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Appliances

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Knowledge Objectives (1 of 2)

- Describe a variety of common appliances and their components and operation.
- Explain how to conduct an investigation of a fire involving an appliance.

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Knowledge Objectives (2 of 2)

- Determine the origin of a fire involving an appliance.
- Determine the cause of a fire involving an appliance.

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Skills Objectives

- Evaluate appliances at a fire or explosion scene.

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Introduction

- Appliances may be ignition source
- Information in this chapter assumes that:
  - Origin has been determined
  - Appliance is suspected ignition source

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Recording the Scene When an Appliance Is Involved

- Indicators that appliance caused fire
  - Fire patterns placing area of origin near appliance
  - Severe fire damage to appliance
  - Arcing or melting on conductors in or near appliance
- Document with photographs, diagrams, measurements

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Photographs

- Photograph appliance from different angles
  - Include views of electrical and fuel supply lines
  - Record entire area
  - Record positions of controls and thermal protection devices

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Diagrams and Measurements

- Locate appliance on diagram
- Include measurements locating appliance in relation to:
  - Fixed landmarks
  - Combustible fuels
  - Power sources

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Documenting the Appliance (1 of 3)

- Primary power source
- Power source, energy storage
- Energy source adapter
- Power/fuel source feed and connections
- External overload protection
- Bonding and grounding
- Power for controls
- Internal circuit protection and disconnects
- Operational controls

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Documenting the Appliance (2 of 3)

- Feedback devices and sensors
- Movable parts
- Cleaning, cooling, heating components
- Clocks and timers

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Documenting the Appliance (3 of 3)

- Obtain from labels or plates on the appliance:
  - Manufacturer
  - Model and serial number
  - Date of manufacture
  - Name of product
  - Warnings and caution notes
  - Recommendations and ratings
  - Additional data, such as installation diagrams

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Recovery and Reconstruction of Appliance Components (1 of 2)

- Gather components moved during fire or firefighting
- Reconstruct appliance in prefire location
- If necessary, arrange for truck or trailer to transport appliance to secure location
- Do not test or operate appliance at fire scene
  - X-rays may be useful

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Recovery and Reconstruction of Appliance Components (2 of 2)

- This ohmmeter is being used to check the electrical continuity of a coffeemaker.

Courtesy of Ray Franco

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Determining the Origin of a Fire Involving an Appliance

- Fire patterns place appliance at point of origin
  - Appliance shows more severe damage
  - Damaged parts not necessarily an indicator
- Verify that electrical power was on at time of fire
  - Document power source back to service panel
- Reconstruct the scene.

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Determining the Cause of a Fire Involving an Appliance (1 of 3)

- Was the appliance:
  - Attached to power source?
  - Energized?
  - Operating poorly recently before fire?
- Could recent operating conditions generate significant heat?
- Consider moisture, nearby combustible materials

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Determining the Cause of a Fire Involving an Appliance (2 of 3)

- Water-using appliances
  - Consider relation to water/moisture
- Heat-emitting appliances
  - Consider nearby combustibles
- Large current appliances
  - Consider poor connection or overloaded circuit

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Determining the Cause of a Fire Involving an Appliance (3 of 3)

- Heavy appliances
  - Consider short circuit at power cord
- For appliances with controls, timers, or internal electronics
  - Consider poor circuit board connection problems, relay, power switching or control component failures, or contamination of sensor connections

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Appliance Operation

- Investigator should thoroughly understand
  - Including understanding of safeguards
- Document any modifications to appliance
- Determine appliance were energized and on at time of fire

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Disassembly

- Create protocol with objectives, rules, and extent of disassembly before proceeding
- Take notes and photographs or videos of process
- Consider X-rays if disassembly is not possible.

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Exemplar Appliances

- Exemplar is exact duplicate of appliance in question
  - Can be used to understand how appliance works
  - Can be used to test a proposed ignition scenario

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Appliance Components

- Each appliance:
  - Has a different use
  - Is constructed differently

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Housings (1 of 2)

- The housing is the outer shell of an appliance.
- May contain:
  - Steel
    - Strong and durable
    - Melts at high temperatures
  - Aluminum
    - Low melting temperature

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Housings (2 of 2)

- May contain:
  - Other Metals
    - Includes zinc and brass
  - Plastic
    - Melts at low temperatures
    - Chars and decomposes at high temperatures
  - Wood, Glass, Ceramics

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Power Sources (1 of 3)

- Alternating current supplied by utility company
- Power source components include:
  - Electrical cords
    - Can comprise two or three conductors
  - Plugs
    - Conductors may be attached to the prongs inside a molded plastic housing.

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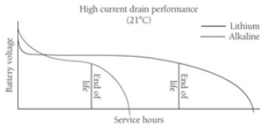
Power Sources (2 of 3)

- Power source components include (cont'd):
  - Step-down transformers (adapters)
  - Batteries
    - Lithium batteries have greater energy density than lead-acid



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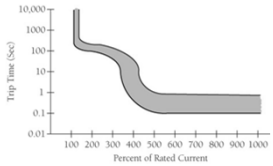
Power Sources (3 of 3)

- Power source components include (cont'd):
  - Protective devices (fuses, circuit breakers)
    - Circuit breakers trip as a result of external fire or when current flow exceeds rating of breaker



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Switches (1 of 2)

- Postfire examination of an appliance switch can sometimes determine its state
- Types
  - Fluid pressure (capillary tube)
  - Bimetal
  - Expanding metal
  - Melting material
  - Motion switch

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Switches (2 of 2)

- Contact damage can be important
  - Safety cutoff switches should not have pitting on the contact faces

Courtesy of Ray Franco

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Solenoids and Relays

- Used to control high-power circuits with a low-power circuit
- Examine contacts to see if they were stuck together during the fire.
- It is not possible to determine the status of electronic switches at the time of the fire.

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Transformers

- Reduce ac voltage
- Isolate appliance from power source
- Components often survive a fire
- Internal damage of the windings may be shown by pattern of internal heating
  - Arcing from turn to turn

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Motors

- Small motors that drive cooling fans are generally not sources of ignition.
- AC motors usually have starting windings with a centrifugal switch to disengage the windings after startup.
- Permanent magnet motors can eliminate the commutation brushes, which can be a source of arcing.

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Heating Elements

- Can ignite combustibles that are in contact with the element
- Safety features:
  - Sheathing
  - Fans
  - Heat tape
- High-resistance heating can also occur at poor connections.

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Lighting (1 of 2)

- Incandescent, fluorescent, LED
- Fluorescent lighting systems
  - Electronic ballasts
    - Unsafe situation: IC malfunctions and semiconductor switch shorts circuit
  - Magnetic ballasts (reactor or transformer)
    - Common failures: arc penetrations into nearby combustibles

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Lighting (2 of 2)

- High-intensity discharge (HID) lighting systems
  - Found in warehouses, manufacturing facilities
  - If arc tube ruptures, outer bulb may break and pieces might ignite combustibles where they land
  - If suspected cause, fixture and pieces must be preserved for examination

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Miscellaneous Components

- Dimmers
- Speed Controllers
- Rheostats, wire resistors (in older appliances)
- Timers
- Thermocouples, thermistors,
- Sensors: pressure, flame, current, proximity

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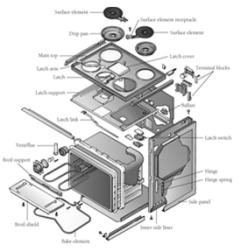
Common Residential Appliances

(1 of 6)

- Ranges and ovens
  - Leftover combustible material



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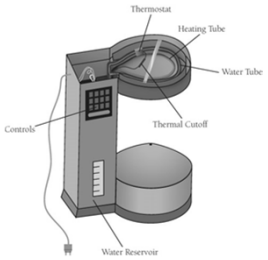
Common Residential Appliances
(2 of 6)

- Air conditioners and heat recovery systems
  - Dust
  - Motors can overheat
- Water heaters
  - Leaks
- Coffeemakers
  - Thermostats, thermal cutoffs, automatic timers



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Common Residential Appliances
(3 of 6)

- Toasters
  - Blocked sensor
- Electric can openers
  - Electrical arcing
- Cooling fans
  - Capacitors
- Refrigerators
  - Damaged power cords or plugs, thermal cutoff failure

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Common Residential Appliances
(4 of 6)

- Deep fat fryers
  - Thermostat failure
- Dishwashers
  - Moisture
- Microwave ovens
  - Dried out material
  - Metal objects
- Space heaters
  - Rough handling
  - Restriction of inlet air
- Electric blankets
  - Folded or bunched
- Window air conditioner units
  - Fan or compressor motor overheating
- Hair dryers and hair curlers
- Clothes irons

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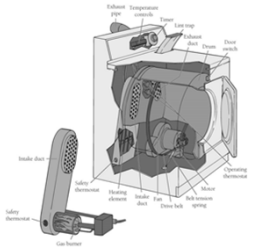
Common Residential Appliances
(5 of 6)

- Clothes dryers
  - Clogged lint filter
  - Frictional heating
  - Spontaneous combustion



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Common Residential Appliances
(6 of 6)

- Consumer electronics
  - Resistive heating
  - Short circuiting of loose switches
  - Overcharged batteries

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Summary (1 of 6)

- In a fire scene, the most convincing indicators that an appliance caused the fire are:
  - Patterns that point to the area of origin being near the appliance
  - Severe fire damage to the appliance
  - Arcing or melting found on conductors in or near the appliance

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Summary (2 of 6)

- The investigator should evaluate the fire patterns on the appliance in relation to the remainder of the fire scene.
- The investigator should thoroughly understand how the appliance operated and its safeguards.

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Summary (3 of 6)

- Before beginning disassembly, a protocol should be created with the objectives, ground rules, and extent of disassembly identified based on the specific reason for carrying out the process.

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Summary (4 of 6)

- Postfire examination of a switch can sometimes determine its state and thus whether the appliance was energized at the time of the fire.

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Summary (5 of 6)

- Components of a transformer often survive a fire. Internal damage of the windings may be shown by a pattern of internal heating, arcing from turn to turn.

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Summary (6 of 6)

- Appliances with heating elements are designed to maintain a distance between the element and surrounding combustibles.