Candles provide the ignition source for approximately 23,000 residential fires annually, leading to nearly $400 million in direct property losses.\(^1\) Of candle fires, 93% were ignited unintentionally, and most originate in bedrooms. Specifically, approximately 50% of candle fires originate because the candle is placed too close to combustible materials; 18% because a candle is unattended or discarded; 11% due to misuse; and 5% caused by children playing with the candle.\(^2\) This appendix provides opinions and support regarding the role of candles in this fire.

Opinion:

It is unlikely that the fire was started by a candle.

Support

Based on a photograph provided by the homeowner of the room before the fire, eight candles have been identified which were identified to be present in the room. The remains of each of these candles and their candle holders were located after the fire and analyzed. None of these candles could have started the fire, as explained in the sections to follow. It is possible but not highly likely that another candle which are not shown in the homeowner photo and which did not have an accompanying holder (cup, jar, stand, etc) could have ignited the fire and completely burned, leaving no evidence. This scenario is considered unlikely.

The eight candles present during the fire are shown and named in Figure F-1. A short description of each of these candles is provided in Table F-1.

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Figure F-1: Homeowner photograph showing the labeling of each known candle prior to the fire.

<table>
<thead>
<tr>
<th>Candle</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>A-NW</td>
<td>Dark red pillar candle, short and wide (approximate diameter 3” and height 3”). Ornate black wire candle stand approximately 10” tall.</td>
</tr>
<tr>
<td>B-NW</td>
<td>Dark red taper candle, narrow and tall (estimated 8” tall and ¾” wide). Tall metal candleholder (approximately 6”).</td>
</tr>
<tr>
<td>C-NW</td>
<td>Tall, narrow metal candleholder similar to B-NW with undetermined candle.</td>
</tr>
<tr>
<td>D-NE</td>
<td>Short and wide red pillar candle (approximately 3” tall and 3” wide). In a clear glass jar.</td>
</tr>
<tr>
<td>E-NE</td>
<td>Tall, wide yellow column candle. Approximately 3” wide and 7” tall. No candleholder.</td>
</tr>
<tr>
<td>F-SE</td>
<td>Tall, wide yellow column candle similar to E-NE. No candleholder</td>
</tr>
<tr>
<td>G-SE</td>
<td>Two small white votive candles, not shown in pre-fire photo. Each is approximately 1.5” wide and 2” tall and has accompanying glass cup holder.</td>
</tr>
</tbody>
</table>

Table F-1.

Candle A-NW

Opinion: Candle A-NW and its candleholder were upright during the fire and did not provide a source of origin.

Support:
After the fire, candle A-NW and its candleholder were found in separate locations. The candleholder was on top of the shelf, on its side, as shown in Figure F-2. Prior to the fire, a sheet of blue fabric covered the shelf top, as can be seen in the pre-fire photograph in Figure F-1. Attached to the bottom of the candleholder post-fire was a circular piece of this fabric, photographed in Figure F-3. The combined candleholder and residual fabric match the protected area on top of the shelf. This protected area indicates that the candleholder was upright during the fire and prevented burning on the shelftop underneath, as described in NFPA 921 section 6.15.2. The candleholder fell over after the fire, probably from the force of the firehose.

Figure F-2: Photograph of northwest corner, indicating location of the candleholder for A-NW.

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3 NFPA 921.
Candle A-NW was found on the floor in the extreme northwest corner of the room, behind the shelf. Its location is shown in Figure F-4. The paraffin and wax of the candle was mostly undamaged from the fire, with some charring on the wick and melting of the base. Because of this minimal damage, the candle was not located in the area of most intense burning, close to the wicker table. The melting point of paraffin is in the range of 50-70°C and its fire point in the range 238-263°C. The fire point of a liquid fuel is the minimum temperature for which there is enough vapor density to ignite the fuel and continue burning after ignition. The fire point for wax is far below the flashover temperature of 580°C. The candle could not have been close to the primary fuel sources or it would have been more severely and perhaps completely burned. The candle was probably on its stand, laid on the table, during the fire. A picture of the candle and its holder is shown in Figure F-5, which can be compared to the pre-fire photo in Figure F-1.

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Figure F-4: Photograph of the floor at the northwest corner, with candlestick B-NW and candle A-NW.

Figure F-5: Photograph showing the candle and candleholder for B-NW together.
Candle B-NW

Opinion: Candle B-NW was not the ignition source, and the candleholder was upright during the fire.

Support:
Candle B-NW and its candleholder were also found in separate locations after the fire. The candleholder was found in the extreme northwest corner of the room, beside candle A-NW. It is shown in Figure F-4. The candle, on the other hand was found on the wicker table, laying on magazines.

Figure F-5: Photograph of items on top of the wicker table after the fire, including candle holder C-NW and candle B-NW.

The candle holder left a protected area on the shelf top, which indicates that the candle holder was upright during the fire. The protected area can be seen in Figure F-6 below, along with the protected areas for each other object on the table.

Candle B-NW is partially melted, from the outside and not from the wick. As stated above, the fire point for paraffin wax is approximately 300°C below the flash point temperature, which means that the candle could not have survived if it was close to the primary fuel source during the fire. Therefore it is likely that the candle was upright on the candle holder during the fire, and knocked over by the firefighters. Furthermore, it could not have provided the initial ignition source.
Figure F-6: Photograph of northwest corner of room, showing protected areas left on the shelf top.

Candle C-NW

Opinion: It is unlikely that candle C-NW provided the ignition source, and the candlestick was upright during the fire.

Support:
The candlestick for C-NW was found on the magazines on the wicker table after the fire. The candlestick location is shown in Figure F-5. However, the candle holder left a protected area with the blue fabric from the shelf top, shown in Figure F-7 below. Therefore, the candle holder must have been upright during the fire.
The actual candle was not found during the post-fire inspection. It is possible that there was not a candle in this candle holder (no candle can be seen in the homeowners' pre-fire photograph). It is also possible that there was a candle in the candle holder which completely melted during the fire, since the fire point of wax is much lower than the temperatures during flash over. However, since the candlestick was upright during the fire, it is unlikely that the candle itself fell over to ignite the fire.

_Candles in the northeast and southeast corners_

Opinion: Candles D-NE, E-NE, F-SE, G-SE did not ignite the fire.

Support:
Each of the candles in the northeast and southeast corner of the room is isolated from the area of origin of the fire. These candles could not have provided an ignition source for the fire because there is no fuel medium for any of these candles to spread to the area of most intense burning around the wicker table.

The post-fire location of candle D-NE is shown in Figure F-8 below.
Candle D-NE was initially located on top of the television, but fell into the extreme northeast corner of the room as a result of the roof collapse or the fire hose.

Candle E-NE was also initially placed upon the television. It remained on the television after the fire and shows some melting. This melting likely took place primarily during flash over. The candle after the fire is shown in Figure F-9 below.
Figure F-9: Photograph of northeast corner of room, showing the large yellow candle on top of the television after the fire.

Candle F-SE is located in the opposite corner of the room from the suspected area of origin. The candle is next to the printer, on a short table in the southeast area of the room. The candle shows some melting, as seen in Figure F-10. Due to its distance from the area of origin it can be ruled out as an ignition source.
Finally, the two candles labeled G-SE were also located around the printer table. The exact location cannot be determined, since they are not shown on the homeowners’ pre-fire photograph and were found on the ground after the fire. Since these candles are not significantly melted or located near fuel media, they can be ruled out as potential ignition sources. The candles’ locations after the fire are shown in Figure F-11.
Figure F-11: Photograph of southeast corner of room, showing the location of the two small white candles.