New York State Chapter 23 of the
International Association of Arson Investigators, Inc.

ELECTRICAL FIRE CAUSATION

FOR THE

FIRE OFFICER

NYS IAAI's Awareness Series

- Free series of training modules designed to educate/promote awareness to line fire officers and fire fighters
- Modules address Origin and Cause investigations, role of the fire investigator, multi-agency investigations, role of suppression crews in fire investigations, etc.
- Presentation was developed and disseminated in conjunction with a 2013 FEMA Fire Prevention and Safety Grant awarded to NYS IAAI

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www.nyfireinvestigators.com

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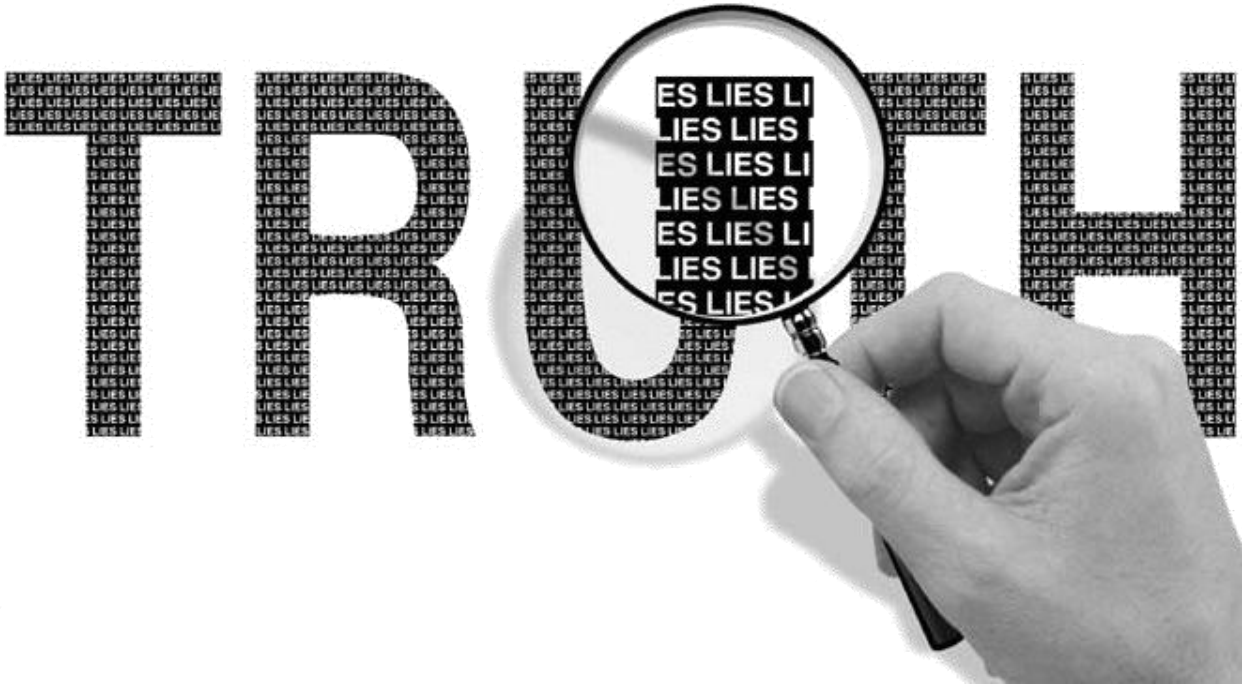
Getting to the



begins with YOU!

Enabling Objectives

- Fire Chief/Line Officer Responsibilities
- Fire Investigation & its purpose.
- Fire Investigation Protocol / NFPA 921 & NFPA 1033
- Electrical Safety
- Electrical Investigation
- Public v. Private

Fire Chief

NYS General Municipal Law; Article 10, 204-D

- **204-d. Duties of the Fire Chief.**

The fire chief of any fire department or company **shall**, in addition to any other duties assigned to him by law or contract, *to the extent reasonably possible determine or cause to be determined the cause of each fire or explosion which the fire department or company has been called to suppress.* He shall file with the office of fire prevention and control a report containing such determination and any additional information required by such office regarding the fire or explosion. The report shall be in the form designated by such office. *He **shall** contact or cause to be contacted the appropriate investigatory authority if he has reason to believe the fire or explosion is of incendiary or suspicious origin.* For all fires that are suspected to have been ignited by a cigarette, within fourteen days after completing the investigation into such fire, the fire chief shall forward to the office of fire prevention and control information detailing, to the extent possible: (a) the specific brand and style of the cigarette suspected of having ignited such fire; (b) whether the cigarette package was marked as required by subdivision six of section one hundred fifty-six-c of the executive law; and (c) the location and manner in which such cigarette was purchased.

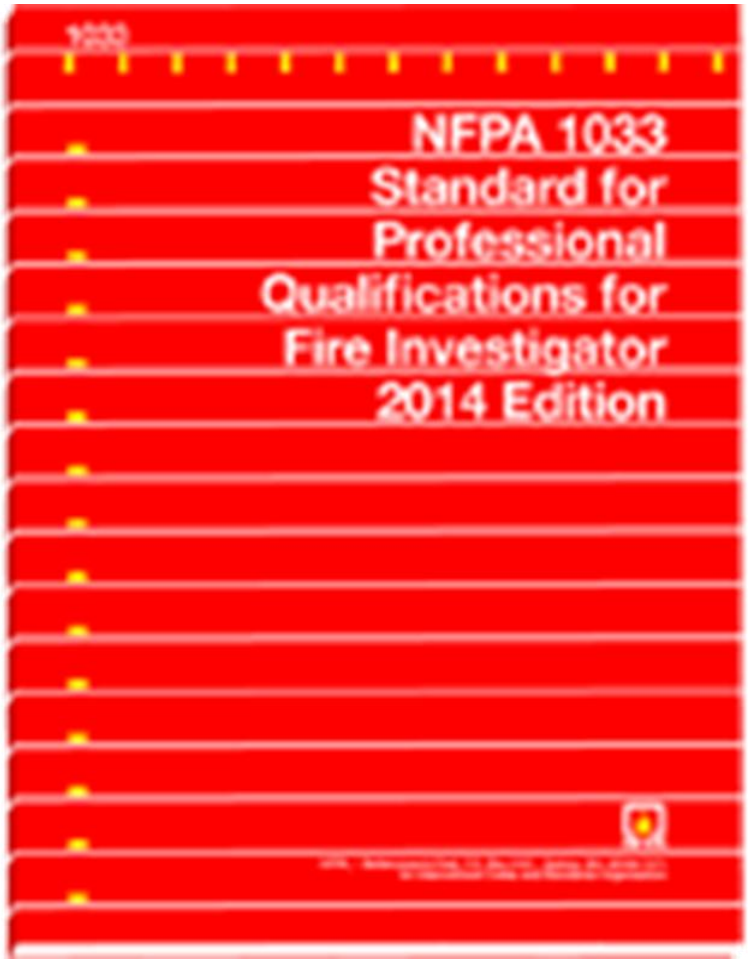
What is the purpose of Fire Investigation?

- **To determine the origin, cause, and development of a fire or explosion.**

- **To determine the responsibility, circumstances and factors that were necessary for the fire to have occurred.**

- ***Fire Prevention*** **!!! .....to identify & learn how to avoid this from happening again!**

Protocols: NFPA 1033

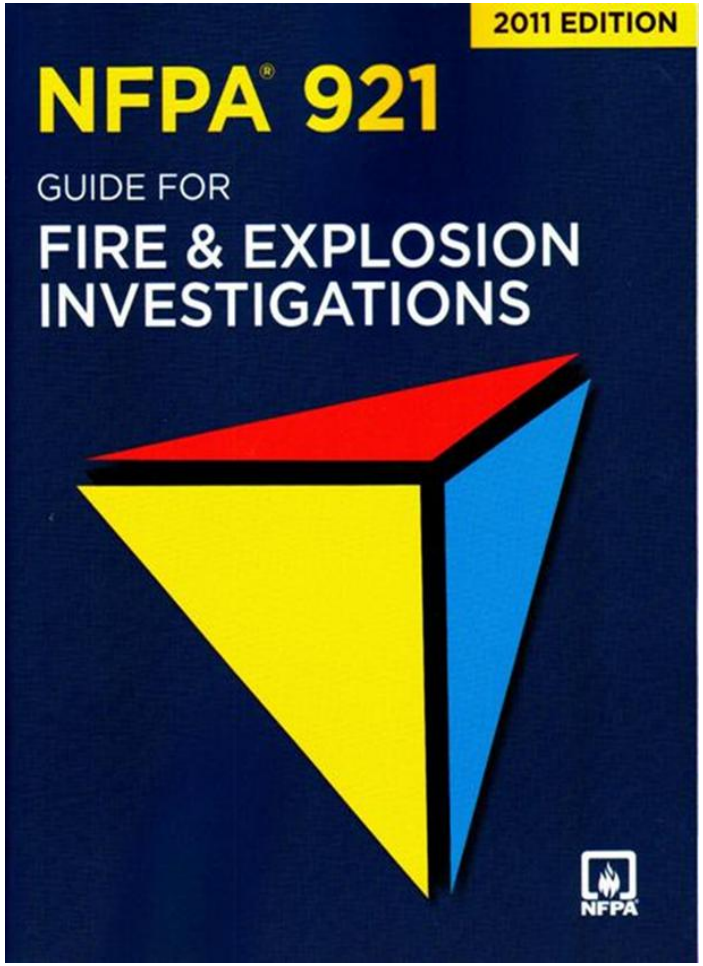


1.2* Purpose. The purpose of this standard shall be to specify the minimum job performance requirements for serving as a fire investigator in both the private and public sectors.

3.3.10 Requisite Knowledge. Fundamental knowledge one must have in order to perform a specific task.

3.3.11 Requisite Skills. The essential skills one must have in order to perform a specific task.

Protocols: NFPA 921

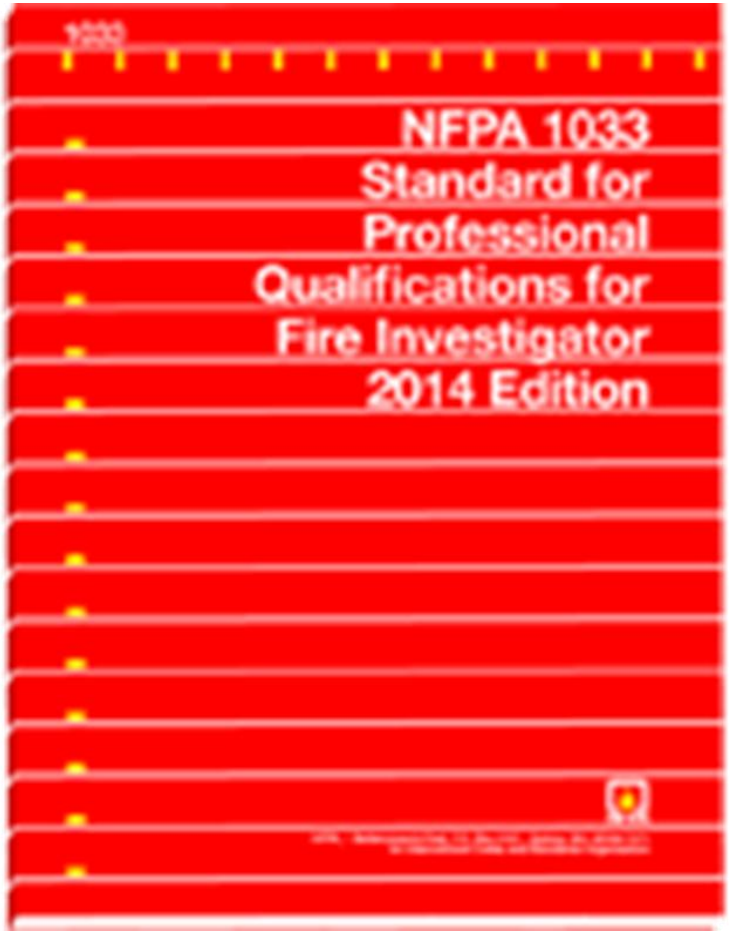


1.2.1 **Purpose**: ***"The purpose of this document is to establish guidelines and recommendations for the safe and systematic investigation or analysis of fire and explosion incidents…*** This document has been developed as a model for the advancement and practice of fire and explosion investigation, fire science, technology, and methodology."

1.3 **Application**: ***This document is designed to produce a systematic, working framework*** or outline by which effective fire and explosion investigation and origin and cause analysis can be accomplished. It contains specific procedures to assist in the investigation of fires and explosions. These procedures represent the judgment developed from the NFPA consensus process system that if followed can improve the probability of reaching sound conclusions. Deviations from these procedures, however, are not necessarily wrong or inferior but need to be justified.

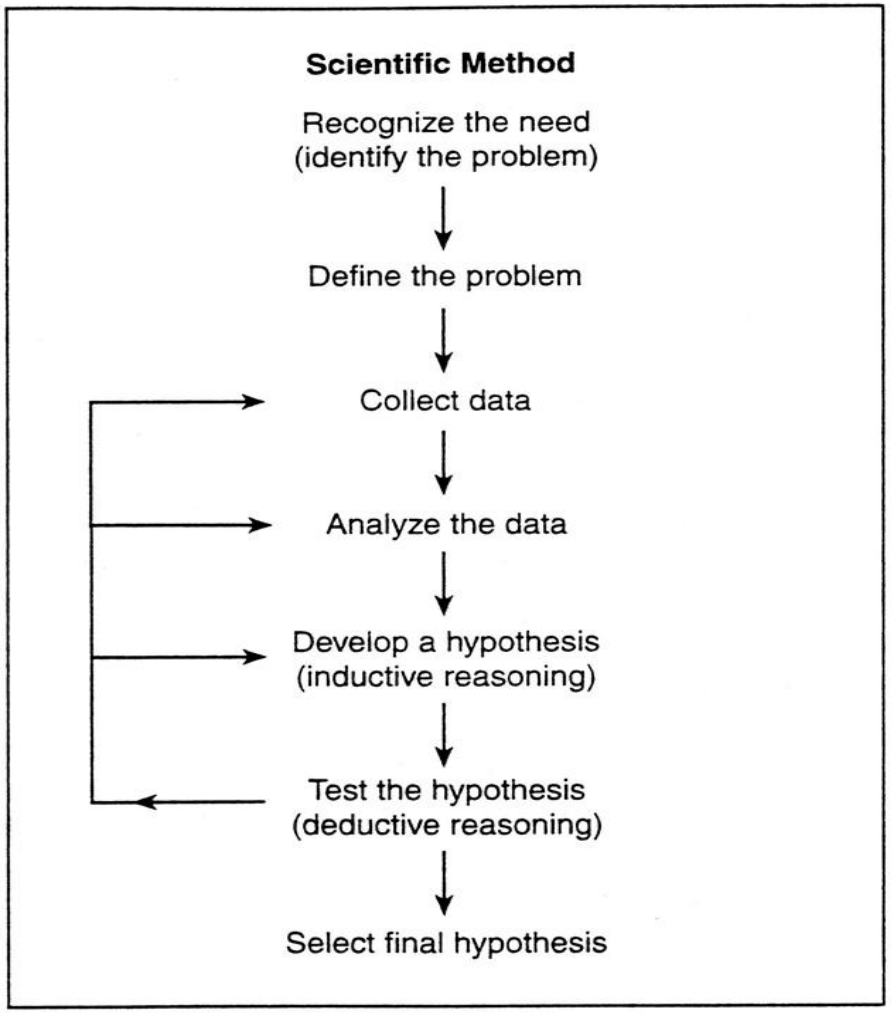
4.2 **Systematic Approach**: ***The systematic approach recommended is that of the scientific method***, which is used in the physical sciences. This method provides for the organizational and analytical process desirable and necessary in a successful fire investigation.

NFPA 1033



4.1.2* The fire investigator **shall** employ all elements of *the scientific method* as the operating analytical process throughout the investigation and for the drawing of conclusions.

Scientific Method



Origin first … then Cause

- Most important task of a fire investigator is to first identify the origin – may also be most difficult!
- In short, the investigator must identify where the fire started.
- Investigators are much more likely to identify a cause when they have correctly identified the origin first!!

How do Fire Investigators arrive at the Origin?

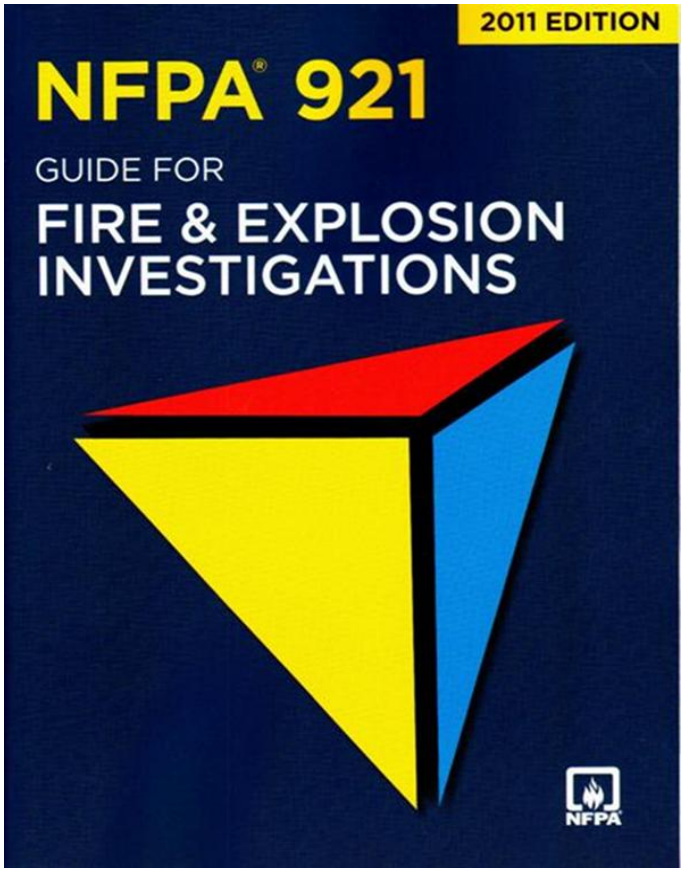
NFPA 921 Guide for Fire & Explosion Investigations (2014 Ed.)

- **Witness Information.** The analysis of observations reported by persons who witnessed the fire or were aware of conditions present at the time of the fire

- **Fire Patterns.** The analysis of effects and patterns left by the Fire.

- **Arc Mapping**. The analysis of the locations where electrical arcing has caused damage and the documentation of the involved electrical circuits .

- **Fire Dynamics.** The analysis of the fire dynamics, that is, the physics and chemistry of fire initiation and growth, and the interaction between the fire and the building's systems .



Fire Cause Determination

- Is the process of identifying the ***first fuel ignited***, the ***ignition source***, the ***oxidizing agent***, and the circumstances that resulted in the fire.

- Generally follows origin determination

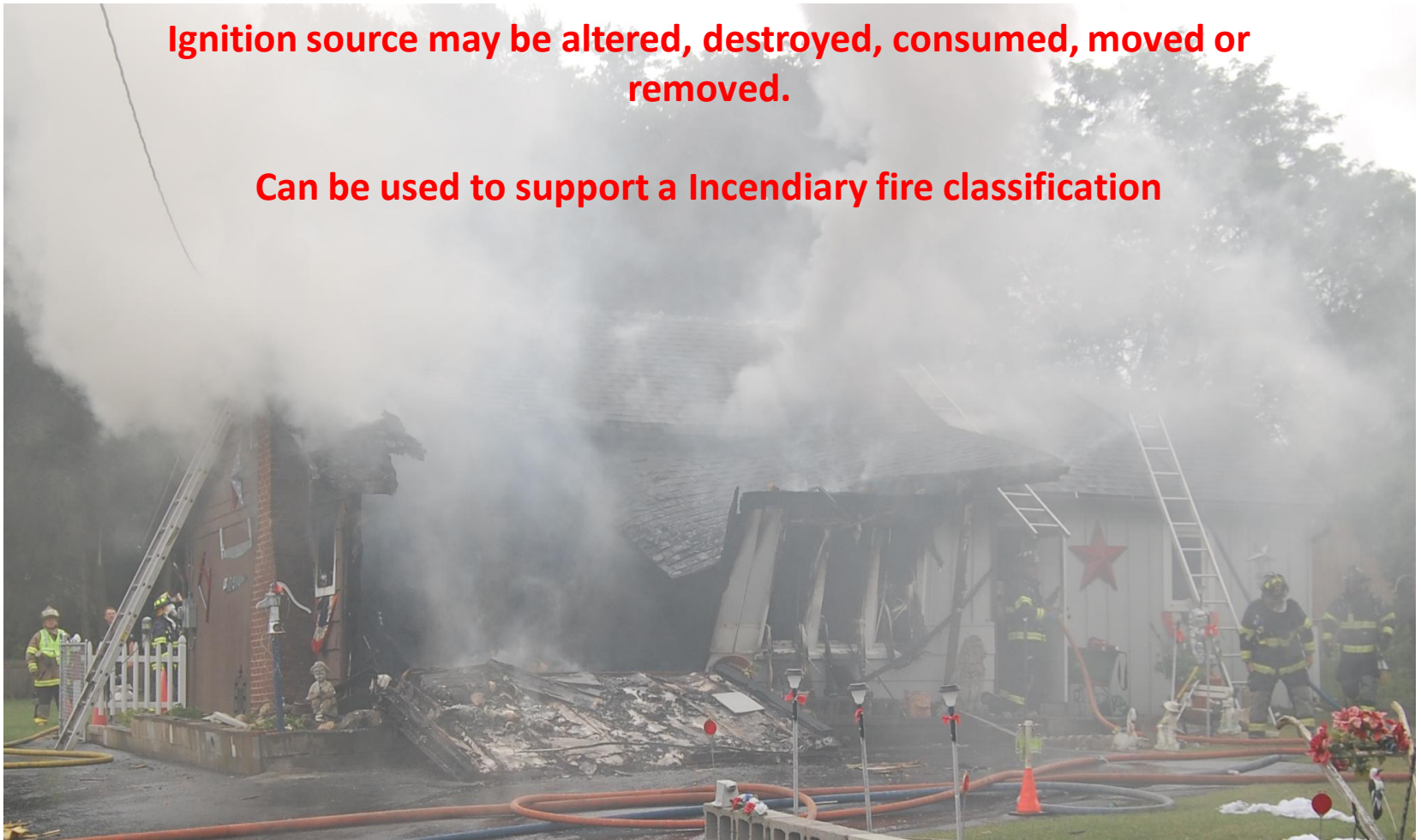
- Is reliable only if the origin has correctly determined.

Fire Cause Determination

- The purpose is to identify an ignition source and a first fuel ignited, and then the events that brought them together
- The focus should be in the area of origin
- Overall methodology is the *SCIENTIFIC METHOD*

Fire Cause Determination

Sometimes there is no physical evidence of the ignition source, but an ignition source can be hypothesized (inferred) based on other data.



Ignition source may be altered, destroyed, consumed, moved or removed.

Can be used to support a Incendiary fire classification

Fire Cause Determination: Classifications

- Accidental
- Natural
- Incendiary
- Undetermined

NOTE – Suspicious is NOT an acceptable cause classification

ACCIDENTAL

- Electrical
- Heating equipment
- Mechanical
- Cooking
- Smoking
- Candles
- Spontaneous heating
- Individuals (i.e., cleaning motorcycle in the house with gasoline)

NATURAL

- Acts of God
- Lightning

INCENDIARY

- A fire that is deliberately set with the intent to cause the fire to occur in an area where the fire should not be. (NFPA 921 Section 3.3.108, 2014 Ed.)

- **Often improperly used synonymously with the term ARSON.**

- *Arson* - Legal term - The crime of maliciously and intentionally, or recklessly, starting a fire or causing an explosion. *(NFPA 921 Section 3.3.13, 2014 Ed.)*

UNDETERMINED

- Whenever the cause cannot be proven to an acceptable level of certainty
- When the level of certainty is possible or suspected, or in which there is only suspicion of that cause
- Those fires that have not yet been investigated
- Those that are under investigation, and have insufficient information to classify further.

REMEMBER…

- Fires are not always incendiary. No assumption of cause should ever be made.
- Accidental causes should be ruled out before the word "INCENDIARY" leaves your lips
- If you're not sure: “*Undetermined*”
- An “*Undetermined*” call can be changed when more data becomes available

Fire Investigation Methodology

- Receipt of Assignment
- Scene Examination
- Scene Documentation
- Analysis, documentation and collection of evidence
- Witness and subject interviews
- Follow-up investigation
- Origin and Cause determination if possible

Chronology of Fire Scene Investigations

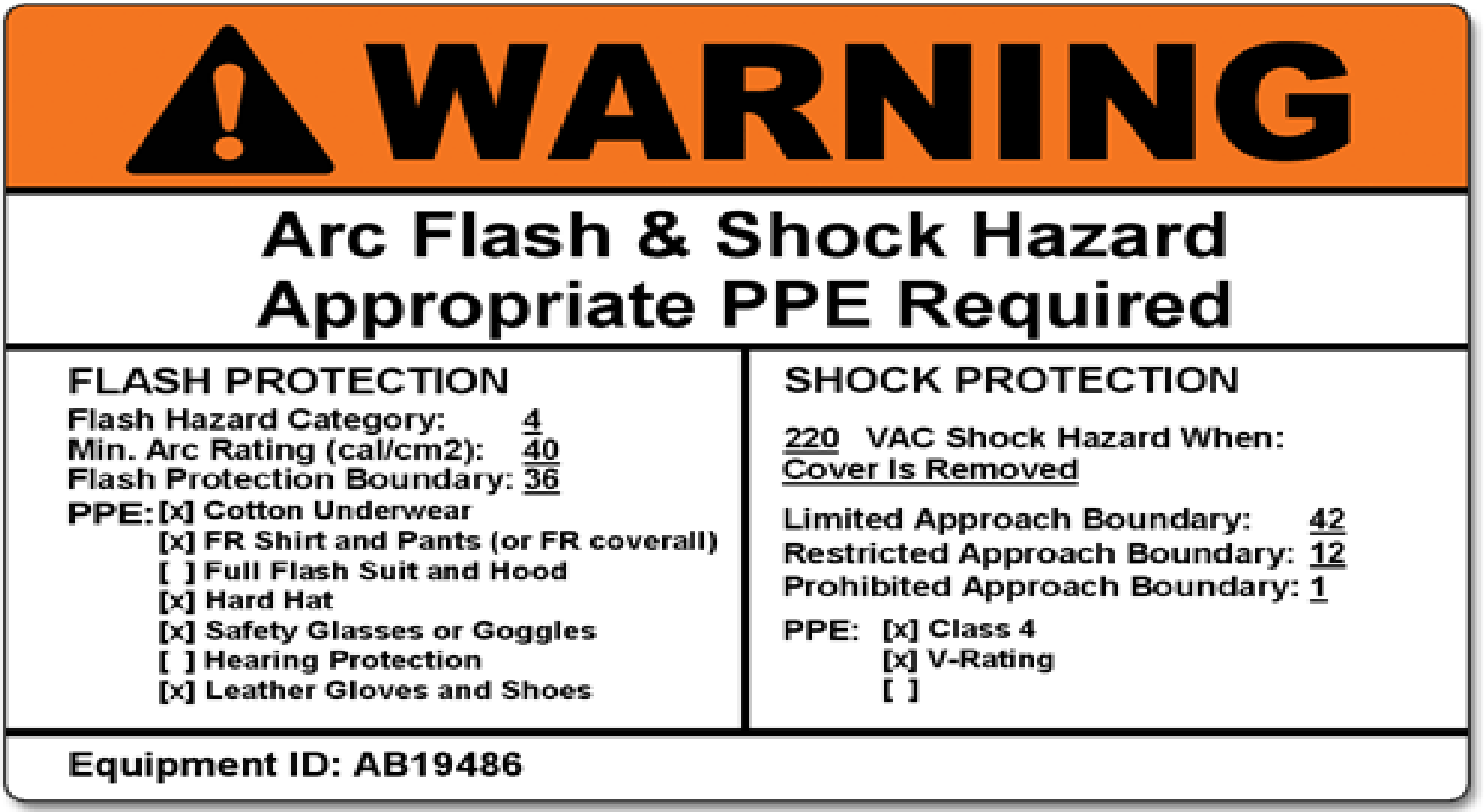
- Arrival at scene – Initial Response (recognize need, identify problem)
- Exterior examination (collect data)
- Interior examination (collect data)
- Interviews (collect data)
- Coordination with other agencies and public & private sectors
- Hypothesis development and Field/Lab testing (hypo. Development & test)
- Administrative, Technical, and Peer Reviews (hypoth. Testing)
- Conclusion (hypothesis conclusion)

NFPA 1033 2014 Ed.

1.3.7* The investigator shall have and maintain at a minimum an up-to-date basic knowledge of the following topics beyond the high school level:

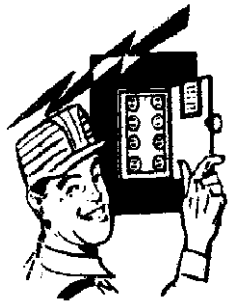
(1) Fire science
(2) Fire chemistry
(3) Thermodynamics
(4) Thermometry
(5) Fire dynamics
(6) Explosion dynamics
(7) Computer fire modeling
(8) Fire investigation
(9) Fire analysis
(10) Fire investigation methodology
(11) Fire investigation technology
(12) Hazardous materials
(13) Failure analysis and analytical tools
(14) Fire protection systems
(15) Evidence documentation, collection, and preservation
(16) Electricity and electrical systems

Equipment Labeling



ELECTRICAL HAZARDS

- May be present on a fire scene long after the fire is over.
- Never assume that all sources of electrical energy have been safeguarded against.
- Electrical energy can be present in the form of energized circuits or stored energy.
- Never attempt to disconnect electrical utility service from the structure. This should only be accomplished by the utility representative.
- Electrical service may brought to a structure from multiple sources (overhead or underground).



Electrical Hazards

Electrical Hazards

Electrical Safety

- SAFETY is the number one concern
- Make sure the system is de-energized
- CHECK with a metering device before touching anything!!!

Electrical Safety

- Use observations and testing equipment to verify that electricity is disconnected

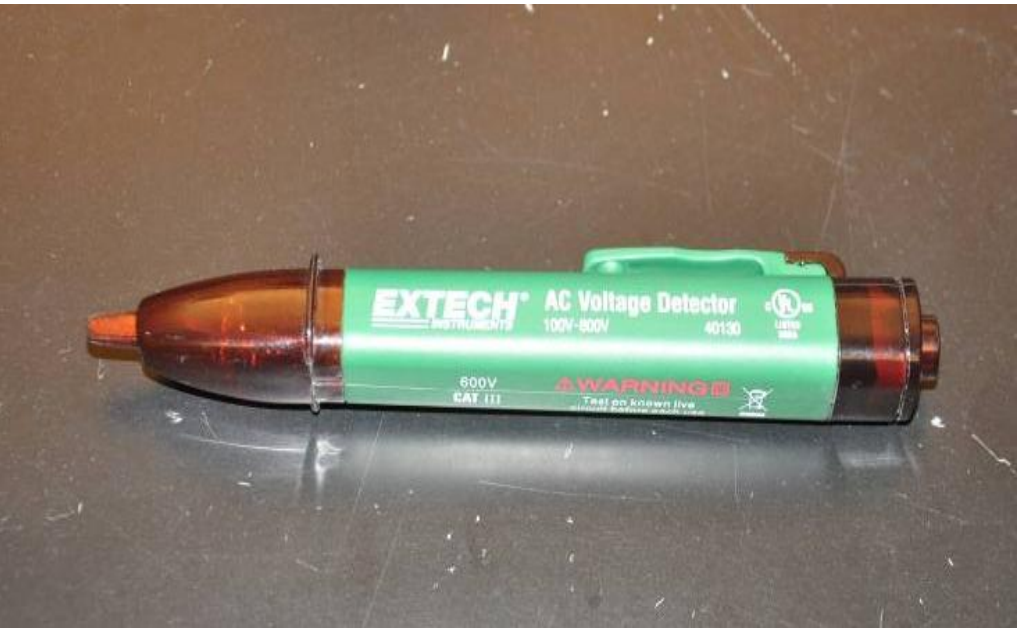
- Never assume that power has been disconnected

Electrical Safety

Effects of 60 hertz electricity:

- **1 mA** — Threshold of perception
- **5 mA** — Maximum "harmless" current
- **10-20 mA** — Maximum "let-go" current
- **50 mA** — Pain, possible fainting, mechanical injury. Heart and respiratory functions continue
- **100-300 mA** — Ventricular fibrillation will start, respiratory center remains intact
- **> 300 mA** — Sustained myocardial contraction Temporary respiratory paralysis Burns if current density is high

Proximity Tester



- Also known as tick tracers.
- Detect the electrostatic field generated around an AC conductor.
- Provides an audible signal as voltage is detected.
- Need to check against a known source.
- Need to check batteries.
- Operator needs to have physical contact with ground.

DIGITAL MULTIMETER

- Contact measurement device - physical contact with the conductors
- Not intended to measure high voltages (Greater than 600 volts).
- Require batteries to operate.
- The probes and insulation provide the only defense from electric shock and connect to specific terminals on the meters.

❖ **There have been instances where cheap meters used beyond their ratings have exploded and caused severe injury and death!!!**

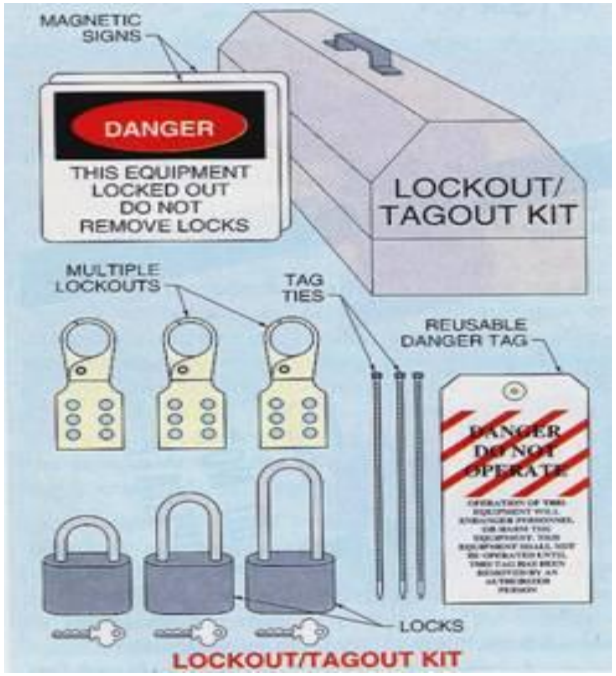
Digital Voltage and Continuity Tester

- A contact measurement device.
- Automatically determines range and function.
- Measures AC/DC voltage from 12–600V and detect voltage when the battery dies.
  - The LCD does not show values.
- Three notifications for voltage detected:
  - Light
  - Sound
  - Vibration
- Continuity is reported by light and sound.

WIGGY

- This is also a contact measurement device.
- This type of meter does not require batteries.
- The readings are not as accurate.
- The meter vibrates when an electric field is detected to provide tactile feedback.

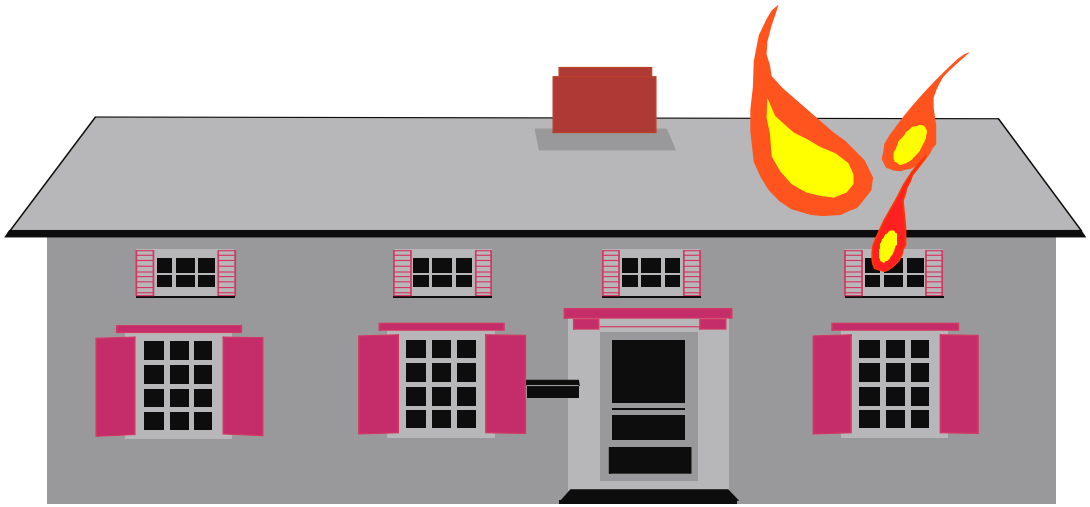
Lock Out / Tag Out



- **Lockouts and tagouts do not by themselves remove power from a circuit.**
- **An approved procedure is followed when applying a lockout/tagout.**
- **Lockouts and tagouts are attached only after the equipment is turned OFF and tested to ensure that power is OFF.**

This is where it all started!

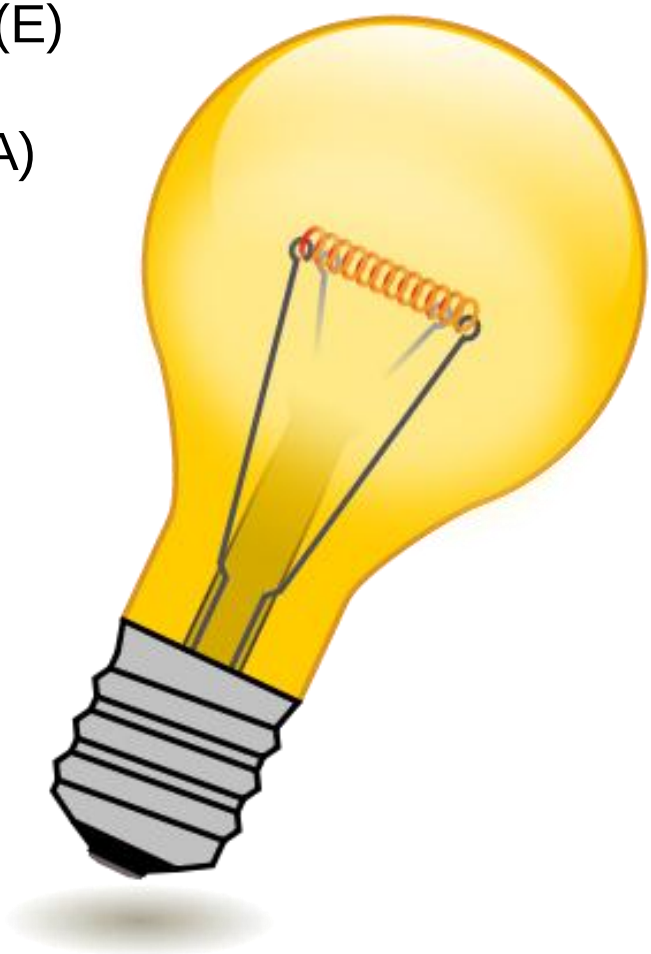
ELECTRICITY



- It's the flow of electrons due to a difference in energy potential between two points on a conductor.
- You cannot see electrons, only their effects; some are wanted, others are not.

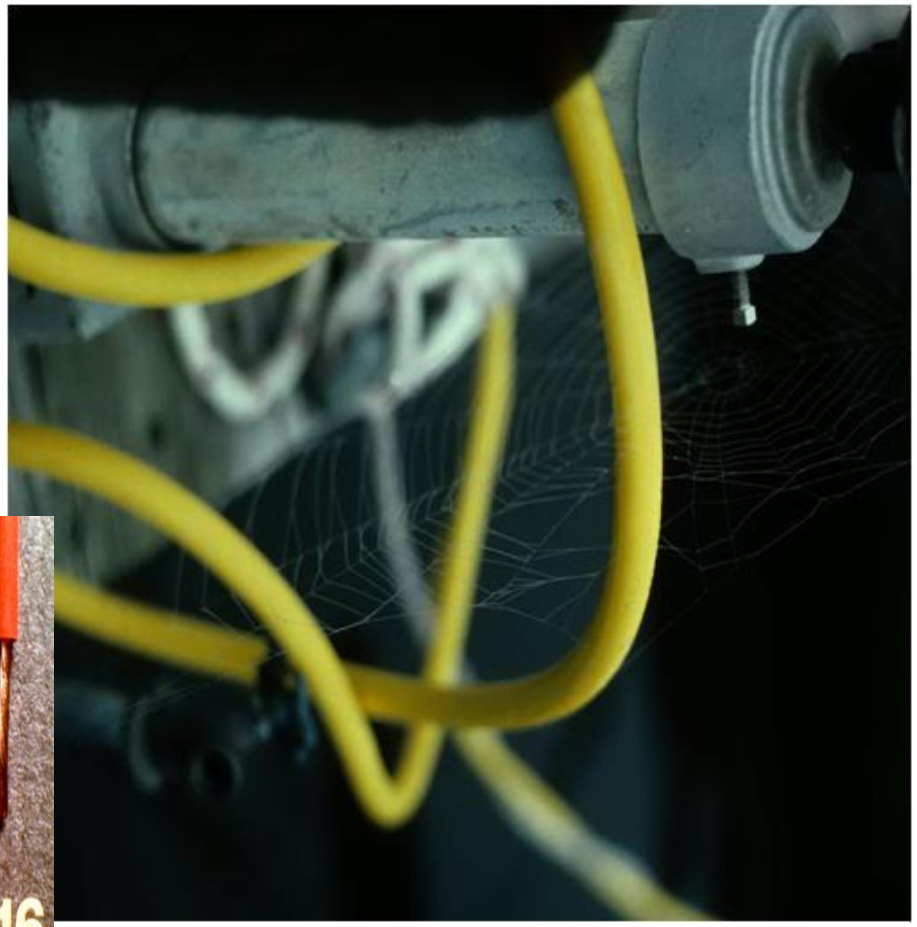
COMMON ELECTRICAL TERMS

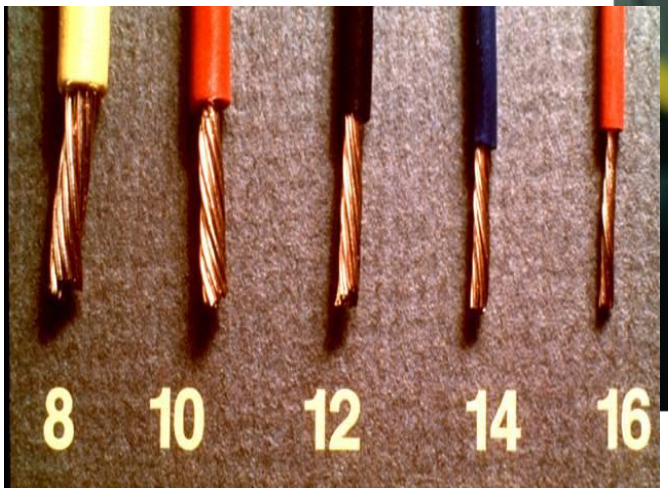
- Voltage (V) …… or electromotive force (E)
- Current (I) ……...or amperes or amps (A)
- Power (P) ……or watts (W)
- Resistance (R)
- Conductance (1/R)
- Capacitance (C)
- Inductance (L)



CONDUCTORS

- Materials that allow current to flow freely with minimal resistance.
- Cooper and aluminum are two of the most recognized materials used.



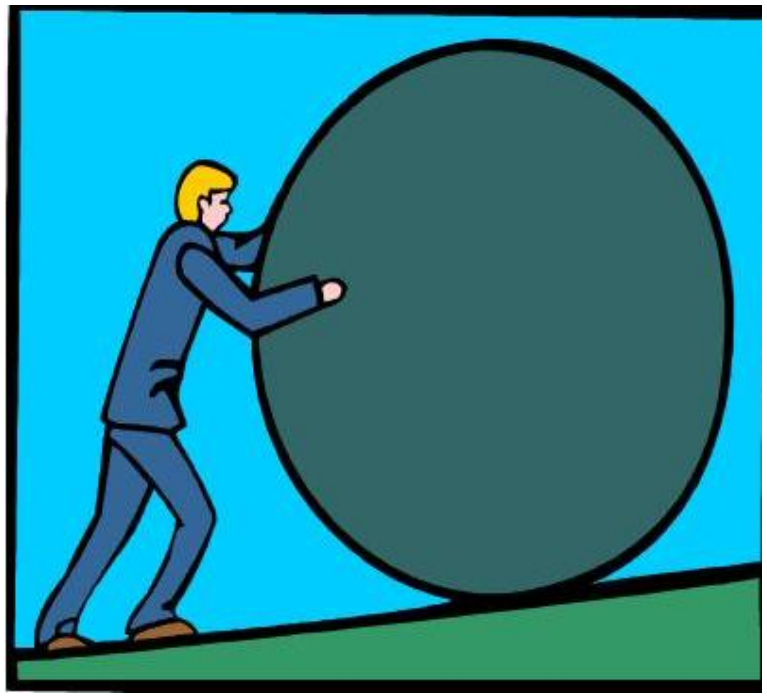


INSULATORS

- They work the opposite of conductors; they oppose or stop the flow of current. Some insulators are glass, porcelain, air, and pure water.
- However, a high enough voltage may defeat the insulator.

VOLTAGE (VOLTS)

- Electrical pressure that moves the electrons through the conductor.
- EMF (Electro-Motive Force)
- E (Volts)



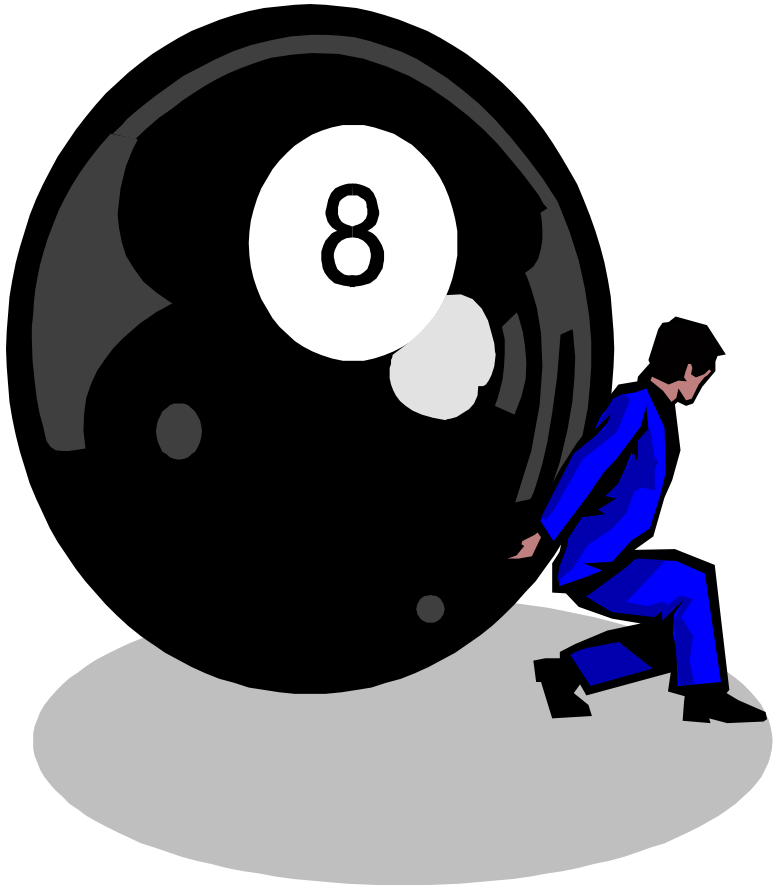
CURRENT (AMPERE)

Is the rate at which electrons flow through a conductor. It is determined by measuring the amount of electrons flowing past a single point in one second.

I (Ampere or Amps)

RESISTANCE (OHMS)

- This is the opposition to current flow.
- Measured in Ohms
- Greek Symbol Omega (Ω)



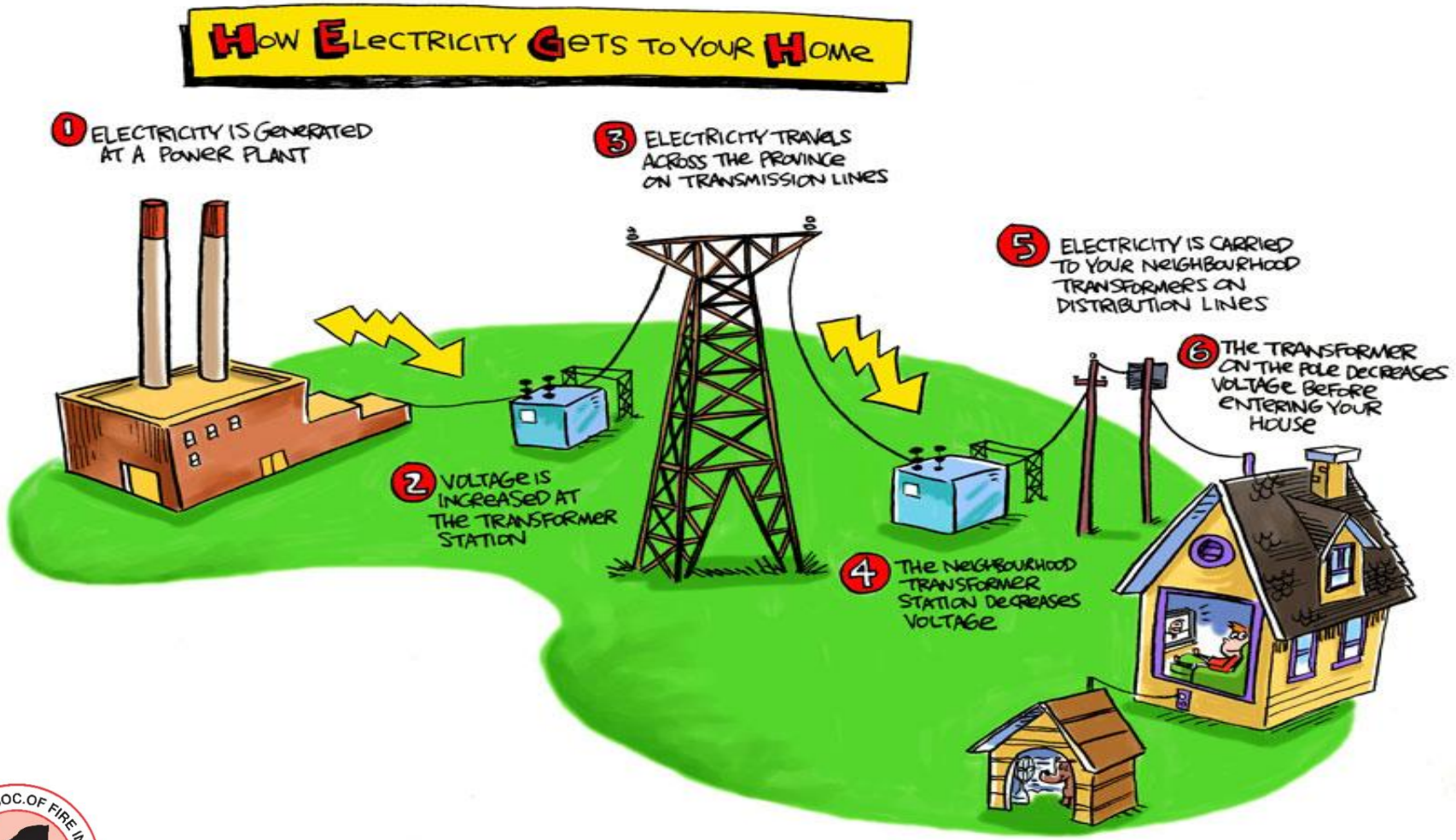
WATTAGE (WATTS OR kW)

- This is the quantitative measurement of work done or power consumed in an electrical circuit.
- Watts themselves are no big deal, unless they exist for some time.

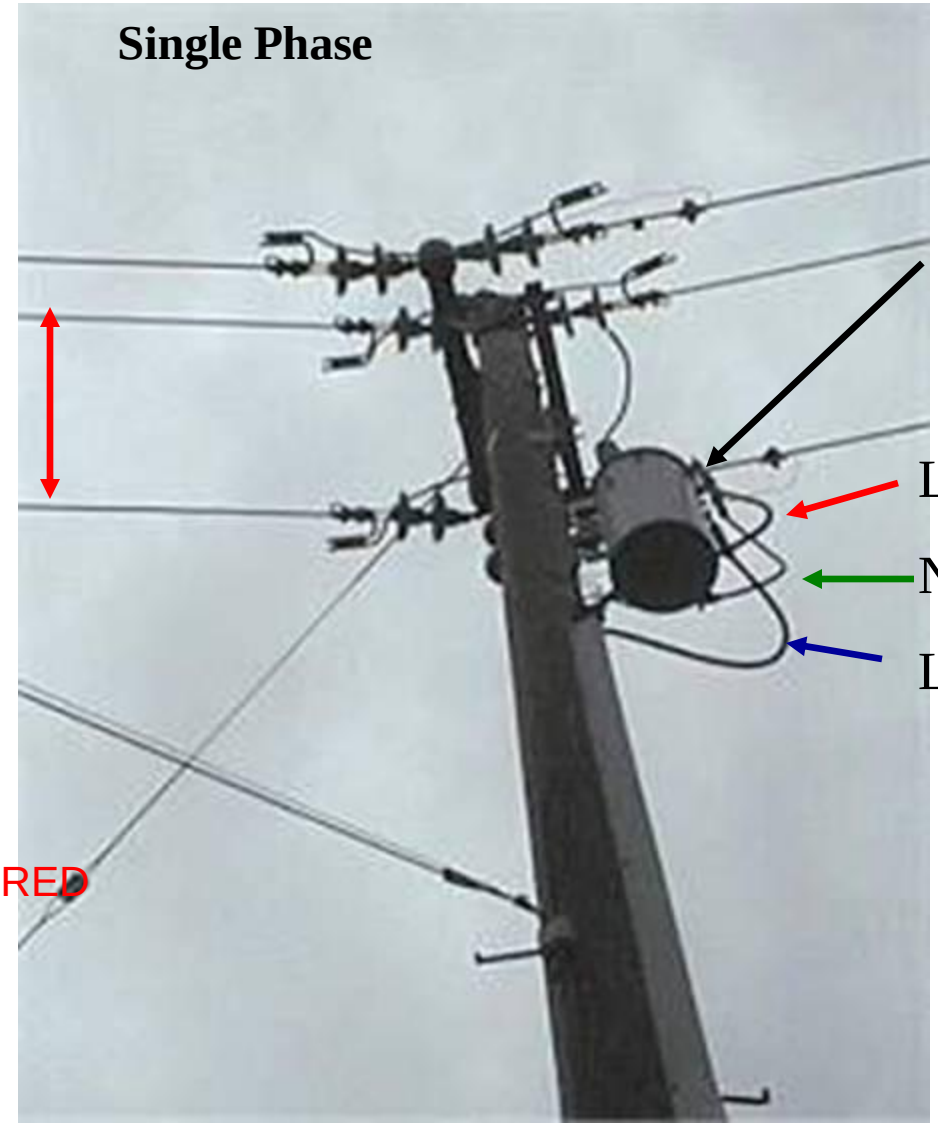
FOUR EFFECTS OF ELECTRICITY

- Thermal Action
  - Heat
- Magnetism
- Chemical reaction
  - Oxidation
  - Corrosion
- Illumination
  - Light

ELECTRICAL DISTRIBUTION



DISTRIBUTION LINES



Distribution voltages vary per utility company

A transformer is provided to step the voltage down to safer voltages

Line 1

Neutral

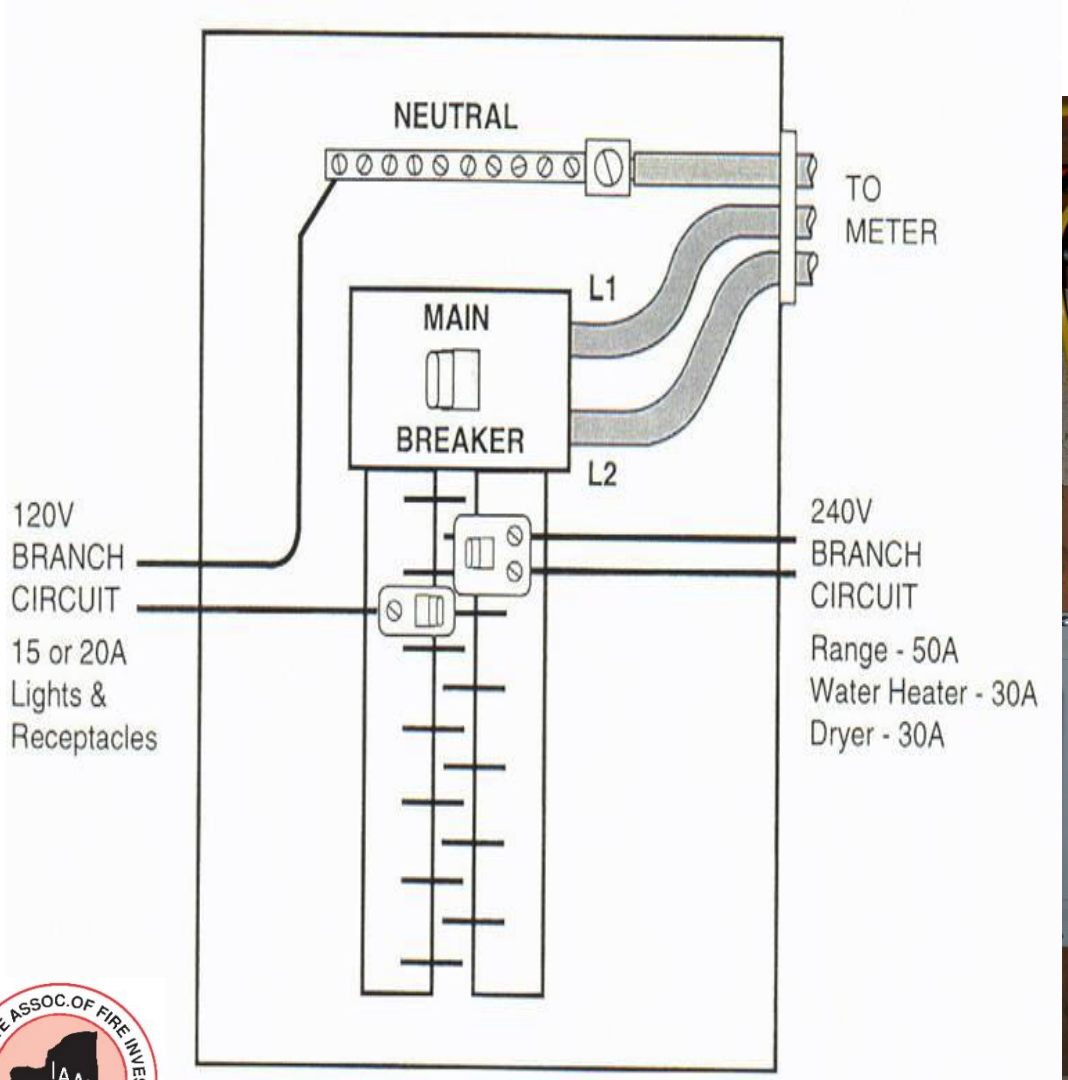
Line 2

120 volts
240 volts
120 volts

DANGER!
THE HIGH VOLTAGE WIRES ARE BARE or COVERED NOT INSULATED

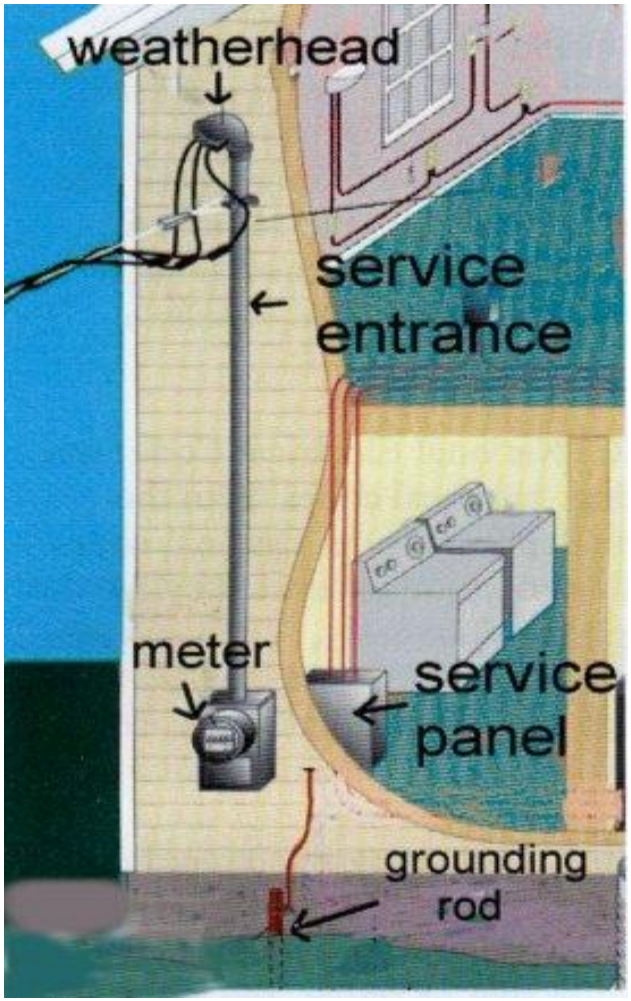
This is for household use. Industrial and commercial use is usually three phase 120/208V or 277/480V

Electrical Panel



Investigation: Service Entrance

- Begin on the exterior.
- Check for electrical failures at the attachment point, weather head, service conductors, and meter base.
- Document the process with photographs.



Investigation: Distribution Panel

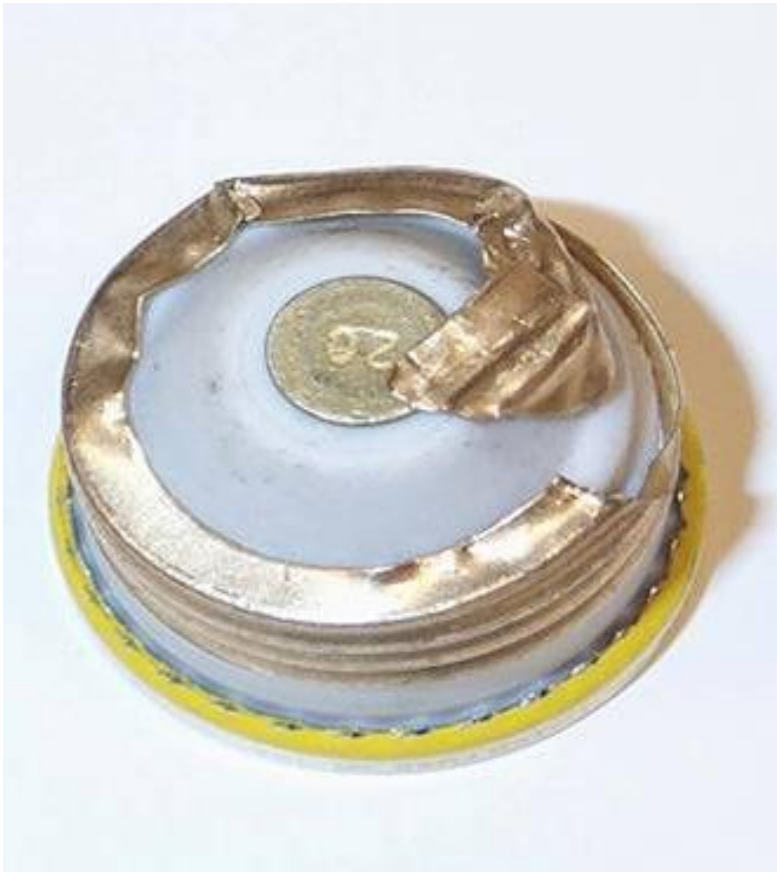
- Identify fuses or breakers
- Note any blown fuses or "tripped breakers“
- Breakers can be removed to check bus bars for evidence of pitting or signs or arcing.

***WARNING ***

This may damage or destroy the breaker and any chance of civil recovery.

Evidence of Tampering

Evidence of Tampering



Evidence of Tampering

Arcs & Sparks

- **Arc is the flow of current through air, or such as medium as charred insulation, temperature 5000 -7000 F degrees.**
- **Static electricity and lightning are natural arcs.**
- **350v is minimum to cross an air gap.**

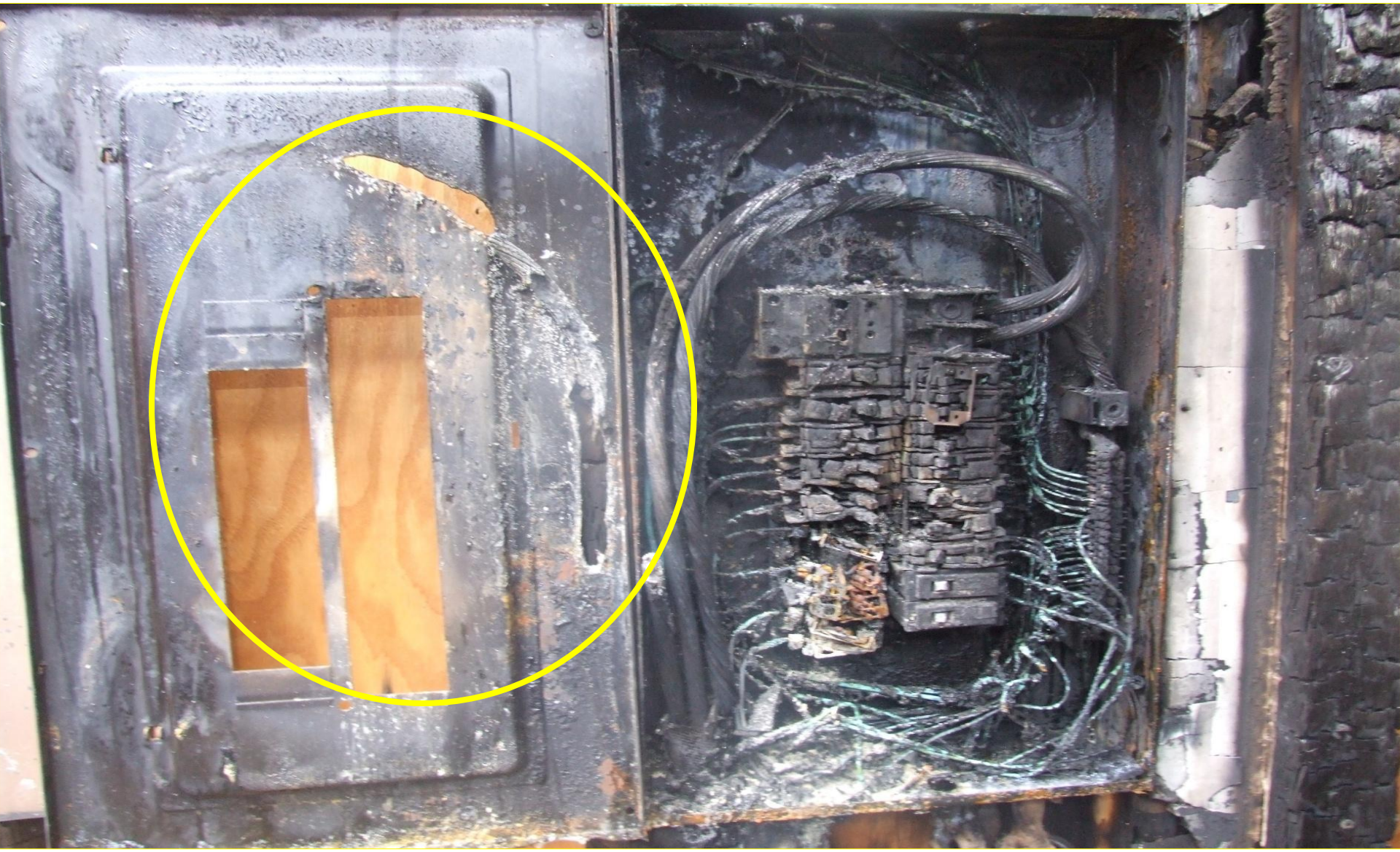
Sparks

- **Sparks are much different; the spark is an incandescent particle, not an electrical discharge.**
- **Much better ignition source.**

Electrical Damage ... Not Cause

- Holes or "*blow-outs*" (Ex: Load centers, metal conduits, etc...)
- Holes in metal conduit or metallic sheathed cables.
- Where the fire impacted the metal enclosure causing the insulation to fail resulting in an electrical fault to the metal enclosure.

Electrical Damage … Not Cause



Arc Fault Mapping

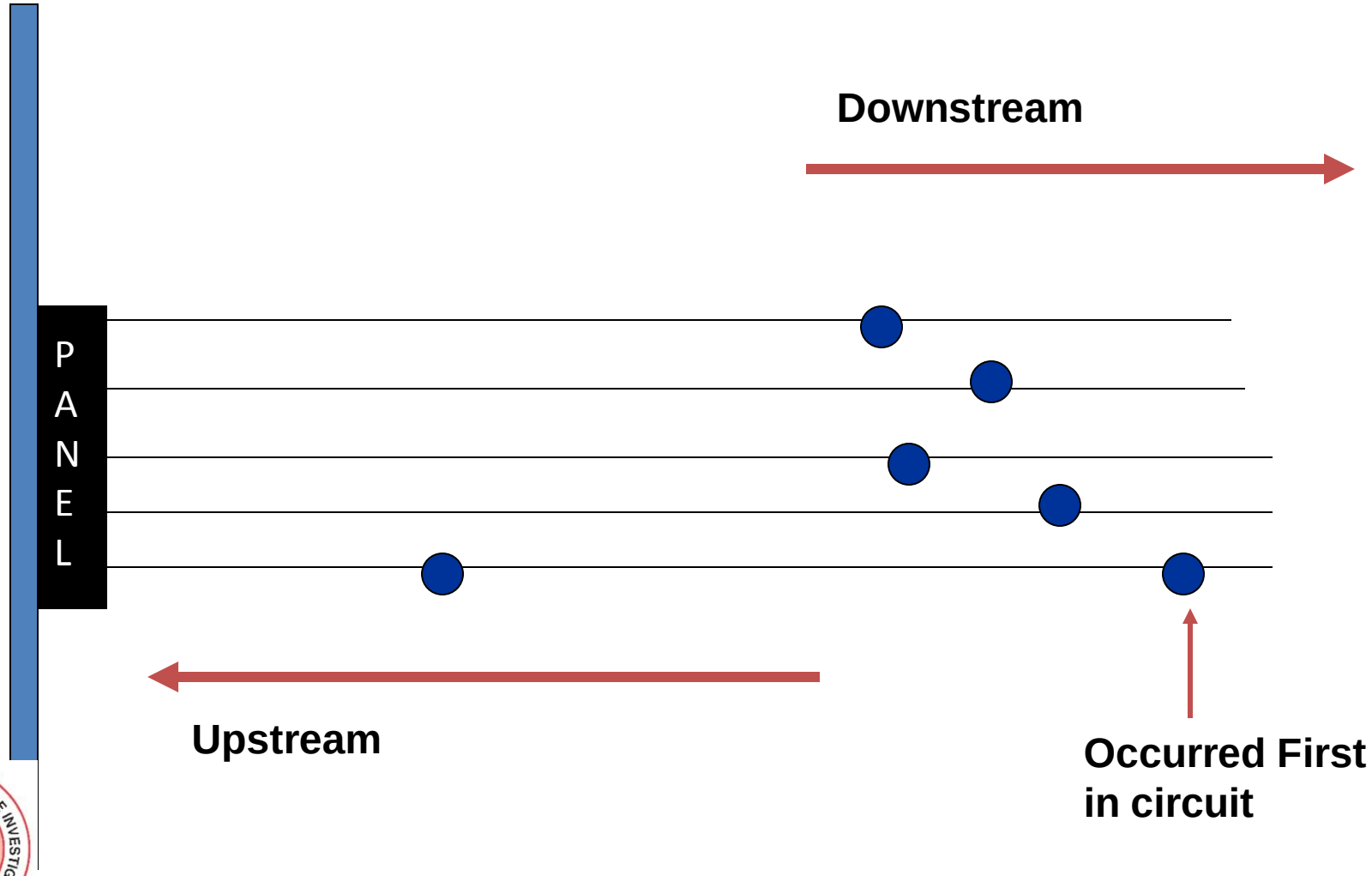
NFPA 921 (2014 ed.) - Sec 9.11.7 *Arc Surveys*

Investigative tool for large- and small-scale incidents

Identification and documentation of electrical arc damage found in circuit wiring, conduits, load centers, cords, appliances, etc.

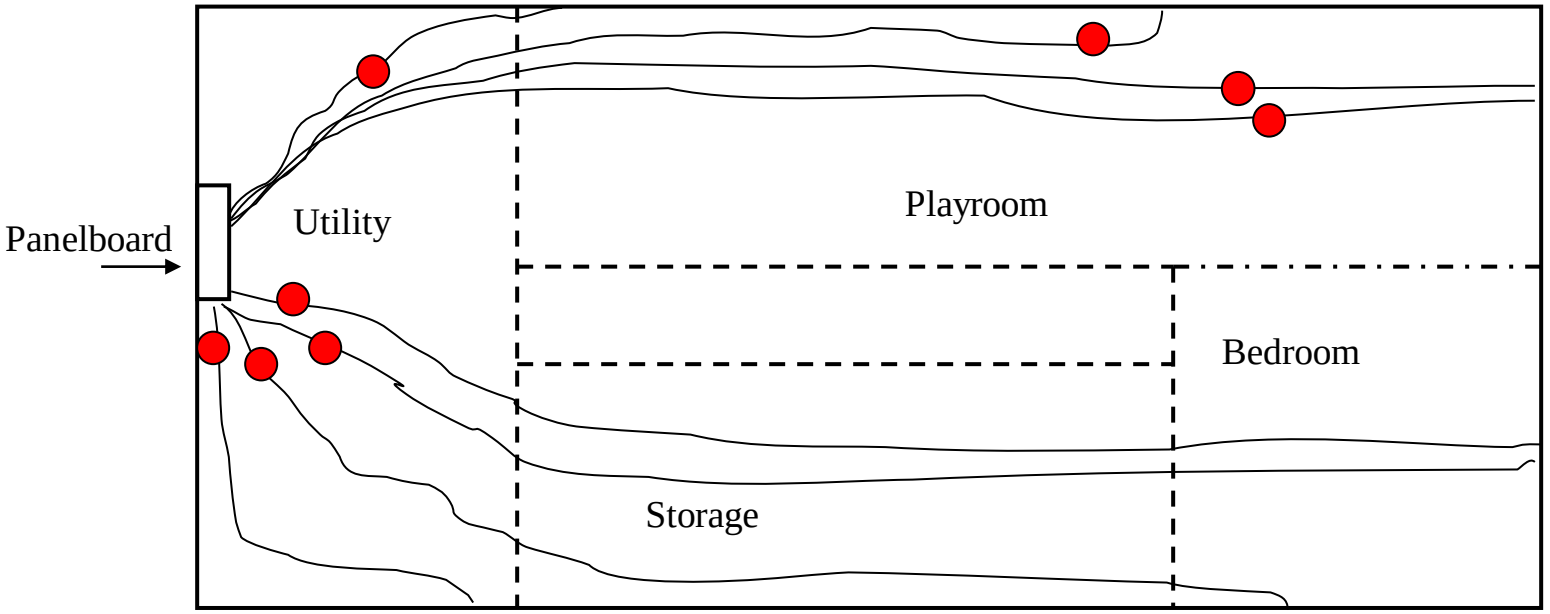
Location of arc damage identifies circuits energized at the time they were compromised by the fire.

Upstream vs. Downstream Damage



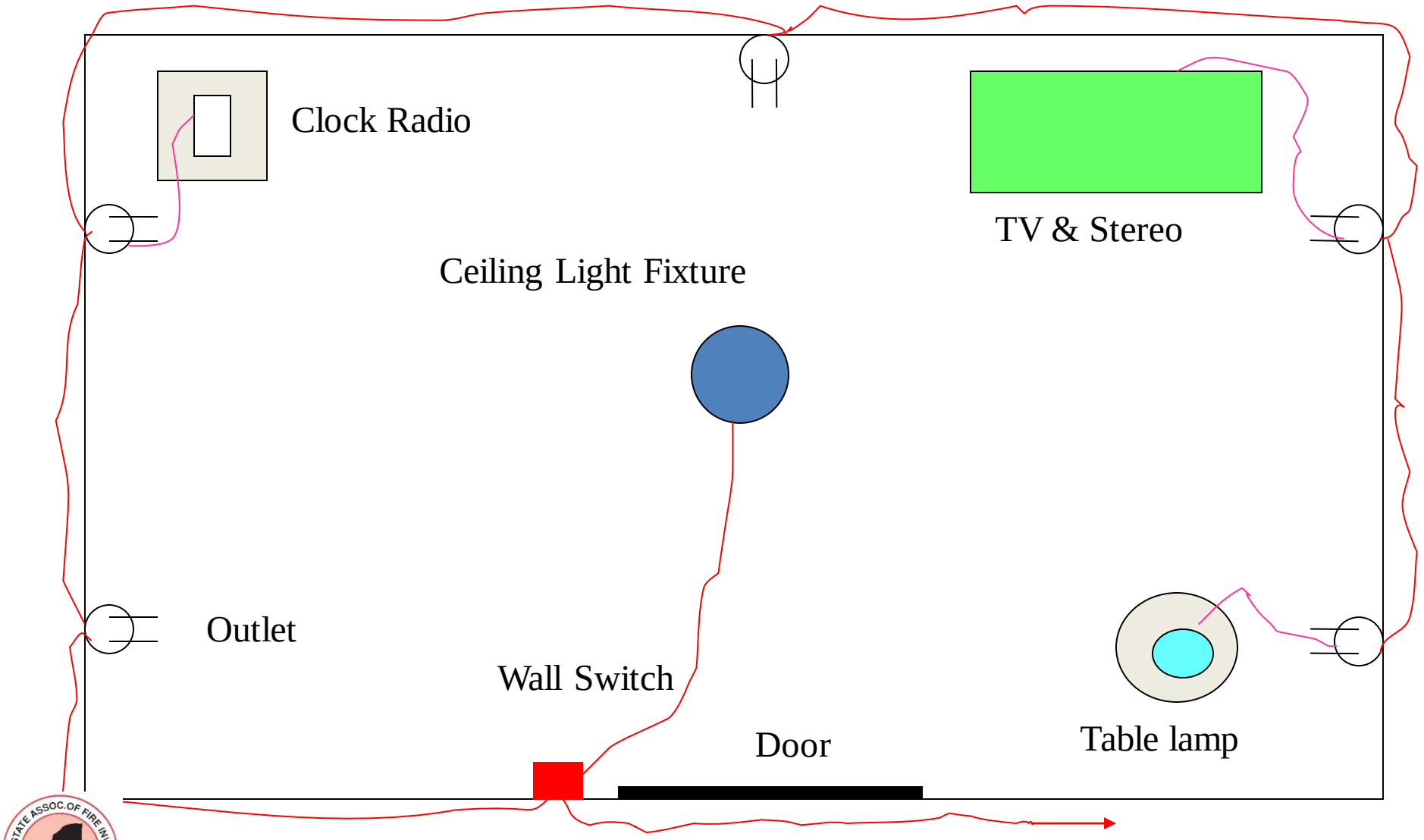
Arc Mapping

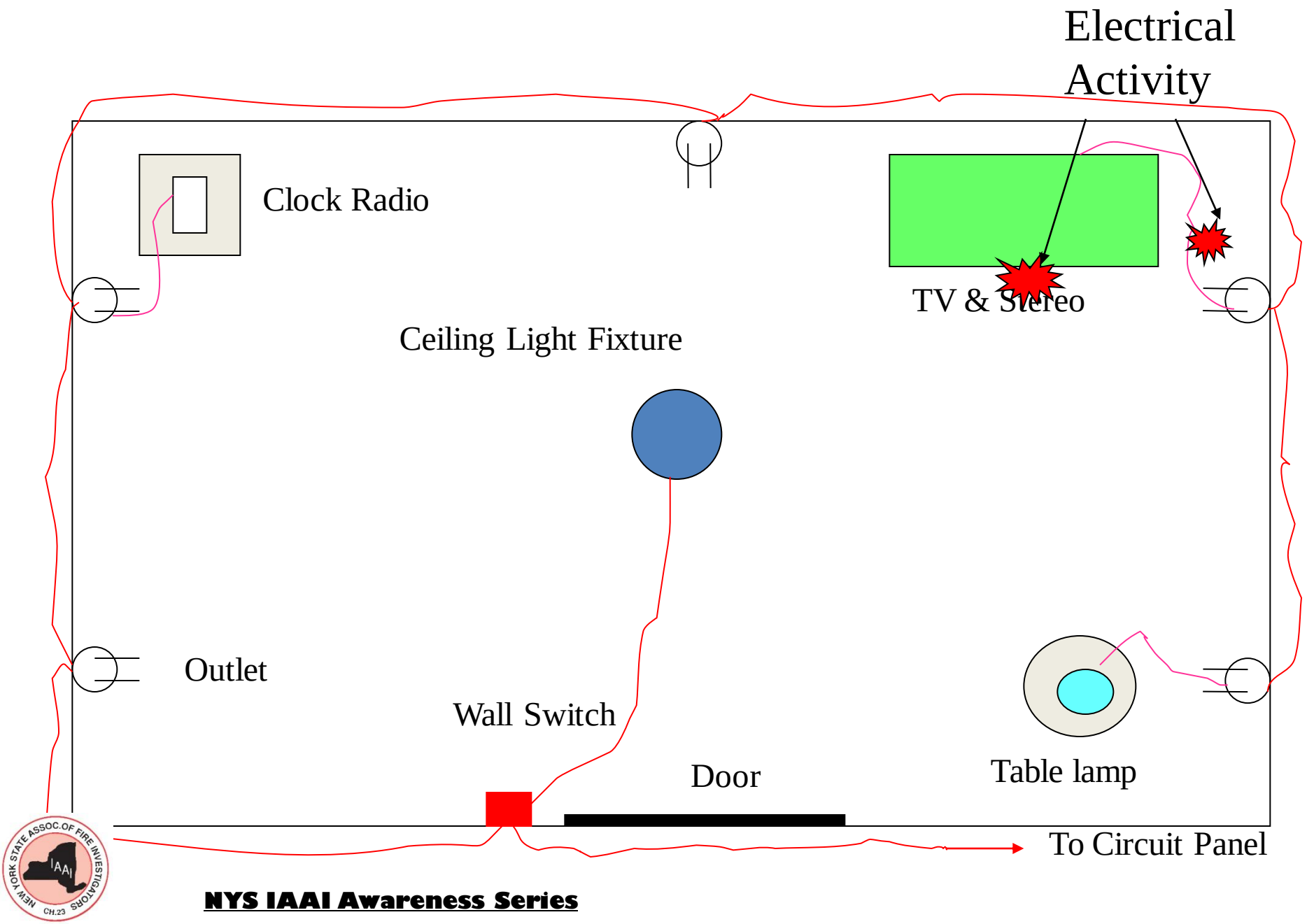
- # of tripped breakers/fuses will give an idea of how many faults you can expect to find
- Locate, mark and plot on a drawing all faults



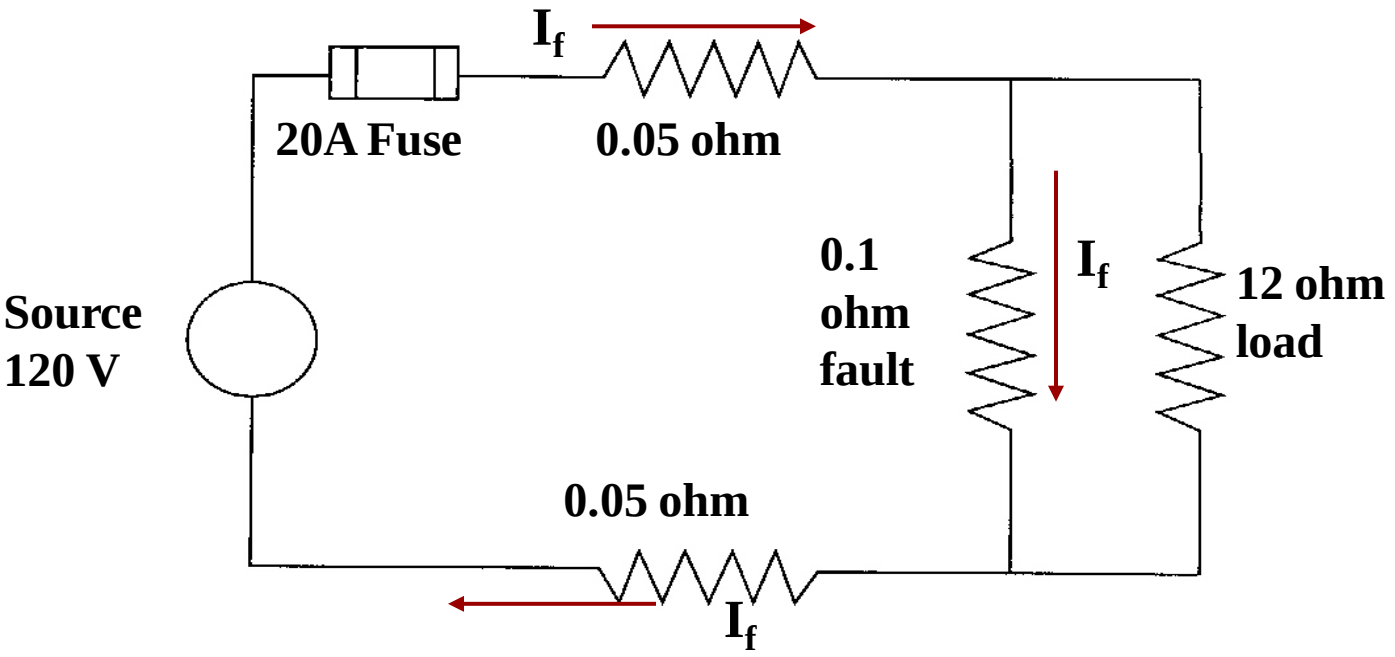
In this case,

- The fire could not have started in the utility room.
- The arc faults in the playroom indicate the fire first attacked the energized conductors here first.
- Had the fire started in the utility room first, the conductors would have de-energized and no downstream arcing would have been found in the playroom.


Clock Radio
TV & Stereo
Ceiling Light Fixture
Outlet
Wall Switch
Door
Table lamp
To Circuit Panel


Electrical Activity
Clock Radio
TV & Stereo
Ceiling Light Fixture
Outlet
Wall Switch
Door
Table lamp
To Circuit Panel

MYTH: Short Circuits Cause Fires



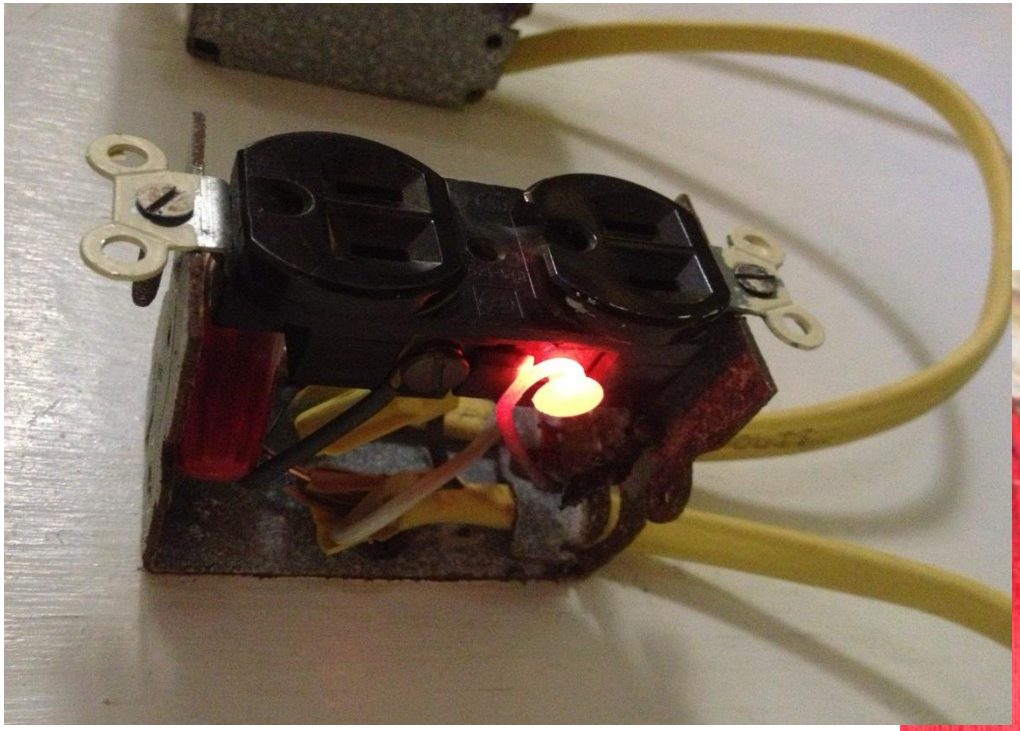
I_f = 120V/0.2 ohm = 600 Amps

- At 600 amps the fuse blows (or circuit breaker trips) instantly. Even if a penny was placed in the fuse holder the 60 amp main fuse would trip. Short circuits rarely cause fires.
- ❖ They are short duration events that cause overcurrent devices to operate.

LOOSE OR FAILED CONNECTIONS

A splice requires electrical continuity. It also requires mechanical security. This requires the use of proper terminals or connectors. Wire nuts are one way to maintain electrical contact and mechanical integrity. Duct tape is NOT an adequate connection.

LOOSE OR FAILED CONNECTIONS



Circuit Protection Failure

Spoliation

Defined: Loss, destruction, or material alteration of an object or document that is evidence or potential evidence in a legal proceeding by one who has the responsibility for its preservation. (NFPA 921)

Repercussions:

- Sanctions
  - ✓ Dismissal of claims or defenses,
  - ✓ Preclusion of evidence, and the
  - ✓ Granting of summary judgment for the innocent party.

Spoliation

DO NOT:

- ✓ Take “Trophies” or Souvenirs…. its stealing!!
- ✓ Destroy contents without reason
- ✓ Take appliances / devices / evidence apart
- ✓ Demolish the structure unless there is a life safety issue! (Extinguishment of Fire vs. Nuisance)

Public and Private Sectors

What's the difference?

- Public does not typically engage in failure analysis
- Private will engage in failure analysis when investigation warrants it.
- Insurance has the "cooperation" clause
- Insurance has outside expertise
- Money!

The classification of ***"Accidental"***

NFPA 921

19.2.1.1 Accidental fires involve all those for which the **proven** cause does not involve an intentional human act to ignite or spread fire into an area where the fire should not be. When the intent of the person's action cannot be determined or proven to an acceptable level of certainty, the correct classification is undetermined.

Public and Private Sectors

- **Subrogation**
  - 3rd party; Circumstances in which an insurance company tries to recoup expenses for a claim paid out when another party is responsible.
  - Plaintiff in an action
- **Liability**
  - Being responsible for someone else's loss/damages.
  - Defendant in an action

References

- NFPA 921- Guide for Fire & Explosion Investigations; 2014 Edition.
- NFPA 1033- Professional Qualifications for Fire Investigator; 2014 Edition
- NYS Association of Fire Investigators Chapter 23 “Fire Preservation”; PPT- 2005 Ed.