



Kentucky Division
of Forestry

REPORT OF THE ACCIDENT INVESTIGATION TEAM

for the

ISLAND FORK FIRE

APRIL 6, 1999 • NEAR CRANSTON, KENTUCKY



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The Kentucky Division of Forestry thanks the U.S.D.A. Forest Service and the Daniel Boone Firefighters Association for their assistance in the preparation of this report.



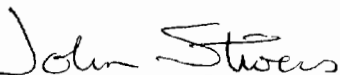
ISLAND FORK FIRE REPORT

Report of the Accident Investigation Team for the Fire Fatalities of KEVIN REX SMITH AND KENNETH ALLEN NICKELL



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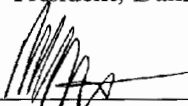
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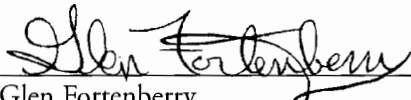
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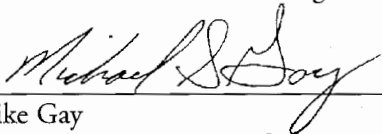
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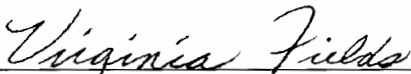
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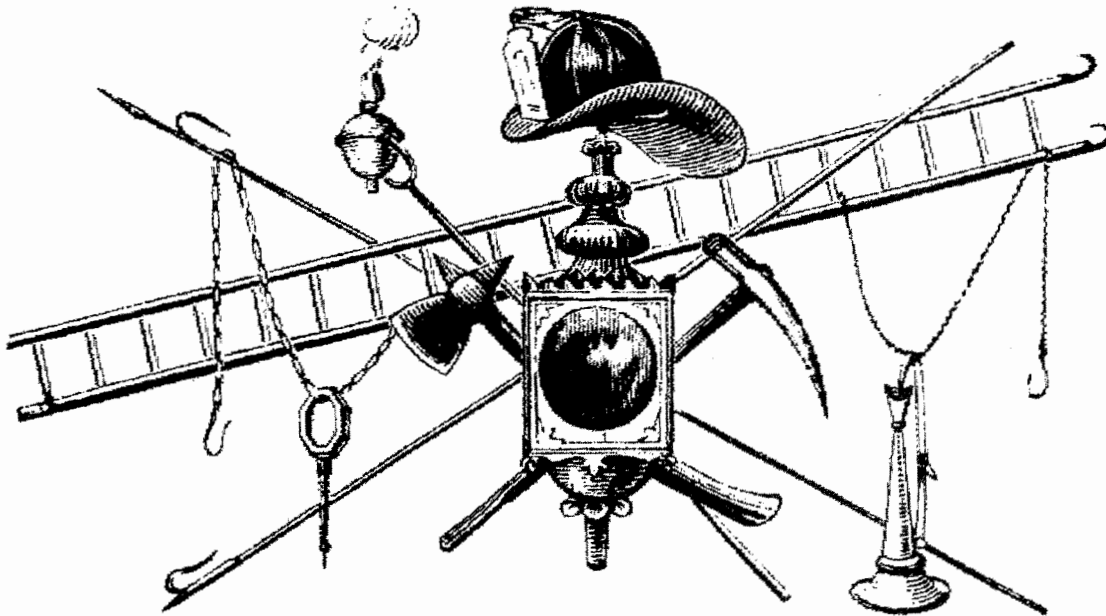


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In Memory of
KEVIN REX SMITH
and
KENNETH ALLEN NICKELL

Volunteer firefighters of the Route 377 Volunteer Fire Department who perished on the Island Fork Fire due to the unforeseen interaction of strong winds and complex terrain. This resulted in a rapidly spreading, high intensity fire that prevented them from using escape routes to reach the safety zone or burned-over area.



EXECUTIVE SUMMARY

ON APRIL 6, 1999, two volunteer firefighters died of smoke inhalation on the Island Fork Fire. The Island Fork Fire was located near Cranston, Kentucky, northeast of Morehead, in Rowan County. The victims were constructing a fireline with a leaf blower and fire rake on a wild-land fire site where the fuel was primarily hardwood leaf litter. Depth of the leaf litter varied from six inches to over two feet. There is a dominant hardwood canopy with occasional white pines. Average tree height is ninety feet, and there is very little mid-story vegetation.

THE VICTIMS were part of a seven-person team. As the team was clearing the fireline with hand-tools, two spot fires occurred. Five team members attacked the spot fires on the north side of the drainage. The two victims proceeded to construct a handline and were approximately 250 feet ahead of the team leader when the leaf blower stopped. A call was made for gas for the leaf blower as it was placed in the drainage. This was the last time there was visual contact between the victims and the rest of the team.

SOON AFTER, the winds increased dramatically with gusts of 35+ mph. The light fuels produced a wall of flames 14 to 20 feet high leaving bark char up to 50 feet high on the overstory trees. This blow-up separated the five team members from the two victims. This occurred in the same time frame in which the Incident Commander ordered all firefighters off the fireline due to wind increases. This sequence of events occurred in a very short time frame.

ABOUT THIS TIME, flames surrounded the victims. Two scouts from another fire department at the top of the drainage described the situation as a 40-foot wall of fire moving rapidly in a clockwise motion and so loud they could not hear each other. This description depicts a classic chimney effect fire.

THE VICTIMS RAN UPHILL to within 300 feet of the ridgetop. At this point, the victims reported they were on fire and were going to run into the black (an area where the fire had already burned). Soon after, a search was made, and the two victims were found approximately 500 feet below the ridgetop. The entire sequence of events from initial attack to location of the victims was less than one hour.

THE INVESTIGATION FOUND that the significant causal factors of the fatalities were flame lengths, wind speeds, spot fires, and terrain. Standard Fire Orders 2 and 3 summarize the significant causal factors. See Appendix D.

EXECUTIVE SUMMARY

INVESTIGATORS RECOMMEND, with respect to the significant causal factors of the fatalities, that the Kentucky Division of Forestry (KDF) and fire departments engaged in wildland firefighting develop:

- **A process for keeping Volunteer Fire Departments (VFDs) informed of weather during fire season.**
- **A simulation exercise of the Island Fork Fire for use by VFDs.**

The following recommendations are not related to the significant causal factors of the fatalities:

- Develop a plan to implement the standards of NFPA 1051, "Wildland Firefighter Professional Qualifications."
- Develop a plan/process to implement the standards of NFPA 1077, "Standard on Protective Clothing and Equipment for Wildland Firefighting."
- Develop a common communications plan.

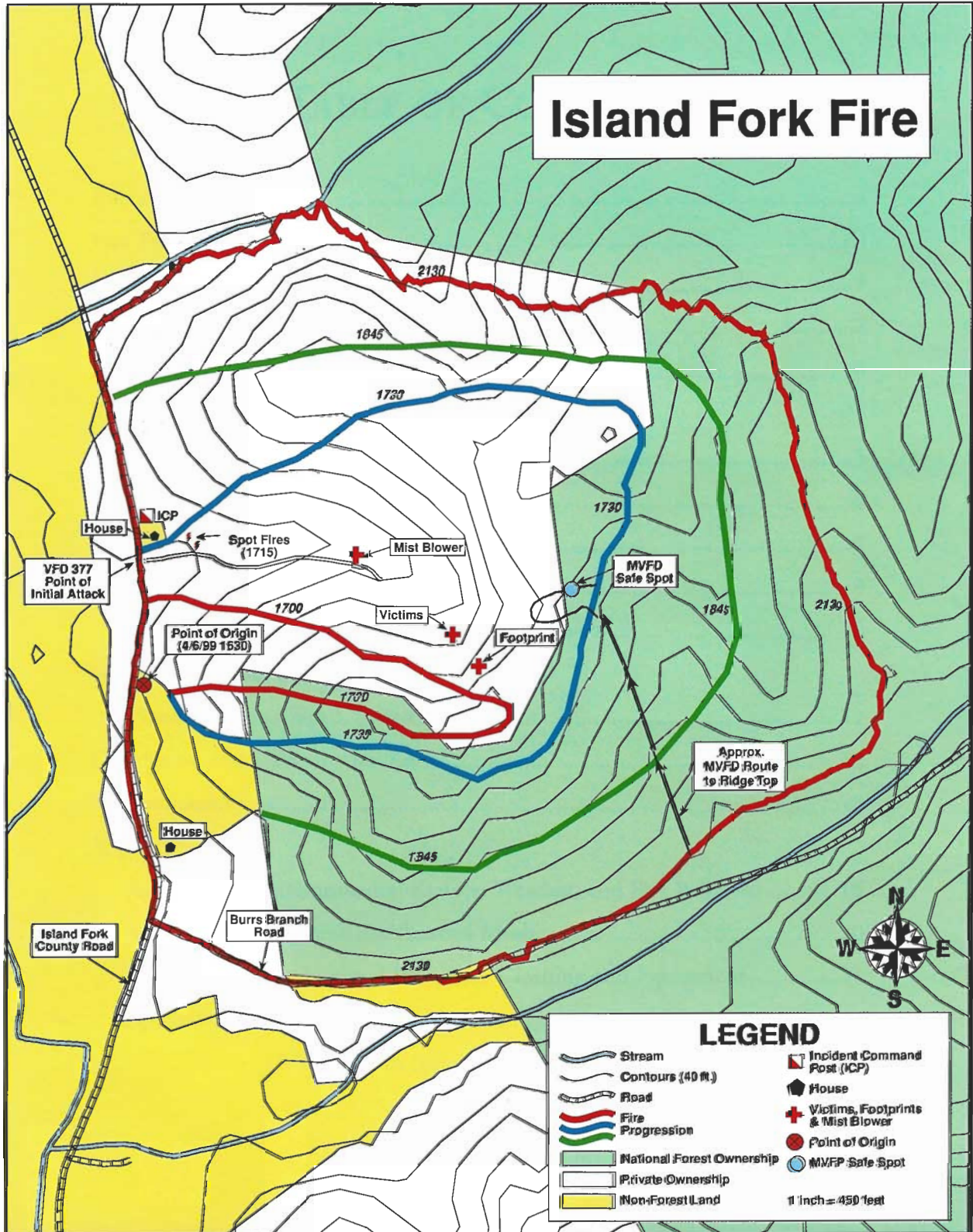
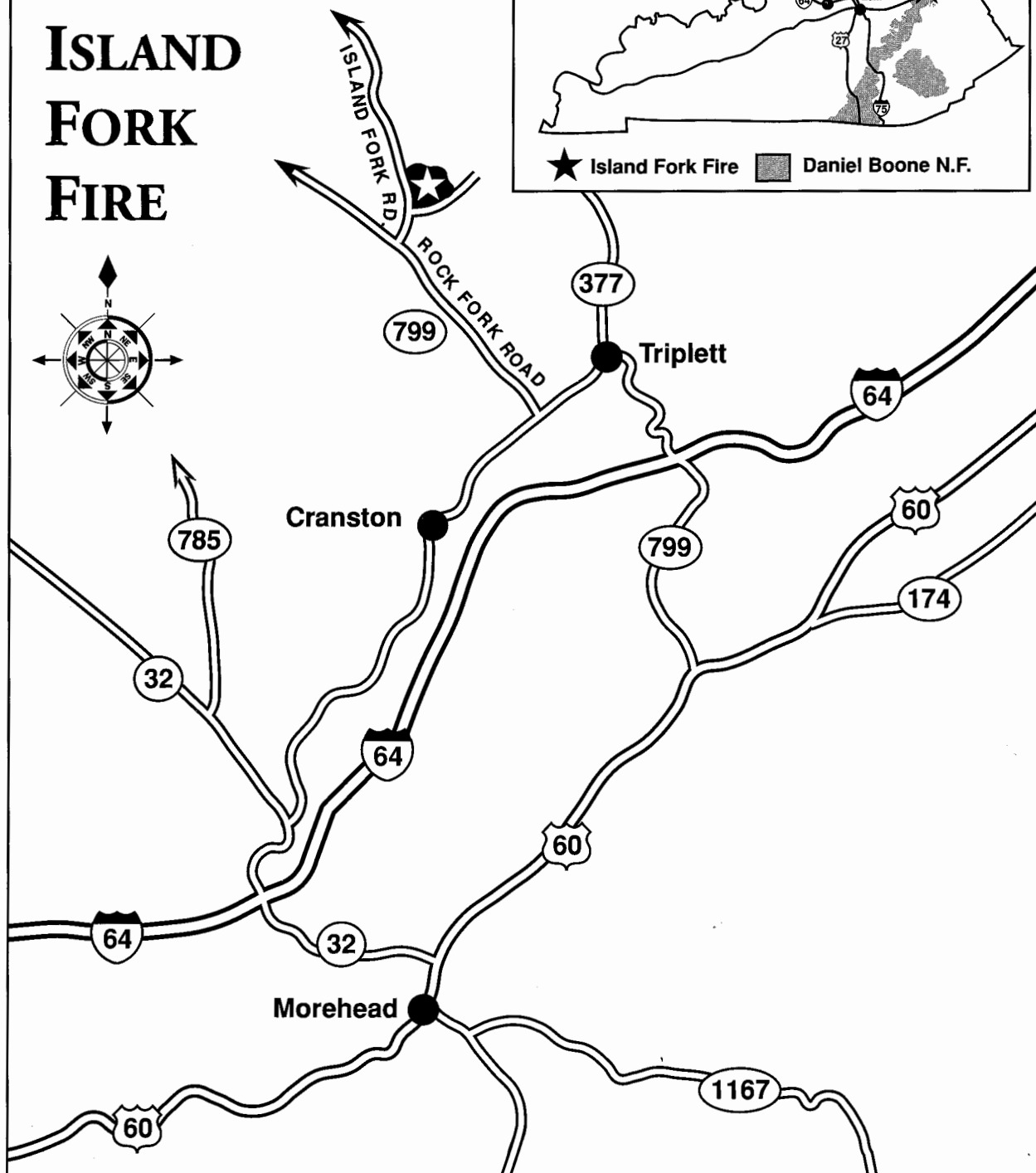


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ISLAND FORK FIRE REPORT

VICINITY MAP OF ISLAND FORK FIRE



INTRODUCTION

ON APRIL 6, 1999, Kevin Rex Smith, 30, and Kenneth Allen Nickell, 28, died after being over-run by a wildland fire. Both were volunteer firefighters using handtools and a leaf blower to construct a fireline on the Island Fork Fire. The fire burned a total of 153 acres in a hardwood forest with trees 90-110 feet in height.

ON APRIL 9, 1999, an accident investigation team was assembled at the request of the Kentucky Division of Forestry. From April 9 to April 11, 1999, this team investigated the Island Fork Fire and the fatalities. Interviews conducted by the Kentucky State Police, Kentucky State Fire Marshal, and Kentucky Division of Forestry were reviewed. The incident site was visited, and photographs of the fire scene were taken aerially and on the ground. The fire site was videotaped aerially. Copies of the death certificates, dispatch records, and maps of the scene were obtained.

THE ROUTE 377 Volunteer Fire Department (VFD) has approximately 30 members and serves a large portion of Rowan County. The two victims were volunteer firefighters with the Route 377 VFD. Kenneth Nickell had over seven years experience as a wildland firefighter. Kevin Smith was a recruit with the VFD. Both men were in "very good" physical condition. The Route 377 VFD regularly responds to wildland fires in the spring and fall.

THREE FIRE TRUCKS and 15 people initially attacked the fire, 10 from the Route 377 VFD and 5 from the Morehead Fire Department. A captain with Route 377 VFD was the Incident Commander (IC). Before the fire was controlled, there were 9 engines, over 45 personnel, and 5 agencies involved with this fire. However, only the events involving the crew that contained the victims are included in this report.

SEQUENCE OF EVENTS • APRIL 6, 1999

THE INVESTIGATION of the Island Fork wildfire fatalities was initiated on April 6, 1999, by the Kentucky State Police. Its specific focus was on the origin and cause of the fire and the causes of death of the individuals. The coroner of Rowan County, Kentucky, declared the time of death at 6:21 pm on April 6, 1999.

AN INTERAGENCY INVESTIGATION TEAM was established by the Kentucky Division of Forestry (KDF) to review the entire fatality scenario for the purpose of developing lessons learned for future wildfire incidents. The team was composed of members from the KDF, Daniel Boone Firefighters Association, and the U. S. Forest Service. Technical specialists in fire behavior, law enforcement, and fire equipment were assigned to assist the team on technical matters. Through dispatch logs and witness reports, the sequence of events was determined to be as follows:

Hour

1630 Approximate time fire starts.
Rowan County 911 receives wildland fire call.
Route 377 VFD receives dispatch call/page.
Morehead FD dispatched/paged.

1647 Route 377 VFD arrives at fire scene (IC plus nine others).

1650 to 1735 The following sequence occurred with times of each unknown but in order:

- IC instructs crews to construct line and protect structures. Structures are near anchor point on Island Fork paved road. Fireline anchored at paved road and construction begins in an easterly direction using handtools and a leaf blower.
- Seven persons with Route 377 VFD construct line easterly with Kenneth Nickell and Kevin Smith being the lead men using a leaf blower and a rake. Nickell has a radio.
- Spot fires begin to occur. Five team members double back to attempt control of spot



fires. Two or three spot fires are attacked while Nickell and Smith continue to move easterly up the hollow remaining in visual contact with other team members. Strong winds experienced in the drainage where the team is working.

- Nickell and Smith last "seen" by other five team members approximately 320 feet from locations of the spot fires.

Re-creation of last area where Nickell and Smith were seen by other Route 377 VFD firefighters.

SEQUENCE OF EVENTS • APRIL 6, 1999

- 1650 to 1735
- Nickell calls on the radio stating they (Nickell and Smith) had been burned.
 - Two Morehead FD personnel scouting from Burrs Branch Road up the hill to the top where they become aware of the rapidly developing situation. They decide not to move down the hill to Nickell and Smith's location due to heavy smoke and high winds driving the fire uphill. They move northeasterly over the ridgetop into a small safe spot they constructed where the fire would be backing down the hill after it made its run over the top of the hill.
 - Route 377 VFD unit 1102 calls for an ambulance and medical helicopter. (Morehead PD commo log supports request made at 1741.)
 - Nickell radios that he and Smith "are in trouble." Five other team members who returned to ICP not yet allowed by IC to go back and assist due to fire behavior.
 - IC permits others to look for Nickell and Smith but orders that they stay in the burned area working their way up the drainage. They locate the victims and notify the IC.
 - IC calls and asks for Morehead 300 to take IC role.
- 1727 Morehead RD-FMO hears of wildland fire report in Island Fork area and relays information to Forest Dispatch.
- 1734 KDF 110 en route (ETA 5 minutes).
- 1750 KDF dispatch hears of injuries at Island Fork Fire. KDF personnel 102 and 115 converging on Island Fork area.
- 1754 Requested State Fire Marshal to scene; firefighters down.
- 1810 Muses Mill VFD dispatched to the Island Fork Fire.
- 1830 Morehead Ranger District, Daniel Boone National Forest crew (seven people) arrives at Island Fork Fire.
- 1830 KDF 102 arrives on scene.
- 1843 KDF 115 arrives on scene.
- 1857 Kentucky State Police (KSP) and Rowan County coroner on scene conducting investigation.
- 2015 Supervisory Law Enforcement Officer (USFS) arrives and joins KSP and coroner on the hill conducting investigation.
- 2130 Lines being tied together and fire contained.

FINDINGS

KEY

D Did not contribute.

I Influenced.

S Significant causal factor.

FIRE BEHAVIOR

I FM9 exhibited characteristics of FM2 [burned @ higher rate of speed (ROS)].

I Light, fluffy fuels.

D 1-hour fuels consumed; 10-hour, 100-hour, 1,000-hour were not.

S "BEHAVE" predicts 13' + flame length (FL)/witnesses 14'-20'.

I Cold front passage in the morning.

I Class "4" day of 5.

S Winds strong/gusty from west 14+ mph sustained, gust 35 mph between period 1600-1800 hours.

I Fuel Moisture: 1-hour 5-6%; 10-hour 6%; 100-hour 13%.

D KBDI 77.

I RH 24-27%, 1600-1800 hours.

I Temperature 73-75 degrees F at 1600-1800 hours.

D Bark char maximum 50'.

I Rain: March 21-April 1 - 1.0"; April 1 - 0.16"; April 2-6 - 0".

I "0" green-up.

I Ground cover 100% leaf litter.

D White pine needles "set" indicating rapid ROS.

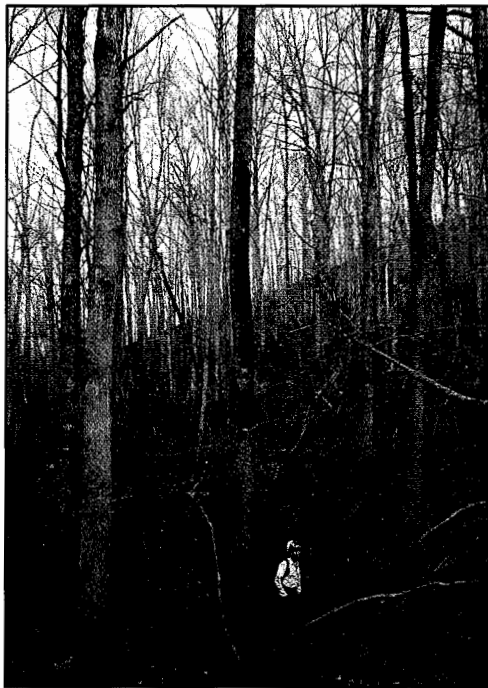
S Spot fires occurred on the north side of drainage within 150' of anchor point on road.

FINDINGS

ENVIRONMENTAL FACTORS

D Did not contribute. **I** Influenced. **S** Significant causal factor.

- S** Terrain is a classic "chute/chimney."
- I** Leaf litter (FM9) was a minimum of four years old.
- I** Slopes averaged 40%.
- I** Aspects varied.
- I** E-W unnamed drain that turns SE.
- I** Elevation difference 280'.
- I** Slope distance 600'.
- I** Canopy oak/hickory/poplar maturing with open mid and understory with sparse white pine.



Example of bark char height in fire area.



Aerial shot reveals classic "chute/chimney" terrain.

FINDINGS

INCIDENT MANAGEMENT

D Did not contribute. **I** Influenced. **S** Significant causal factor.

- D** Fire originated on private land on the Island Fork Road.
- D** Route 377 VFD was dispatched to the fire by 911 at 1635 hours.
- D** Initial attack force from Route 377 VFD consisted of ten people, one engine.
- D** Three stayed at road to protect house; seven began constructing fireline up hollow.
- D** Captain Blevins was IC.
- D** ICP established on road.
- D** Route 377 VFD had two hand-held radios on line, total of four hand-held radios.
- D** Anchor point was established on road.
- I** Line construction was direct attack, using handtools and leaf blowers.
- D** Route 377 VFD engine protected the structures at the anchor point.
- D** Morehead FD was dispatched by 911 at 1636 hours.
- D** Morehead FD scouted the south end, moving to the east on foot.
- D** IC requested spot weather forecast.
- D** Morehead FD Engine 8 supported Route 377 VFD engine.
- S** Spot fires caused containment problems.
- I** Route 377 firefighters within 250' of one another.
- D** IC had radio communications with firefighters.



Original fireline area to the east of ICP.

FINDINGS

INCIDENT MANAGEMENT

D Did not contribute. **I** Influenced. **S** Significant causal factor.

- D** Five firefighters at west end had visual contact with Nickell and Smith.
- D** Wind and spots increased; IC ordered all firefighters to pull back.
- D** Nickell called on radio for gas for leaf blower.
- I** Fire exceeded suppression capability of initial attack forces.
- D** Five firefighters returned to ICP.
- I** Nickell and Smith moved uphill to east.
- D** Nickell and Smith called IC on radio and reported, "They were heading out."
- I** Nickell and Smith reported, "The fire's got us; we're blocked."
- I** Nickell and Smith near top of hill.
- I** Nickell and Smith on radio, "We're burned."
- I** Nickell and Smith, "Trying to get into black."
- D** IC ordered five firefighters back from entering fire to look for Nickell and Smith; released to look, staying in the black.
- D** IC ordered medical helicopter.
- D** Morehead FD scouted south end and went to top of ridge.
- D** Morehead FD heard radio communications, called out to two firefighters.
- D** Morehead FD firefighters observed fire intensity, smoke, heard "roar," wall of flames in a clockwise motion.
- D** Morehead FD, "Let's not be part of the problem."

FINDINGS

CONTROL MECHANISMS

D Did not contribute. **I** Influenced. **S** Significant causal factor.

- D** IC was known to all firefighters.
- D** IC had radio communications with all firefighters.
- D** IC was acting safety officer.
- D** Team leader was identified.
- D** Structural and wildland teams established.
- D** ICP established.
- D** Four radios, two on fireline belong to Route 377 VFD; other arriving units possessed radios.
- D** Leaf blower operator carried his personal radio.
- D** Leaf blower operator set down blower.
- D** Not a common communication frequency (three separate frequencies).
- D** Last seen together and were found together.
- D** Status checks of IC were often and regular.
- I** Attempts to get weather forecast failed.
- D** Victim maintained radio contact with IC on personal radio until the end.
- D** Morehead FD scouts heard radio traffic of IC/victim.
- D** Crew members had visual contact with the two firefighters up until the blower was left.

FINDINGS

INVOLVED PERSONNEL PROFILES

D Did not contribute. **I** Influenced. **S** Significant causal factor.

- D** IC is fully qualified:
 - NFA Safety Officer. • S130.
 - IC Training. • S190.
- D** All personnel met appropriate training and physical fitness standards of Route 377 VFD.
- D** First fire of the day; on the fire less than one hour.
- D** Route 377 VFD had previous brush fire responses during spring 1999.
- D** Experience level ranged from six months to 10+ years.

EQUIPMENT

- D** Standard for Route 377 VFD.
 - Helmet. • Long-sleeve cotton shirt. • Rugged sole boots.
 - Leather gloves. • Long pants.
 - If carrying a leaf blower, additional equipment: • Ear protection. • Wildland fire coat.
- D** Seven people on fireline had wildland fire shirts.
- D** Seven people on fireline had cotton pants.
- D** Two victims met Route 377 VFD standards for PPE.
- D** No fire shelters were available.
- D** Leaf blower quit and was placed on ground.
- D** Heat load and fire intensity exceeded the performance limitations of PPE.

GENERAL

- D** Response and initial attack in twelve minutes.
- D** Preliminary report of coroner states cause of deaths was smoke inhalation.
- D** Fire was human-caused.
- D** Fire was contained at 2130 hours at 153 acres.
- I** From fire report to death of victims was less than one hour.

SIGNIFICANT CAUSAL FACTORS*

FLAME LENGTHS

THE BEHAVE PREDICTION SYSTEM calculated 13-foot-plus flame lengths. Witness statements confirmed 14- to 20-foot flame lengths. Flame lengths above four feet typically warrant "other than handline" direct and/or parallel attack. Flame lengths over 12+ feet typically call for indirect attack. Larger flame lengths coupled with the wind event and chimney effect created conditions that compromised a timely retreat along escape routes.

WIND

IT WAS STEADY AT 14 MPH with gusts to 35 mph from the west between 1600-1800 hours. Wind speeds behind a cold front are "predictable" in terms of higher wind speed (sustained winds plus gust) and direction. Higher wind speeds have a direct effect on rates of spread, flame lengths, and control/containment success, and can compromise the time to utilize one's escape routes to the safety zone.

SPOT FIRES

SPOT FIRES OCCURRED on the north side of the drainage and within 150 feet of the anchor point. Spotting indicates control problems and warrants changed conditions affecting strategy and tactics. This is a watch-out situation.

TERRAIN

IT IS A CLASSIC CHUTE/CHIMNEY. These terrain features funnel winds in a predictable manner and accelerate rates of spread and intensity of fire behavior.

• • • • •

*Significant causal factors are those conditions, decisions, and events that the investigation team believes directly caused the fatalities. These factors are illustrated in Standard Fire Orders 2 and 3, and Watch-Out Situations 3, 11, 15, 16, and 17. See Appendix D.



Needle set from heat in burnover vicinity.

CONCLUSION

IT IS THE BELIEF of the entire investigation team that the two fatalities on the Island Fork Fire resulted from the unforeseen interaction of strong winds and complex terrain. This resulted in a rapidly spreading, high intensity fire that prevented the two firefighters from using escape routes to reach the safety zone or burned-over area.

COMMENDATIONS

THE RAPID RESPONSE by Route 377 VFD to initially attack the Island Fork Fire is commendable.

THE IC'S ACTION to call all firefighters off the fireline probably saved the lives of 5+ firefighters.

TWO SCOUTS with the Morehead Fire Department are to be commended for their decision not to go into the drainage from their position on the ridge, but to instead construct a safe area away from the blow-up situation.

RECOMMENDATIONS

The following two recommendations directly address the significant causal factors of the fatalities as determined by the investigation team:

■ **Develop a process of improved information management to keep Volunteer Fire Departments (VFDs) informed of weather during fire season.**

Accomplishing this would give VFDs current and predicted weather at the time of dispatch or at the time of arrival at the incident. Key weather factors given to the IC (i.e., temperature, relative humidity, and wind speed-direction) could be considered and evaluated in concert with other local on-site factors including fuels, topography, and wildland-urban interface. This would address Standard Fire Order 2 (initiate all action based on current and expected fire behavior) and Standard Fire Order 3 (recognize current weather conditions and obtain forecasts).

■ **Develop a simulation exercise of the Island Fork Fire for use by VFDs.**

The fire simulator trailer, which is a joint venture between the Kentucky Division of Forestry (KDF) and the Daniel Boone National Forest, can use the Island Fork incident for training with VFDs. Additional simulations can be developed that represent the range of wildland fire incidents VFDs typically face with heavy emphasis on fire behavior, complex terrain, variable weather conditions, and fuel types. This should emphasize fire behavior, complex terrain, and complex weather situations.

RECOMMENDATIONS

These following recommendations are not related to the significant causal factors of the fatalities:

DEVELOP A PLAN to implement the standards of NFPA 1051, "Wildland Firefighter Professional Qualifications." This would provide the opportunity to get additional basic and advanced wildland fire training.

DEVELOP A PLAN AND PROCESS to implement the standards of NFPA 1077, "Standard on Protective Clothing and Equipment for Wildland Firefighting." Improvements in protective clothing and equipment are a continuing process. Meeting or exceeding the NFPA 1077 standards should be a goal for all wildland fire organizations.

DEVELOP A COMMON COMMUNICATIONS PLAN (radios, frequencies, cells) to include adequate radios for VFDs, common frequencies, use of cell phones, and procedures. This would allow VFDs, KDE, and USFS to be able to communicate (not just scan) from unit to unit and improve efficiency on multi-jurisdiction wildland fires.

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APPENDIX A

ENVIRONMENTAL FACTORS, WEATHER, AND FIRE BEHAVIOR

ENVIRONMENTAL FACTORS

1. Fire occurred in an east/west drainage that gradually made a slight turn to the southeast as it neared the head of the drain.
2. Slopes on either side of the drainage averaged 40% with about 600 feet of horizontal distance from the drainage to the ridgetop.
3. Elevation difference from the drain to the ridgetop averages 280 feet.
4. Rainfall for the year was above average but below average for the past thirty days.
5. A cold front passed through the area beginning at 0100 hours, and by 1000 hours winds had switched to the west, and by 2000 hours they had become northwesterly.
6. High winds, low 1-hour fuel moistures, chimney effect, and steep slopes were the main contributors to fire spread.
7. Smoke limited visibility with rapid combustion of fuels.

WEATHER

WEATHER OBSERVATIONS used are from a FTS weather station (Triangle Weather Station) that is approximately nine miles south of the Island Fork Fire and is the closest source of actual automated weather recordings.

- Temperatures ranged from 76 degrees at 1600 hours to 73 degrees at 1800 hours.
- Humidities were from 24% at 1600 to 27% at 1800.
- Winds were from the west at an average 17 mph from 1600 hours to 1700 hours and decreased to 14 mph by 1800 hours.
- Gusts up to 35 miles an hour occurred during this time frame.
- 1-hour fuels were calculated to be 5-6% during this time period.
- 10-hour fuels were 6%.
- 100-hour fuels from the 1300 hours reading at the Triangle Weather Station were 13%.

APPENDIX A

ENVIRONMENTAL FACTORS, WEATHER, AND FIRE BEHAVIOR

WEATHER

A GENERAL FIRE WEATHER FORECAST for a 22-county area for April 6 called for mostly sunny skies, temperatures from 67 to 72 degrees, and humidities ranging from 40 to 45%. Winds were forecasted to be from the southwest at 10 to 25 mph.

RAINFALL MEASURED SINCE MARCH 20 for the Triangle Weather Station is one inch. High temperatures have ranged from the mid-60s to the upper 70s since the first of April.

THE KBDI (KEETCH BYRAM DROUGHT INDEX) is a system for relating current and recent weather conditions to potential or expected fire behavior. This system was originally developed for the southeastern United States and is based primarily on recent rainfall patterns. The index ranges from 0-800 and accurately describes the amount of moisture that is missing. A rating of zero defines the point where there is no moisture deficiency, and 800 is the maximum drought possible.

- The KBDI for the area is at the average for this time of year.
- The KBDI for the general area for April 6 was calculated to be 77. On April 6, 1998, the KBDI for the area was 80.
- These KBDI values also came from the Triangle Weather Station. This is a new weather station that has only been in operation for two years.
- KBDI readings from the Stanton Weather Station which is approximately 40 miles southeast of the incident were 60 for April 6, 1997; 40 for April 6, 1998; and 90 for April 6, 1999, from a new automated station that is replacing the manual station at Stanton.

APPENDIX A

ENVIRONMENTAL FACTORS, WEATHER, AND FIRE BEHAVIOR

FIRE BEHAVIOR AND FIRE POTENTIAL

ALTHOUGH IT IS NOT UNUSUAL, especially during the initial attack, no fire behavior predictions were done for the Island Fork incident. The Kentucky Division of Forestry had classed the day as a Class 4. Ratings are 1-5 with 1 being the least and 5 being the highest fire danger.

THE FIRE BEHAVIOR FUEL MODEL would typically be an FM9, which can be described as loose hardwood leaf litter under stands of oak, hickory, maple, and other hardwood species of the east. Under the conditions that are present this time of the year in Kentucky, the fuels can burn more like a Fuel Model 2, which can be described as open stands of timber with annual grass understory. Fire behavior runs used will utilize the two fuel model runs for FM2 and FM9.

FINE FUEL MOISTURES were manually calculated for the site, but the 10- and 100-hour fuels from the Triangle Weather Station were used for the site. A fine fuel moisture range of 5-6% was used for calculations, the 10-hour fuel moisture used was 6%, and the 100-hour fuel moisture was 13%.

THE FIRE BEGAN at approximately 1630 hours on April 6, 1999. Elevations ranged from slightly under 1,000 feet near the point of origin to slightly over 1,200 feet on the ridgetops. Winds were from the west at 14-17 mph with gusts over 30 mph. Estimated fire behavior for the Island Fork Fire was:

- Forward Rates of Spread (ROS) ranged from 100-115 feet per minute.
- Flanking ROS was 5 feet per minute.
- Backing ROS was 2-5 feet per minute.
- Flame Lengths (FL) 10-13+ feet.
- Probability of Ignition 60-70%.

WITNESS STATEMENTS verified that short range spotting did occur. The only reference to actual flame lengths stated that they were between 14 and 20 feet.

ESTIMATED FIRE SPREAD and descriptions in the following paragraph are derived from the BEHAVE1.w fire prediction system and statements from witnesses. Unless specifically mentioned, all estimates are from the BEHAVE runs or interpretations from fire behavior evidence from the scene.

APPENDIX A

ENVIRONMENTAL FACTORS, WEATHER, AND FIRE BEHAVIOR

ISLAND FORK FIRE PROGRESSION

THE FIRE BEGAN TO SPREAD in a northerly and easterly direction after the ignition and by 1700 hours (see the progression map) had burned near the south side of the main drainage where the fatalities occurred. The fire had also spread up the drainage to the top of the ridge and is estimated to be about 300 feet wide. Witnesses did not state a time but did say that spots began to occur across the drain. Evidence on the scene shows that efforts to control the spot fires were unsuccessful. Fire behavior estimates would make this between 1700 hours and 1720 hours.

AT APPROXIMATELY 1730 HOURS (see the progression map), the fire being carried by strong winds began to funnel up the drain to the east and to the northeast on the north side of the drain. It was at this time that the two firefighters became trapped up in the drainage. As the fire topped out on the ridge, it appeared to spot a short distance over the ridgetop and then make a run back up to the ridgetop on the east side of the ridge. After this, the fire began to back down the ridge on the east side of the main ridge, and when influenced by the wind, it would make short fast runs. By 1845 hours, most of the west side of the main ridge had been burned. After 1845 hours, no more estimates were made, and final fire suppression efforts were completed around 2130 hours and shown as the final perimeter on the progression map (see page III).