FIRE-EX FORENSICS INC.

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Amended Report: People v. Angela Garcia, Fire-Ex File Number 12-1103

Summary:

Based upon review of the submitted materials it is the opinion of the undersigned that the original conclusions of the investigators were not founded on defensible scientific knowledge and that the fire of November 20, 1999 should be considered to be undetermined as to both its origin and cause. In making their determination, the original investigators relied on fire patterns that are now known to be produced by ventilation effects of a post-flashover fire in a compartment. During their examination, they failed to consider concepts of fuel loads, ventilation and fire/smoke movement that are much better understood today. Factors such as variables in the speed and nature of smoke movement in a multi-story structure are better understood as a result of published research since 2001. Furthermore, the analytical procedures used by the original investigators are outdated and contradicted by guidelines of good professional practice as outlined in the three leading expert treatises in the field: *NFPA 921 (2011 Edition), Kirk's Fire Investigation (7th Edition)* and *Forensic Fire Scene Reconstruction (3rd Edition)*.

Materials Received:

The following materials have been received to date in the above matter.

Two sealed boxes received on December 21, 2012 via UPS:

A. Cleveland Fire Dept. (CFD) reports

1. Incident reports
2. CFD Fire Investigation Unit report by Lt. Albert Lugo
3. a: Duplicate of A2 (above)
   b: Report on scene examination by Capt. Patton.
   c: Interview report: Angela Garcia (interviewed by Patton 11/22/99).
   d: Interview reports: Linda Mason and Joy Gambrell
   e: Interview reports: (W) Farone and Mason
   f: Anonymous caller (re: Angela)
   g: Interview: (W) James Smith (by Patton) 11/23/99
   h: Interview: (W) Shirley Brandon (by Peachman)
   i: Report re: Angela Garcia's behavior at hospital
   j: Report by Lugo re: anonymous caller
   k: Interview: Lucy Ahmad (by Lugo 11/24/99)
   l: Interview: Judith Nichols (by Patton)
   m: Interview: Mario Watkins (by Kovacic 11/24/99)
   n: Coroner Report: Dr. Bligh-Glover
   o: Watkins statement
4. a: Duplicate of A2 (above)
   b: Floor plans by Lugo
   c: Black and white copies of scene photos
   d: ADT system information
   e: Ignitable liquid patterns

B. Cleveland PD records

C. Expert Reports
   1. a: Canine report – Bob Gartner
      b: Nationwide C&O report by Gartner (4/6/01)
   2: CSE reports by Doug Carpenter and Richard Roby (5/2/01)
   3: SEA reports by Snyder and Wallace, 2/16/00 and Robert Moss 2/2/00

D: Investigative Reports, interviews

E: Flash drive with court exhibit photos (pdf)

F: Tonya Lanum materials (statement, interviews, letter)

G: 1. Timeline
   2. Scene diagram (upper floor)
   3. County auditor records

H: Medical records
   1. Angela Garcia
   2. Nyeemah Garcia

3. Nijah Evans, including P-M report

I: Color photos (exterior, interior)

J: Trial transcripts
Volumes 3 – 13

One sealed box received via UPS, 1/22/13

K: Color photos (state and defense exhibits)

Received via email 2/25/13

L: Floor plan of first floor (by A. Garcia) with notes

Sealed envelope received via US Mail 3/11/13

M: Trial transcripts of Gregg McCrary

The undersigned was retained on December 14, 2012 by Attorney Joanna Feigenbaum of the Ohio Office of the Public Defender to review the materials available in the matter of Ohio v. Angela Garcia to establish the accuracy and reliability of the original investigators and to determine, if possible, the origin and cause of this fire based on current professional guidelines.

Fire:

According to Item A1 the fire in question was reported on Saturday November 20, 1999 by telephone (9-1-1) call, resulting in an alarm time of 1935 hours (7:35 PM) and a reported arrival time of 1939 hours at 9618 Harvard St., Cleveland. First firefighters on scene reported building to be well involved on the first floor (Item A2). No audible smoke alarm was heard. No ADT alarm was reported. Firefighters were advised there were two children inside. Front foyer and living room were too involved for entry. Fire crews forced the rear door and security screen and climbed stairs to recover two victims from the floor of the front (north) bedroom. Both victims were declared dead at the hospital. Fire spread to upper floor, attic, and roof and caused extensive damage to all floors. The scene was examined by CFD personnel on Nov 21, 1999 and by private sector investigators on Nov 22, 1999 just prior to its destruction (authorized by municipal authorities). Cleveland weather conditions at the time of the fire were approximately 44° F, 93% humidity with calm to slight winds (per Weather Underground, METAR station KBKL).

Investigation:

The fire scene was originally investigated by Cleveland Fire Dept personnel Lt. Albert Lugo and Capt. Richard Patton. Nationwide Investigator Bob Gartner attended the scene with his fire canine on Nov 21, 1999 (with negative alerts from the canine as to the presence of any ignitable liquid accelerants). Crawford Insurance investigators Snyder and Wallace conducted a brief site inspection on November 22, 1999. All investigators indicated

the fire started in the northeast corner of the dining room by failure or misuse of a large decorative candle reportedly left burning by the occupant just prior to the fire. The conclusion as to origin depended heavily on the consumption of the wood floor in that area of the room (coinciding with the metal candle holder found there). Based on apparent conflicts and contradictions in statements by Angela Garcia and witnesses, investigators later concluded the fire had been deliberately ignited by Ms. Garcia, and so testified in her trial (Item J).

Structure:

The structure involved was a 2-story wood framed single-family residence with an attic and full basement. The overall dimensions were recorded as approximately 37' in width by 49' 11" in length (including porches). The structure was approximately 100 years old and was of balloon-frame construction on a cement block foundation. The exterior was wood siding covered with asphalt shingles, covered one side (and on the rear extension) by vinyl siding. The roof was asphalt composition shingles of various types. There was a deep, covered front porch that extended the width of the structure and an extension at the rear (used as a pantry) adjacent to the rear door. The structure faced North onto Harvard Avenue (street address: 9618 Harvard, Cleveland OH). There were no dimensions of the interior rooms of the structure (See Figure 1). The main floor consisted of an entry foyer in the northwest corner, a living room in the northeast corner, a dining room in the southeast and a kitchen in the southwest. An open staircase opened from both the entry foyer and the kitchen with a landing at its west end and an east-west stairwell leading to the second floor. A stairway below opened into the kitchen from the basement. The second floor included two bedrooms to the south end, a master bedroom to the northeast and a bathroom in the northwest corner. All second floor rooms opened into a short central hallway. Stairs led to the attic above. Interior finish appeared to have been painted lath-and-plaster walls and ceilings with wood floors, covered in the living, dining room and stairs with wall-to-wall carpet. In the dining room, there was wood paneling wainscoting applied to the lower half of the walls. Electrical power was provided via overhead drop to a meter on the northwest corner. There was no documentation of the gas service (if any).

Analysis:

Stairway Fire:

The primary investigators apparently formed a new hypothesis of the fire's initiation based on the information from the jailhouse informant, Tonya Lanum (Item F). She reportedly heard Angela Garcia say she started the fire on the stairs trapping her two daughters but not with the intent of hurting them. Evaluation of scene photos revealed that

the carpet on the left side of the lower stairs (above the foyer) was burned away, leaving the carpet on the right side still intact. The failure to detect what was theorized to be a substantial trail of ignitable liquid up the stairs by a well-trained and highly experienced accelerant canine team should strongly indicate that the alleged burn pattern on the left side of the lower stairs was not the result of ignitable liquid (See Figures 2 and 3). Cognitive testing should have led to the conclusion that had enough ignitable liquid been used on the stairs there should have been a canine alert. The investigators failed to consider the dynamics of the fire in the foyer as spread up the stairs. The foyer was well involved in the fire according to arriving firefighters and other witnesses. The railing on the foyer stairs (left) side was an open wooden banister with a gap between the bottom rail and the stairs (State Exhibit 4-24, photo #000171 and Figures 3 and 4). This gap exposed the carpet to radiant heat and direct flame from the foyer side. The right side was a solid lath and plaster wall. Plaster falling from this wall during the fire would protect the nearest carpet from radiant heat as the fire extended and burned up the stairs. Charring to the stair tread sides of base boards on both sides of the upper stair case appears equal (States Exhibit 4-22, See Figure 5)). The investigators erroneously concluded this partially burned carpet was the result of deliberate ignition of an ignitable liquid. There was no physical evidence of an ignitable liquid. Reliance on a burn pattern to "prove" use of an ignitable liquid amidst generalized severe burn damage is excluded by current practices (NFPA 921, 2011, 6.3.7.8).

The finding of an undamaged cigarette lighter on the stairs during the scene examination must be considered in the context of collapse of walls and furnishings in the bathroom and the attic above (as seen in State Exhibit 4-25). Had a plastic lighter been dropped on the stairs prior to the fire, it would have been severely damaged by exposure to the radiant heat and flames on the stairs. The lighter was much more likely to have fallen on the stairs during later stages of the fire or suppression. There was no demonstrable connection between this lighter and the fire.

<u>Minimal Smoke/Soot on Angela Garcia's clothing or face</u>

There was great reliance on reported observations that Angela Garcia did not bear excessive/noticeable deposits of soot or smoke on her face or clothing to support her descriptions of conditions on the upper floor were during her escape. However, neighbor Shirley Brandon, testified (Item J, p. 580) she did see soot on Ms. Garcia and she left a sooty handprint and blood on her door when she came to call for help. It must be remembered that smoke/hot gas movement is buoyancy driven, filling the ceiling space before spilling under door headers to fill the next space. A fire starting in the living room furniture would require some time to produce a smoke layer deep enough to flow beneath the header or soffit of the doorway between the living room and foyer. Even more time

would be required for smoke to cross the foyer and flow up the ceiling of the stairwell. While no dimensions were recorded of the house, the photographs verify the ceilings on the main floor were 8 ½ - 9 feet high (as typical of large houses built in the Victorian period). The doorways appear to have been approximately 7' tall. Smoke fills rooms from the ceiling downward (in the absence of forced air circulation or other mechanical means). With the high ceilings in these rooms, the smoke would accumulate to considerable depth before reaching nose height on an adult standing in that room (see Fig 7-1, *Forensic Fire Scene Reconstruction 2nd ed*., p. 307). The smoke layer obscures light coming from overhead light fixtures, causing rapid loss of visibility inside (note the fire is occurring at 7:30PM on a day where sunset was recorded at 5:04PM per Weather Underground). Smoke also causes confusion and disorientation, especially in dark conditions (*Forensic Fire Scene Reconstruction 2nd ed*., pp.307-308, 322-325). With the reported loss of room lights (and the television), it would be expected that Ms. Garcia would have difficulty keeping track of two frightened, small children well before she was exposed to severe smoke conditions. As she attempted to open the bedroom window, it would be easy to lose the children in the dark. The trial testimony of Dr. Fratianne (Item J, pp. 2041-2120) included several major factual errors and misrepresentations about smoke, heat and fire conditions. His conclusions were largely based on speculation about the fire and its spread in the house.

The toxicology results indicated that both children succumbed to smoke inhalation (with fatal COHb saturations of 66% and 87%) (Item 14). Their bodies would have been exposed to thermal damage after death to cause the burns observed after recovery. It is not unusual for fire victims to become entangled in curtains/blinds or cords as they try to escape. Plastic mounting brackets often fail in the hot smoke layer, causing the collapse of the window coverings. A firefighter attempting a rescue in heavy smoke would not be able to unwind such encumbrances until well after recovery. It was ludicrous to suggest that one of the children was deliberately restrained with the window blind cords.

Escape

It was claimed by Investigator Patton that the windows in the north (master) bedroom were too narrow for Ms. Garcia to escape. Examination of the scene photos (Item I and K) indicates the window bay was on the order of 4' wide and that the windows were approximately 16-18" wide. (One photo shows an adult male fire fighter in proportion to these windows). It would appear that Ms. Garcia would have had no trouble in slipping through the lower portion of one window without removing the dividing sash. Opening the window would be expected to draw the hot smoke up the stairs and into the bedroom towards the window. This would make visibility considerably worse.

The roof below this window (over the front porch) was steeply pitched and anyone on it would be very likely to slide down it and off onto the front lawn area. It cannot be established from the photographs if the glass fragments on the roof are soot-coated or clear. One witness reported that some appeared clear, indicating they been broken out before heavy soot could condense on the interior of the window. Fragments of flat glass on the shingle roof would make it very slippery.

Origin Determination

The original investigators all concluded the area of origin of the fire was the northeast corner of the dining room. This determination was apparently entirely based on the large hole burned through the wood floor at that location (and the large metal candle stand which Ms. Garcia said bore a large 3-wick wax candle, lighted at the time). The furnishings of this room apparently consisted of a metal table with a wood top, six metal dining room chairs with upholstered seats and back rest, a metal floor lamp and carpet on the floor. The large window was reportedly covered with a mini-blind (according to Item L). There was wood-paneling wainscoting on the lower portions of the walls. The investigators concluded that the fire started in the dining room and burned downward into the floor, but did not attempt a fire-spread analysis.

The adjacent living room reportedly was furnished with a desk, computer, sofa (on the east wall), armchair (or loveseat), carpet, television and a computer. The remains of the sofa, computer, and desk were identified in the post-fire photos, as was a metal 'torchiere' floor lamp (Figures 6 and 7). Ms. Garcia claimed there was a 'heart-shaped' wax candle in use on the television cabinet.

Witnesses Jernigan and Fails (Item J, pp. 871 and 906) reported the bulk of the fire to be in the "front of the building". First arriving firefighters DeBarr and Atkins reported the primary fire to be in the living room and dining room (Item J, p. 728 and p. 819). It should be kept in mind that such observations may be limited by the access the witness had to view all portions of the building and what windows and doors were available to provide a complete view inside. The 'front' of this building constituted the living room and entry foyer. The dining room had a large bay window on its east side and a large window on its south side. It should be noted that the fire plume damage above the south window dining room is much less than that above the east windows of the living room and dining room (Figures 8 and 9). Had the fire started in the dining room, there should have been equal damage above both windows of the dining room. Wind conditions at the time of the fire were reported to be nearly still and shifting from a WSW wind to a SE wind so the absence of fire damage above the south window would not be wind-caused.

It has already been observed (by Roby, Item C2) that there was much less fire damage in the kitchen than in the living room. While some of this could be the result of fuel loading differences, it is clearly worth noting that a fire starting in the NE corner of the dining room would expected to produce more equal fire spread into both adjacent spaces.

Firefighter Atkins reported focusing his prolonged hose stream attack to his left (into the living room) for an estimated 25 min. (Item J, p. 330). It should be noted that the NE corner of the dining room would not be in line of such suppression, leaving it to burn longer there than in other more central areas of the room. The original investigators failed to note the role thin wood wainscoting could play in providing a distributed fuel load around the perimeter of such a room.

With regard to fire patterns in the dining room, it is now recognized that "saddle burns" on the floor joists are not solely indicators of ignitable liquid fire but are expected when any wood floor burns from above, particularly in an intense, post-flashover condition (see NFPA 921, 2011 ed., 6.3.7.12, p. 63) (Figure 10). It seems that all of the original investigators concluded that the fire originated in the NE corner of the dining room because of the irregular burn through of the floor in that area. These conclusions today are cautioned against in *Kirk's Fire Investigation 7th Ed.* (pp. 276-278) and *NFPA 921* (17.4.1.3). It is also acknowledged today that holes in floors are not <u>proof</u> of an area of origin or the presence of ignitable liquid (see NFPA 921, 2011 ed., 6.3.3.2.5) and that irregular fire patterns on floors cannot be identified as the proof of an ignitable liquid based on shape alone (NFPA 921, 2011 ed., 6.3.7.8).

Non-accelerated post-flashover fires in rooms have been shown to be able to produce deeply charred floor patterns (*Kirk's Fire Investigation*, *7th Ed*., p. 299), and irregular penetrations similar to those observed here (*Forensic Fire Scene Reconstruction*, 2nd Ed., Fig. 3-26, 2009). Conversely, the use of an ignitable liquid has not been observed to produce extensive (widespread) penetrations of wood floors (*Kirk's Fire Investigation*, *7th ed.,* pp. 273-278, 300; also *Forensic Fire Scene Reconstruction*, *2nd Ed*., 2009, p. 163). Recent work by Carman has demonstrated the relationship between ventilation and post-fire patterns in flashover fires (Carman, 2009).

It should be pointed out that the there were several smaller areas of fire penetration of the floor in the living room and dining room that should have indicated that ventilation-effects in post-flashover room fires were responsible. These patterns occurred most under the large windows of the living and dining room or along the path that a flow of entrained fresh (oxygen-rich) air would take between the windows and open doorways of the dining and living rooms. These ventilation effects are cited today in NFPA 921, 2011 ed., 6.3.22, and 17.4.1.4; also *Kirk's Fire Investigation, 7th Ed.*, pp. 296-297. The openings in the northeast corner tend to follow the direction (E-W) of the floor joists (Figure 11). If a fire starts above a floor, it has no "reason" to progress in an east-west direction. If a fire starts

below a floor, the channels of the joist structure will direct the fire travel. The role of structural elements is described in NFPA 921, 6.3.5.3. This observation supports a hypothesis that the fire began below the northeast corner. With the presence of irregular house wiring, the original investigators could not have eliminated that hypothesis.

Cause:

Photographs of the underside of the floor structure in the vicinity of the dining room burn-through show the effects of a sustained low-energy fire in the floor joist immediately beneath the metal candle stand. In this area were many loose electrical wires and an uncovered electrical junction box (Figures 12A/B). The wiring in this area (and in other areas of the building) shows it to be un-systematic mix of insulated wires, Romex, BX (flexible steel cable) and original knob-and-tube wiring. None of these methods alone pose a special fire risk if they are installed according to NEC methods. It is when they are present as random and irregular open junctions that they pose a fire risk. It should be noted that this house was over a century old and was of balloon-frame construction. This would allow a fire ignited by the wiring in this location to spread into the void space of the nearby wall (which shows extensive fire damage) and rapidly involve the interiors of the outer walls all the way to the attic and roof before being noticed by the occupants (Figure 13). The original investigators failed to consider and eliminate these critical accidental ignition hypotheses.

The reported contents of the living room also offered several hypotheses about an accidental fire. The remains of a torchiere floor lamp were present in the living room. Such lamps were often fitted with high wattage lamps that can ignite nearby combustibles on contact or by radiant heat alone. There were a computer and monitor, and a television in the living room. While failures causing fires in those devices are rare, they are known to occur. Most significantly, Ms. Garcia reported she had a “heart-shaped” candle on the television that was burning prior to the fire. Unattended candles have become a major cause of accidental residential fire (12,800 in 2002 per CPSC and 18,000 in 2002 per NFPA). Asymmetric or ‘designer’ candles are especially subject to failure – from an unplanned release of wax and exposure of wick causing an unsafe increase in flame size to heating and even ignition of containers, or decorative inclusions. Even small candles in metal dishes have been known to heat the dish to the point it can melt through thermoplastics such as television or radio cabinets and ignite the components within. Such failure history would cause today’s investigator to carefully consider and test a candle ignition hypothesis for the living room.

Candle “Tests”

According to the SEA report of 2/2/00, the exemplar candle tested was 6” diameter and 6” high, for a total of 2.65 litres of volume. If allowed to melt to a thin liquid, coverage

of about 0.53 m^2 would be expected on this carpet (*Kirk's Fire Investigation 7th Ed.,* p. 109). Estimation of the area of the fire induced hole is in excess of 1 m^2, therefore this hole was not made solely by combustion of candle wax. The floor penetrations in the dining room are most extensive between the east window and large door opening to the living room but also appear inside the large south window, further supporting the hypothesis that they were ventilation-driven.

Ignitable Liquids:

For an investigator to conclude that a fire was set with ignitable liquids, far more than irregular patterns of burn damage must exist, especially in multiple rooms where prolonged flashover burning has occurred. There must be a qualified laboratory result demonstrating such a liquid being detected in a sample from the fire scene (also excluding possible contributions from household products normal to the scene). In this case, not only were there no canine alerts at all, there were no positive findings of an ignitable liquid of any kind. Claiming that a badly documented "unusual" burn on the stairs was proof of an ignitable liquid trail was only speculation and under today's professional guidelines, it should never have been offered in court (NFPA 921, 6.3.7.8). Further, there no indications of any "non-fire" activities that could support the intentional fire hypothesis. There were no unusual fuels or re-arrangement of expected fuels; there were no provable indications of separate fires; no proof of indicators of trailers; no flash burns on Ms. Garcia (indicating close proximity to ignitable vapors); and no lab identification of ignitable liquids (and no containers for same found at the scene).

Electrical:

The electrical system was never properly examined (only the breakers and the fixed household receptacles – neither of which often bears proof of a fire ignition failure). Arc fault mapping is part of the recommended practice for origin determination today and that was rarely done in 1999. (NFPA 921, 2011 ed., 17.1.2)

The building was demolished by authorities two days after the fire, denying any subsequent investigators the opportunity to collect and analyze additional data. The arson charges were not filed until long after the building was demolished, denying the defendant any opportunity for re-examination. The original investigation concluded the fire to be accidental based on the scene exam. The conclusion was only modified when an informant came forward with allegations of admission by the accused, and additional undeveloped photos (included in Item K).

Conclusions:

Based on review of the submitted materials, it is the opinion of the undersigned that

1. The original investigation of November 1999 does not meet current professional guidelines (as published in *NFPA 921*, *Kirk's Fire Investigation*, *Forensic Fire Scene Reconstruction*, and other peer-reviewed publications and expert treatises) and its conclusions as to the origin and cause of the November 20, 1999 fire are unreliable and unsupportable. This fire should be classified as undetermined in both origin and cause.
2. The original investigators misinterpreted patterns of fire damage to erroneously conclude the fire began in the northeast corner of the dining room (and then much later concluded the fire was spread up the central stairs by means of an ignitable liquid accelerant – despite the lack of any physical evidence). In summary, there is no reliable evidence that the fire started in the dining room.
3. Their conclusions that the fire was deliberately ignited with the extensive use of an ignitable liquid were reached despite the absence of any positive laboratory findings or even canine alerts, in violation of all professional guidelines of that date as well as today.
4. The original investigators failed to assess the fire dynamics of smoke and flame spread in accordance with today's knowledge to evaluate the exposure to occupants. This led to the erroneous conclusion that Ms. Garcia had to have shown pronounced signs of smoke exposure.
5. They failed to formulate and consider alternative hypotheses about the area of origin of the fire and possible accidental causes. The presence of non-code compliant electrical wiring immediately below the purported area of origin should have prompted a more complete assessment of both the possible origin and cause. The hypothesis that a fire ignited beneath the floor and spread under the concealed spaces of the east wall, compromising wiring as it spread before breaking out in the living space is equally supported by the fire patterns and witness statements.
6. They failed to <u>eliminate</u> all possible accidental causes before concluding the fire was deliberately set. This is in violation of current accepted practice as there was no inconvertible evidence of an incendiary fire. In part, this was due to their initial conclusions that the fire started in the dining room. That precluded their consideration of the candle on the TV and the 'torchiere' lamp in the living room, both well known accidental sources of ignition.
7. Recent (2009) research has demonstrated the effects of ventilation in prolonged post-flashover fires to create areas of intense damage to floors

and walls. There was no consideration of ventilation effects (from large window and door openings), rendering the origin determination unreliable.

8. They failed to document all the potential fuel packages in both rooms, including the carpet and wood wainscoting and assess their roles in fire growth and spread.
9. The candle test by SEA (2/2/00) (and Dolence Engineering) involved the testing of one candle for failure. This is woefully inadequate by any scientific standard. Failures of asymmetric candles and decorated candles are well known, but even they do not all fail. Testing one candle (asserted to be the same as the one present) presents no reliable data.
10. The assessment by CSE (5/2/01) of fire damage aided by melted candle wax burning in the northeast corner of the dining room as it is wicked up by the carpet appears to be without support by actual test data. While the mechanism they suggest is sound, it is unlikely that melted candle wax would be responsible for all the floor penetration observed in the dining room.
11. The testing done by CSE with regards to the alarm system when exposed to fire demonstrated that the indicated “system trouble/tamper” at 19:30:32 followed by a “busy” signal at 19:33:42 would be expected from fire attacking the exposed wiring either at the basement (central box) or in the foyer (key pad). In either location, the wiring would be mounted on the adjacent wall surface and exposed to the fire early in its development.
12. The purported “patterns” of fire damage on the lower stairs were the effects of the general fire in the foyer moving towards the stairs from the living room (driven by convective buoyant flow in the stairwell). The left-hand ends of the lower stairs would be exposed to fire coming through and under the stair rail and inducing heat damage and fire effects from left to right on those stairs. (These patterns were deemed to be the result of ignitable liquid on the stairs by the original investigators).

These conclusions are based on review of the materials submitted to date and reliable published data, as well as extensive personal knowledge of laboratory analysis, fire dynamics, ignition processes, flame spread, fire growth, smoke production, and fire indicators. They are expressed to a reasonable degree of scientific certainty. If additional information becomes available that has a bearing on these conclusions, these conclusions will be amended or supplemented appropriately.

Disposition:

The materials submitted will be retained pending further requests.

Dr. John D. DeHaan, President
Fire-Ex Forensics, Inc.

Fellow, American Board of Criminalistics (Fire Debris)
Fellow, American Academy of Forensic Sciences
Fellow, Forensic Science Society (U.K.)
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References Cited:

NFPA 921, 2011 Ed., *Guide for Fire & Explosion Investigations*, NFPA 2011

Kirk's Fire Investigation, 7th Ed. John D. DeHaan & David J. Icove, 2012, Brady Publishing, Prentice-Hall.

Forensic Fire Scene Reconstruction, 2nd Ed. David J. Icove & John D. DeHaan, 2008, Brady Publishing, Prentice-Hall.

Carman, SW. "Improving the Understanding of Post-Flashover Fire Behavior". *Fire & Materials* (Proceedings), Jan 2009, pp 789-800.

NFPA 921 Citations:

6.3.22 Ventilation-Generated Patterns (pg. 53)

Ventilation of fires and hot gases through windows, doors, or other openings in a structure greatly increases the velocity of the flow over combustible materials. In addition, well-ventilated fires burn with higher heat release rates that can increase the rate of the char spall concrete or deform metal components. Areas of great damage are indicators of a high heat release rate, ventilation effects, or long exposure. Such areas, however, are not always the point of fire origin. For example, fire could from slow-burning fuels to rapid-burning fuels, with the latter producing most of the fire damage.

6.3.2.4 Full Room Involvement-Generated Patterns (pg. 54)

If a fire progresses to full room involvement (*see 5.10.2.1 through 5.10.2.8)* damage found at lower levels in the room down to and including the floor can be more extensive due to the effects of radiant flux and the convected heat from the descending hot gas layer and the contribution of an increasing number of burning fuel packages. The radiant heat flux has the greatest impact on surfaces with a direct "view" of the hot gas layer. As the hot gas layer descends to floor level, damage will significantly increase. Damage can include charring of the undersides of the furniture, burning of carpet and floor coverings under furniture and in corners, burning of baseboards, and burning on the undersides of doors. Full room involvement can result in holes burned through carpet and floor coverings. The effects of protected areas and floor clutter on low burn patterns should be considered *(see 6.3.3.2.8)*. Although the degree of damage will increase with time, the extreme conditions of the full room involvement can produce major damage in a few minutes, depending on ventilation and fuels present.

6.3.3.2.5 Holes in floors...(pg. 55)

Holes in floors may be caused by glowing combustion, radiation, or an ignitable liquid. The surface below a liquid remains cool (or at least below the boiling point of the liquid) until the liquid is consumed. Holes in the floor from burning ignitable liquids may result when the ignitable liquid has soaked into the floor or accumulated below the floor level. Evidence other than the hole or its shape is necessary to confirm the cause of a given pattern.

6.3.5.3 Structural elements... (pg. 56)

Structural elements, such as studs or joists, can influence the patterns created by fire penetrating up or down or laterally through a building surface. For example, a fire that moves upward through a floor may exhibit patterns significantly influenced by the joists, as

opposed to a fire that moves downward through the same floor. The investigator should keep in mind that only the last burning direction through the surface may be evident.

6.3.7.8 Irregular Patterns (pg. 59)

Irregular, curved, or "pool-shaped" patterns on floors and floor coverings should not be identified as resulting from ignitable liquids on the basis of visual appearance alone. In cases of full room involvement, patterns similar in appearance to ignitable liquid burn patterns can be produced when no ignitible liquid is present.

6.3.7.11.1 Flashover and Full Room Involvement (pg. 62)

In the course of a flashover transition, fire spreads rapidly to all exposed combustible materials as the fire progresses to full room involvement. *(See 5.10.2.6.)* This process can produce relatively uniform depths of char or calcination. If the fire is terminated before full room involvement, relatively uniform burning can be evident on vertical surfaces above the bottom of the hot layer. When the fire has progressed to full room involvement, the area pattern may be uneven and may extend to the floor. The uniformity described in this section may not be consistent throughout the room or space. Some exposed surfaces may exhibit little or no damage due to ventilation effects or the location of furnishings or fixtures that may prevent charring, darkening, or discoloration of wall and ceiling surfaces.

6.3.7.12 Saddle Burns (pg. 63)

Saddle burns are distinctive U- or saddle-shaped patterns that are sometimes found on the top edges of floor joists. They are caused by fire burning downward through the floor above the affected joist. Saddle burns display deep charring, and the fire patterns are highly localized and gently curved. They also may be created by radiant heat from a burning material in close proximity to the floor, including materials that may melt and burn on the floor (e.g., polyurethane foam). Ventilation caused by floor openings may also contribute to the development of these patterns, shown in Figure 6.3.7.12.

17.4.1.3 Pattern Generation (pg. 163)

The investigator should not assume that the fire at the origin burned the longest and therefore fire patterns showing the greatest damage must be at the area of origin. Greater damage in one place than in another may be the result of differences in thermal exposure due to differences in fuel loading, the location of the fuel package in the compartment, increased ventilation, or fire-fighting tactics. For similar reasons, a fire investigator should consider these factors when there is a possibility of multiple origins.

17.4.1.4 Ventilation (pg. 163)

Ventilation, or lack thereof, during a fire has a significant impact on the heat release rate and consequently on the extent of observable burn damage. The analysis of fire pattern data should, therefore, include consideration that ventilation influenced the production of the pattern. Ventilation-controlled fires tend to burn more intensely near open windows or other vents, thereby producing greater damage. Knowledge of the location and type of fuel is important in fire pattern analysis. During full room involvement conditions, the development of fire patterns is significantly influenced by ventilation. Full room involvement conditions can cause fire patterns that developed during the earlier fuel-controlled phase of the fire to evolve and change. In addition, fires can produce unburned hydrocarbons that can be driven outside the compartment through ventilation openings. This unburned fuel can mix with air and burn on the exterior of the compartment, producing additional fire patterns that indicate the fire spread out of the original compartment. Thus, knowledge of changes in ventilation (e.g. forced ventilation from building systems, windows breakage, opening or closing of doors, burn-through of compartment boundaries) is important to understand in the context of fire pattern analysis. Determination of what patterns were produced at the point of origin by the first item ignited usually becomes more difficult as the size and duration of the fire increases. This is especially true if the compartment has achieved full room involvement.

17.4.5 Arc Surveys or Arc Mapping (pg. 166)

Arc surveys (also known as arc mapping) is a technique in which the investigator uses the identification of arc locations or “sites” to aid in determining the area of fire origin. This technique is based on the predictable behavior of energized electrical circuits exposed to a spreading fire. The spatial relationship of the arc sites to the structure and to each other can be a pattern, which can be used in an analysis of the sequence in which the affected parts of the electrical system were compromised. This sequential data can be used in combination with other data to more clearly define the area of origin. There are circumstances, such as complete destruction of the branch circuits, melting of conductors from fire exposure, post-fire re-energizing of the electrical system, or the inability to recognize arc damage on conductors, that make it more difficult or impossible to use this technique. The identification of arc sites in the area of fire origin may help to identify a potential ignition source(s) for consideration. The investigator is cautioned to consider that conductors only pass through certain areas, and therefore, the amount of information available will be limited by the spatial distribution of the conductors available for arcing. Mapping of arcs on conductors that are exposed to the developing fire, such as appliance cords or branch circuit conductors that are in the compartment of the fire, may provide the most useful information. Branch circuits that are located behind some type of thermal

barrier, such as gypsum board or plywood, may not provide useful arc mapping information, as the circuit protection may open prior to the fire damaging the conductors located behind ceilings and walls.

18.7 Selecting the Final Hypothesis (pg. 174)

Once the hypotheses regarding the "cause" of the fire have been tested, the investigator should review the entire process, to ensure that all credible data are accounted for and all credible alternate cause hypotheses have been considered and eliminated. When using the Scientific Method, the failure to consider alternate hypotheses is a serious error. A critical question to be answered by fire investigators is, "Are there any other cause hypotheses that are consistent with the data?" The investigator should document the facts that support the cause determination to the exclusion of all other reasonable causes.

18.7.4 Undetermined Fire Cause.

The final opinion is only as good as the quality of the data used in reaching that opinion. If the level of certainty of the opinion is only "possible" or "suspected," the fire cause is unresolved and should be classified as "undetermined." This decision as to the level of certainty in data collected in the investigation or of any hypothesis drawn from an analysis of the data rests with the investigator.