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# NATIONAL TRANSPORTATION SAFETY BOARD

## WASHINGTON, D.C.

AIRWORTHINESS GROUP CHAIRMAN'S FACTUAL REPORT

(27 Pages)

(19 Pictures)

**NATIONAL TRANSPORTATION SAFETY BOARD**
Office of Aviation Safety
Washington, D.C. 20594

# Airworthiness Group Chairman's Factual Report

December 1, 2016

## A. ACCIDENT DCA16MA204

| | |
|---|---|
| Location: | Lockhart, Texas |
| Date: | July 30, 2016 |
| Time: | 0742 central daylight time (CDT) |
| Aircraft: | Heart of Texas Balloons Balony Kubicek BB85Z, registration N2469L |

## B. GROUP

Participants at the accident site, from July 31, to August 2, 2016:

Chairman: Tom Jacky
National Transportation Safety Board
Washington, D.C.

Member: Brian Murphy
National Transportation Safety Board
Washington, D.C.

Member: Joe Panagiotou
National Transportation Safety Board
Washington, D.C.

Technical Advisor to Czech Air Accidents Investigation Institute:

Wil LaPointe
Kubicek Balloons
San Francisco, CA

Examination of Envelope and Basket Cables at NTSB Laboratory, October 20, 2016:

Chairman: Tom Jacky
National Transportation Safety Board
Washington, D.C.

Member: Joe Panagiotou
National Transportation Safety Board

Washington, D.C.

Technical Advisor to Czech Air Accidents Investigation Institute:

Albert Padelt
Best Aviation Services/Kubicek Balloons
Bally, PA

Wreckage Examination at Lancaster, Texas, November 14, 2016:

Chairman: Tom Jacky
National Transportation Safety Board
Washington, D.C.

Technical Advisor to Czech Air Accidents Investigation Institute:

Albert Padelt
Best Aviation Services/Kubicek Balloons
Bally, PA

## C. SUMMARY

On July 30, 2016, at 0742 central daylight time, a Balony Kubicek BB85Z hot air balloon, N2469L, crashed into a field near Lockhart, Texas. The pilot and 15 passengers onboard were fatally injured and the balloon was destroyed due to impact forces and post-crash fire. The flight was operated by Heart of Texas Balloons under 14 CFR Part 91 as a sightseeing passenger flight.

The group met at the accident site from July 31, to August 2, 2016 to document the airworthiness aspects of the aircraft. At the time of the group's arrival the envelope and burners were located in a field, with the basket located in another field approximately ½ mile from the envelope.

At the end of the on-scene phase of the investigation, the following aircraft components were removed and retained by the National Transportation Safety Board for further examination:

1. Multiple basket and envelope (balloon) support cable segments and ends
2. Basket cable covers (sheaths)
3. Envelope data plate
4. Basket data plate

Evidence of balloon contact with the power lines was documented by the group.

On October 20, 2016 the group met at the NTSB's Material Laboratory in Washington, D.C. for further examination of the cables removed from the accident site. Generally, each cable segment was laid out, measured, photographed, and assessed for damage. Some of the cable ends were selected for detailed photo documentation.

On November 14, 2016 the group met at the Air Salvage of Dallas facility in Lancaster, Texas for further examination of aircraft wreckage. The examination included a functional test of the aircraft's three burners.

At the conclusion of each group activity, all pertinent documentation and photographs were provided to each of the parties.

No pre-existing envelope, basket, or burner failures were identified by the group. Evidence of electrical arcing was noted on envelope load cables, basket support cables, burner equipment, and basket frames.

## D. DETAILS OF INVESTIGATION

### 1.0 AIRCRAFT IDENTIFICATION

The aircraft was identified as:

Envelope:

| | |
|---|---|
| Manufacturer: | Balony Kubicek |
| Model Number: | BB85Z |
| Serial Number: | 1076 |
| Year of Manufacture: | June, 2014 |

Basket/Gondola[1]:

| | |
|---|---|
| Manufacturer: | Kubicek Balloons |
| Model: | K60 |
| Serial Number: | 551 |
| Year of Manufacture: | June, 2014 |
| Component Weight: | 785 lbs. |
| Type Certificate: | B04CE |

The envelope was located in an open field approximately ½ mile from the basket's final location. The burner platform and burners were attached to the envelope via the envelope load cables.

The basket was located in an open field, approximately ½ mile from the envelope's final location. At the time of the group's arrival, the basket's four fuel cylinders had been removed

[1] According to AC 91-71, a gondola is a compartment occupied by the pilot and passengers. It is usually constructed of wicker, metal, or fiberglass. For the purposes of this Factual Report, gondola and basket are synonymous.

from the basket and set aside.

## 2.0 BASKET DESCRIPTION AND EXAMINATION

### 2.1 General Description of Basket

The structural elements of the basket were constructed with stainless steel welded tubular frames. There was a lower portion of tubular frame and an upper portion of tubular frame spaced approximately 4 feet apart vertically. The support for the upper frame and spacing between the two frames was maintained by wooden rods. The skin of the basket was woven rattan material (in a wicker basket style). The top portion of the frame was also covered with leather upholstery. The floor of the basket was constructed from a type of wood composite flooring. The bottom of the basket was lined with several (2" x 3") boards spaced apart running length-wise across the bottom, with a hard plastic cover. The boards acted as landing skids.

The tubular frames, along with the woven wicker material, separated the basket into five compartments – four for passengers and one for the pilot and fuel tanks.

The basket had six stainless steel wire rope cables (stainless steel stranded cable ~1/4" diameter) that provided the support and connection to the burner support frame. Each basket cable was connected to the burner support frame, ran along a burner support rod (covered by a padded burner support rod cover) down to the basket, ran through eyelets on the upper frame down the basket outer wall to the basket floor, transversed across the bottom of the basket floor, passed up along the opposite wall, through eyelets on the upper basket frame and then back up through the basket and support rod cover to one of the eight attach points on the burner support frame. Each cable end attached to the burner support frame; the basket was therefore connected to the burner support tray by twelve cable attachments to the eight burner frame attachment points.

The burner support frame and tray were considered part of the basket assembly. The frame had eight hard points for attaching the stainless steel basket support cables and the envelope load cables.

For the purposes of this report, the envelope load cables were considered part of the basket. For more information regarding the envelope load cables, see Section 2.6.

### 2.2 On-Scene Examination of Basket

#### 2.2.1 General Examination

The basket was examined at the accident site. The examination of the basket revealed that the post-crash fire had consumed almost all of the combustible components of the basket with the exception of a few small fragments of the woven rattan in the center of the front part of the basket. However, the areas of the basket that survived were charred. See Figure 1.

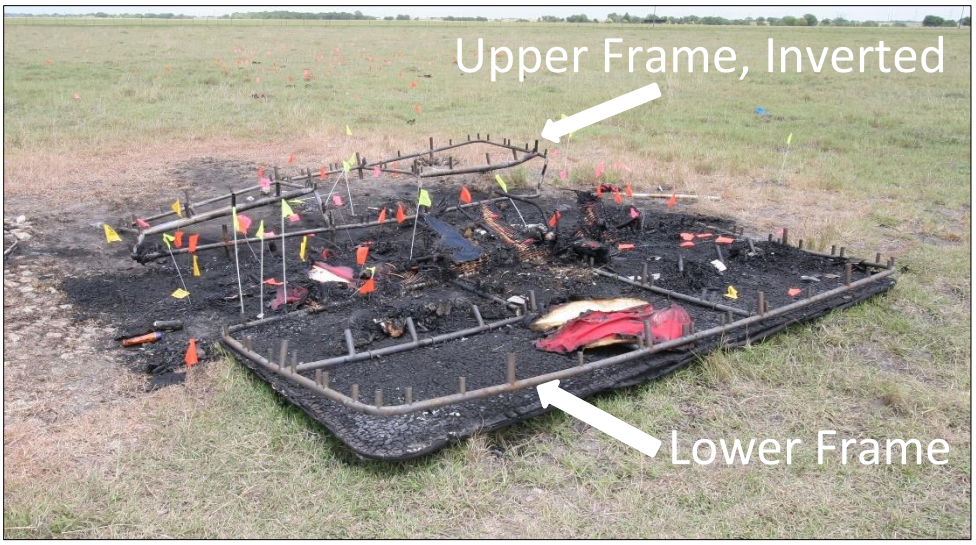



*Figure 1: Remains of the basket assembly. Lower portion of tubular frame, with flooring, in foreground. The upper tubular frame is in background. The upper frame is inverted relative to the lower frame.*

The upper basket frame was deformed and bent.

Two loose, unidentified cable segments were found near the basket. The segments were retained for further examination.

#### 2.2.2 Evidence of Electrical Arcing on Support Cables and Frame

The group's examination of the basket support cables exhibited multiple severed cables (Figure 2). The severed ends of the cables exhibited strand fusing. Each of the twelve ends of the basket support cables were cut and retained for further examination.

*Figure 2 - Example of basket support cable that exhibited strand fusing at severed end.*

Evidence of electrical arcing was also noted on the carabiners which attached these cables to the burner frame. See Figure 3.

*Figure 3 - Electrical arcing damage on carabiner and burner frame attachment point.*

Evidence of electrical arcing was noted on the basket at the forward left corner of the upper and lower basket frames (Figures 4 and 5, respectively).

*Figure 4 – Electrical arcing damage on forward left side of upper basket frame.*

*Figure 5 – Electrical arcing damage on forward left corner of the lower basket frame.*

### 2.3 Burner System

The balloon's fuel and burner system consisted of three propane burners attached to a burner assembly, a fuel manifold, four onboard fuel tanks, and associated hoses to supply fuel to the burners. The burner assembly was attached to the burner support frame, which was connected to the basket and envelope via support cables.

#### 2.3.1 Burner Assembly Description

The balloon had three propane burners (Identified as IGNIS, Serial Numbers 999, 1000, and 1001), manufactured by Kubicek Balloons, to heat the air mass inside the envelope. The burners were connected to each other by a gimballed burner block; the block was connected to the burner support frame. The two gimbals allowed for the burner's rotation about a lateral and longitudinal axis.

The base of each of the burners was painted a different color – red, white, and blue. For purposes of the investigation, the burners were identified by its color.

The three burners could be operated individually or all at once by use of hand levers. See Figure 6.

*Figure 6 - The three burners. Levers and valves are at the bottom.*

### 2.3.2 On-Scene Examination of the Burners

All three burners were found with the pilot light fuel valves in the open position.

Evidence of electrical arcing damage was found on the bottom of the base of the red burner. See Figure 7.

*Figure 7 - Electrical arcing evidence found on underside of the red burner.*

### 2.3.3 Further Examination of the Burners

The group met at the Lancaster, Texas storage facility to further examine the wreckage, including the burners.

A visual examination and a functional test was conducted on each of the burners.

#### 2.3.3.1 Visual Examination of the Burners

**Blue Burner Visual Examination:**

The igniter appeared to function with no apparent physical damage internal to the burner. There was black carbon build up on the burner but appeared to be consistent with normal use. The pressure gauge did not work. The pilot valve and whisper valve both operated using what appeared to be higher than normal force, but were functional.

The outer surface of the burner coils had evidence of abrasion and reconstituted metal dripping on the coil.

**Red Burner Visual Examination:**

The igniter appeared to function, no visual damage to the burner. There was black carbon build up inside the burner but appeared to be consistent with normal use. The whisper valve and pilot valve both operated using what appeared to be higher than normal force. The black handle was bent (impact damage). There was evidence of electrical arcing damage at the pilot valve and bottom of the red burner handle.

**White Burner Visual Examination:**

The pressure gauge appeared damaged and did not appear to work. There was black carbon build up inside the burner. The piezo igniter did not spark at the burner tip across to the pilot burner (as normal). Rather, the spark appeared to cross from the base of the piezo to the base of the pilot burner.

No visual evidence of electrical arcing on the outer burner base was found. The outer coils had evidence of abrasions and the lower black coil structure was bent.

The two burner gimbals were rotated freely.

2.3.3.2 Functional Test of the Burners

After the visual examination, the three burners were functionally tested. For the tests, all existing hoses and fittings were disconnected from the burners.

A hose and fuel cylinder, provided by the group, were attached to each burner separately for the test. The test included use of the pilot light, pilot valve, whisper valve, and main valve.

The following observations were made of the functional test, completed in the following order:

**White Burner Functional Test:**

Overall, the white burner functioned without any apparent failures.

The pressure gauge did indicate 150 psi during the burner operation but it did not indicate zero when pressure was removed.

The pilot light piezo worked intermittently (unlike during the earlier examination) and was able to start the pilot light.

The pilot light valve did not open on the first or second attempt, but it did open on the third attempt and allowed fuel to the pilot light.

The main valve and whisper valves both worked; flames were evident during the test.

No evidence of leaks to the connection, burner, or coils.

**Blue Burner Functional Test:**

No evidence of leaks to the hose connection, burner, or coils.

The pilot valve and pilot light were operated without any apparent failures.

The main valve and whisper valve operated without faults.

**Red Burner Functional Test:**

The valve handle was bent; the group attributed this to ground impact.

No evidence of leaks to the hose connection, burner, or coils.

The pilot light valve and pilot light operated without any apparent failures. The whisper valve operated without any apparent failures.

The main valve operated without any apparent failures. However, when the valve was released (closed), a flame continued in the bottom of the burner can due to a valve stem leak. The group attributed the valve stem leak to the deformed valve handle and ground impact damage.

2.4 Propane Fuel Hoses

The fuel hoses used to connect the fuel cylinders to the burner manifold and assembly were all identified as the following type:

| | |
|---|---|
| Manufacturer and Model: | PARKER 'Elite' 462ST-6 |
| Pressure Rating: | WP 5075 (psi) |
| Hose Diameter: | 10mm (3/8 inches) |

The hose construction consisted of an inner tube covered with two layers of braided steel sheathing and an outer rubberized jacket.

A fuel hose of about 8' length was found attached to the red burner. The hose was fitted with a T-shaped manifold at the other end. Examination of the manifold revealed that both of the connections to the "T" fitting had sheared off. The attached fuel hose was manufactured in 2014. No visual evidence of arcing, abrasion, or fire damage was noted. The T-manifold was removed from the hose and retained by the group.

The examination of the hose attached to the red burner revealed that the hose appeared to use a Tema fitting. The outer O-ring was missing from the quick disconnect fitting. The inner O-ring was still present.

The fuel supply hoses for the blue and white burners were found sheared off at their respective burners.

## 2.5 Fuel Cylinder Description and Examination

### 2.5.1 Description of Fuel Cylinders

The four fuel cylinders are designed to be filled with propane and were stored in the pilot compartment of the basket. The fuel cylinders, with their associated hoses, supply the burners.

The fuel cylinders located at the accident site were all of the same type, and identified as follows:

| | |
|---|---|
| Manufacturer: | Ultra Magic Balloon |
| Model: | M40D |
| Pressure: | 30 BAR |
| Mass: | 21.8Kg |
| Water Capacity: | 95L |
| Notation: | UNE-EN 14140 |
| Inspection Date: | 9/2015 |
| Serial Numbers: | See Section 2.5.2 |

The Federal Aviation Administration's Type Certificate Data Sheet No. B04CE (dated May 1, 2013) for the Kubicek Basket Model Number BB85Z did not include the Ultra Magic Balloon M40D fuel cylinder as an approved type. The paperwork associated with the 100 Hour/Annual Inspection Checklist, dated 5/23/2015, identified six fuel cylinders of Lindstrand Balloons Model Type V-30[2].

The NTSB submitted a request to the FAA to check for a record of a supplemental type certificate (STC) for use of the Ultra Magic Balloon fuel cylinders on N2469L. On November 23, 2016, the FAA indicated that the FAA's aircraft registry did not include an STC record for the accident aircraft.

### 2.5.2 Fuel Cylinder Examination

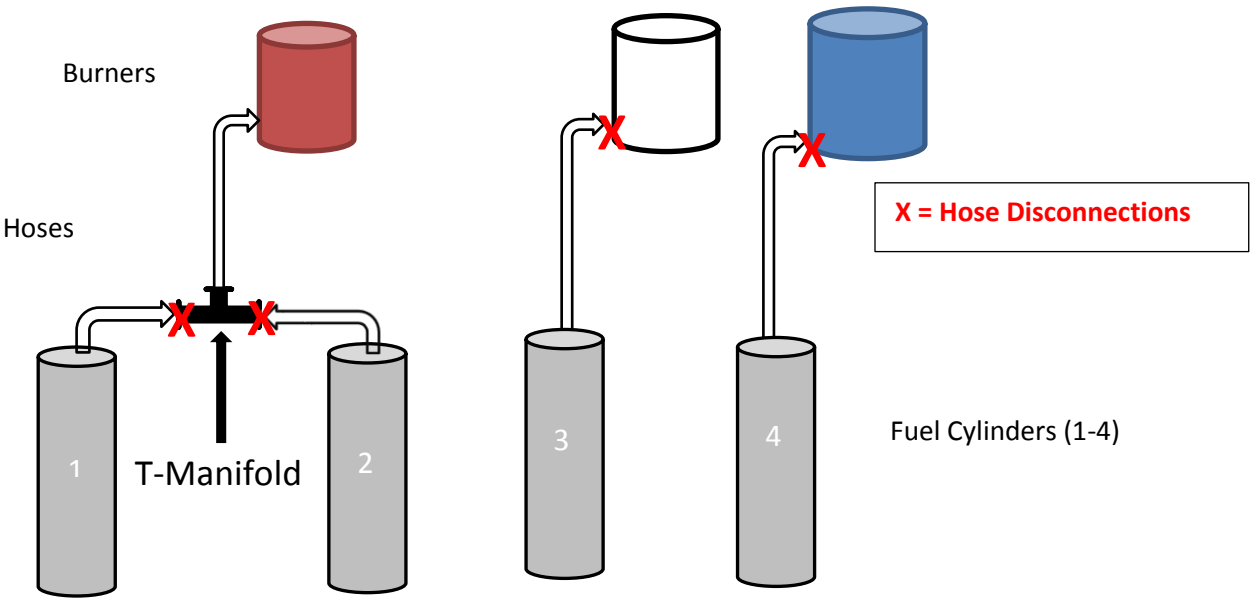
The fuel cylinders were arbitrarily numbered 1-4 for the purposes of the investigation. Cylinder #1 (Serial Number 1080) had approximately 8 inches of hose connected to it. Cylinder #2 (Serial Number 1078) had approximately 18 inches of hose connected to it. Cylinder #3 (Serial Number 1076) had approximately 8 feet of hose connected to it. Cylinder #4 (Serial Number 1077) had approximately 8 feet of hose connected to it. See Figure 8.

All of the fuel cylinders were empty at the time of the examination. All of the cylinders exhibited staining and thermal discoloration as a result of the fire. One of the cylinders (#3) had some deformation to the rim protecting the valve. The valves on each of the cylinders were thermally damaged and were free spinning, but exhibited no visual physical damage due to impact. No ruptures or holes were noted in any of the cylinders.

[2] The Linstrand Balloons Type V-30 Fuel Cylinder is listed in the FAA Type Certificate Data Sheet No. B04CE.


*Figure 8: Fuel Cylinders, as numbered.*

On November 14, 2016, the group conducted further examinations of the fuel cylinders. The fuel cylinders labelled #1 and #2 were connected to shorter hoses; the group considered that, since the shorter hoses were not long enough to connect directly to the burners, they may have been connected to the T-manifold hose connected to the red burner. And if so connected, the other two tanks were then individually plumbed to the remaining two burners (white and blue colored). See depiction below.



## 2.6 Envelope Load Cables - Description and Examination

As mentioned, the balloon was equipped with two sets of metallic, braided cables. In addition to the previously-described basket load cables, the balloon's envelope load cables attached the envelope to the burner support frame.

### 2.6.1 Envelope Load Cables Description

There were 28 stainless steel stranded cables (of ~3/16" diameter) that attached to the bottom of the envelope. The 28 cables connected to the burner support frame via sixteen eyelets to the eight burner support frame attach points. Carabiners were used to connect the eyelets to the attach points[3]. Of the sixteen eyelets, twelve of the eyelets connected two envelope load cables together; four of the eyelets connected one envelope load cable.

The envelope was numbered (1-28) to ensure the correct cable is attached.

### 2.6.2 On-Scene Examination of the Envelope Load Cables

In general, the envelope load cables were found in the field with the burner support frame and envelope. Fourteen of the 28 envelope load cables were found intact. Of the remaining fourteen cables, some of the cables exhibited severed ends with strand fusing. In general, the envelope load cables with strand fusing were located on the front side of the balloon. See Figure 9.

A depiction and description of the arrangement of the on-scene examination of the envelope load cables was included in Attachment 1. The attachment includes description of the

[3] Another carabiner was attached to the envelope load cable carabiner with the basket load cables attached to it.

cable ends and the correlation between the orientation of the basket and the burner support frame.

*Figure 9: Severed end exhibiting strand fusing on cable attaching burner frame to envelope. This cable was one of the cables on the forward side of the balloon. Note envelope in background.*

### 2.7 Examination of Envelope and Basket Cables at NTSB Materials Laboratory

The group met at the NTSB's Material Laboratory in Washington, DC for further examination of the cables removed from the accident site. Generally, each cable segment was laid out, measured, photographed, and assessed for damage. Some of the cable ends were selected for further photo documentation.

For further information, see Attachment 2, Examination of Envelope and Basket Cables at NTSB Materials Laboratory.

## 3.0 ENVELOPE DESCRIPTION AND EXAMINATION

The envelope was constructed from a rip stop polyester fabric for the lower (nearest the mouth) 15 feet and the rest of the envelope above was constructed from a silicon-impregnated

nylon taffeta fabric.

### 3.1 Deflation System and Examination

The vent pulley was used to deflate the envelope by opening the top of the envelope and allowing hot air to escape.

The vent pulley was noted near the equator of the envelope. The deflation vent was noted as opened.

### 3.2 Fire Resistant Fabric

At the mouth of the envelope there was a "skirt" that was constructed from Nomex material. The Nomex skirt was charred and mostly destroyed.

The fire resistant material at the lower end (throat) of the envelope ("scoop") was charred, discolored, and fire damaged. Pieces of the scoop were located near the basket.

The envelope throat, also constructed of fire-resistant material, was charred, discolored, and fire damaged.

### 3.3 Panels

The lower envelope panels were constructed of fire resistant polyester, manufactured by Kubicek. Several of lower panels were noted as either scorched or ripped. A number of panels from the nylon portion of the envelope in the lower area had also been destroyed and were no longer present.

The upper panels, above the balloon's equator did not exhibit any visible evidence of damage.

### 3.4 Crown Line

The black and yellow crown line was located, still connected to the top of the envelope. A small segment of the crown line was located near the basket.

### 3.5 Turning Vent Line

The turning vent line was noted connected to the envelope and burner platform. No visible damage was noted. The carabiner holding the turning vent line was connected with no evidence of arcing.

### 3.6 Control Lines

The control line ropes had evidence of fraying, including on the outer sheathing, but were

still connected to the carabiner. The carabiner exhibited discoloration (evidence of arcing).

## 4.0 EXAMINATION OF POWER LINES

### 4.1 General Description of Power Lines

Above the position where the basket came to rest there were high voltage (340KV) power transmission lines. The basket's final location was approximately mid-way between two towers carrying these lines, identified as Towers 127 and 128. The following sketch (Figure 10) shows the general arrangement of the power cables being carried by the towers:

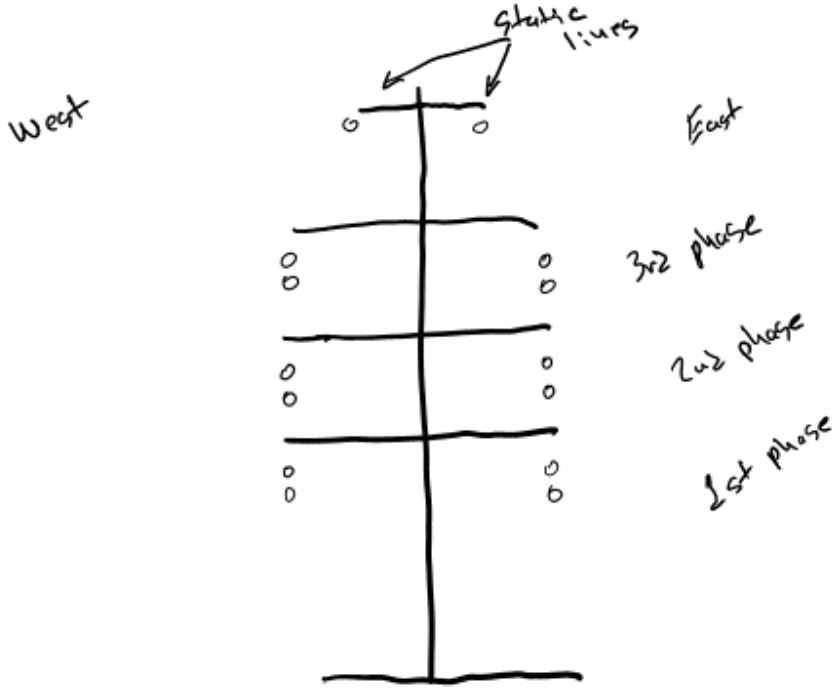



*Figure 10 - Sketch of Power Transmission Lines Arrangement and Tower (additionally, see photos below).*

There were three sets of two power cables on each side (East – West) of the towers for the 3 phases of current. Above the power cables were two static lines of a smaller diameter, which did not convey electrical current, but were electrically grounded.

### 4.2 Visual Examination of Power Transmission Lines

A visual examination of the cables and static lines above the basket location was performed by the group with the assistance of the power company and a bucket truck.

#### 4.2.1 East Side Cables and Static Line

The static line exhibited electrical arcing damage in discrete locations (see Figure 11).

*Figure 11: Example of Static Line (East) electrical arcing damage*

The static line exhibited an approximately 30 foot, continuous section of abrasion/mechanical damage (see Figure 12).

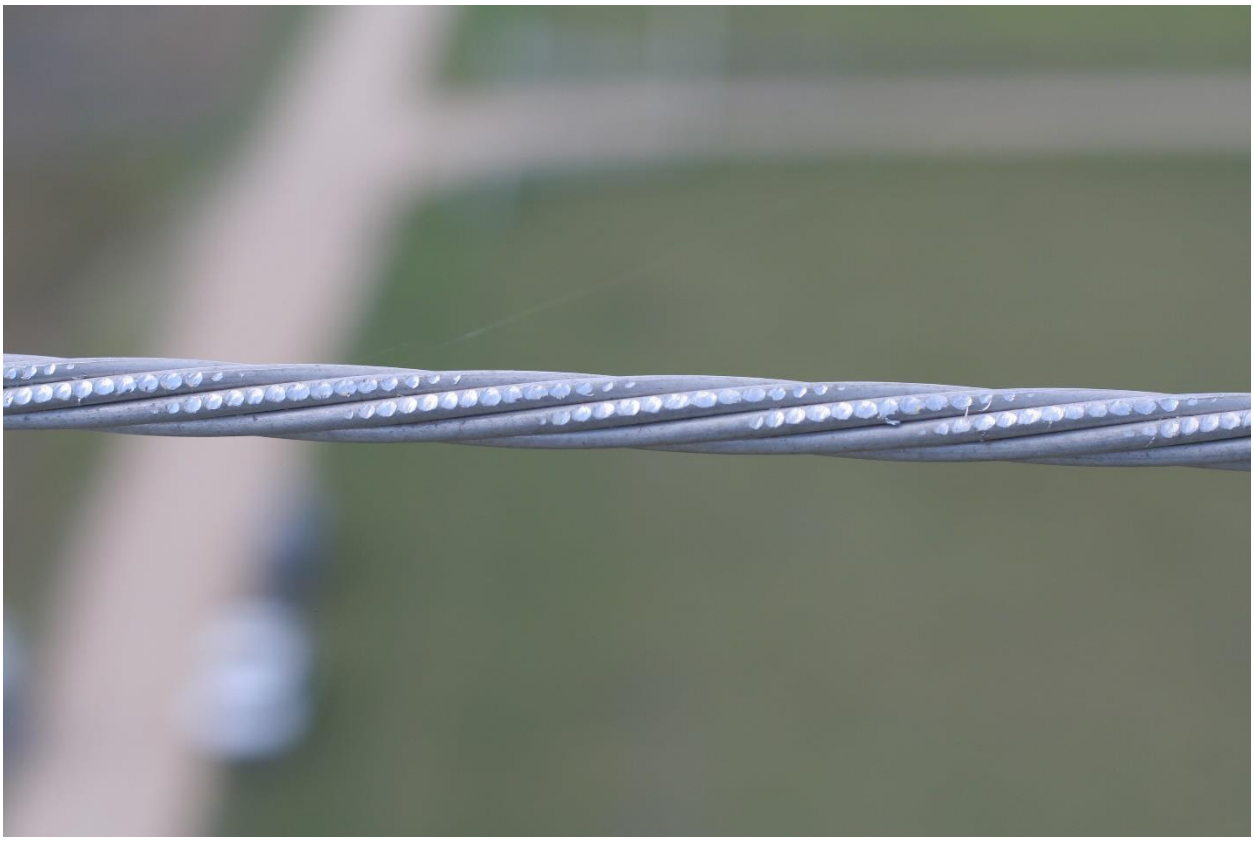


*Figure 12: An example of static line (East) abrasion/mechanical damage.*

The structural support for the East static line was bent (see Figure 13).

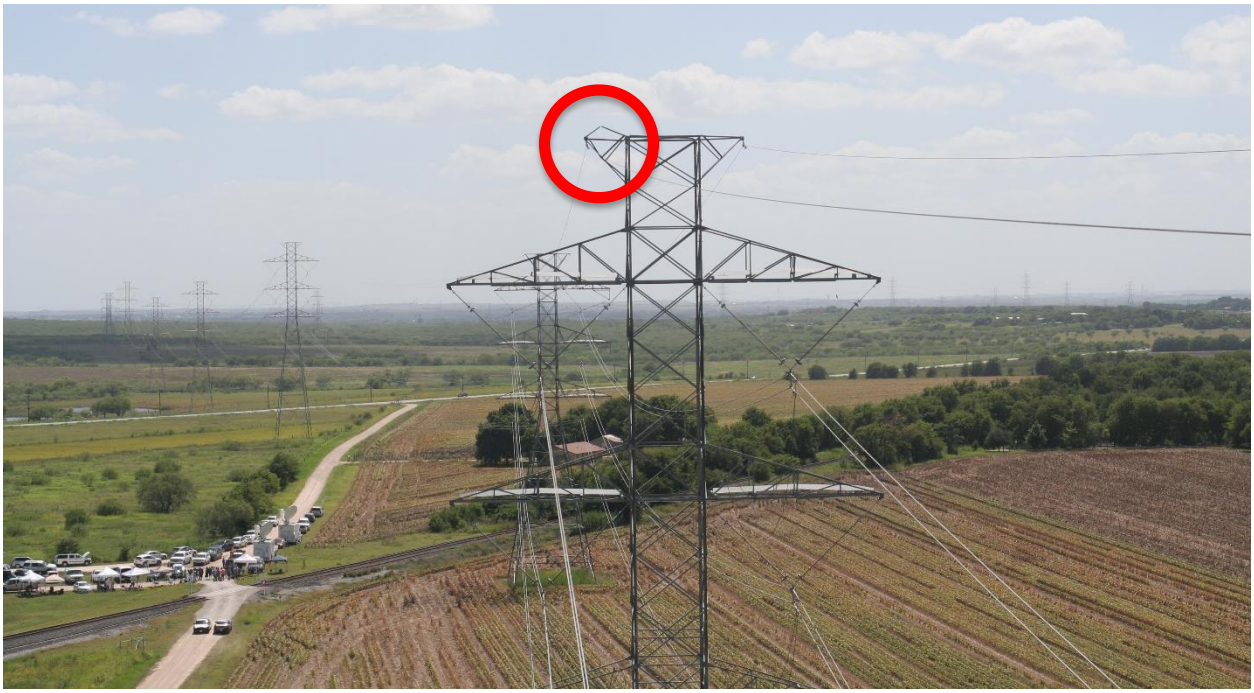


*Figure 13: Structural support for East Static Line with exhibited deformation.*

There was a black spot on the top cable of the 3rd phase pair. This may have been due to an arc flash and was the furthest (North) indication of damage on the power cables. This was approximately situated below the furthest (North) damage observed on the static line. See Figure 14.

*Figure 14: Indication of arcing damage on top cable of 3rd-phase cable pair (East).*

### 4.2.2 West Side Cables and Static Line:

There was evidence of deposited re-solidified metal or direct arcing damage to the top wire of the 1st-phase cable pair. See Figure 15.

*Figure 15 - Evidence of re-solidified metal on cable.*

The top and bottom cables of the 2nd-phase cable pair exhibited areas of arcing damage. This location was approximately right above the resting place of the basket. See Figures 16 and 17.

*Figure 16: Arcing damage on 2nd-phase cable. (West)*

*Figure 17: Arcing damage on 2nd-phase cable (West).*

The top cable of the 3rd-phase pair exhibited a kink/deformation. See Figure 18.

*Figure 18: The kink/deformation on top cable of 3rd-phase cable pair.*

There was evidence of contact with the static line (West), as red fabric was observed attached to the cable. See Figure 19.

*Figure 19: Evidence of contact and a portion of red fabric on West Static Line.*

Thomas Jacky
Aerospace Engineer

Attachment 1 – On-Scene Balloon Cable Examination
Attachment 2 – Examination of Envelope and Basket Cables at NTSB Laboratory