-patterns (can be a sign that an accelerant was used)
  - Floors charred –Can indicate use of an accelerant
  - Trailers (streamers) that lead the fire from one place to another

Image: Havana Rural Fire Department

WHAT IS BURNING IN A FIRE?

- Wood and charcoal are non-flammable
- What burns?
- Why do fires burn differently?

Wood fire

Charcoal fire

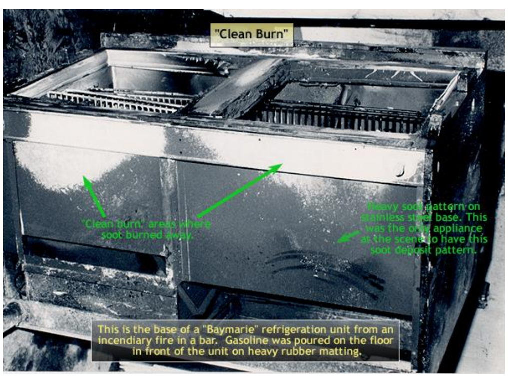
Burn Patterns

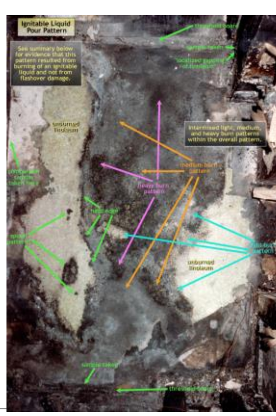
- Burn patterns can be useful in determining the point of origin and cause of the fire
  - **V- pattern**: Most fire moves up an out creating a "V" pattern. Abnormal fires create inverted "v" patterns. Most investigators have associated inverted "V" patterns with accelerants.
  - **Clean Burn**: a fire pattern on a non-combustible surface where soot deposits have been burned away by direct flame contact or intense radiant heat, leaving a "clean" area bordered by sooty stains.

Burn Patterns

- **Ignitable Liquid Burn Pattern**: Charred material next to uncharred material with a flow pattern present (Line of demarcation)
- **Wood Char Patterns**: This is natural, since post-fire patterns found on wood members are generally more pronounced and extensive than those found on many other construction materials.
- There is not much agreement on what quantitative interpretation, if any, can be placed on such patterns.


Classic "V"
doors open during fire
Note classic slope toward point of origin, creating "V" shape.
point of origin
No thermal damage
door open during fire
door closed during fire


"Clean Burn"
"Clean burn" areas where soot burned away.
Heavy soot pattern on stainless steel base. This was the only appliance at the scene to have this soot deposit pattern.
This is the base of a "Baymarie" refrigeration unit from an incendiary fire in a bar. Gasoline was poured on the floor in front of the unit on heavy rubber matting.


Ignitable Liquid Pour Pattern
See summary below for evidence that this pattern resulted from burning of an ignitable liquid and not from flashover damage.
unburned linoleum
Intermixed light, medium, and heavy burn patterns within the overall pattern.
medium burn pattern
heavy burn pattern
unburned linoleum

FIRE CLUES

- **Point of Origin –**Location where the fire started.
- **Char Patterns** –

Pattern	Description	Indication
Classic V	Burn pattern narrower at bottom and spreads outward as it rises	Ordinary burn pattern, no accelerant used
Inverted cone	Burn pattern is wider along the floor and narrower as it burns upward	May be caused by an accident or by accelerant poured along the floor
Alligatoring	Burn pattern resembling the scales of an alligator	Possible use of an accelerant, but not absolute
Spalling	The breaking away of layers of concrete due to exposure to high temperatures	Possible use of an accelerant, but not absolute
Streamers	Burn pattern that shows a trail from one area to another	Accelerant used to spread the fire from one area to another
Arc damage	Spark caused by a release of electricity	Electrical fire; may also be a result of a fire that has burned through wire insulation
Pool or plant	A burn pattern in a puddle configuration	Poured accelerants accumulated in a pool at the lowest point

FIRE CLUES

- **Point of Origin –** Burn patterns and other damage can help determine the point of origin, or the location where the fire started.
- **Char Patterns** – Created by very hot fires that burn very quickly and move fast along its path, so that there can be sharp lines between what is burned and what isn't.
  - A char pattern on a door would help an investigator determine which side of the door the fire was on.
  - A char pattern on the floor would help investigators determine the use of an accelerant and its path.
- **V-Patterns** - Fire burns up, in a V-shaped pattern, so a fire that starts at an outlet against a wall leaves a char pattern that points to the origin.
  - A very narrow V-shape might indicate a fire that was hotter than normal, such as one helped along by an accelerant.
  - A wide V-shape might indicate a fire that was slow burning.
  - A U-shape could indicate that there was a "pool of origin" rather than a point of origin, such as might be caused by, say, a puddle of gasoline.

- **Heat Shadows** - Occur when heavy furniture shields part of a wall, help determine the origin point.
- **Glass -** Glass fragments, windows, and light bulbs can provide clues to a fire.
  - Light bulbs tend to melt toward the heat source, so the "direction of melt" can indicate the direction of the fire.
  - The shattered or cracked glass of the windows can provide indications as to how a fire burned.
  - A dark soot layer on the glass could indicate a slow, smoldering fire.
  - Clear glass with an abnormal pattern of cracking could imply a very hot fire, possibly due to an accelerant.
- **Chimney Effect** - Since fire burns upwards, there can be a "chimney effect" where the fire ignites at a point, the superheated gases rise upward and form a fireball, which continues straight up to burn a hole in the ceiling. If the roof is not entirely burnt, and the fire investigator finds such a hole, the origin of the fire could be directly underneath.
- **Color of smoke** – Determine what type material was burning
- **Color of flames** – Indicates at what temperature the fire was burning.

Examples of Investigator Activities

- During the Fire
  - If present during the fire and suppression, observe suppression activities of the firefighters
- Immediately After the Fire Is Extinguished
  - Secure access to the scene
- During Clearing of the Scene
  - Supervision of the overhaul operation
- After Clean-Up
  - Examine significant burn patterns
  - Look for evidence of ignition sources

Fire Investigation Guidelines

- NFPA 921: Guide for Fire and Explosion Investigations
- A systematic approach to fire investigations:
  - The assignment is received and the investigator is notified of his/her responsibilities
  - The investigator plans the investigation and assembles tools, equipment, and personnel
  - The scene is examined and data is collected
  - Physical evidence is collected, documented, tested, and evaluated
  - The scientific method is used to analyze the information obtained

Fire and Arson Investigator Requirements

- NFPA 1033: Professional Qualifications for Fire Investigator
  - Specifies minimum job performance requirements the minimum standards required for service as a fire investigator in both the private and public sectors.
  - Job performance requirements describe the performance required for a specific job.
  - The complete list of requirements for each duty describes the tasks an individual must be able to perform in order to successfully carry out that duty; however, they are not intended to measure a level of knowledge.
  - The duties and job performance requirements define the parameters of the job of fire investigator.