NATIONAL TRANSPORTATION SAFETY BOARD
Office of Aviation Safety
Washington, DC 20594

HUMAN PERFORMANCE

HUMAN PERFORMANCE FACTUAL REPORT

January 25, 2018

I. ACCIDENT DCA17FA109

Operator	Air Cargo Carriers (ACC)
Location	Charleston, WV
Date	May 5, 2017
Time	0651 EDT
Vehicle	Shorts SD 3-30
Registration	N334AC

II. OPERATIONAL FACTORS / HUMAN PERFORMANCE GROUP

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III. SUMMARY

On May 5, 2017 at 6:51 a.m. eastern daylight time (EDT), Air Cargo Carriers flight 1260, a Shorts SD3-30, N334AC, crashed during landing on runway 5 at the Charleston Yeager International Airport (CRW), Charleston, West Virginia. The airplane was destroyed and the two pilots suffered fatal injuries. The flight was operating under the provisions of 14 CFR Part 135 as a cargo flight from Louisville International Airport (SDF), Louisville, Kentucky. Instrument meteorological conditions prevailed at the time of the accident.

IV. DETAILS OF THE INVESTIGATION

The Human Performance and Operational Factors Group learned of the accident on Friday, May 5, 2017 and travelled to the site. The group included members of the Human Performance and Operational Factors Group from the NTSB, FAA, AAIB and Air Cargo Carriers (ACC).

From Saturday, May 6, 2017 to Monday, May 8, 2017, the group conducted activities that included but was not limited to making initial information requests to the FAA and ACC, performing an accident site walk through, recovering PEDs and crew logs, interviewing next of kin and significant other interviews for the captain and first officer, and reviewing flight manuals and paperwork.

On Tuesday, May 9, 2017, interviews of ACC personnel were conducted at company headquarters in Milwaukee, Wisconsin; an initial interview of FAA personnel at the MKE FSDO including ACC POI, PMI, and FLM was conducted on May 10.

On May 16, 2017, a phone interview was conducted with a former employee of ACC who had flown as a first officer with the accident captain.

On June 19, 2017 and July 11, 2017, phone interviews were conducted with friends of the first officer.

On June 26, 2017, NTSB group members travelled to the Milwaukee FSDO and conducted formal interviews with the FAA POI for ACC, and the front-line manager for ACC.

V. FACTUAL INFORMATION[1]

1.0 Flight Crew Information

1.1 The Captain

1.1.1 The Captain's 72-Hour History

On Sunday May 1, the captain conducted a flight departing at 2309 EDT from CRW to BKW arriving at 2327. He then departed on a flight at 2350 from BKW to SDF.

On Sunday May 2, the flight arrived at SDF at 0130 EDT. The final leg of the trip departed SDF at 0520 EDT and returned to CRW at 0622 EDT. According to his CPAP machine, the captain began using his CPAP at 0659 local until 1630. He departed on a flight that night at 2302 from CRW to SDF.

On Monday May 3, the flight arrived at SDF at 0025. He departed SDF at 0450 and arrived in CRW at 0549. His CPAP machine showed use from 0654 until 1242 and his cell phone records showed an outgoing text message sent at 0715. He departed on a trip that night at 2302 from CRW to SDF.

On Tuesday May 4, the flight arrived SDF at 1206. He flew a return flight from SDF at 0528 and arrived in CRW at 0637. His CPAP showed use from 0712 to 1511. He cooked dinner for his girlfriend that night and met her around 1900. He got ready for work around 2100. He flew a flight departing CRW at 2242 and arrived in SDF at 2358.

On Wednesday May 5, witness reports at SDF suggested that he stayed at the airport in the crew room until his next flight from SDF to CRW that departed at 0541. This was the accident flight.

1.1.2 The Captain's Personal Background

The captain resided in Charleston, WV. The captain's girlfriend stated that the captain slept "a lot." On days where he would finish flying about 0600, he would go to bed anywhere between 0900 and 1100 and his CPAP machine required him to sleep for at least 6 hours. [2] She stated he never seemed un-energetic.

According to his girlfriend, he occasionally drank alcohol on weekends. He ate well. He was overweight, but was "working on it." According to his girlfriend, he played volleyball up to two times per week. He wore prescription glasses when flying and took prescription medication for a heart condition. He did not smoke, drink coffee, nor use illicit drugs. He had had no major life changes in the past year and his girlfriend stated his mood was "so happy" on the night prior to the accident.

[1] The Operations Group Chairman's Factual Report can be referred to for additional information

[2] He was required to use a CPAP machine for obstructive sleep apnea (Further details provided in the medical officer's factual report).

1.2 The First Officer

1.2.1 Summary of PED Activity

Date	Time	Activity
05/04	1657:47	Outgoing phone call
05/03	1710:38	Incoming phone call
05/02	1754:47	Outgoing phone call
05/01	1316:12	Outgoing phone call
	0743.40	Outgoing SMS text message

1.2.2 The First Officer's 72-Hour History

On Sunday, May 1, the FO sent a text at 0744 EDT. An outgoing voice call was made at 1316 on May 1. She conducted a flight departing at 2309 from CRW to BKW arriving at 2327. She then departed on a flight at 2350 from BKW to SDF.

On May 2, the flight arrived at 0130. The final leg of the trip departed SDF at 0520 and returned to CRW at 0622. The next call or text activity occurred at 1755. She departed on a flight that night at 2302 from CRW to SDF.

On May 3, the flight arrived at 0025. She departed SDF at 0450 and arrived in CRW at 0549. Her next call or text activity occurred at 1711. She spoke with her boyfriend on the phone that evening about 1730-1800. She had also spoken with her brother on the phone for an hour that evening. She flew a trip that night departing CRW at 2302.

On May 4, the flight arrived in SDF at 1206. She flew a return flight from SDF at 0528 and arrived in CRW at 0637. The next call or phone activity occurred at 1330 when she sent a text message. The following activity occurred at 1658. That evening, she spoke to her brother on the phone after she awoke which ended at 1838. She cooked dinner and called her brother again later that night to speak to her mother. She flew a flight departing CRW at 2242 and arriving at SDF at 2358.

On May 5, her return flight departed 0541 for CRW. This was the accident flight.

1.2.3 The F/O's Personal Background

The first officer resided in Charleston, WV. The first officer's boyfriend stated that she typically went to bed immediately after she came home from the flight in the morning. He stated that flying at night was a difficult transition for her, but she had started to adjust. He stated she could have been a morning or evening person as she was very adaptable. She had a healthy lifestyle. He had never seen her take pills of any kind. He had not seen her take prescriptions or herbal supplements. She rarely drank alcohol. During her last phone call with her brother, he described her spirit as "excited" which was normal for her. She typically exercised for one hour doing the insanity workout. She normally got 7-8 hours of rest. She did not take naps normally. She wore glasses or

contacts. She did not have any issues with color vision. Her brothers were not aware of any prescriptions she was taking. She did take vitamins. She did not smoke or take illicit drugs.

1.3 Medical and Pathological Information

Post-accident toxicological testing was performed by the FAA Civil Aerospace Medical Institute's (CAMI's) Bioaeronautical Sciences Research Laboratory.[3] Tissue specimens from the captain tested negative for ethanol and a wide range of drugs, including major drugs of abuse. Tissue specimens from the first officer tested negative for ethanol and for a wide range of drugs, including major drugs of abuse.

2.0 Captain's Flight Proficiency

The first officer who had flown with the accident captain prior to the accident first officer rated the accident captain's landings as 7 on a scale of 10. He stated that 90% of the time the captain's approaches were stabilized but sometimes they came in low. This was easy to do in the aircraft and easy to recover with engine power compared to coming in high which was much worse as the aircraft had difficulty descending. He stated that in the cases they went missed, it was because they were high on the approach. He stated that the decision to go around could come from either pilot. He had called for go arounds with the accident captain before, which he executed without question. There were also cases where the accident captain as the pilot flying would himself call for a go around. He rated the accident captain's flying skills as "very good" and he did not see him do anything unsafe. He stated that the accident captain was very knowledgeable and often quizzed him in the aircraft. He stated that they followed the FOM and SOPs. They flew IFR most of the time. He rated the accident captain's IFR flying skills as better than his own when he himself first started with the company.

In text messages with 5 of her friends, the accident first officer stated that the accident first officer had told them that while the accident captain's VFR flying skills were "awesome," she had concerns with the his IFR skills. She had told one friend during a phone call that the accident captain had had trouble staying on heading, speed, and course when in IMC. She also told him that the accident captain would fly at 4000 feet altitude around Charleston which her friend, a former pilot for ACC, considered dangerous because of the mountainous terrain and towers in the area. She also had told him about instances where the accident captain had "ducked" below MDA on approaches before.

In text messages to friends, she described a conversation with another captain she had flown with at the company. This captain had told her that that he had been sent to fly with the accident captain by the chief pilot because the accident captain "could not fly a missed approach" when the chief pilot had flown with him.

[3] Specimens were tested for ethanol, illicit substances, and a wide range of prescription and over-the-counter medications.

3.0 Pilot Adherence to Standard Operating Procedures (SOPs)

The first officer described situations in text messages to friends where the captain slept during flight. These text messages were sent, according to her, while she was flying the aircraft and he was asleep. In addition, she described a series of flights in February 2017 where the captain asked her to fly every leg for four days in addition to handling radios while he slept.

Each of the former ACC pilots interviewed stated that they had witnessed instances of SOPs being disregarded when they were flying at ACC. One former first officer stated that he felt that there was a culture where senior pilots with experience as captains felt like they could bend boundaries of SOPs and the FOs may not be taken seriously. When this specific former first officer encountered this behavior, he responded by doing additional training and more studying to become more confident in the aircraft and better able to speak up about issues to the captain.

A former ACC captain stated that he had flown with a handful of pilots at ACC who flew "way" outside of SOP . He discovered that at ACC there was a compromise between flying to standards and managing the cockpit work environment. When asked what kind of behavior he had seen outside of SOPs, he stated that some pilots wouldn't be standardized and adhere to the established approach profile for the Shorts that determined airspeed, gear, and flap settings at specific locations on an approach. He stated he had flown with one pilot who was always in a hurry and gave the example of another pilot flying inbound to the airport at 3000 feet and fast, then diving to the airport at the last minute. Another pilot would program the GPS for the return leg even though they hadn't landed on the outbound leg yet. He had also seen pilots pull the fuel levers to ground to get the aircraft to descend faster. He witnessed pilots slip the aircraft, which he didn't believe was safe to do in the Shorts. He said most of what he had seen from other pilots in terms of not following SOPs was related to poor planning. He clarified that these were specific individual pilots at the operator and not a reflection of the overall culture of the airline.

4.0 Company Policies

4.1 Crew Resource Management (CRM) Training

The initial course for CRM was provided to pilots during initial new hire training. This course was a 2-hour segment on topics relating to CRM background and skills, effective communication, teambuilding, attitudes and decision making, situational awareness, workload management, and stress and error management.

The director of training[4], who also taught the course, described CRM training as lecture-based using PowerPoint slides and as each topic was presented he discussed different examples relating to hypothetical scenarios or personal stories of good and poor CRM. He stated that CRM was also addressed during simulator debriefs. The president stated that CRM was incorporated into their training program in 1994. He stated that the majority of CRM training was conducted during initial

[4] The director of training had held the position for about 2 years. He was also a check airman and had been with the company for 5 years.

new hire training, and it was reviewed during recurrent training and during upgrade training. He further stated that "during upgrade, it is increased almost to the initial level for the change in seat." ACC did not have any additional training materials or slides for recurrent or upgrade training.

According to the chief pilot,[5] the company emphasized CRM during training, but it did not have a specific training course for CRM nor did they do specific inflight CRM training during simulator training.[6] He stated that CRM was inherently prevalent in their training and operation and added that "CRM training starts when they walk into training and ends when they leave."

Chapter 5, Section 3 of the ACC Pilot training program stated that CRM (135.330) was covered in concurrence with FAR Part 135 regulations. Chapter 5, Section 4 stated that an examination would be provided on FAR's 61, 91, and 135. When queried, ACC management stated that this examination was combined with their "end of indoctrination week 1" test which was a multiple-choice pass/fail exam corrected to 100%. Upon failure (a score less than 70%) the pilot was removed from the class and terminated. The chief pilot stated that they did not retain the tests or have a copy of the individuals test results. Upon review of the test content, there were no questions relating to the principles of CRM.

When asked how CRM training was evaluated, the president stated that "CRM [training] is an ongoing process through the class during the lecture phase. The lecture items are put to use and evaluated during the chair flying, FTD session and finally in the simulator or aircraft as applicable. CRM [training] is a continuing process while in ground school, hangar visits and anytime the trainees are together. We want the correct actions and teamwork at all times, not just in the cockpit."

A former captain for ACC described the CRM training at ACC to be basic and the check rides were not crew-oriented. Compared to what he received at his current major airline and stated that ACC's CRM training could be improved upon.

When interviewed, the first officer who was assigned to fly with the accident captain prior to the accident first officer, stated that when he first started flying with the accident captain, he did have trouble voicing concerns "because he didn't know [the accident captain] very well. He said that he felt the accident captain was open to suggestions and he enjoyed flying with him.

4.2 Policy on Crew Base Assignments

ACC's crew assignment policies were base specific. Two pilots, one captain and one first officer, would be assigned to each base. Pilots did not rotate to different bases unless they were reassigned. A former captain who had left the company to fly for a major airline stated that he was concerned about ACC's policy of having the same crew fly together consistency and stated that there was no way to do checks on the pilots. He stated that flying together can get monotonous and people can

[5] The chief pilot had held the position for about 2 years. He was a simulator instructor and had been with the company for 9 years.

[6] On an email dated December 28, 2017, the chief pilot stated the company did have a CRM program and crews typically discuss their own CRM scenarios as they come up during training.

get into routines. Further, he stated that in a multiple crew pairing situation, if there was someone who isn't following SOPs, there are multiple people who can catch it. There was also benefit from multiple crews so that pilots can learn from different people. He stated that it was great for low time pilots to learn from multiple people.

Another former captain who had flown for ACC stated that he understood that speaking up to the captain was difficult as it could have created a hostile work environment and poor CRM as he had heard of this happening with another crew pair where the first officer had an issue with the captain and "ended up in tears." The first officer that had flown with the accident captain prior to the accident first officer stated that while he had gotten along with the accident captain, in general as a first officer "you hope you get along with the captain because you'll be flying with him" constantly.

A witness who had known the accident first officer from his current job and kept in touch with her after she began flying for ACC stated that the accident first officer and accident captain seemed to get along and the first officer would be able to get along with anybody regardless of if she liked them. He had a specific conversation with the accident first officer about speaking up in the cockpit even if she wasn't comfortable doing so. In the several months prior to the accident, he understood that she would have conversations with the accident captain and was more comfortable speaking up. Another former captain with ACC who had kept in touch with the accident first officer after she began flying for ACC also stated that the accident first officer was not the type to speak up. He assumed this was something he referred to as "new pilot syndrome" which he described as her not wanting to complain immediately after starting the job.

The FAA POI was asked if there were any changes to risk assessment if an operator was operating aircraft along the same route, with the same crew pairing. He considered two pilots flying exclusively together to be beneficial as "there was value in familiarity with the other person." He stated that there was no downside to having crews flying exclusively together.

4.3 Policy on Portable Electronic Devices

When asked whether ACC had a policy on PED usage in the cockpit, and if so, how that policy was communicated to the pilots, the company stated that they train FAR 135.144 on portable electronic devices and the only approved item for use was the iPad EFB. Upon review of ACC training manual, training documents, and FOM, no references to 135.144 nor personal electronic devices were found.

4.4 Safety and Oversight Programs

Section 6.2 of the company's FOM set for the policy and procedures for safety management:

> "1. It is the intention and policy of the Company to establish and operate with the highest safety standards. Employees must operate within the scope of all Company policies and Federal Aviation Regulations.

2. All supervisory personnel shall enforce a basic policy of safety being the top priority in all operations. All ground and flight equipment is to be kept in good operating condition. Safety shall be promoted through personnel training, and the use of sound judgement in all operations."

Section 10.17 of the company's FOM described procedures for a multi-use reporting form:

> "This form is a multi use form it will be used to collect data/information regarding daily flight/crew operational issues events such as,
>
> 1. Mechanical reliability reporting information 135.415
> 2. Mechanical interruption report information 135.417
> 3. NTSB 830 information.
> 4. Customer service issues. Unusually long delays customer due to weather, (high mins Capt.) freight left on aircraft etc.
> 5. Un-forcast delays beyond the control of the certificate holder.
> 6. Information required by the abnormal flight report described in Chapter 6 page 4 of this manual.
> 7. Safety of flight information gathered by a crew. This item would need to be initiated by the crew."

The chief pilot stated that their safety program consisted of a "see something, say something" protocol. He stated that while it is not written policy, pilots are encouraged during pilot training to report safety issues they encounter on the line. ACC did not utilize a safety management system (SMS) or formal flight risk assessment (FRA) process. Company personnel stated that they had hired a ground instructor a few weeks prior to the accident who had interest and experience in SMS.

The chief pilot stated that ACC did not have a formal or documented irregularity or safety reporting program. To issue a report, pilots were expected to call or email the director of training or chief pilot. This process was the same for reporting difficulties with colleagues. Safety reports were not formally logged nor tracked. There was no method to research trend evaluate trends of safety or irregularity calls.

Operational oversight consisted of annual recurrent training. In addition, the chief pilot occasionally flew the line for pilots who called in sick which enabled him to observe the field operation. There was no "initial operating experience" type of program. The chief pilot stated he typically checked in with a new pilot a week after they start flying the line to see how things were going. This follow-up was not conducted with the accident first officer. He stated that the most challenging part of his job was managing from afar since he could not see the attitudes and demeanors of his pilots. He stated he assumed that if a pilot was having difficulties that they will reach out. They did not solicit feedback regarding how crews were working together at the base.

Several former pilots stated that ACC could not detect behavior that was outside of standards. One former pilot stated that ACC occasionally sent a check airman to fly with pilots, but that pilots become model pilots for that flight and "return to their bad habits" when the check airman is no

longer there. He had never brought his concerns about pilots not following SOPs to ACC management. He confronted the pilots directly.

One former pilot stated that he felt safer flying in a Part 121 operation because everything he did once he walked onto the aircraft was recorded and monitored which provided a level of safety. He said he never felt he couldn't say anything to ACC management. He could call the chief pilot with ideas, but he would not know whether those got implemented. He had felt pressure to complete the flights and had thought it was because it was his first job and he wanted to "push through." He said that ACC did not seek feedback from pilots. He described the company communication as "awful" and he never knew what "the office" was up to.

Another former pilot was asked to describe the safety programs at ACC compared with his experiences since he's left ACC. He stated that there were some shortfalls that they could improve upon such as training in an actual aircraft vs. simulator. In addition, the training at his current company consisted of complicated airports and approaches as scenarios on check rides. He stated that ACC did not do this, and he considered CRW to be a complicated airport given the terrain surrounding it. He stated that if ACC had had an ASAP program, he "absolutely" would have used it. He felt they also could have used a Professional Standards Program as well due to the culture, pilots did not know whom to go to with problems, and there was also a feeling no matter if it was true or not your job may have been on the line for speaking up. When asked what kind of issues he would have reported in ASAP if ACC had one, he stated he would have reported altitude deviations, approaches, differences in interpretations of the MELs. There were many deviations, particularly because the aircraft did not have an autopilot and he would have reported issues as a crew. He stated that ACC needed a way of identifying issues.

Former pilots also described low morale within the company that could have been attributed to schedule and fatigue. One pilot stated that the duty days never exceeded maximum hours, however they were very long, and he sometimes did not get as much rest as he would have. He stated that the overall amount of flying was too much and felt he was constantly sick because of the schedule. He had never received blame from the company for calling in sick. He hadn't known anyone who had called in fatigue nor had he called in fatigued himself. There were times where he was tired but legal to fly. He described that in the back of his head he did think "what's the company going to think if I call in fatigued once a week?" He stated that ACC was a good place to build flight hours. They flew 6 nights per week with an 11pm – 6am schedule, but "the schedule sucked." Another pilot stated that he believes that ACC needed to give their pilots more time off. He felt that that would keep people from rushing and taking shortcuts to be done with the flight. When he left ACC, he felt burned out from the schedule he was flying.

5.0 Previous Flights Involving the Accident Crew

5.1 Nose Gear Light Illumination Departing CRW – December 30, 2016

The first officer had exchanged text messages and had phone conversations with friends and her brother regarding a flight on December 30, 2016 from 0355Z to 0423Z.[7] According to her text messages, she was originally flying pilot on the leg departing CRW. She described that on takeoff, the nose gear light stayed on instead of extinguishing to indicate that it was up and locked. The captain took control of the aircraft while she referenced the QRH. He flew maneuvers to return to the airport when in VMC and IMC that she described as "really steep turns, like 60 degrees of bank" and descending at 800 fpm. She described that the captain was disoriented. He decided to land in the opposite direction to takeoff with a strong crosswind which she described almost blew them off the runway. Upon landing, the chief pilot instructed them to put pins in the gear to ensure they didn't retract in flight and continue the flight. The initial text messages in the thread describing the event opened with her stating that she had "just had the biggest scare of my life. Thought I was going to die."

Two former ACC employees who were also friends with the first officer stated during interviews that she should report the incident to the company and both had offered to talk to the chief pilot on her behalf. They did not believe that the company knew about the captain's decision making and maneuvering to make it back to landing and was only aware of the gear issue. She assured them that she wanted to handle the situation herself without going to the company and was going to speak to her captain herself. Her friends believed the conversation happened but had not heard anything from her on the topic.

The METAR observations surrounding the time of the flight at CRW were as follows:

- METAR KCRW 300454Z 29009G25KT 9SM -SN FEW034 BKN045 OVC055 02/M04 A2993 RMK AO2 PK WND 32029/0407 SLP138 P0000 T00171039 400830000=
- METAR KCRW 300354Z 27009G18KT 10SM -SN SCT029 SCT045 OVC070 02/M03 A2992 RMK AO2 SNE0257B13E15B52 SLP136 INTMT -SN FLURRIES P0000 T00171033=

The below graphic shows the initial portion of the flight path in blue, the latter portion of the flight path in purple, and radar altitudes 1700 ft or less as filled red points.

[7] Text message excerpts can be found in Attachment 1

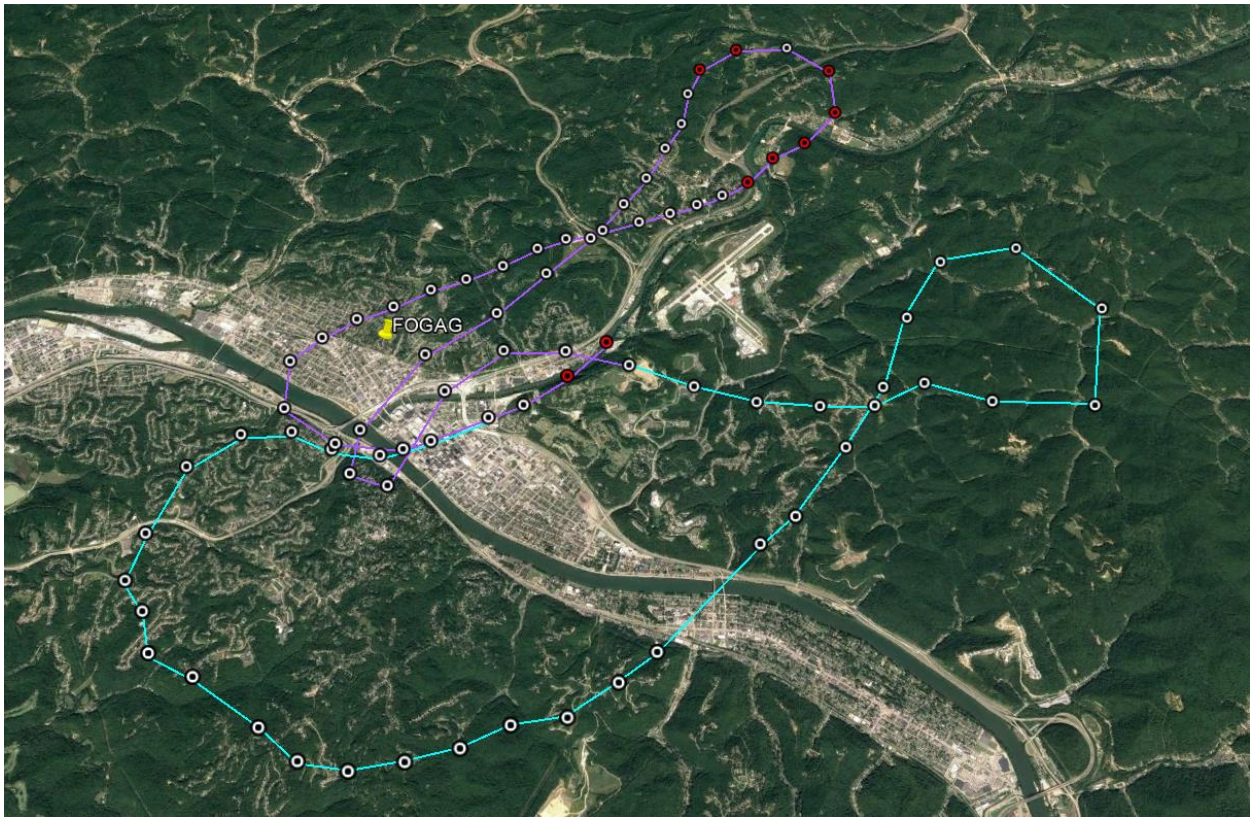

Figure 1. December 30, 2016 flight path departing and arriving CRW.

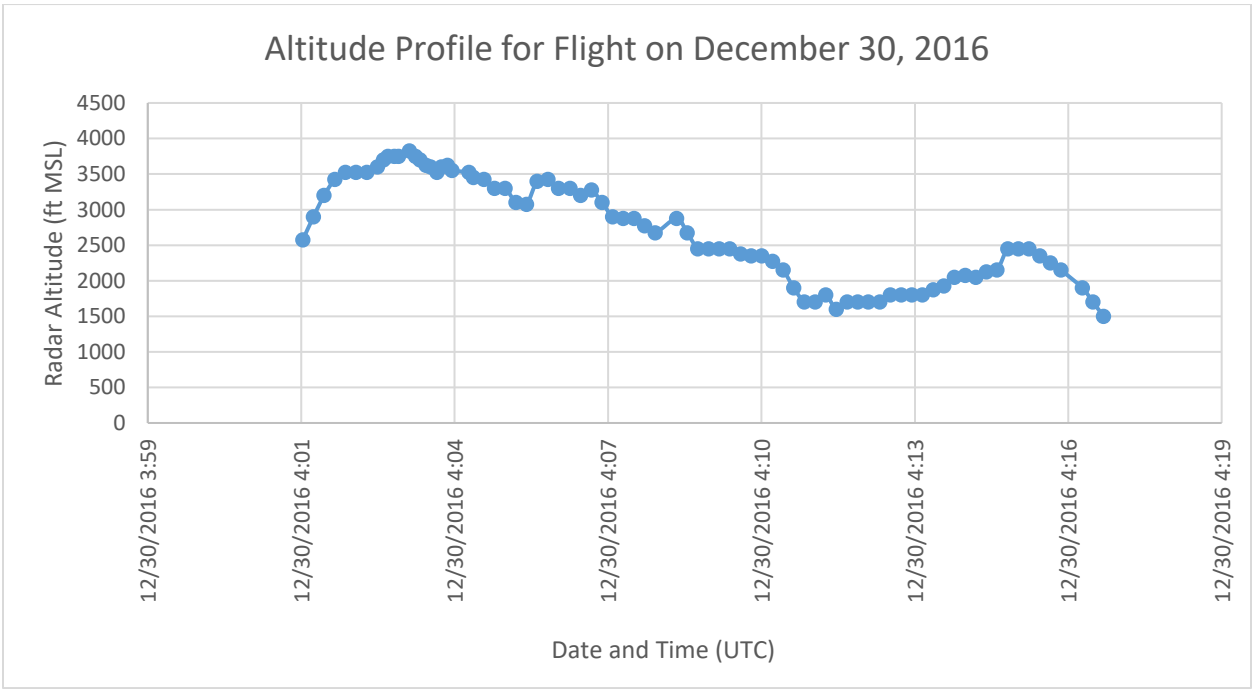

Figure 2. December 30, 2016 altitude profile for departing and arriving CRW.

5.2 Previous VOR-A Approaches into KCRW[8]

5.2.1 January 24, 2017

Date	Time Landing (UTC)	Route	Pilot Flying
01/24/2017	1111	SDF - CRW	CA[9]

The METAR observations surrounding the time of landing at CRW were as follows:

- KCRW 240954Z 26003KT 10SM OVC010 04/03 A2967 RMK AO2 RAE31 SLP049 P0000
- KCRW 241054Z 29003KT 10SM OVC010 04/03 A2969 RMK AO2 SLP055 T00440028
- KCRW 241154Z 29003KT 6SM -RA BR OVC012 04/03 A2971 RMK AO2 RAB39 SLP064 CIG RGD P0000 60000 70093 T00440028 10044 20044 53020
- KCRW 241234Z 00000KT 4SM -RA BR OVC007 04/03 A2973 RMK AO2 P0001 T00440033

Radar information showed that during this flight radar altitude was 1450 ft MSL approximately 1 mile prior to FOGAG. This altitude was maintained until the aircraft was lined up with runway 5 and radar coverage was lost.

Figure 3. Radar location of flight on January 24, 2017 at 1450 ft msl.

5.2.2 March 14, 2017

Date	Time Landing (UTC)	Route	Pilot Flying
03/14/2017	1042	SDF - CRW	CA

[8] No NOTAMs reporting LOC out of service at CRW existed for each of the days where the VOR-A was flown by the crew.
[9] CA reported PIC time in his company crew log for the flight from SDF to CRW on January 24, 2017.

The METAR observations surrounding the time of landing at CRW were as follows:

- METAR KCRW 141054Z 30008G16KT 250V320 4SM -SNRA BR OVC005 01/M01 A2984 RMK AO2 RAB27 SLP107 P0000 T00061011=
- SPECI KCRW 141047Z 31011G16KT 280V340 4SM -SNRA BR OVC005 01/M01 A2984 RMK AO2 RAB27 P0000 T00061006=
- SPECI KCRW 141028Z 33008KT 4SM -SNRA BR SCT006 OVC011 01/M01 A2983 RMK AO2 RAB27 P0000 T00111006=
- METAR KCRW 140954Z 31008G15KT 6SM -SN SCT012 BKN020 OVC032 02/M01 A2982 RMK AO2 SNB54 SLP099 P0000 T00171011=

Radar information showed that during this flight, radar altitude showed 1,500 ft MSL approximately one mile prior to FOGAG. About 0.5 miles prior to FOGAG, radar altitude showed 1,600 ft MSL. About FOGAG, radar altitude showed 1,400 ft MSL. The aircraft descended to a radar altitude of 1300 before radar coverage was lost.

Figure 4 Radar location of flight on March 14, 2017 at 1500 ft msl.

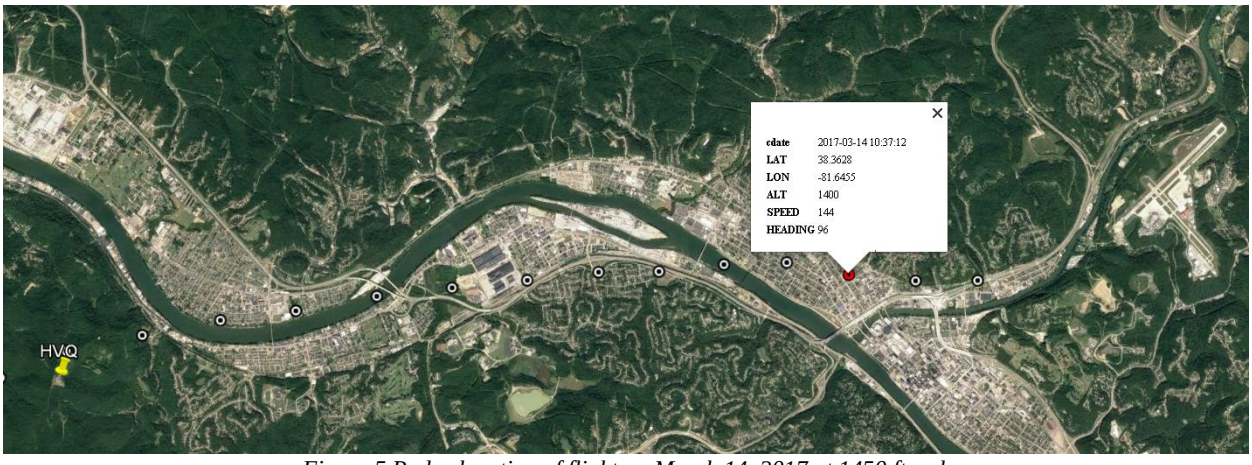

Figure 5 Radar location of flight on March 14, 2017 at 1450 ft msl.

5.2.3 April 7, 2017

Date	Time Landing (UTC)	Route	Pilot Flying
04/07/2017	1034	SDF - CRW	CA

The METAR observations surrounding the time of landing at CRW were as follows:

- KCRW 070954Z 34005KT 9SM -RA SCT009 BKN015 OVC025 02/01 A2977 RMK AO2 SNE43 SLP083 P0004 T00220006
- KCRW 071016Z 29012G18KT 5SM -RA BR SCT008 OVC014 02/01 A2978 RMK AO2 P0001 T00220006
- KCRW 071054Z 29010KT 8SM -RASN SCT008 OVC014 02/00 A2980 RMK AO2 SNB38 SLP094 P0002 T00220000

Radar information showed that during this flight, radar altitude was 1,575 ft MSL, about 3 miles prior to FOGAG. Radar altitude dropped to 1,475 ft MSL about 2 miles prior to FOGAG. The radar altitude was 1,575 about one mile prior to FOGAG and altitude crossing FOGAG was 1,600 ft MSL.

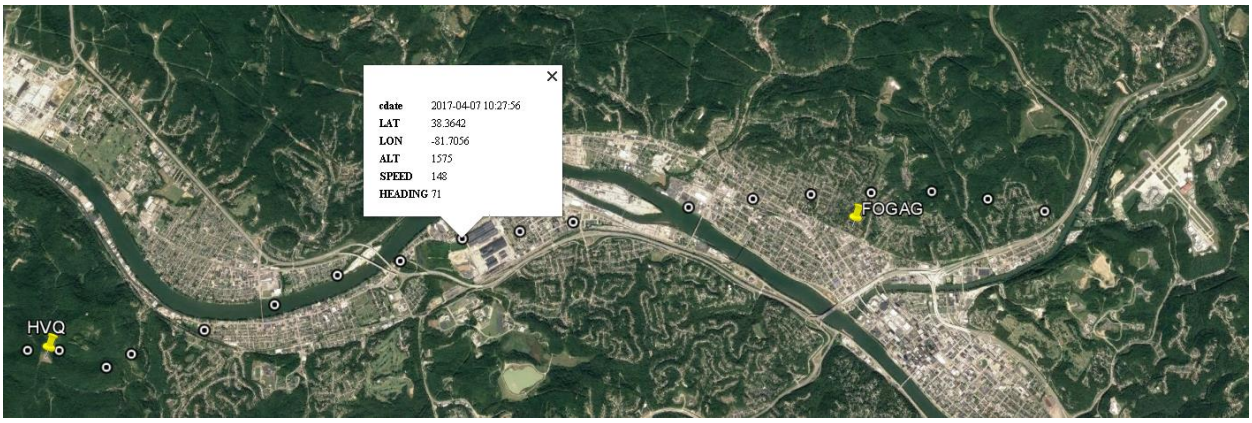

Figure 6. Radar location of flight on April 7, 2017 at 1575 ft msl.

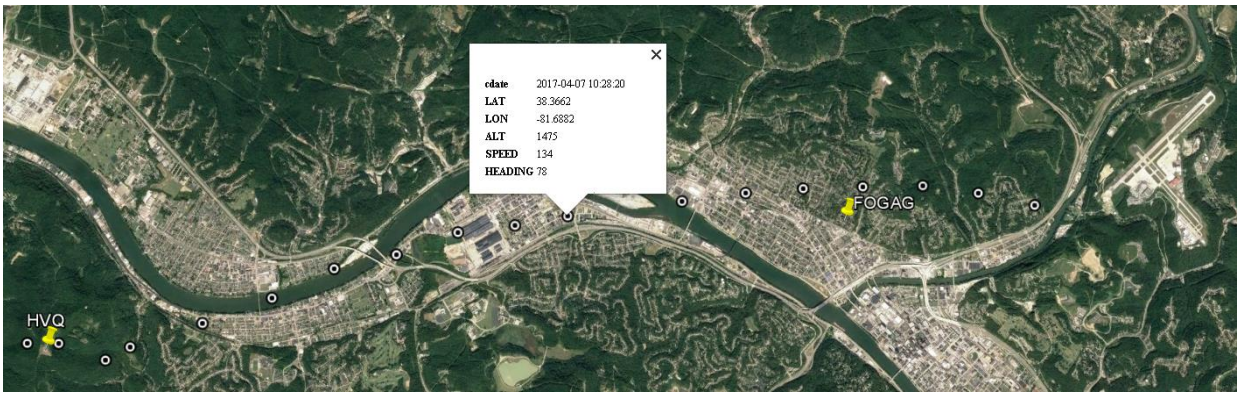

Figure 7 Radar location of flight on April 7, 2017 at 1475 ft msl.

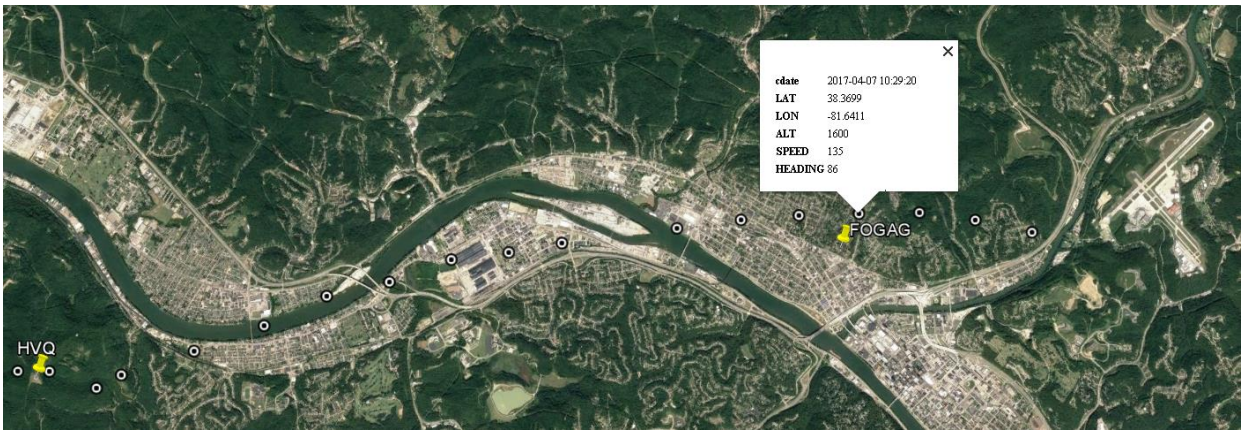

Figure 8. Radar location of flight on April 7, 2017 at 1600 ft msl.

5.3 Security Camera Footage of Previous Landings into CRW

Airport security camera footage was provided by CRW airport for 17 of the 20 flights flown by this crew into CRW in the month prior to the accident. In 10 of these flights, the aircraft landed on Runway 5 and the video contained the environment immediately over the runway capturing the aircraft's flare, touchdown, and roll out. For the 7 remaining flights, the aircraft landed on Runway 23, and the positioning of the security camera provided a view of the base and final legs of the traffic pattern and flare.

Date	Landing Runway	Pilot Flying[10]
04/07/2017	5	CA
04/11/2017	23	CA
04/12/2017	23	FO
04/13/2017	5	CA
04/14/2017	5	FO
04/15/2017	5	CA
04/18/2017	5	FO
04/19/2017	5	CA
04/20/2017	5	FO
04/21/2017	23	CA
04/22/2017	5	FO
04/25/2017	5	CA
04/27/2017	23	CA
04/28/2017	5	FO
05/02/2017	23	FO
05/03/2017	23	CA
05/04/2017	23	FO

[10] As reported by the captain on the company flight logs and crew log

The following describes the video for the 7 flights landing on 23 where it was available.

- April 11, 2017 – Nighttime, VFR, conditions prevailed with dawn light apparent in the right side of the viewing area. The aircraft entered the field of view about 0609:51.557 at the top left of the screen in a location consistent with a right downwind leg for runway 23. About 0610:26.590, the aircraft appeared to turn right base for runway 23. About 0611:07.723, the aircraft completed the base to final leg and appeared established on final approach. About 0611:46:823, the video showed an initiation of flare, and about 0612:00.090, touchdown occurred.
- April 12, 2017 – Dawn lighting conditions prevailed with low level clouds apparent over the field. The aircraft landing lights were in view at the beginning of the video footage illuminating the clouds on the right side of the viewing area in a location consistent with an extended final approach for runway 23. About 0628:06.691, the aircraft lights came into focus and the aircraft appeared to exit the cloud deck. About 0629:04.157, the aircraft appeared to initiate flare.
- April 21, 2017 – Night time visual conditions prevailed. The video began with the aircraft in the top of the field of view in a position consistent with an extended right base to runway 23. About 0602:57.882, the aircraft appeared to begin a turn from right base to final approach leg for runway 23. About 0603:17.616, the aircraft completed the turn to final and was wings level and established on final approach. About 0603:32.549, the aircraft was shown initiating a flare.
- April 27, 2017 – Dawn visual conditions prevailed, and a layer of surface fog was apparent in the valley north of the airport adjacent to the runway. The video began with the aircraft in the top of the field of view in a position consistent with an extended right base to runway 23. About 0620:13.620, the aircraft appeared to be in a turn from base to final. The aircraft remained in a banked attitude until about 0620:26.886 when it went wings level on final approach to runway 23. About 0620:38.786, the aircraft appeared to initiate flare.
- May 2, 2017 - Day visual conditions prevailed with a layer of clouds over the field. The video began with the aircraft in the top of the field of view in a position consistent with an extended right base to runway 23. The aircraft disappeared from view approximately 0619:16.371 apparently due to color saturation of the camera and re-entered the view approximately 0619:55.470 established on final approach. About 0620:16.904 the aircraft initiated its flare.
- May 3, 2017 – Night time visual conditions prevailed with dawn light apparent in the right side of the video frame. The video began with the aircraft in the top of the field of view in a position consistent with a right base to runway 23. About 0546:24.825 the aircraft appeared to initiate a base to final turn and completed the turn about 0546:48.425 when the aircraft became wings level on final approach. The aircraft appeared to initiate flare about 0547:00.325.
- May 4, 2017 – Day visual conditions prevailed. The video began with the aircraft in the top of the field of view in a position consistent with a right base to runway 23. The aircraft appeared to complete the turn to final approach and go wings level about 0636:01.536 and initiated flare about 0636:16.503. The aircraft appeared to float before touching down about 0636:23.970.

VI. ATTACHMENTS

1. Excerpts from first officer's SMS conversations
2. Excerpts from NTSB email correspondence with Air Cargo Carriers

Sathya Silva
Human Performance Investigator