Appendix E - Electrical Fire Scenarios
Electrical Fire Scenarios

Opinion:

The fire was caused by resistive heating and short circuiting on the power brick power cord near the connector to the power brick.

Support:

The only electrical objects close enough to the most intense part of the fire were the laptop, the power brick for the laptop, and the lamp. The lamp was found to be unplugged. Melted copper is visible on the wires leading up to the brick/cord connection, and the cord was plugged in at the time of the fire. Fires of this scale rarely result in melted copper, due to copper’s high melting temperature and high conductivity. As the insulation of the wire was barely melted less than a foot from the copper melt location, this was most likely the result of a short circuit. The power brick and the cord were covered in blankets before the fire, so sufficient fuel existed to start a fire. The other electrical devices in the room did not present a danger of causing a fire or did not display signs consistent with electrical damage.
NFPA-921 requirements for an electrical fire are:

1) The electrical wiring, equipment, or component must have been energized from a building’s wiring, an emergency system, a battery, or some other source.

2) Sufficient heat and temperature to ignite a close combustible material must have been produced by electrical energy at the point of origin by the electrical source.

Electrical heat can be produced by

1) resistance heating
2) over-current
3) arcs
4) sparks.

As sparks are particles produced from melting metals produced by arcs, this report will examine three ignition modes: resistance heating, over-current and arcs.

Resistance Heating

Resistance heating can be caused by heat producing appliances (such as the space heater) or poor condition of the wiring. For example, a loose screw inside an appliance can be in contact with a terminal, the appliance still works, but the loose screw increases the resistance and thus heating at the contact point. This heating promotes the formation of oxides which can increase the resistance in metals, eventually causing a heating spot to develop and ignite combustible materials nearby.

Resistance Heating Candidates:

Space Heater
Opinion: The fire did not start with the space heater.

Support:

The most common ignition sources for resistance heating fires are space heaters. Figure 2 shows that that the space heater is not heavily damaged. There is no indication that the heating elements inside the space heater overheated. Therefore the fire did not start in the space heater. In addition, the owner of the apartment said after the fire that he did not plug in the space heater (Appendix A).
Laptop Power Brick / Power Cord

Opinion:

Resistance heating in the power cord may have caused the initial fire.

Support:

The laptop connection between the power brick and the power cord is a potential source for resistive heating, especially at the connector. Repeated plugging and unplugging of the cord could cause a series resistance to build up at the interface. The large amount of damage to the connector is consistent with the possibility that the connector was the source of the fire and that the damage was caused by resistive heating. The connector was completely melted, as to be nearly unrecognizable after the fire.

Other objects

The condition of the wiring of the other electrical objects in the room was inconsistent with resistance heating issues. The cords of the other devices were largely intact, and the damage to the cords could be attributed to fire and flashover damage.
Over-current

Over-current or overload can cause the temperature inside a conductor to reach melting temperature. For over-current or overload to occur, there must be a short circuit and usually the protection equipment such as fuse, circuit breaker or surge protector must fail.

Power Strip

Opinion:

The power strip was not the source of the fire.

Support:

The power strip displayed little damage, most likely due to flashover. Although overload is most likely to occur on an extension cords or power strips, if there is a sufficient source of resistance elsewhere most of the power dissipation will not take place in the wire or the power strip.

Laptop Power Brick / Power Cord

Opinion:

A short circuit in the power cord occurred, and may have caused the start of the fire.

Support:

The power cord leading to the power brick is the only object in the room that exhibits characteristics of low resistance, high current damage (Fig. 3). This is visible in the spots of melted copper along the wire. This could only have been caused by electrical damage as the fire itself was never very hot, and the power cord nearby exhibited much less fire damage (the insulation was not melted).

The cord between the laptop and the power brick exhibits only fire damage (Fig. 4), and the overload protection built into the power brick means that this cord is unlikely to cause failure.
Figure 3: Melting on wire near connector to power brick

Figure 4: Power Brick
Figure 5: Power cord downstream of the adaptor

Figure 6: Damage to power cord. Insulation is still intact not too far from melted region.
Other Electrical Ignition Sources

Laptop
Opinion:
   The laptop was not the source of the fire.
Support:
   The laptop exhibited fire damage only due to flashover. The battery of the laptop was intact; had the battery exploded the laptop would have shown more serious fire damage.

![Top of laptop – flashover damage](image1.jpg)

![Underside of Laptop (little damage, battery intact)](image2.jpg)

Figure 7 – Laptop damage

Lamp (on bookshelf)
Opinion:
   The lamp was not the source of the fire.
Support:
   The lamp was not plugged in (Appendix A).

Television
Opinion:
   The television was not the cause of the fire.
Support:
   The television exhibited fire damage only due to flashover. The television was also far from the heaviest damage during the fire.
VCR
Opinion:
   The VCR was not the source of the fire.
Support:
   The VCR exhibited fire damage only due to flashover (only exterior damage).
The VCR was also far from the heaviest damage during the fire.

Cell phone
Opinion:
   The cell phone was not the source of the fire.
Support:
   The cell phone exhibited fire damage only due to flashover (only exterior damage). The cell phone was also far from the heaviest damage during the fire, and was resting on the chair. Had the cell phone started the fire, the chair would have been demolished.
Blackberry
Opinion:
The Blackberry was not the source of the fire.
Support:
The Blackberry exhibited fire damage only due to flashover (only exterior damage). The Blackberry was also far from the heaviest damage during the fire.

Printer
Opinion:
The printer was not the source of the fire.
Support:
The printer exhibited fire damage only due to flashover. The printer was also far from the heaviest damage during the fire.

Figure 12 – Damage to printer