

FIRE-EX FORENSICS, Inc.

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January 20, 2003

Mr. Jon Hulsing
Ottawa County Prosecutor
414 Washington Avenue, Room 208
Grand Haven, MI 49417

Report re: State v. Karen Sue Boes , Fire-Ex File Number 02-1105

Summary:

In the opinion of the undersigned, the fire at 523 William Street, Zeeland, Michigan, on July 30, 2002, was the result of flammable liquid spread on the floor and/or contents of the northeast bedroom and the eastern portion of the second floor hallway and ignited in the hallway. At the time of ignition the door to the bedroom was partially open and the initial fire burned in the hallway for some brief time interval before vapors from the gasoline in the bedroom migrated to the hall to be ignited. At that time a deflagrating combustion explosion propagated through the bedroom, slamming the door shut and lifting the east portion of the mansard- (or barn-) style roof. The subsequent fire in the room was limited by a deficiency of oxygen in the room to support generalized combustion and resulted only in limited fire and radiant heat damage to exposed surfaces. The fire in the hallway continued to burn at the east end against the bedroom door. This fire eventually penetrated the hollow-core bedroom door to the northeast bedroom and the gypsum board ceiling of the hall, permitting extension of the fire into the ceiling space above the hallway and into the upper half of the bedroom, inducing generalized fire damage to the contents of the bedroom.

primary - the
fire from migration
of vapors

secondary

The victim, Robin Boes, was in the bedroom at the time of the fire and succumbed to asphyxiation by inhalation of combustion products. Her body was reportedly found in a face-down position on the floor between the foot of the bed and a large circular chair. Her burns were consistent with exposure to the radiant heat of the later bedroom fire except for the burns to her face (which was protected by her face-down position between the furniture). Her facial burns and limited hair singeing were entirely consistent with exposure to a flash fire of brief duration as would be produced during the deflagration described. The burns to her clothing and upper body were not consistent with those that would be expected from self-immolation where gasoline is splashed on the body and then ignited. In the absence of competent ignition sources in the hallway (operational electrical or gas appliances), the ignition of the flammable liquid vapors in the hallway would require an open flame (or arc or spark source) deliberately introduced.

Ignited
*
X for ignition
fire

Evidence Received:

The following items have been received to date:

Binder of documents received from S/A Mike Marquardt, BATF, in person on September 25, 2002, containing:

- #1: ATF Report by S/A Marquardt, dated 8/2/02.
- #2: Zeeland FD dispatch records.
- #3: Report by Ted Vanden Brink, Zeeland FD.
- #4: Consent form.
- #5: Weather data.
- #6: Michigan State Police (MSP) Incident Report by Sgt. Stormzand with evidence list, dated 7/31/02 (two copies).
- #7: Autopsy Report re: Robin Boes, by Dr. David Start, dated 9/20/02.
- #8: MSP Report by D/Sgt. Gary Cuperus and D/Sgt. Michael Harris with supplements.
- #9: MSP Forensic Science Lab Report by Kevin Streeter, dated 9/3/02.
- #10: MSP Supplemental Report re: doors.
- #11: ATF Polygraph Report re: Karen Boes, not further examined.

The following was received on December 24, 2002, via FedEx:

- #12: Transcript of preliminary hearing testimony of S/Sgt. Greg Stormzand.

The following items were received in person on January 10, 2003:

- #13: Binder of photos taken by S/Sgt. Stormzand.
- #14: Copy of "Fire Findings" report by Jack Sanderson, dated 9/26/02.
- #15: Copy of "e-Lab" Report by Tom Beamish, dated 12/10/02.
- #16: Copy of resume of Adolf Wolf, Holland, Michigan.

The following items were received in person on January 11, 2003:

- #17: Binder of digital photos taken by S/A Marquardt (various dates).
- #18: Prints of photos taken by S/A Marquardt on January 10, 2003.
- #19: Binder of photos taken by S/A Marquardt (various dates) with log sheets.
- #20: Supplemental reports (re: firefighter interviews) by Zeeland Police Chief Olney.
- #21: Sample of carpet reference specimen recovered from closet of Robin Boes.

In addition, the undersigned attended the fire scene on January 10, 2003, and assisted in the documentation and recovery of various exhibits. On January 10, 2003, the exhibits in custody of MSP S/Sgt. Stormzand were examined visually by the undersigned.

It was requested that the origin and cause of this fire be determined, if possible.

Scene:

The fire occurred in a two-story, wood-frame residential structure with integral single-car garage and a below-grade basement at 523 William Street, Zeeland, Michigan. The structure, which faced approximately south, was brick veneer on the ground floor and siding on the second floor.

The structure consisted of a living room, kitchen, dining room, sewing room, bathroom, laundry, and garage on the ground floor with a central enclosed stairway with a door at its foot that led to the second floor. The second floor consisted of a master bedroom to the west, a bathroom, one bedroom at the east end of an east-west hallway, and another on the south side, accessed from a north-south hallway. There was a partial basement with a "walk-out" door on the west side of the structure (under the living room). All fire damage was limited to the second floor, and there was no significant amount of fire damage to the exterior of the structure. The roof was wood frame

(2" x 4" and 2" x 6") with 1" x 12" or 1" x 10" wood decking and asphalt-shingle covering. The weather at the time of the fire was reportedly clear with a temperature of approximately 75°F and a relative humidity of 82%.

The stairs to the second floor were accessed via a 2' 8" x 6' 8" door at the bottom that opened onto the entry foyer on the ground floor. The northeast bedroom was approximately 10' x 11' in size with a mansard-style ceiling that was 7' in height at the center, sloping to a height of 6' 6" at the west wall and to 5' 4" at its east wall. There was a single double-hung sash window at its north end (2' 8" x 3' 8" in overall size) and a 2' 6" x 6' 8" hollow-core door at its southwest corner. This door opened into the room from an east-west hallway approximately 33" wide by 8' long with a ceiling height (sloping upward from 85½" on the north to 89" (7' 7") at the south wall). Opening to the north from this hall was a bathroom and to the south was a small closet and a north-south hallway that led to the entry door to the southeast bedroom (not involved in the fire). The west end of this east-west hall led to a stair landing a single step down. This landing provided access to a short north-south hallway with a closet and to the master bedroom to the west, two steps up from the landing. The walls and ceilings of the hall, bathroom and adjacent areas to the west were of ½" (nominal) gypsum board (drywall). The walls and ceiling of the northeast bedroom were covered with ⅝" (nominal) cellulose fiberboard (celotex) which had been painted and papered. The floors on the second floor were plywood covered with synthetic carpet and urethane foam pad. In the hallway the carpet was short-loop (commercial) carpet over urethane foam pad. The bedroom was carpeted with a newer synthetic pile carpet over a "rebond" urethane foam pad.

Fire:

The fire was reported at 0901 hours by Gena Zuverink, a neighbor passing by who saw white smoke or steam coming from the east side of the roof. She stopped and entered the structure ND finding the front door closed but unlocked. She reportedly saw light smoke in the ground floor rooms and heavier smoke at the top of the stairs (the door to the stairs being open at the time). She reportedly heard the smoke detector sounding at the top of the stairs but heard no response when she called out. The family dog fled the house when she opened the front door. She called 9-1-1 via her cell phone and remained on scene until the fire department arrived at 0907:47. Arriving fire personnel found the upstairs heavily charged with smoke and heat, but no visible fire, and began a search and rescue operation. After the west (master) bedroom was searched, the fire in the east hallway became much larger and a hose stream suppression was initiated. The fire

NB - didn't know where she from

Burned for 20 minutes

in the east hallway was quickly knocked down (by 0921 hours), and the bedroom door beyond was found in the fully closed position but badly fire damaged. The remains of the door were knocked down and the ceiling fire in the bedroom suppressed. The body of the victim (Robin Boes) was found lying face down on the floor between the foot of the bed and a circular bamboo chair in the southeast corner of the room. She was rescued but not responsive to treatment and pronounced dead at the scene.

Firefighters reported that the windows of the structure were closed and intact upon their arrival except for the west window on the south (front) upstairs, over the covered porch. The glass of that window was pointing outwards in shards from the frame. (This window was in the master bedroom, south wall). Most of the remaining glass from that window was removed by firefighters, who also broke windows on the west wall of the master bedroom, second floor bathroom and north wall of the northeast bedroom (where the victim was found) to ventilate smoke and steam. Remaining pockets of fire were reportedly quickly extinguished.

*Master Bdr m
Window in
point out*

Victim:

The victim, Robin Boes, was found dressed in striped cotton panties and a pink sleeveless halter top. Both items had been scorched on the rear surfaces. The fronts of both garments appeared to have been undamaged by fire. The victim was found to bear soot deposits and skin slippage (partial thickness burns) on the face, neck, arms, legs and back. There was no charring or full thickness burns noted during post-mortem exam. The skin of the chest, abdomen, pelvis and buttock was spared injury. The damage to the legs extended from feet to upper thigh and on front, rear and sides of both legs and was most marked on the rear of the left leg. The face and front of the neck bore partial thickness burns and there was some singeing of loose hair around the margins of the face. There was no damage to the majority of scalp hair or to the underside of the chin. She had extensive soot deposits in the trachea and bronchi as well as pulmonary edema. Her blood was free of alcohol and drugs of abuse and had a 39% COHb saturation.

*eyelids
eyebrows
frontal hair*

Fire Damage:

Fire damage to the structure was limited to the second floor with the primary areas of most severe damage being the east-west hallway and the northeast bedroom. Fire damage became higher and less severe along the south hallway, north into the bathroom, and west into the landing area at the top of the stairs and into the west (master) bedroom and north hallway. The

no damage to the closet

ceilings in the east-west hall, the north-south halls, the landing, bathroom, and bedrooms of the second floor were apparently pulled during firefighting operations as there was no thermal damage to the wood structure above those areas except for the east end of the east-west hall. In that area there was significant charring of the undersides of the four ceiling joists between the bedroom door and the center of the bathroom door. The drywall on the adjacent upper walls that survived the fire suppression was completely calcined and its supporting paper charred away at the east end of that hallway. The drywall on the east side of the closet had also been calcined from floor to ceiling. The drywall on the west side and ceiling had also been destroyed by fire. Areas of the drywall near the floor on both sides of the hall appeared to have been thermally damaged more severely than portions at mid-level. The left trim molding of the closet was deeply charred from floor to top of door frame, but the right-hand molding was only fire damaged at its top and its inside surface. The bottom of the out-facing molding and the adjacent painted drywall were spared any fire damage. The bathroom cabinets were undamaged by fire, although the mirror above was broken by thermal shock. There were heavy deposits of soot and smoke on the upper half of the bathroom walls. The hollow-core bathroom door was in the open position during the fire and had been severely charred diagonally upward from floor level at the door. The carpet in the east-west hallway was severely damaged by heat and flame. There were small portions of the carpet that remained intact but adhering remnants of charred cloth indicated that this was the result of garments on the floor at the time of the fire. The carpet in the middle of the hall from beneath the bedroom door nearly to the landing step, and from the bathroom door opening nearly across the hall to the south hall, was destroyed. The carpet pad was destroyed in front of the bedroom door to the bathroom door, and the plywood floor in the center of the hall near the bathroom door was charred to some depth. There was a small electric hair curler (identified as a 36-Watt-Revlon brand) adhering to the hall carpet at the east side of the bathroom door. It appeared to have burned in place. Carpet under it was melted but not charred. Its cord was not plugged in (the nearest outlet being over 8' away in the bathroom).

In the northeast bedroom the only areas of roof rafters affected by fire were along the separation of roof and knee wall above the small door into the attic/storage space and around the ceiling fixture in the center of the room. The underside of the cellulose ceiling covering was charred throughout the room (particularly at the south end) but it remained intact (except where pulled during overhaul). There were undamaged roof rafters above and to the south of the door that would have been charred if the ceiling or wall had failed inside the bedroom door to allow fire to penetrate outwards from the room. The damage to the rafters above the east end of the hallway

was entirely consistent with a substantial fire in the hallway causing failure of the drywall and subsequent travel of the fire eastward towards the bedroom.

The hall side (skin) of the hollow-core¹² bedroom door was completely destroyed while the bottom portion of the inner skin of the door and the internal framework survived. The hinge-side door frame and jamb had been fire damaged and there was damage to the underside of the door and the bottom of the inner skin. The door was found in the fully closed position by firefighters, but there was an area of surface thermal damage from a floor level plume extending along the north bedroom wall beside the latch side of the door. This damage was to the cast-resin baseboard and the wall immediately above it. It extended approximately 8-10" into the room from the door frame. The carpet along the "closed-door" position was destroyed across the width of the door, but there was additional damage to the carpet extending some inches into the room past the closed-door position. The surface of the carpet pile across much of the room and particularly near the door had been scorched and melted. Impressed into an area of melted carpet was an impression of the underside of the door in a partly open position (open approximately 8"). The end of this melted impression was only 2 or 3" from the wall and its position corresponded to the extension of floor level thermal damage (scorching) to the bottom of the wall and baseboard. Synthetic carpets tend to warp and flex as they are heated in a fire exposure and there were warped areas of carpet visible in the bedroom beyond the door.

The thermal damage to the contents of the room was nearly entirely surface scorching by radiant heat. The room did not go to flashover and the exposed areas of carpet were only melted and scorched. The furnishings were surface scorched with only limited areas of the bedding burned to any depth. The plastic gas can found near the center of the room was softened on one side (facing the desk to the northwest) and on its top. The plastic pour spout found on the floor nearby was softened by heat at its tip (and along the tether for its safety cap). Flammable liquid residues were detected and identified by laboratory analysis as automotive gasoline in several areas of the bedroom carpet and in fluid from a wastebasket, as well as from the gasoline can itself.

Explosion Damage:

The roof section on the east side of the northeast bedroom has been lifted and pulled away from the top plate of the short (~5' 4") knee wall that forms the east side of the northeast bedroom. The damaged area extended approximately 14' from the north end of the roof. The shingles had been displaced along this seam and there were portions of the fiberglass insulation protruding

through the 1½" to 3" opening, but there was no obvious thermal damage. The window in the northeast bedroom was not broken until firefighters ventilated the room. That window consisted of four panes of glass, each approximately 9" x 25" in size set in a heavy wood frame. Window panes of that dimension would be expected to withstand some overpressure without fracturing. There was no other identifiable explosion damage to the structure. Other windows in a direct line with a deflagrating fuel-air mixture in the hallway would include the bathroom window and the west window of the master bedroom. None of these windows was observed to be broken prior to fire ventilation activities, and they would be the ones most susceptible to breakage. The window on the south wall of the master bedroom was not in a direct line with the hallway and its damage was not consistent with deflagration overpressures in the room. The presence of an open closet door on the north wall of the master bedroom (which would be pushed closed by a pressure wave propagating in through the hall door) and an undamaged wall behind the bedroom door (which would have been struck by the doorknob of the bedroom door forced back by a deflagration) demonstrated no pressure propagation in the hallway.

Conclusion:

① The absence of thermal damage to the front of the garments and to the chest, abdomen, and underside of the chin of the victim demonstrate that a flammable liquid was not poured or splashed onto the head or torso of the victim and ignited. The protected areas of the torso and ② buttocks were consistent with the garments found protecting the skin from radiant heat and with the protection offered by the face-down position of the victim during most of the exposure to heat. The partial thickness burns on the lower legs and arms, and those on the face, were ③ consistent with exposure to an enveloping flash fire (of brief duration) followed by a more sustained fire at floor level and hot gas layer exposure while she was standing. The soot in the victim's trachea and bronchi, pulmonary edema, and her COHb saturation of 39% were the result of survival for some time in the fire environment breathing combustion products. The inhalation of toxic gases other than CO, exposure to oxygen deficient conditions in the room and shock from the burns to her exposed legs may all have contributed to her death from the fire products.

④ The most significant fire in the structure was at the east end of the east-west hallway, adjacent to the bedroom door. This fire was sufficiently large (well fueled) to cause flames to reach the ceiling of the hallway and cause failure of the drywall at that end. The fuels normally found (and identified post-fire) in this location would have been carpet, pad, the hollow-core door, clothing, and the contents of the closet (and its wooden door). These materials together would not be able

Close - chimney effect

up the closet

to fuel a fire of sufficient size to allow flames to reach the hall ceiling. An additional fuel such as a flammable liquid would be needed to achieve that flame height from a fire at floor level. In the experience of the undersigned, failure of 1/2" drywall properly nailed, taped and mudded requires at least 20 minutes of direct flame exposure before it fails and falls away. The ceiling drywall at the east end of the hall had just failed and the adjacent wall drywall was just beginning to fail when the fire was extinguished (reportedly at about 0921 hours). The fire in the hall then had burned at or near maximum size for some twenty minutes to achieve the damage seen. The witness saw the fire about 0900 hours and reported it. That means the fire had to have grown to a maximum in the time between Mrs. Boes leaving the house (reportedly at 0855) and the time the fire was seen by the witness. In the absence of a substantial fuel load such as a modern chair or sofa (which can become involved in a very large fire in 2-3 minutes after open flame ignition), the only fuel capable of such size and rapid growth is an ignitable liquid in significant quantities. Investigators reported the odor of an ignitable liquid in the hallway debris but laboratory tests did

not confirm the presence of any such liquid accelerant. Extensive destruction of a low-density substrate such as synthetic carpet and pad during a fire of 20 minutes duration has been known in controlled tests to destroy all identifiable residues of flammable liquids such as gasoline. The destruction of the carpet between the bedroom and bathroom indicates a severe fire occurred in that location capable of consuming identifiable traces of flammable liquid spread on the carpet (or on clothing).

*Area of
the line
longer fire*

Gasoline was identified in several locations in the bedroom – on carpet, bed and objects. An open plastic gas can with residues of gasoline within was found in the bedroom. Gasoline spread on such porous materials will, at normal temperatures (65-80°F), produce an ignitable concentration of vapors in a small enclosed space such as the bedroom, particularly at floor level.

✓ The complete evaporation of even 1-2 fluid ounces of gasoline (30-60 ml) will produce enough vapor to cause a substantial (1 psi) increase in pressure in a deflagration in a room of 20m³ volume.

He agrees

While open flame ignition sources (kitchen matches) were found in the room, primary ignition did not occur in the bedroom. Primary ignition in the bedroom would have caused the door to close forcefully and lift the roof section. [The closing door would have prevented the formation of the thermal damage pattern on the baseboard and wall and the formation of the contact pattern between the partially melted carpet and the underside of the door in the partly open position.

Since both of these events occurred, it can be concluded the fire was not ignited from within the room. If the fire were ignited in the hallway with the aid of an ignitable liquid (such as gasoline),

*That is hard
what happened?*

Correct

with the door in the partly open position, the radiant heat would have had the opportunity to melt and soften the carpet pile and cause it to "wrinkle" beneath the door. A fire at floor level just outside the door would be expected to produce the scorching pattern seen on the baseboard and wall inside the door before the door was closed. It was, therefore, concluded that the fire was ignited in the hallway and burned there for some time (15 seconds or longer) before the gasoline vapors migrating at floor level from within the room were ignited. Gasoline vapors migrate in still air at 3-5 cm/second. There was a close fit between the door and the carpet (post-fire measurements showed 0.04 – 0.25 inches (1-6 mm) between the bottom of the door and the partly melted carpet beneath. This close gap would slow the propagation of vapors and retard the propagation of a flame front into the room after ignition. This delay allowed time for the development of the radiant heat pattern on the bedroom wall inside the room. With the door in the partly open position defined by the pattern on the carpet, there was a gap of less than 3" (4.5 cm) between the door edge and the wall, insufficient space for a hand holding a match in the bedroom to reach through and throw the match into the hall.

*slowly burning
vapors
could not get through the opening*

could not get through the opening

could have been open just after the match was lit.

The fire damage patterns to the bedroom door, adjacent walls, ceiling, trim and carpet were entirely consistent with a large fire burning just outside the bedroom door for some 20 minutes or more. This fire penetrated the hollow-core door at its top, allowing fire to enter the bedroom via hot gas layer extension. This hot gas eventually ignited to cause the radiant heat damage to the exposed wall and ceiling surfaces, furnishings, carpet and to the exposed portions of the victim's body. This was likely to have occurred in the time between the rapid growth of the fire noted by the rescue crew and suppression by the attack crew a few minutes later. No readily identifiable protected area of carpet was identified in the area where the body was recovered. This was an indication that she collapsed during the fire after being exposed to radiant heat and smoke in the hot gas layer. The burn patterns extending under the door were also consistent with patterns produced when such a door is closed over a burning quantity of flammable liquid on carpet beneath. The electric hair curler found in the hallway played no identifiable role in the ignition of this fire. (It may have fallen from the closet opposite as shelves collapsed later in the fire.)

could have happened after the door closed if the fire had started on the wall.

Ignition of a premixed volume of gasoline vapor in air in an enclosed space would produce an overpressure in that space (resulting in explosion effects). If the same quantity of vapor/air mixture were ignited in a large open area such as the central hallway, overpressure effects would be greatly reduced or non-existent. The flame propagation is always away from the ignition source, so a hand-held flame applied to one edge of an accumulation of vapors in a large open area would not be expected to produce a burn on the hand or to adjacent clothing.

Why there were no burns on Karen

Assumption that Karen was on the edge of the middle like Robert

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consistent of burn marks on Robbins body

Propagation of a flame front into a closed space such as the bedroom would be expected to produce "flash-back" of flame as well as pressure effects, particularly in the direction of propagation. This would, in part, account for the lifting of the roof section immediately opposite the door. A glass window would normally be expected to fail at modest overpressures, but the size and design of the window in the north wall increased its failure pressure such that it survived. Even with an overpressure of only 1 psi in the bedroom (after the door was closed), the large surface area of the eastern roof section opposite the door would experience a lift of over 3500 pounds. The overpressure in the room would be relieved as the roof lifted and then fell closed but left a hot, oxygen-depleted atmosphere in the room. This oxygen depletion would reduce the amount of flaming combustion that could occur in the room until the door failed from external fire exposure. Limited flaming and smoldering combustion could be sustained in the room, particularly around doors, windows, and other ventilation leakage points. (There were no heating or A/C vents found in the room.) This would account for the extensive destruction of the carpet under the door (in its closed position).

over

did it fall? remains damaged

* The window in the south wall of the master bedroom was not broken by a deflagrating explosion occurring within the hallway/bedroom. Its pattern of damage to both glass and frame was consistent with breakage by mechanical contact from within and not with explosion overpressure. The absence of damage to the west windows in the master bedroom (which were in a direct line with the hallway) and the presence of the open closet door on the north wall (which would have been forced closed by the passage of any pressure wave adequate to break windows further away) preclude the development of explosive force in the hallway.

WRONG

Deflected to the door - compromised opposite corner from door

Robbins window didn't break because of deflagration

But window not NE corner

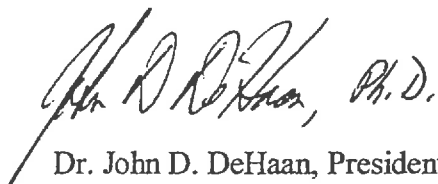
Just like in NE Bedrm

In summary, it was concluded that the fire of July 30, 2002, was not initiated in the bedroom by the occupant, Robin Boes. The fire was initiated in the hallway on ordinary combustibles with the aid of a quantity of flammable liquid, with the bedroom door in the partly open position. The hair curler in the hallway played no role in the ignition of this fire. Gasoline had been previously distributed in the bedroom and the can (with the spout removed) was left in the bedroom. The fire burned in the hallway for some time (15 seconds or longer) before propagating into the bedroom via the gasoline vapors in the bedroom. The resulting overpressure in the room closed the door, lifted the roof and left a hot, smoky, oxygen-deficient atmosphere in the room that impeded Ms. Boes' attempts to escape. She was eventually overcome by burns, heat, inhalation of products of combustion, and oxygen depletion.

These opinions are expressed to a reasonable degree of scientific certainty and are based on the documentary evidence supplied to me and on known scientific and fire engineering principles.

Disposition:

The materials submitted are being retained pending further requests.

A handwritten signature in black ink, appearing to read "John D. DeHaan, Ph.D.", is written over a horizontal line.

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

cc: S/A M. Marquardt, BATF

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