

NATIONAL TRANSPORTATION SAFETY BOARD

Office of Aviation Safety
Washington, D.C. 20594

UAS Aerial Imagery Report and Positional Study

06/15/2019

A. ACCIDENT ERA18FA122

Location: Smethport, Pennsylvania
Date: April 8, 2018

B. PERSONNEL

UAS RPIC¹: Michael Bauer
National Transportation Safety Board
Washington, D.C.

UAS RPIC: Cathy Gagne
National Transportation Safety Board
Marietta, GA

C. ACCIDENT SUMMARY

On April 8, 2018, about 1711 eastern daylight time, an MD Helicopter 600N, N602BP, operated by High Line Helicopters, LLC, was destroyed when it collided with a wooden power line support structure and terrain in Smethport, Pennsylvania. The commercial pilot was seriously injured, and two linemen were fatally injured. Visual meteorological conditions prevailed, and no flight plan was filed for the power line construction flight, which was conducted under the provisions of Title 14 *Code of Federal Regulations (CFR)* Part 133. The flight departed an unimproved landing zone adjacent to the accident site.

D. DETAILS OF IMAGERY

1.0 Equipment and Procedures

Equipment

Mapping and viewpoint flights of the accident site were conducted on May 6, 2019, using the NTSB DJI Phantom 4 Professional V2 (P4PV2) small unmanned aircraft system (sUAS, commonly known as a drone). The sUAS was deployed to conduct an aerial imaging mission of the powerlines the helicopter impacted and map the terrain in the area in and around the power poles. The flights were conducted a year after the accident and the construction work of the power lines had since been completed by the power company.

¹ RPIC – Remote Pilot in Command

A mapping flight of an exemplar MD Helicopters MD 600N helicopter was conducted on May 14, 2019, using the NTSB DJI Phantom 4 Advanced (P4PADV) sUAS. The sUAS was deployed to create a three-dimensional (3D) point cloud/surface model of the helicopter.

Both P4PV2 and P4PADV were equipped with a dual GPS/GLONASS receiver which provided georeferenced information on all still photos. Each drone was equipped with an FC6310 camera using the Sony Exmor 1" CMOS sensor, with a focal length of 8.8 mm and the number of effective pixels of 20 megapixels. Still photos were captured in a JPG format. One video was taken in MP4 format, with 4K resolution at 30 frames per second.

An additional flight was conducted also on May 6, 2019, using the NTSB DJI Inspire 1 sUAS. The drone was equipped with the Z3/FC350 3.5x zoom camera using the Sony Exmor 1/2.3" CMOS sensor, with an effective focal length of 22 to 77 mm. Still photo resolution is 12 megapixels in JPG or RAW format.

Ground control points at the accident site and at the exemplar helicopter were documented with a Trimble GEO7X differential GPS (DGPS) receiver.

Procedures

The accident site was located in an area of sloping terrain in a mainly open area with some tall trees and approximately 10.3 nm East of Bradford regional airport (KBFD) in Bradford, Pennsylvania. The accident site was in class G airspace. Flights were conducted under the provisions of Title 14 *CFR* Part 107.

Weather conditions were visual flight rules (VFR) conditions with lights winds during flight operations. The purpose of the UAS imagery was to document the map the terrain around the power lines.

The P4PV2 was flown in multiple missions consisting of an overlapping grid over an area encompassing the power poles at the accident site and include the downslope power pole and the upslope power pole at 200 feet (ft) above ground level (AGL) from the home point (accident power pole) to ensure clearance from tall trees and effective overlap. An initial flight was taken at 125 ft AGL; however, the altitude was inadequate for the mission. The takeoff/home point was clear area south of the accident power poles and allowed for maximum line of sight visibility. In addition to the grid missions, additional free flight images of the wires were taken.

The Inspire was hand-flown at a safe distance above the powerline to obtain imagery of the wires. Total flight time using both drones was approximately 1 hour.

The helicopter imaging site was located at a private helipad in Hiram, GA, where the helicopter is stored. The helipad was in class G airspace. Flights were conducted under the provisions of Part 107.

The P4PADV was flown in multiple missions consisting of 1) an overlapping grid (completed over multiple flights to ensure coverage) over an area encompassing exemplar helicopter at 35 ft AGL; 2) two orbits flown at 44 ft and 36 ft AGL; and 3) multiple orbits and perimeter flights flown manually at varying altitudes (as low as 3 ft AGL) to capture oblique images of the helicopter. Total flight time for the exemplar helicopter imaging was approximately 1 hour 20 minutes.

Accident Site Processing

Geo-referenced still imagery was processed using Pix4D photogrammetry software to produce a 3D point cloud and an orthomosaic map of the wreckage site. Relative accuracy (within the map) was calculated at 1.64 inches, twice the average ground sample distance.

Six ground control points were placed in the mapped area prior to the flights and positions were determined using the DGPS. Data was corrected using the continuously operating reference station (CORS) at Coudersport, Pennsylvania (PAPC). DGPS data was used to correct elevation and provide checkpoints for accuracy, conditions and time did not allow for optimal placement of ground control points. Elevation was corrected to approximately 22 inches, positional accuracy (to features outside the map) was measured to 29 inches.

Exemplar Helicopter Image Processing

Geo-referenced still imagery was processed using Pix4D photogrammetry software to produce a 3D point cloud of the helicopter. Relative accuracy (within the point cloud) was calculated at 0.22 inches, twice the average ground sample distance.

Four ground control points were designated on existing identifiable ground features in the mapped area prior to the flights and positions were determined using the DGPS. Data were corrected using the CORS at Newnan, GA (GANW). DGPS data was used to correct elevation and provide checkpoints for accuracy.

In addition, two 5-ft horizontal scale constraints were marked using the aft right corner of the trailer on which the helicopter was parked, with one constraint extending forward (along the right edge of the trailer) and the other extending to the left (along the back edge of the trailer).

2.0 Accident Site Imagery products

Approximately 750 high resolution photos including two panoramic image sets were gathered. Select photos and excerpts from the 3D modeling products are included in this report and detailed in the following paragraphs. A list of images and select output products attached to this report and contained in the docket are listed in section 6.0.

Figure 1 contains a still image taken from across East Valley Road looking towards the accident site power pole and surrounding power poles.

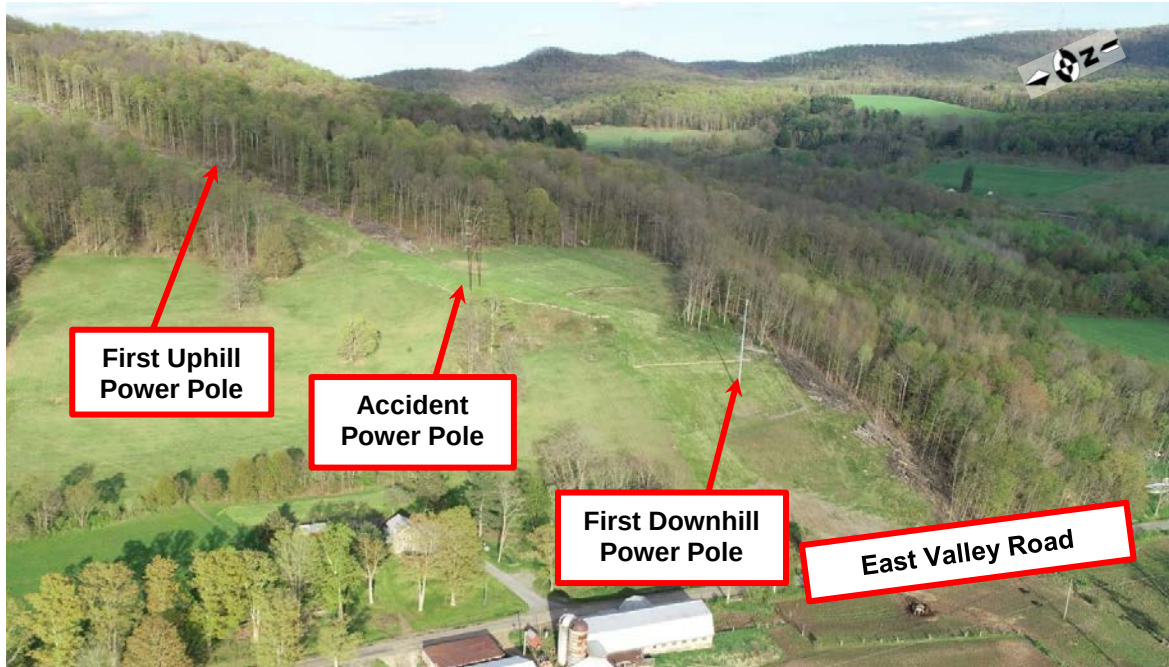


Figure 1 - Accident site overview, cropped (positional arrow approximate)

Figure 2 contains a still image taken from slightly below the accident power pole and is looking along the top wire towards the first uphill (and subsequent) power pole.

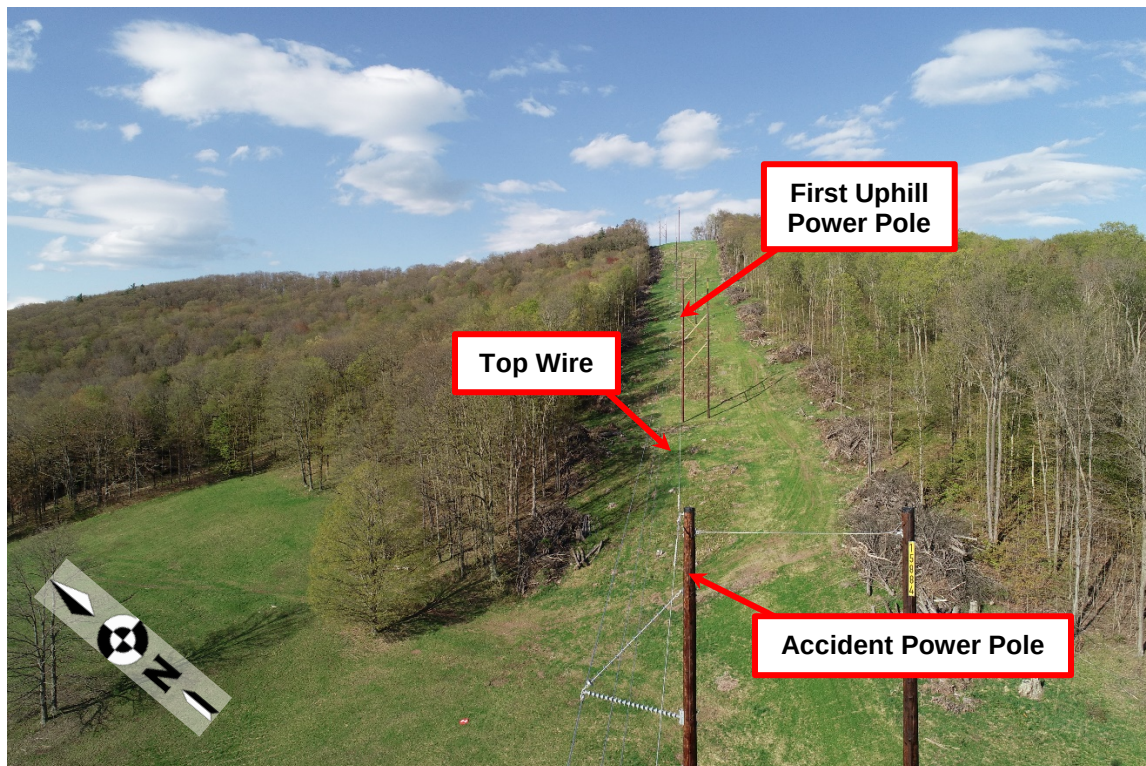


Figure 2 – View from below accident power pole looking uphill along wires (positional arrow approximate)

Figure 3 contains a still image taken from slightly above the accident power pole and is looking along the top wire towards the first downhill (and subsequent) power pole.

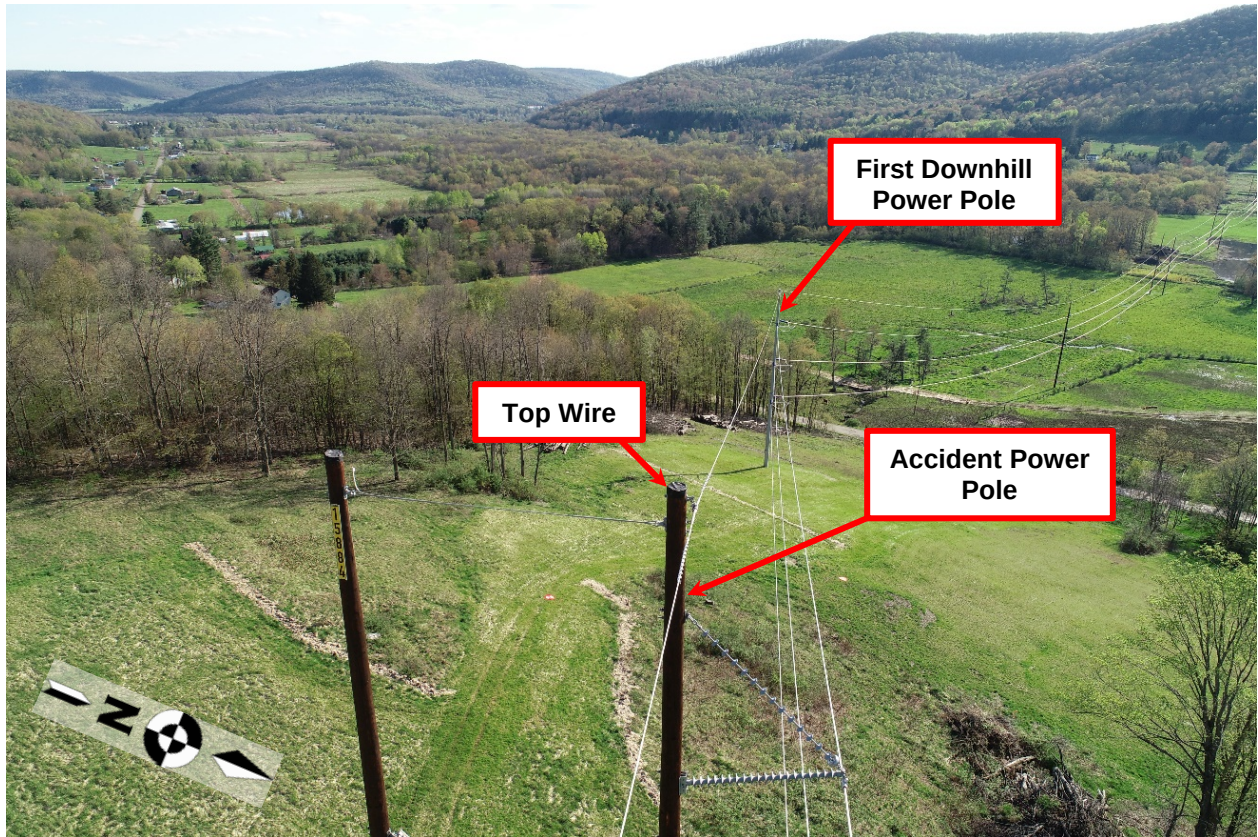


Figure 3 – View from above accident power pole looking downhill along wires (positional arrow approximate)

Figure 4 contains a still image of a side view of the accident power pole. The power company indicated that the top wire was not replaced after the accident. The top wire is in view, and a slight blemish in the direction of the uphill power pole can be seen.

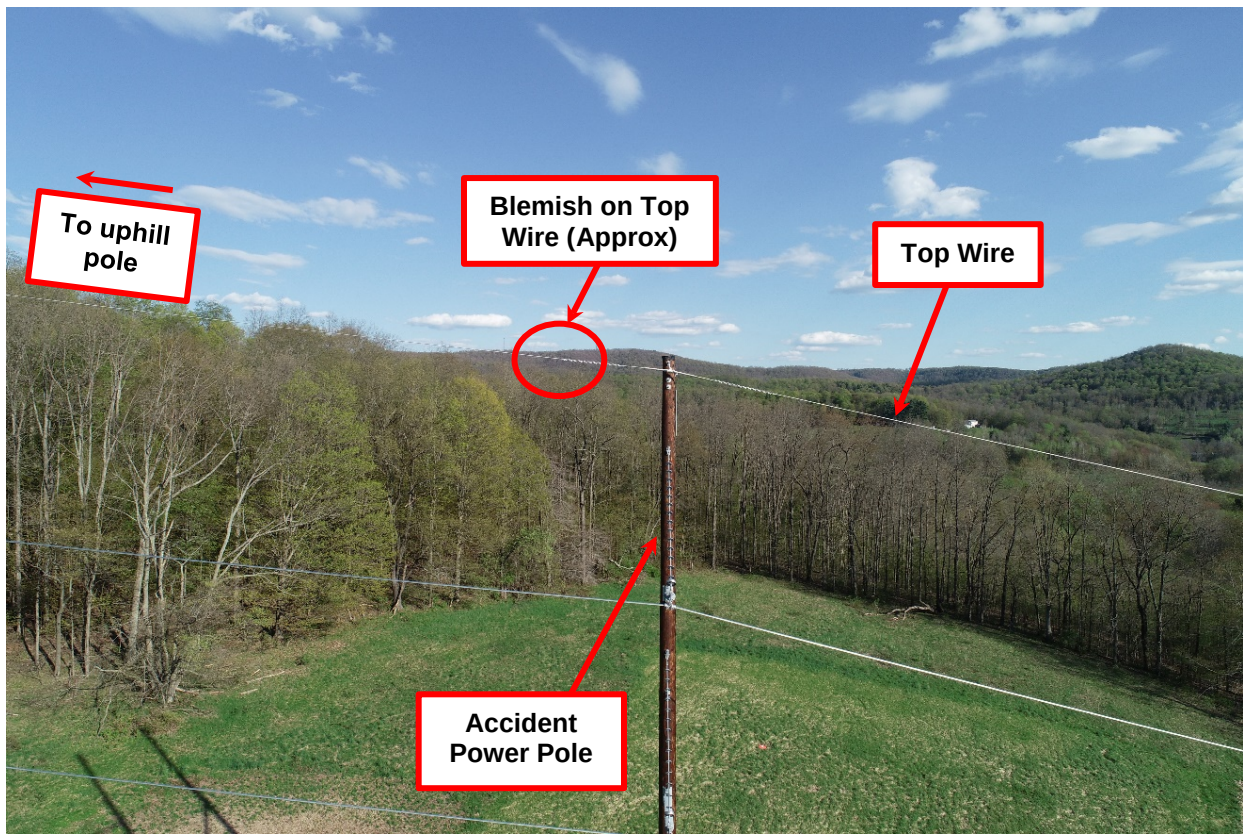


Figure 4 – Side view of accident power pole

Figure 5 contains a still image, which was zoomed and cropped, of a side view of the accident power pole. The slight blemish in the direction of the uphill power pole can be seen.

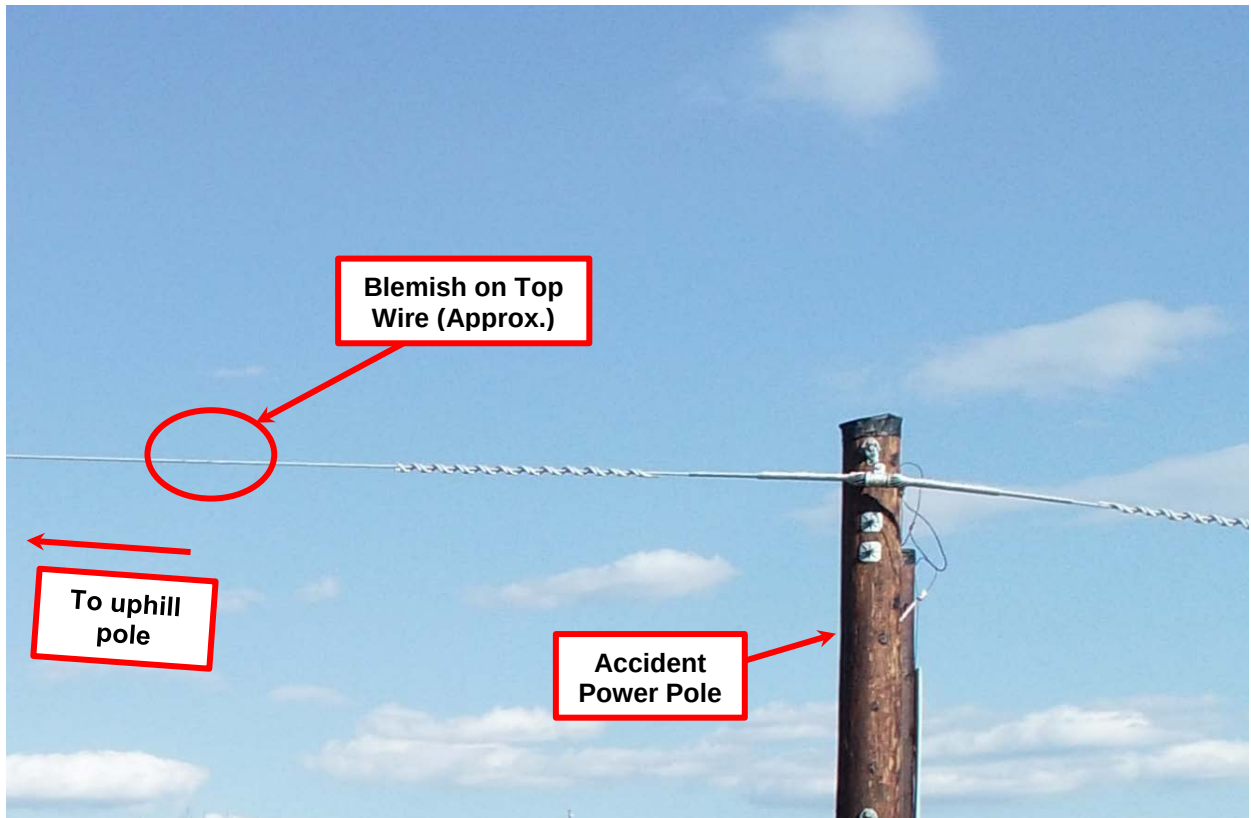


Figure 5 – Zoomed and cropped view of wire blemish (positional arrow approximate)

4.0 Exemplar Helicopter Imagery products

Approximately 636 high resolution photos were gathered.

Figure 6 contains a still image of the exemplar helicopter. Figure 7 contains a screenshot from the point cloud created from the still imagery.



Figure 6 - Photo of exemplar MD900N helicopter



Figure 7 - Screen Shot of exemplar helicopter point cloud

5.0 Dimensional and Positional Study

Utilizing information from the rotorcraft flight manual that was provided by the OEM, measurements of certain features were compared to the point cloud using Pix4D. Table 1 contains the various measurements and the differences between the point cloud and the rotorcraft.

Table 1 - Dimension Comparisons of rotorcraft to the point cloud

Measurement	OEM Data (m)	Point Cloud (m)	Diff (m)	Diff (in)	Diff (%)
Main Rotor Diameter	8.4	8.3	0.1	3.93	1.2
Fuselage Width	1.4	1.35	0.05	1.97	3.6
Distance Between Skids	2.7	2.55	0.15	5.91	5.6
Nose to Tail	9.0	8.87	0.13	5.12	1.5
Top of Rotor to Bottom of Fuselage	2.2	2.19	0.01	0.39	.5
Horizontal Tail	2.0	1.97	0.03	1.18	1.5

The point cloud of the rotorcraft and the terrain at the accident site was exported from Pix4D and imported into a commercially available software. The two point clouds were merged into one view and the software was programmed to allow rotorcraft to be moved along six different axes (up/down, fwd/aft, left/right, pitch, roll, and yaw). The viewpoint of the user can also be relocated and positioned in the same six axes. This allows the investigator the ability to assess the area around the rotorcraft and any stationary object. While the actual positioning of the rotorcraft, operators, and the top wire on the day of the accident is not known, the visualization can assist the investigation. It should also be noted that the weather conditions on the day of the accident are not depicted in the positional visualization.

The following screen shots are depictions from the point clouds positioned in a representative position of the rotorcraft and surrounding terrain. Due to areas of low density (appears as holes in normally solid objects) with the point cloud and certain objects, markings have been placed in the image to highlight the objects.

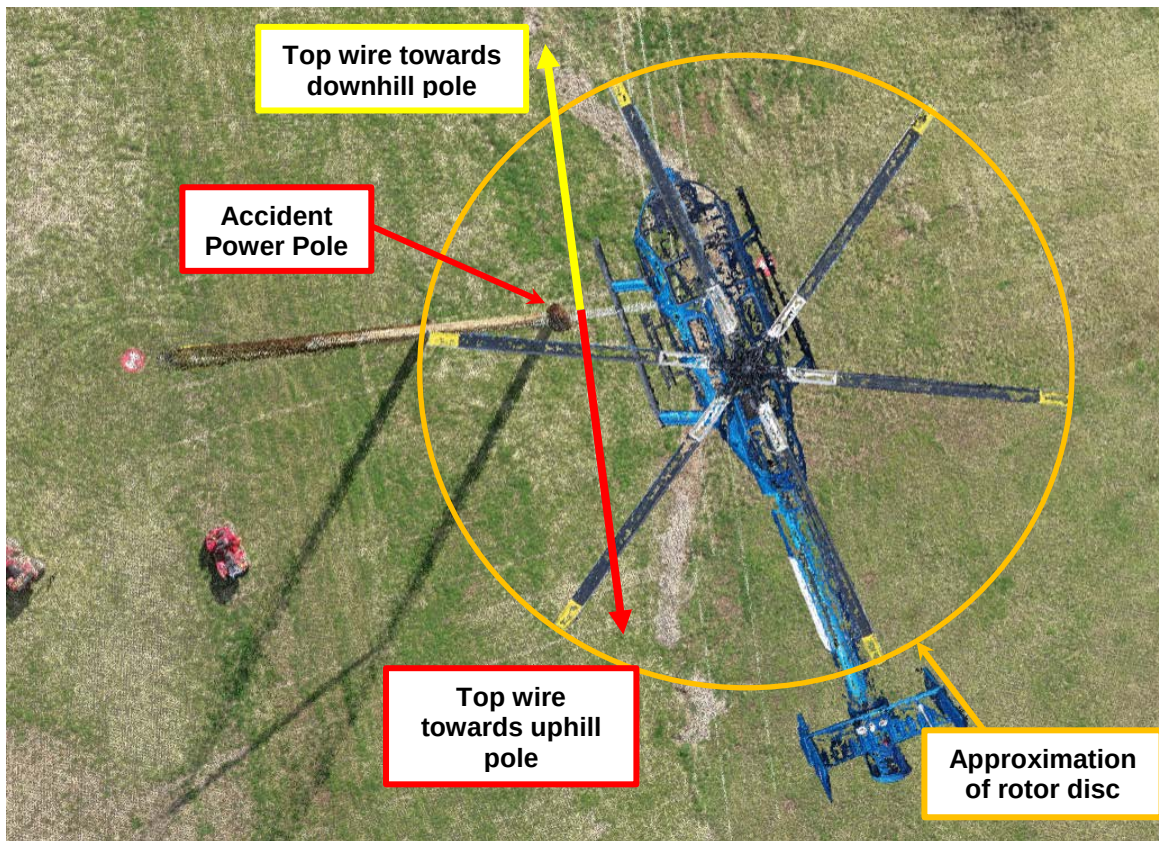


Figure 8 - Screen shot of rotorcraft and terrain visualization (view looking down)

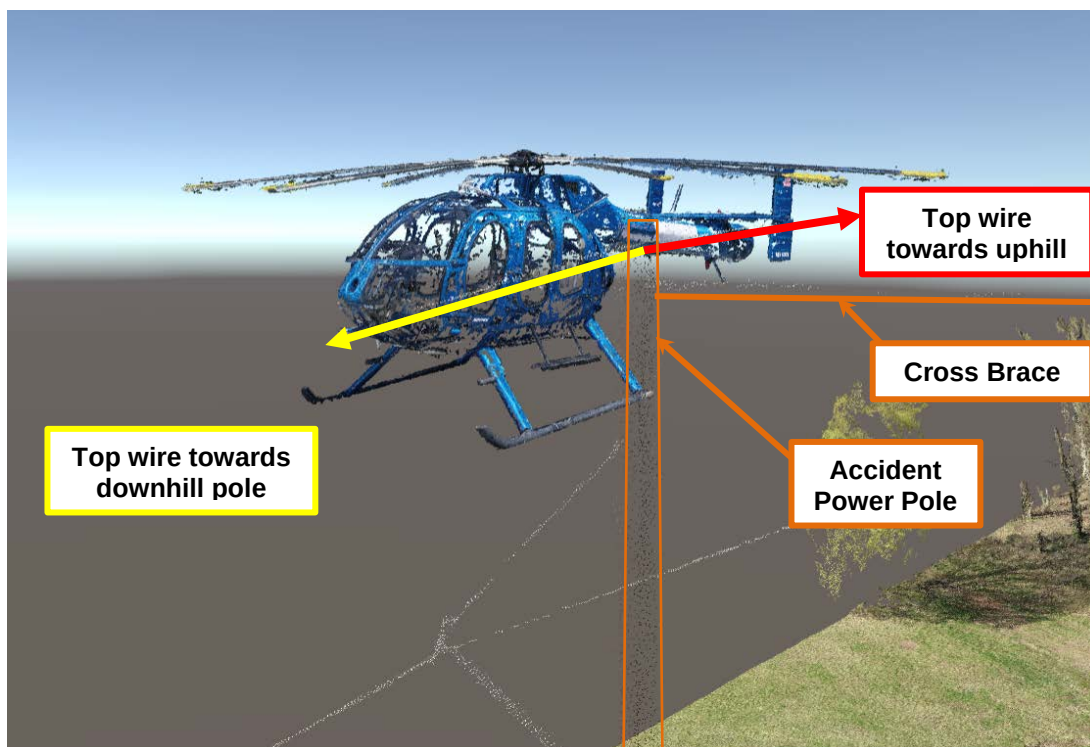


Figure 9 - Screen shot of rotorcraft and terrain visualization (view looking from side at nose of rotorcraft)

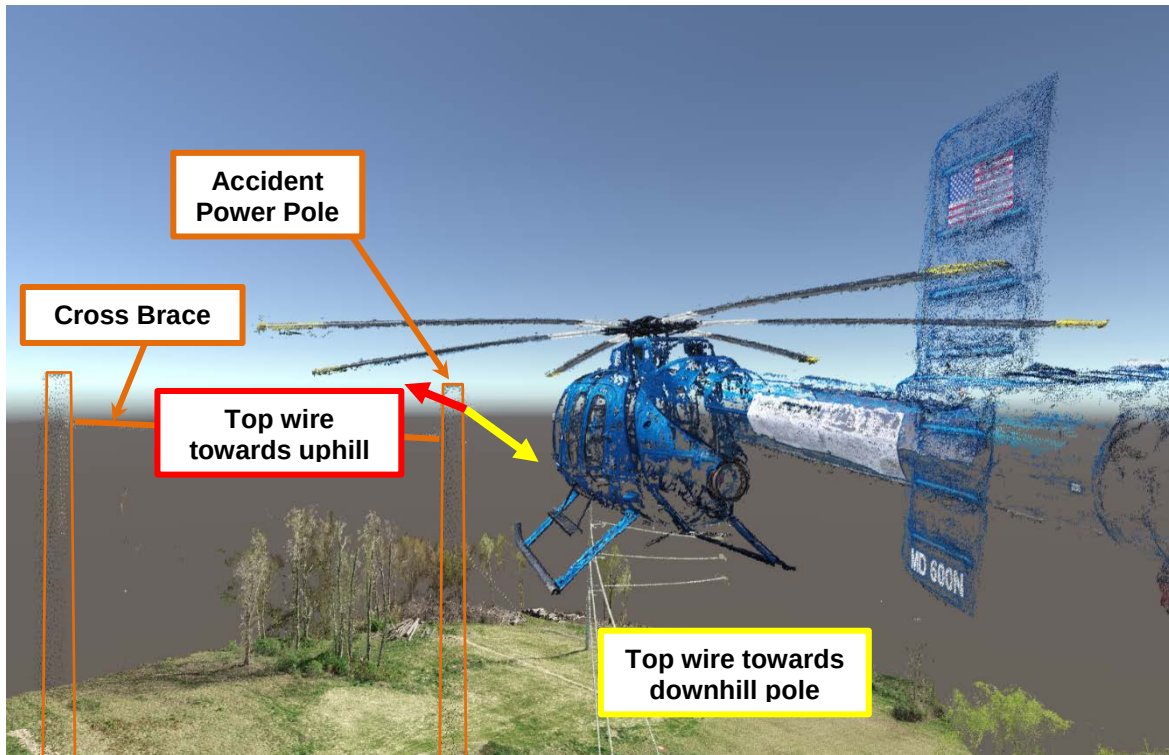


Figure 10 - Screen shot of rotorcraft and terrain visualization (view looking toward accident power pole from aft of rotorcraft)

Additionally, using Pix4D, measurements of the top wire were approximated. Figure 11 contains dimensions taken from the top wire tie point on the accident power pole. Distances in feet and inches are to various features on the top wire. Figure 12 contains angles as the wire leaves from the top wire tie point toward the uphill and downhill power poles.

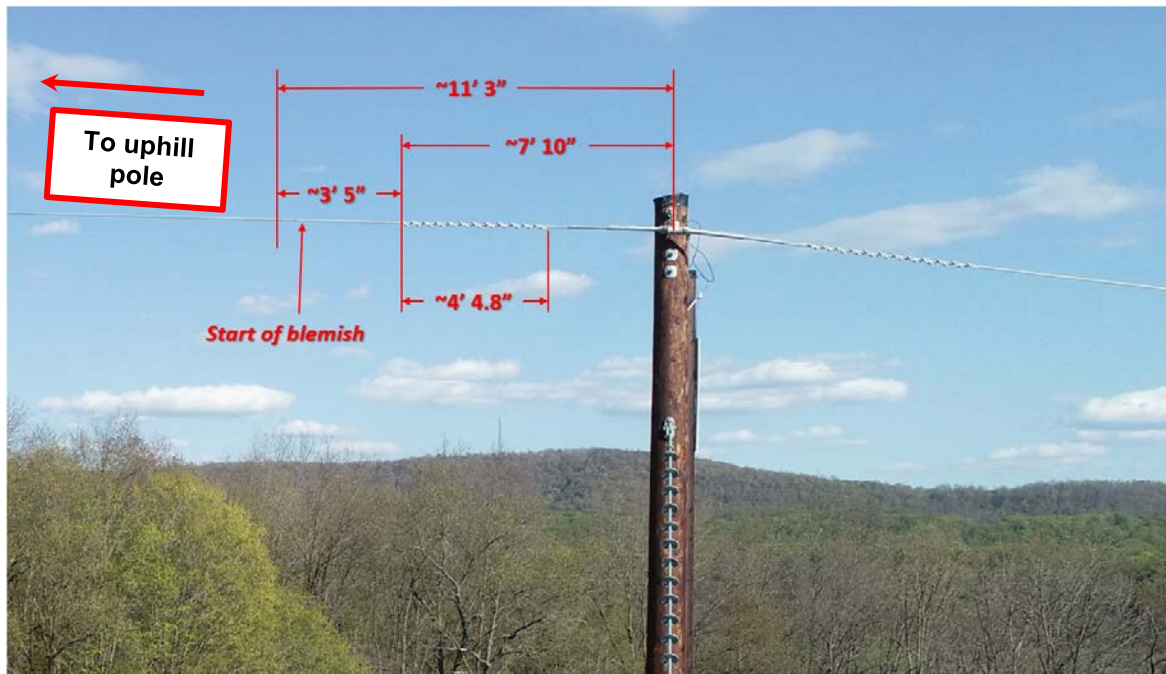


Figure 11 - Distances (in feet and inches) from top wire tie point to various features.

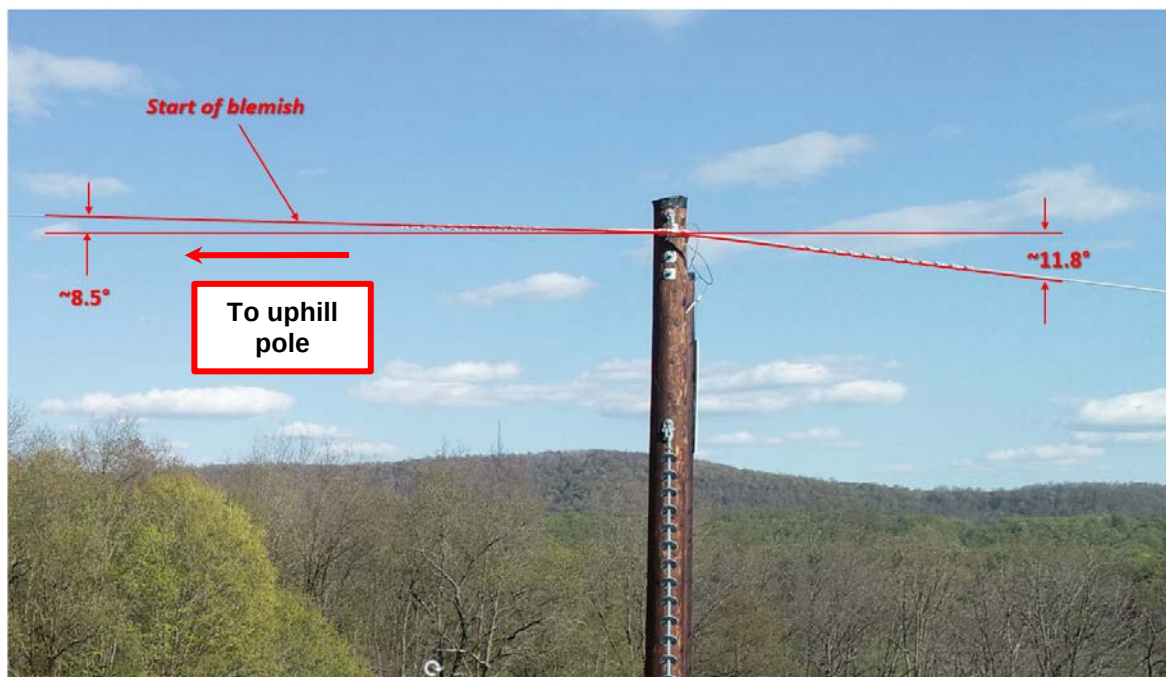


Figure 12 - Approximate wire angles

6.0 Attachments

Attachment 1 – Original Photograph used in Figure 2

Attachment 2 – Original Photograph used in Figure 3

Attachment 3 – Original Photograph used in Figure 4

Attachment 4 – Original Photograph used in Figure 5

Attachment 5 – Orthomosaic map in Google Earth .kmz format