NATIONAL TRANSPORTATION SAFETY BOARD

Office of Aviation Safety
Washington, D.C. 20594

December 12, 2019

STRUCTURES

Group Chairman's Factual Report

DCA19MA143

Appendix B – Boeing EQA Report N732MA
(25 pages)

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7 October 2019
66-ZB-H200-ASI-19117

Clint Crookshanks
Structures Group Chairman
National Transportation Safety Board
490 L'Enfant Plaza East, S.W.
Washington, D.C. 20594-2000
Via e-mail: Clinton.crookshanks@ntsb.gov

BOEING

Subject: EQA Report Transmittal Miami Air 737-800 N7352MA Runway Overrun in Jacksonville, Florida – 3 May 2019

References: (a) E-mail from NTSB to Boeing, 15 July 2019, DCA19MA143 Miami Air grease and wire samples

Dear Mr. Crookshanks:

In support of the NTSB investigation into the subject event, Boeing's Equipment Quality Analysis (EQA) laboratory performed an examination of grease and wire samples removed from N732MA. Please find the EQA lab reports enclosed with this letter.

The information included with this correspondence is controlled under the US Export Administration Regulations (15 CFR Parts 300-799) and has been categorized as ECCN: 9E991.

Please feel free to contact us if you have any questions.

Best regards,

[redacted]

Robert J. McIntosh
Director, Product Safety

Enclosure: Boeing EQA Report AS13067

Equipment Quality Analysis Report

Boeing Commercial Airplanes

TO: Air Safety Investigations

EQA NUMBER: AS13067

DATE: October 4, 2019

MODEL NUMBER: 737-800

AIRPLANE NUMBER: YC904

SUBJECT: ***Right Main Landing Gear Wire and Grease Samples***

IDENTIFICATION:

Part name: Right Main Landing Gear (RMLG) Wires
Boeing part number: BMS13-60T10C03G018-92607(Red)

Part name: Grease
Boeing part number: BMS3-33
Supplier part number: Aeroshell 33

REFERENCE: (a) National Transportation Safety Board Investigation Number DCA19MA143

BACKGROUND:

As reported in reference (a), on May 3, 2019, at 2142 eastern daylight time, Miami Air flight 293, a Boeing 737-800, registration N732MA, departed the end of runway 10 at Jacksonville Naval Air Station (KNIP), Jacksonville, Florida, and came to rest in shallow water in the St. Johns River.

On site investigators noted damage above the window belt between fuselage station (FS) 559 and FS 597, as shown in Figure 1. It was reported that the RMLG was discovered under water and forward of the right wing. A section of blue wire was removed from the folded over skin section in the upper aft area of the fuselage damage, shown in Figure 2. A dollop of grease was found on the back side of the overhead storage bins and was collected from the outside of the aircraft through the damage area. Investigators removed a three-wire harness from the RMLG that had a full length red and yellow wire, and a fractured blue wire. A grease sample was also collected from one of the attachment bearings of the RMLG.

Aircraft YC904 was delivered on April 26, 2001, and was reported to have accumulated 38,928 hours and 15,610 cycles at the time of the incident.

Boeing Equipment Quality Analysis support was requested by the NTSB, through Boeing Air Safety Investigations (ASI), to examine the wires for similarities in the fractured ends, and analyze the grease samples to determine if they are of the same type.

Figure 1 – Image of fuselage showing damage area provided by Boeing ASI

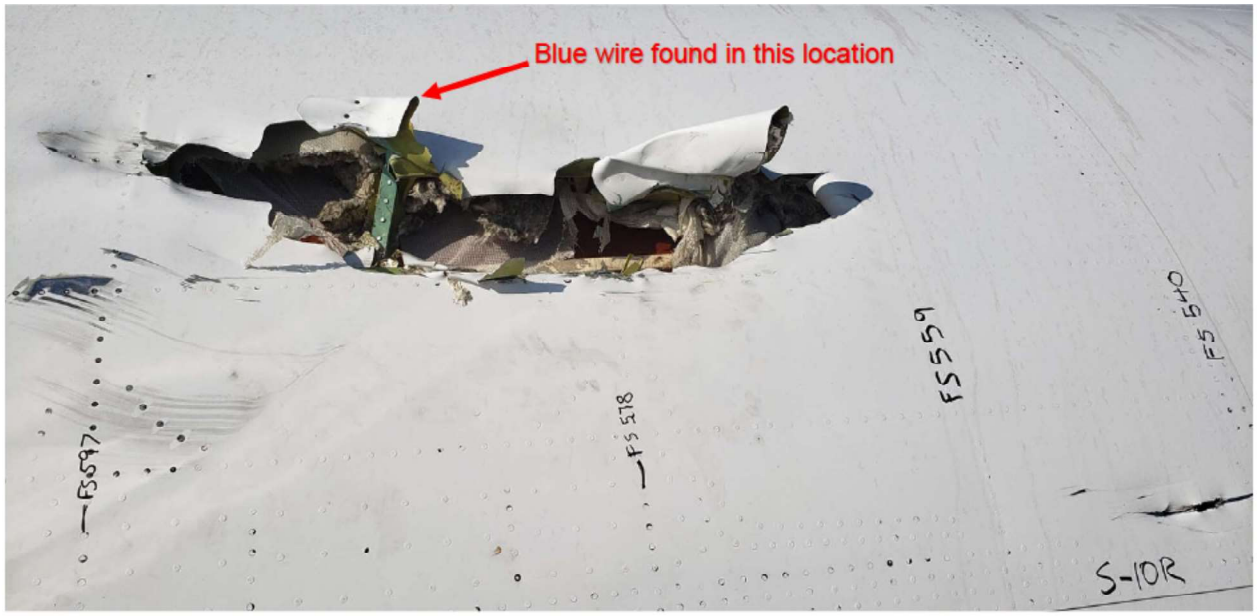


Figure 2 – Image of damage area provided by Boeing ASI

EXAMINATION:

An examination was conducted with representatives of the NTSB, Boeing ASI, and Boeing Structural Damage Technology (SDT), at the EQA facilities in Seattle, WA, on September 24, 2019.

The wire and grease samples were hand carried to the examination by NTSB representatives. The wire samples are shown as received in Figure 3 and Figure 4, and the grease samples are shown in Figure 30 and Figure 31.

The section of blue wire removed from the fuselage is shown in Figure 3, referenced as Wire Section 44. The three-wire harness from the RMLG is shown in Figure 4, labeled RMLG Wires.

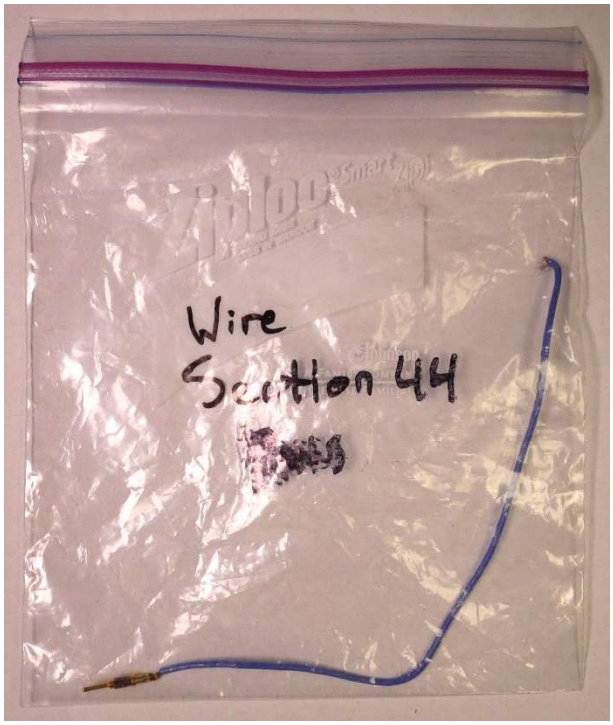


Figure 3 – Blue wire removed from fuselage

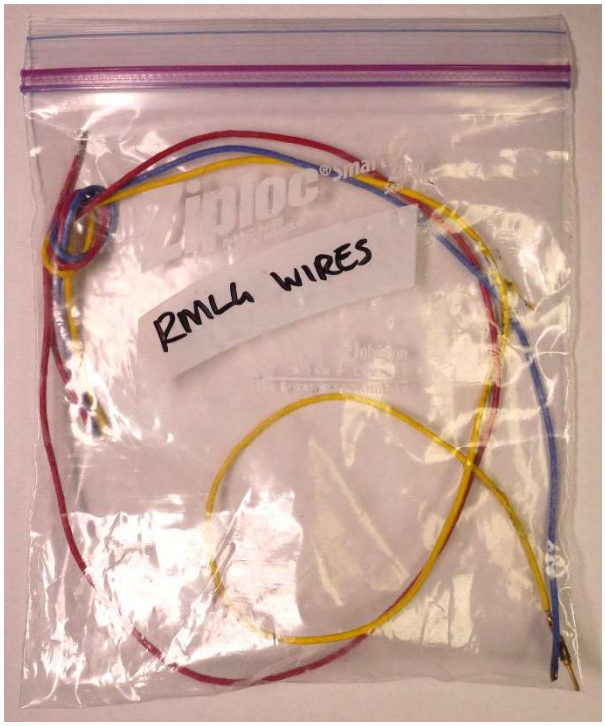


Figure 4 – RMLG wire harness

The RMLG harness was removed from the packaging for examination, Figure 5.

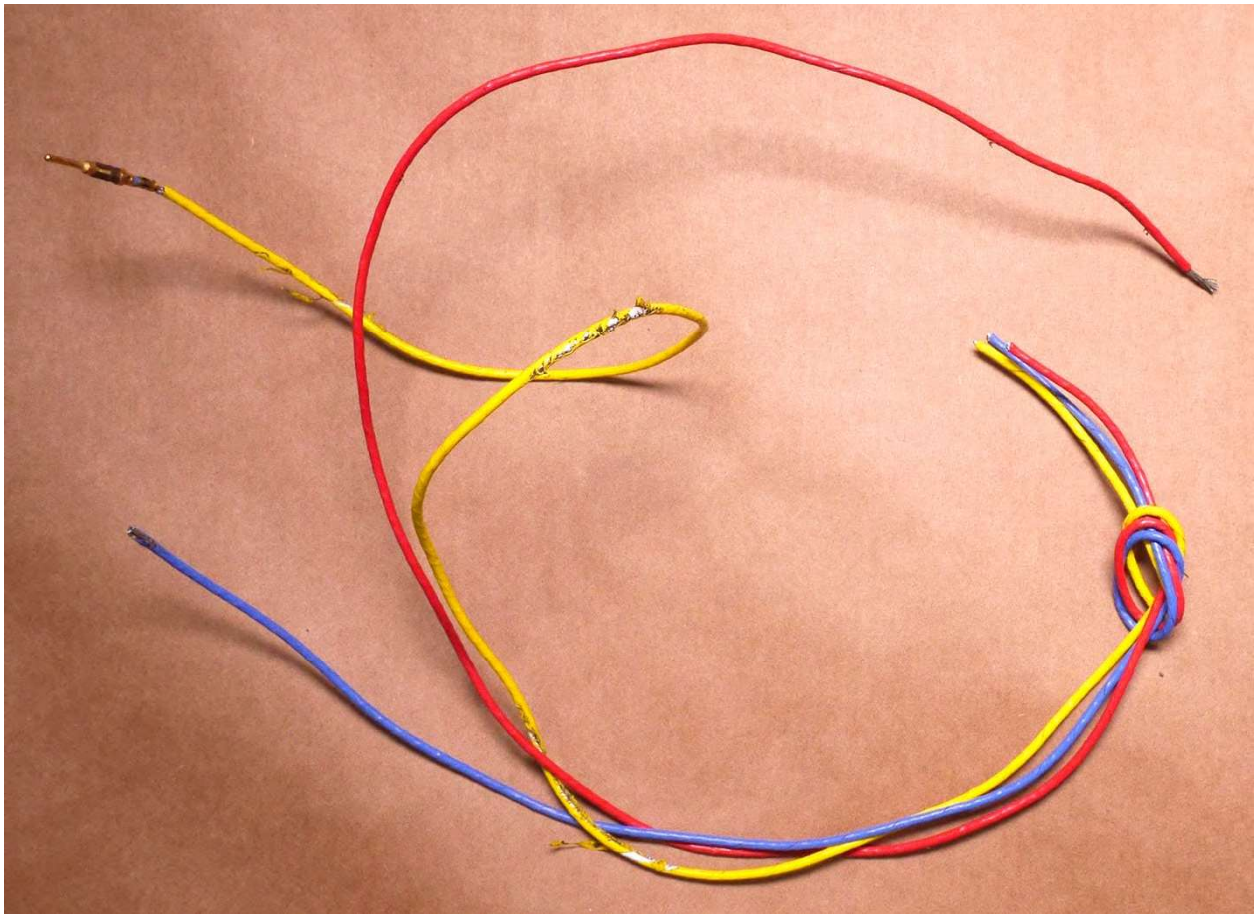


Figure 5 – RMLG harness

The RMLG wire harness had been cut for removal from the gear by on site investigators, as described by the NTSB and Boeing ASI. The cut ends of the wires are shown in Figure 6 through Figure 8.

Figure 6 – RMLG red wire

Figure 7 – RMLG yellow wire

Figure 8 – RMLG blue wire

Figure 6 through Figure 8 - RMLG wire harness cut ends

The end of the red wire opposite the cut end had 0.375 inches of stripped jacket, shown in Figure 9, and was measured to be 26.750 inches in length from the cut end to the end of the stripped wire. One area of damage was noted in the jacket of the red wire.

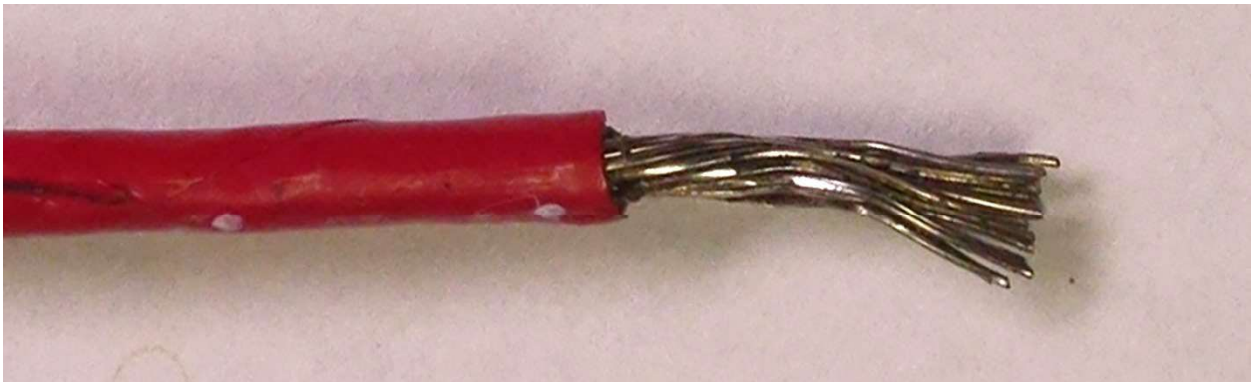


Figure 9 – RMLG red wire stripped end

The red wire had a visible label printed with Boeing Material Specification BMS13-60T10C03G018-92607, shown in Figure 10 and Figure 11. There were no other defects or noteworthy items on the RMLG red wire.

Figure 10 – RMLG red wire showing wire label

Figure 11 - RMLG red wire showing wire label

The RMLG yellow wire had a pin contact opposite the cut end, shown in Figure 12, and was measured to be 27.250 inches from the cut end to the end of the pin contact.

Figure 12 – RMLG yellow wire contact end

Three areas of jacket damage were noted on the RMLG yellow wire, an example of which is shown in Figure 13. There were no other defects or noteworthy items on the yellow RMLG wire. No visible wire label was noted.

Figure 13 – RMLG yellow wire example of jacket damage

The RMLG blue wire was fractured opposite the cut end, shown in Figure 14 and Figure 15, and was measured to be 17.125 inches from the cut end to the fractured end. The blue wire fractured end was coated with particulates from reportedly being submersed in brackish water for several days after the incident, as shown in Figure 14 and Figure 15. No visible jacket damage or wire label was noted on the blue wire.

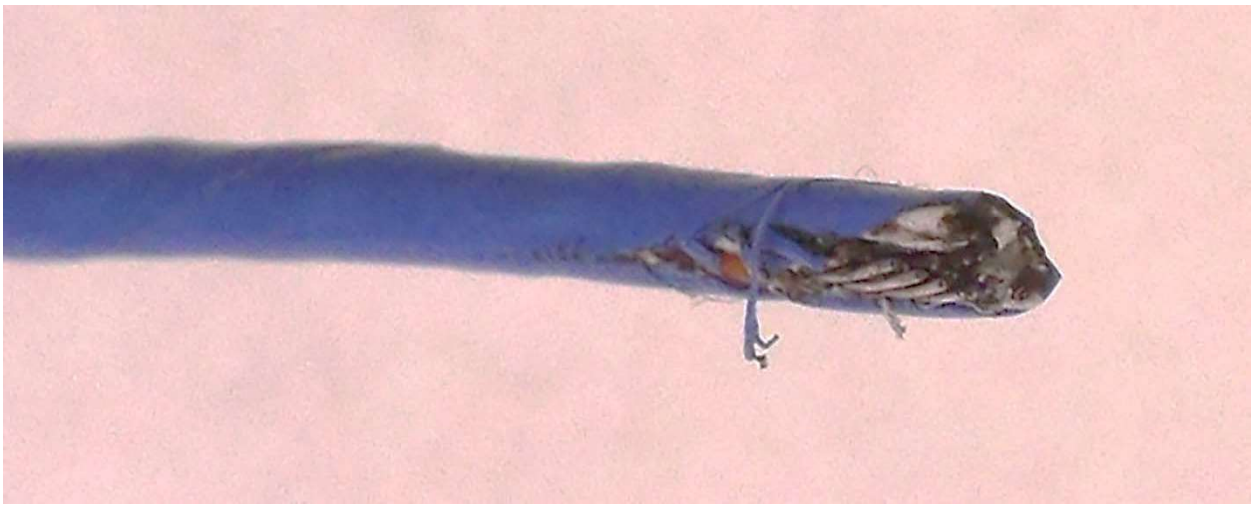


Figure 14 – RMLG blue wire fractured end

Figure 15 – RMLG blue wire fractured end

The RMLG blue wire was cleaned using isopropyl alcohol to remove particulates. The blue wire after cleaning is shown in Figure 16.

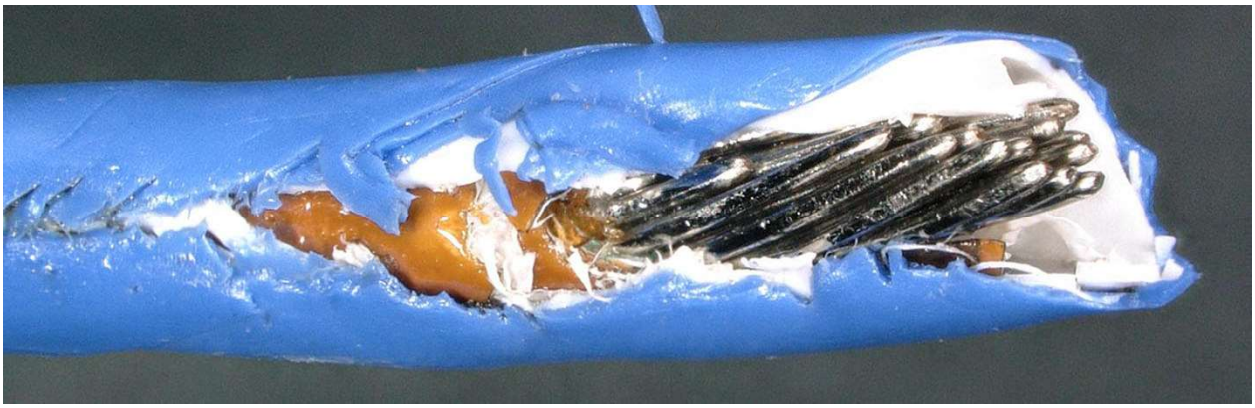


Figure 16 – RMLG blue wire fractured end after cleaning

All visible wire strands were described by ASI and NTSB as showing evidence of necking, or tapering of the wire from being stretched, shown in Figure 17 and Figure 18. There was also evidence of ductile overload, where the stresses applied to the wire exceed the ultimate tensile strength and the material fails quickly, as shown in Figure 17 and Figure 18.

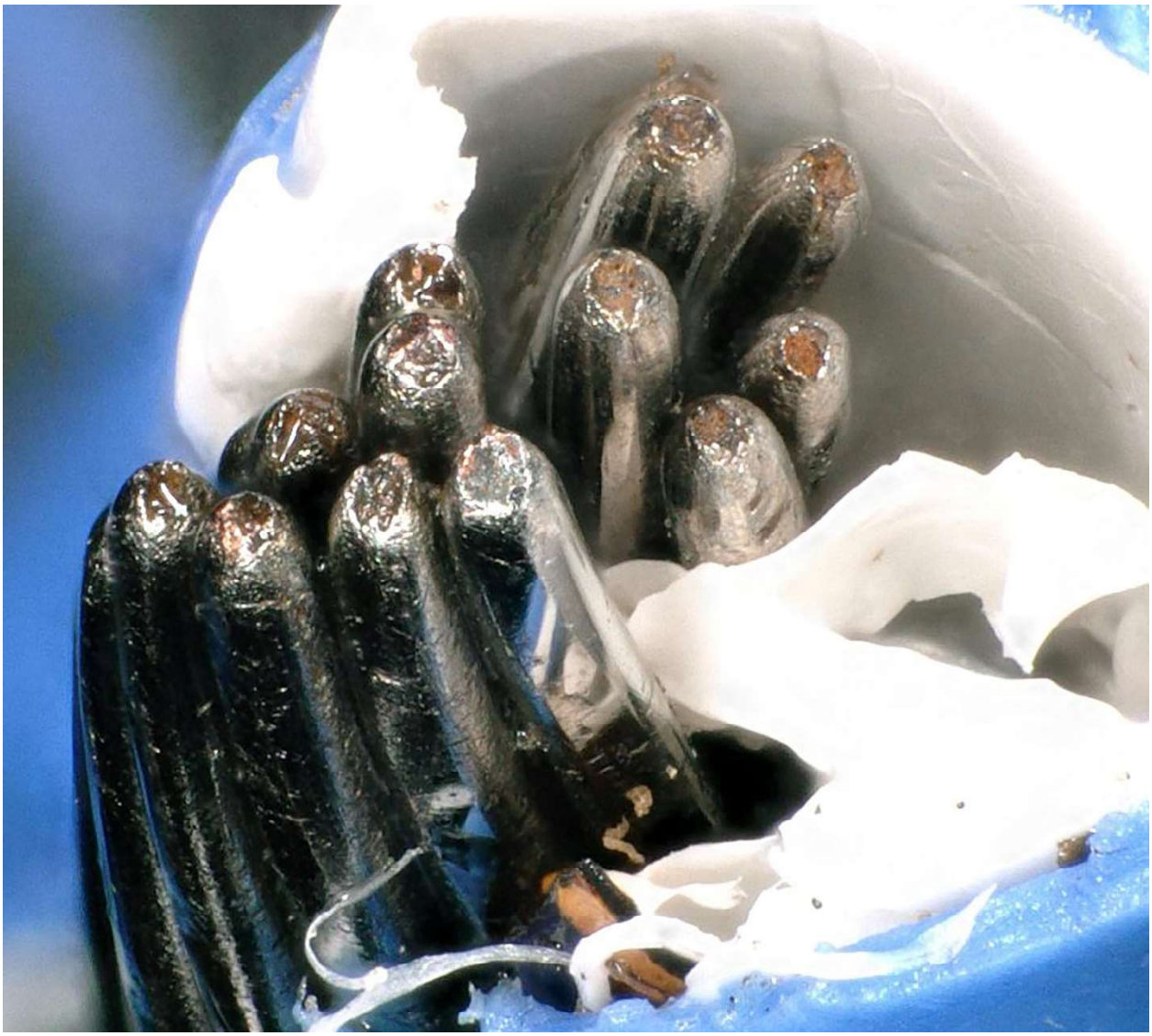


Figure 17 – RMLG blue wire fractured end showing necking and ductile overload

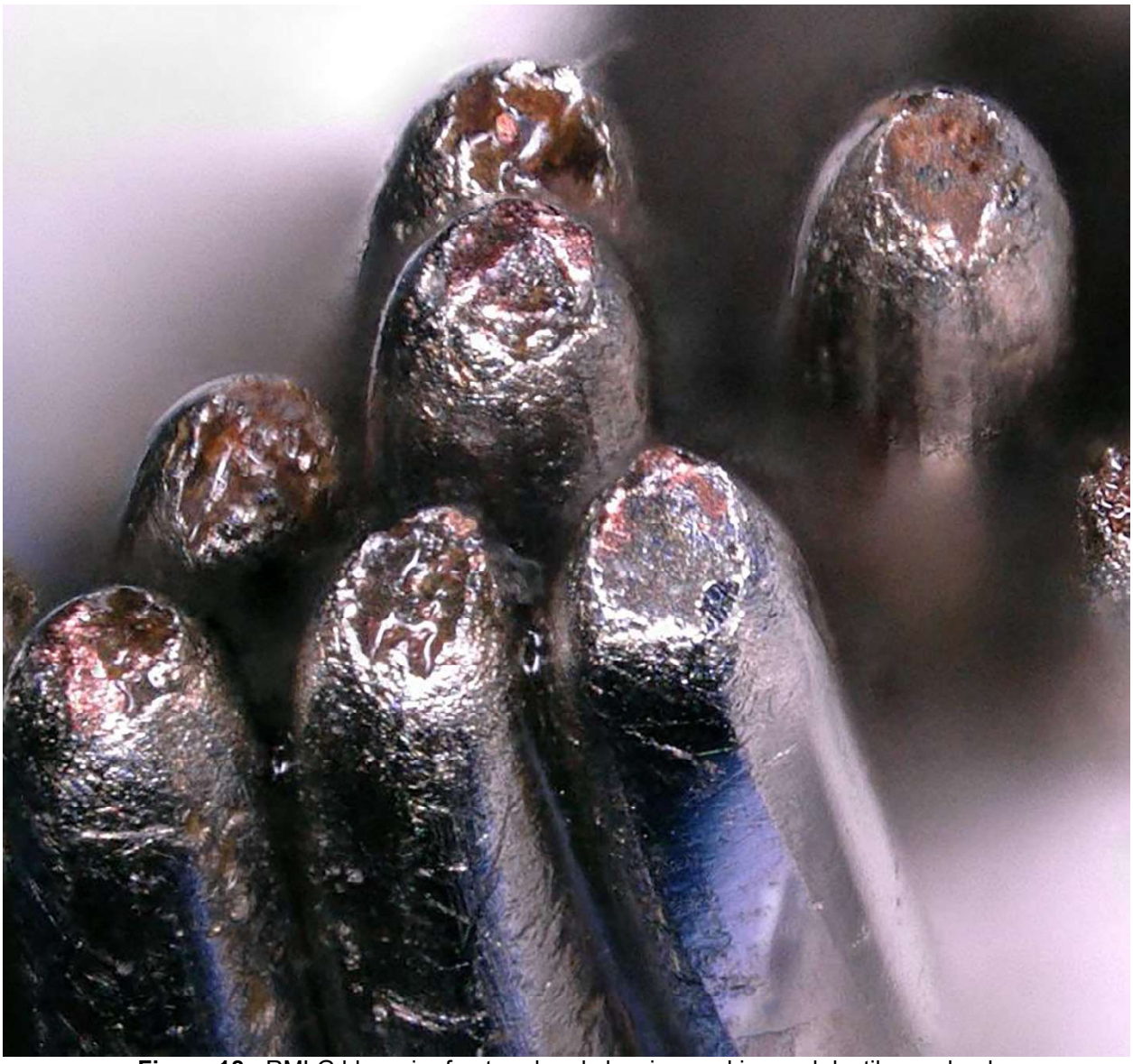


Figure 18 - RMLG blue wire fractured end showing necking and ductile overload

The jacket of the RMLG blue wire was peeled back to expose all nineteen wire strands, shown in Figure 19 and Figure 20.

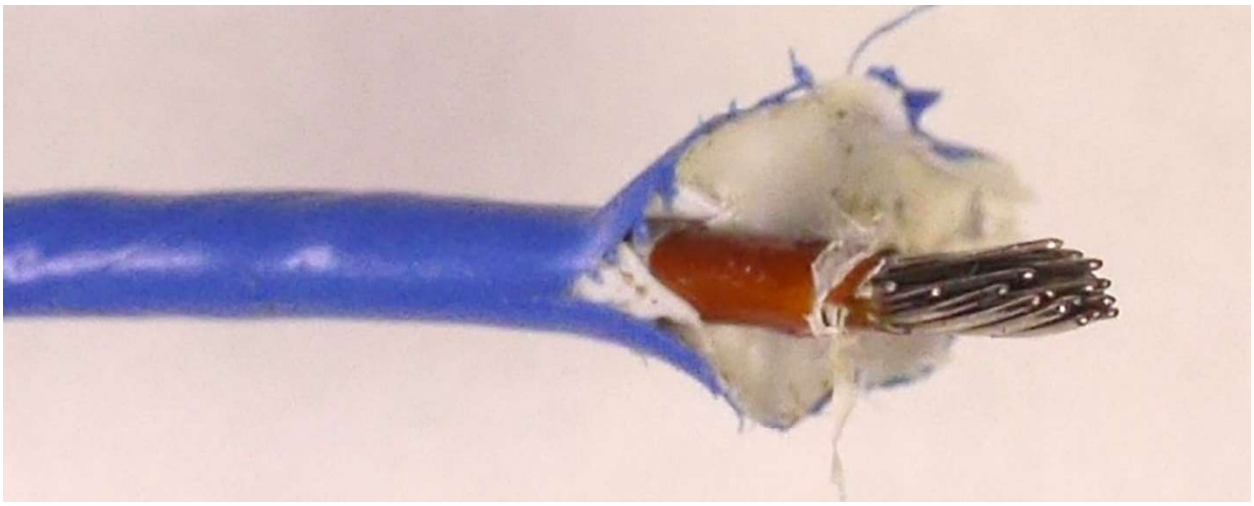


Figure 19 - RMLG blue wire fractured end with jacket peeled back

Figure 20 - RMLG blue wire fractured end with jacket peeled back

Wire section 44 was removed from the packaging for examination, shown in Figure 21.

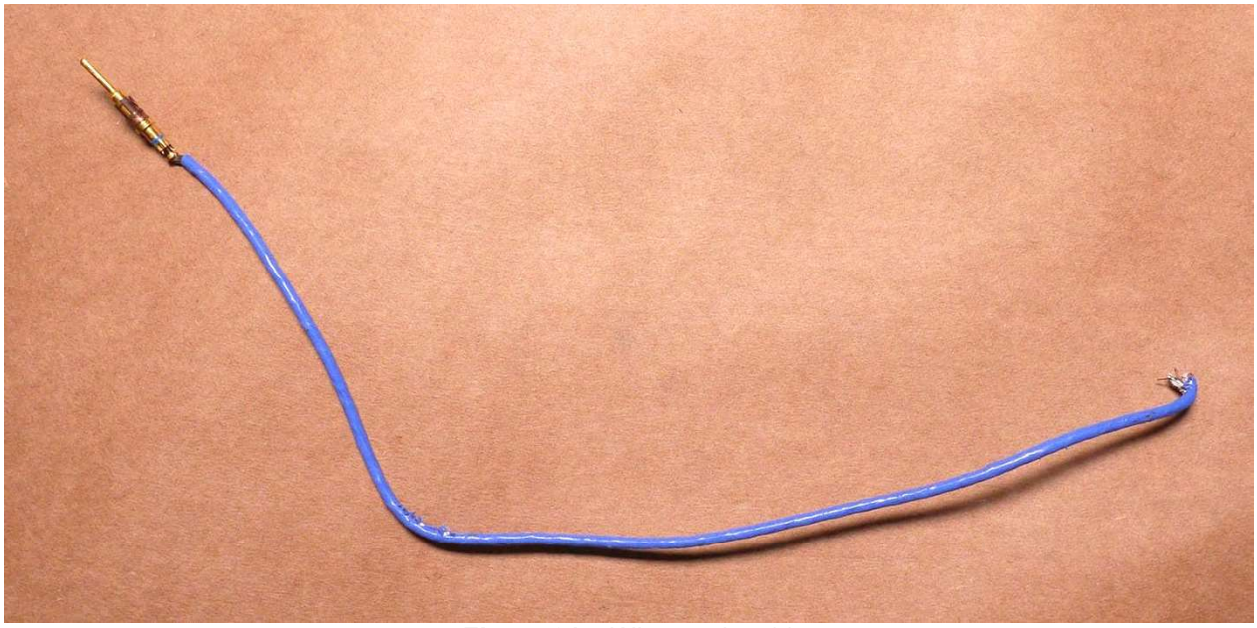


Figure 21 – Wire section 44

Wire section 44 was noted to have a pin contact on one end, Figure 22, with the opposite end fractured and bent to approximately ninety degrees, Figure 23. The wire was measured at 9.875 inches from the bent fracture end to the end of the pin contact, approximately 10 inches with the fractured end straightened. Two areas of damage to the wire jacket were noted.

Figure 22 – Wire section 44 pin contact

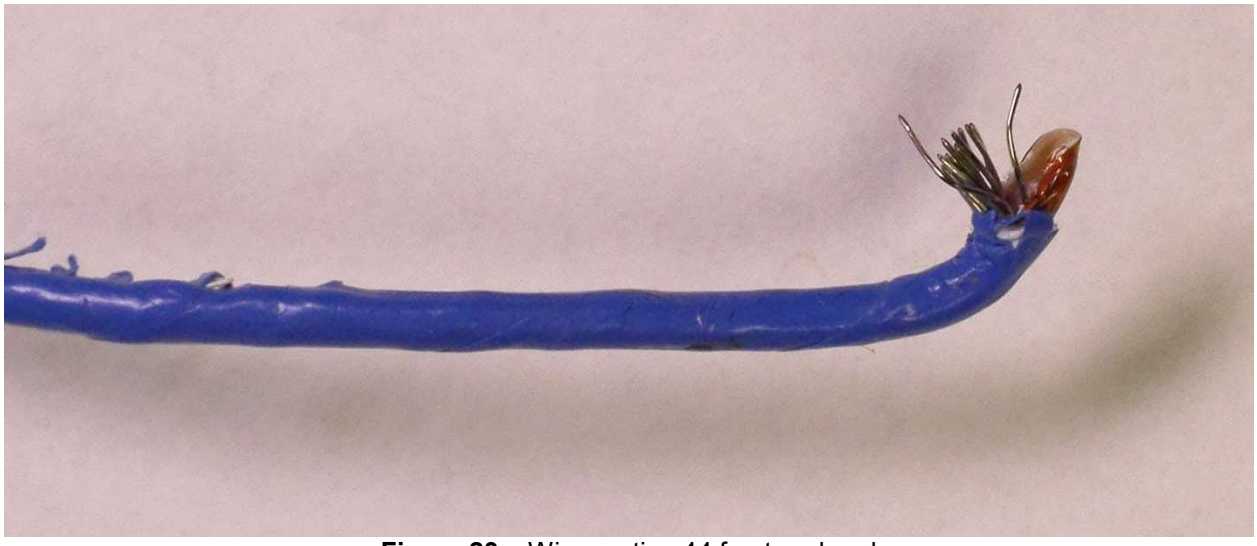


Figure 23 – Wire section 44 fractured end

Digital microscopic images of the fractured end of wire section 44 are shown in Figure 24 and Figure 25.

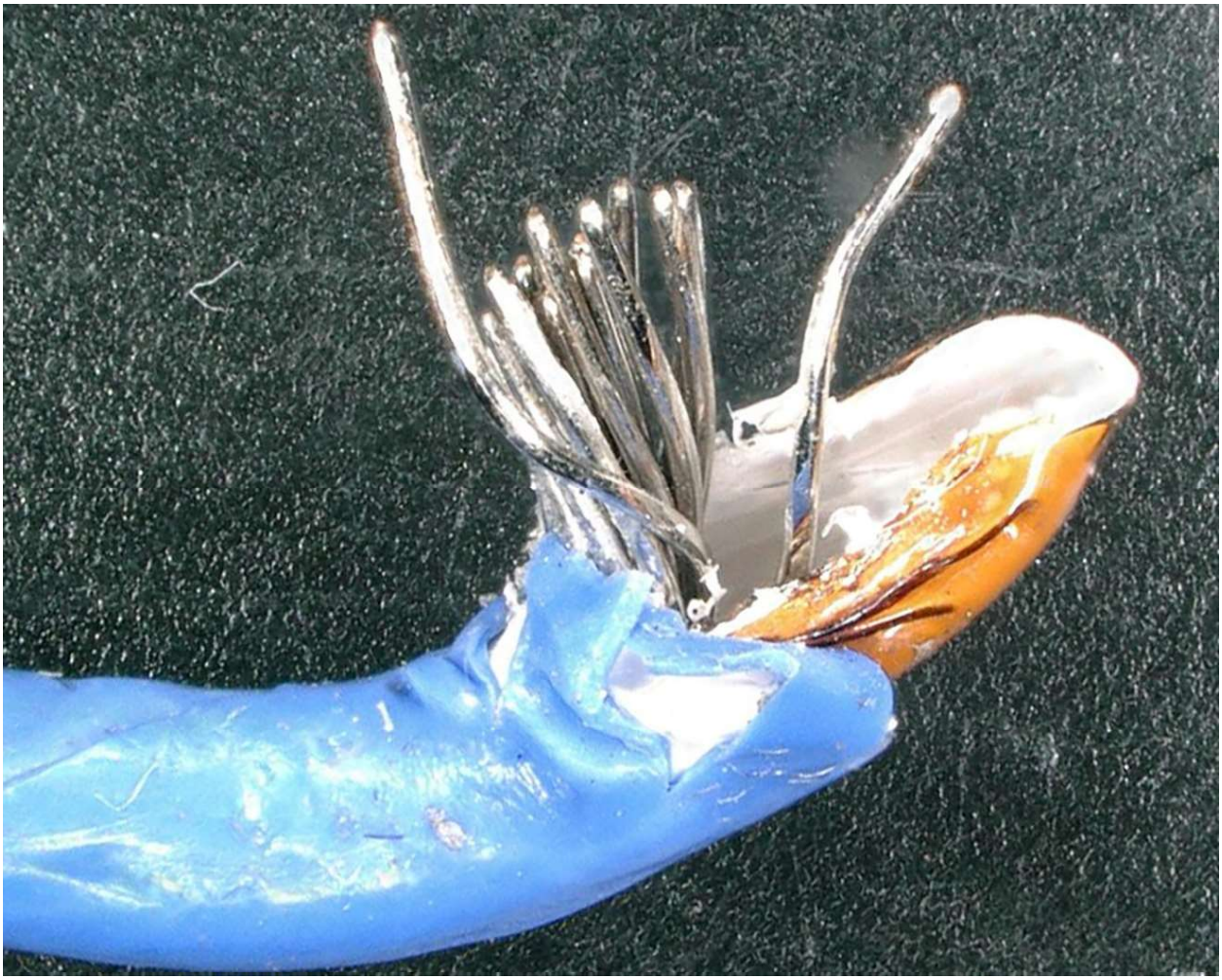


Figure 24 – Wire section 44

All nineteen wire strands were described by ASI and NTSB as showing signs of necking and ductile overload, as shown in Figure 25.

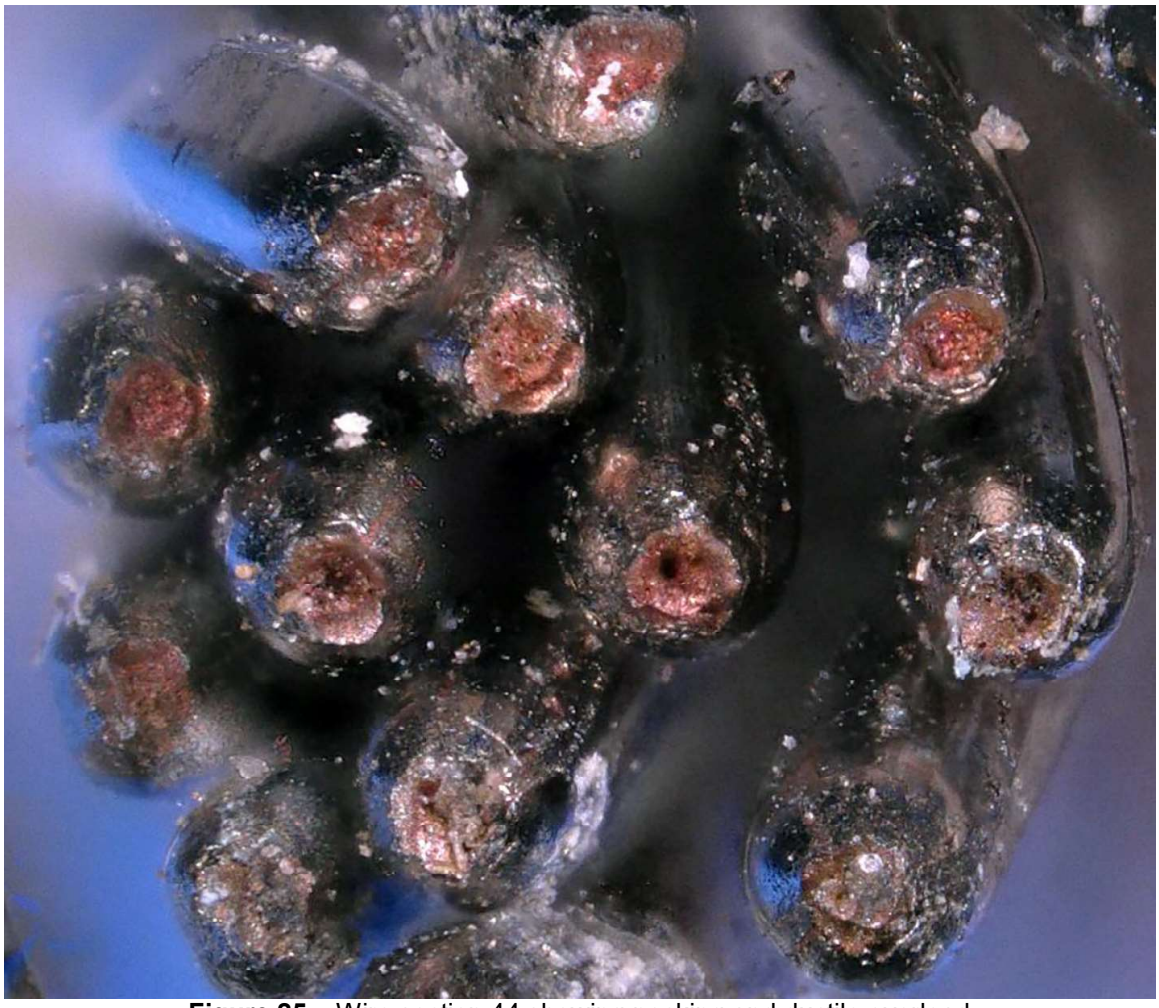


Figure 25 – Wire section 44 showing necking and ductile overload

The fractured end was straightened and two of the wire strands were noticeably longer than the other seventeen.

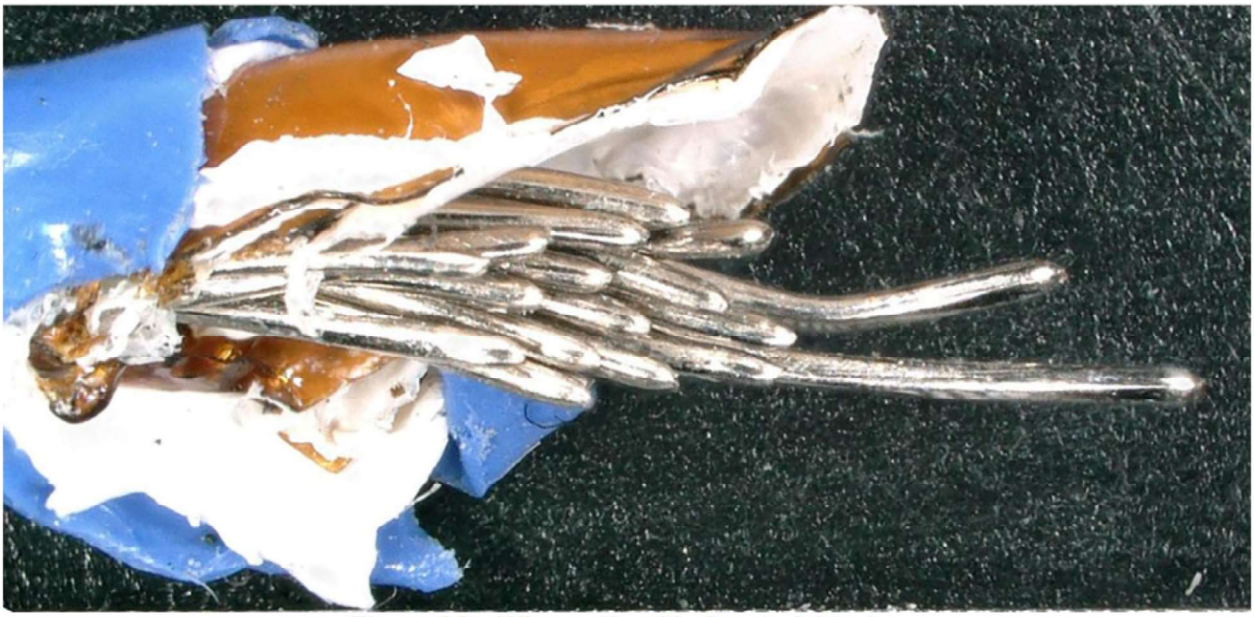


Figure 26 – Wire section 44 after straightening

The fractured ends of wire section 44 and the RMLG blue wire were lined up for comparison, shown in Figure 27 through Figure 29. It was noted that the two long wire strands from wire section 44 closely coincide with two short wire strands of the RMLG blue wire.

Figure 27 – RMLG blue wire and wire section 44

Figure 28 – RMLG blue wire and wire section 44

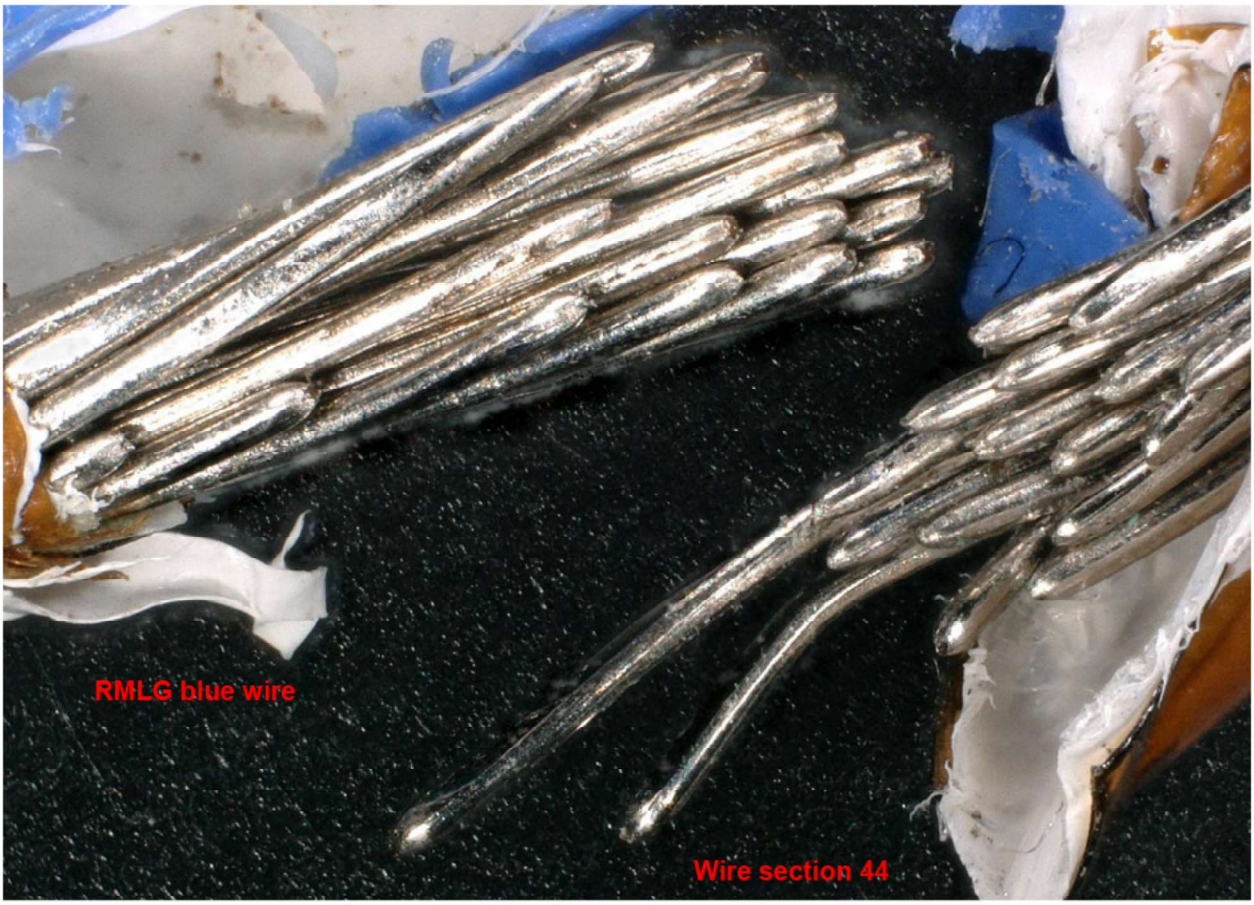


Figure 29 – RMLG blue wire and wire section 44

The two blue wire lengths, when combined, were noted as being similar in measurement to the RMLG red and yellow wires. Table 1 shows the wire lengths for ease of comparison.

Table 1 – Wire lengths in inches

RMLG red wire		26.750 inches
RMLG yellow wire		27.250 inches
RMLG blue wire	17.125 inches	Combined 27.125 inches
Wire section 44	~10 inches	

ANALYSIS:

Two grease samples were provided to Boeing Research & Technology (BR&T) for analysis. The grease sample from the fuselage is shown in Figure 30, labeled Grease Section 44 RHS. The grease sample from the RMLG attach bearing is shown in Figure 31, labeled Grease RHS MLG. It was reported that the landing gear was greased approximately 5 weeks prior to the incident, on March 26, 2019, and the aircraft was returned to service following the Phase Inspection at the end of April, approximately one week prior to the incident. The RMLG was found forward of the right wing, and was reportedly submersed in brackish water for two to three days prior to recovery.

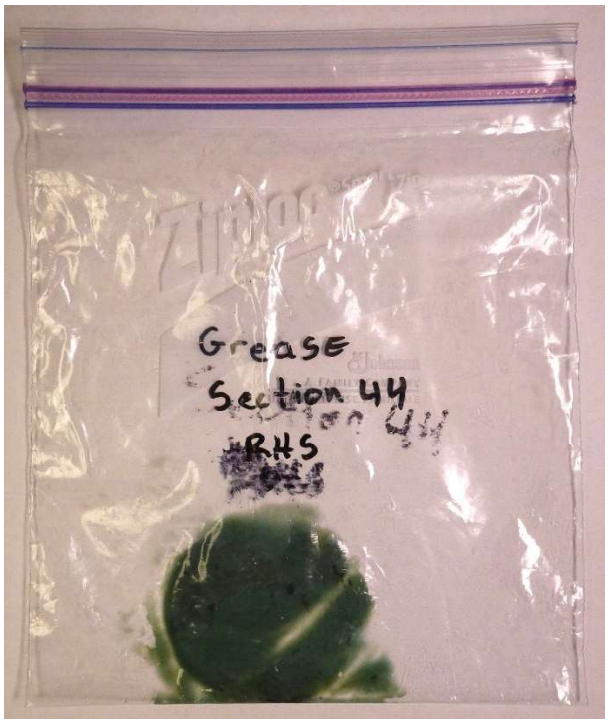


Figure 30 – Grease sample from fuselage

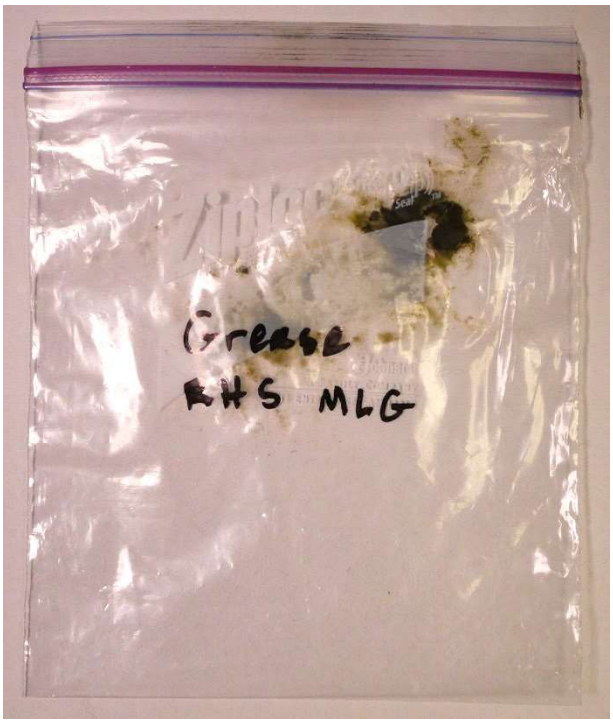


Figure 31 – Grease sample from RMLG

BR&T analysis of the grease samples is included in appendix A.

Both grease samples were consistent with a grease with an ester-modified saturated hydrocarbon base oil and lithium soap complex thickener such as BMS3-33 grease.

Both grease samples were very similar in overall chemistry. There were slight differences in the ratio of the base oil to thickener components between the two samples. Chemical Technology expressed that the “slight differences” were consistent with variations due to normal use, that base oil is reduced over time. The “slight differences” were likely not due to submersion of the grease in brackish water for several days.

Both greases were similar in chemistry and are consistent with BMS3-33; however, the “Grease RHS MLG” contains copper, which wasn’t observed in the “Grease Section 44 RHS” sample.

It is the opinion of Chemical Technology that the grease sample taken from the main landing gear still had sufficient lubricating properties.

DISPOSITION:

The subject wire samples were hand carried out by NTSB representatives. The subject grease samples were consumed in the analysis.

The preceding information is being submitted to the concerned personnel for action as necessary. The EQA group is contemplating no further action upon these RMLG wires at this time.

Signatures on file.

BOEING

Engineering, Test & Technology
Boeing Research & Technology

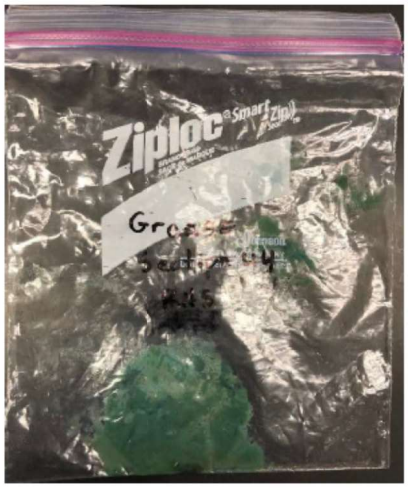
Chemical analysis of grease to support Miami Air EQA investigation

September 24, 2019

Summary

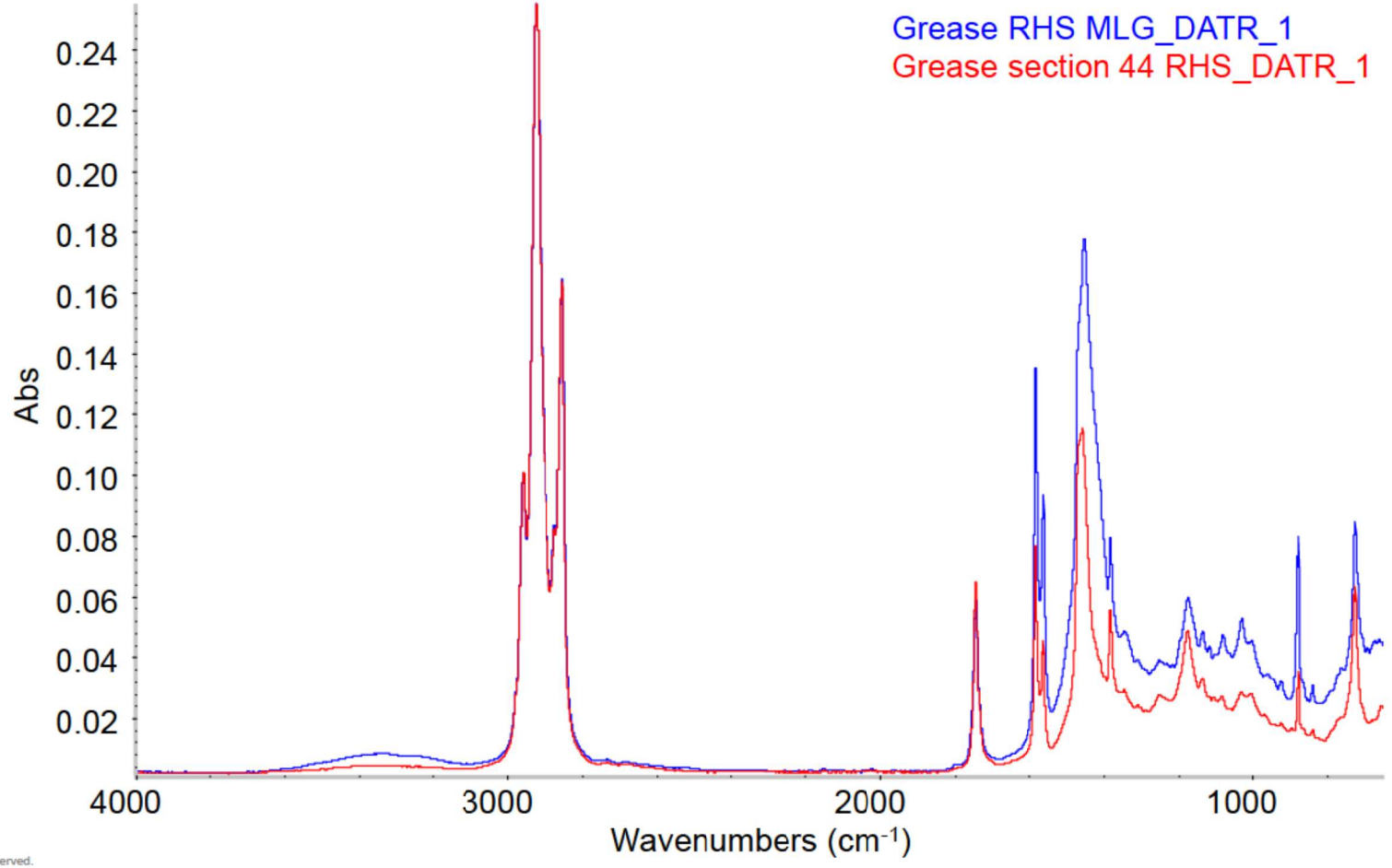
- **Two grease samples were submitted for analysis: "Grease RHS MLG" and "Grease section 44 RHS".**
- **The grease samples were analyzed using electron probe micro analysis (EPMA) and Fourier transform infrared (FTIR) spectroscopy.**
- **Both grease samples were very similar in chemistry and were consistent with a grease with an ester-modified saturated hydrocarbon base oil and lithium soap complex thickener such as BMS3-33 grease.**

Grease RHS MLG

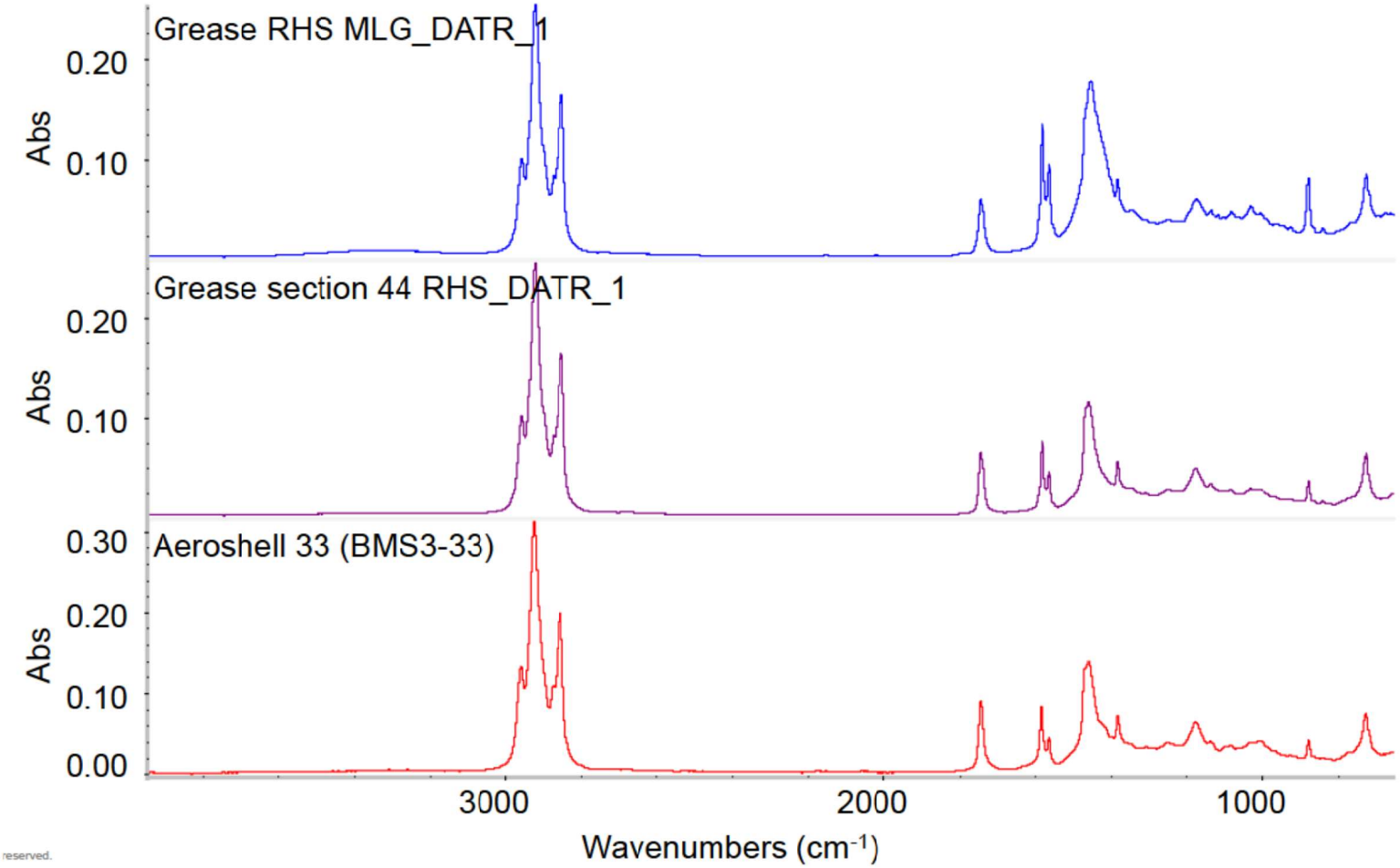


Grease section 44 RHS

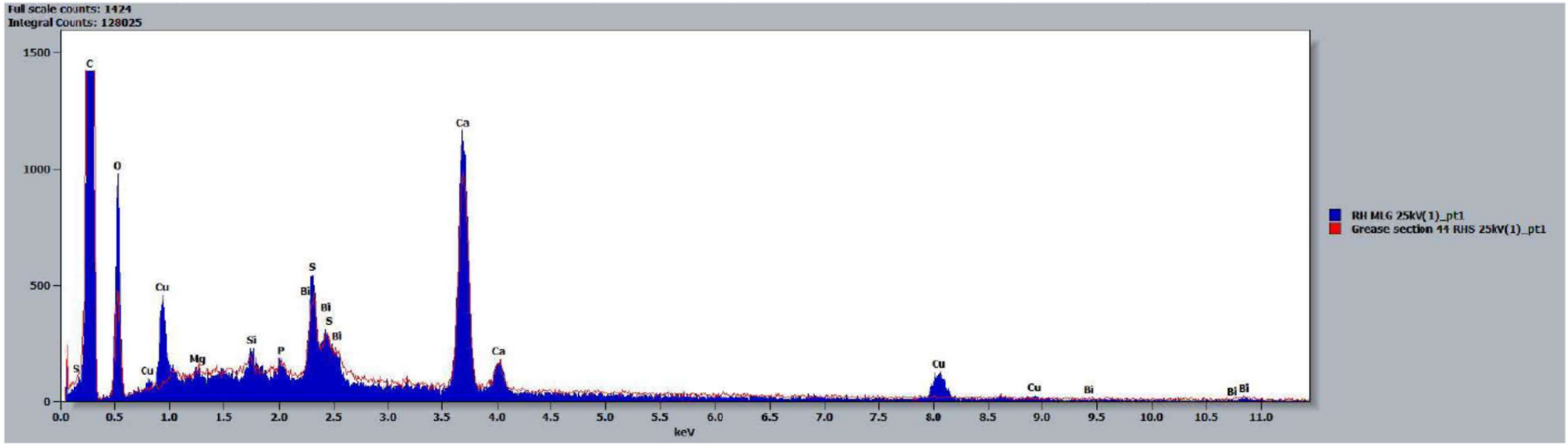
Both grease samples were very similar in overall chemistry; there was slight differences in the ratio of the base oil to thickener components between the two samples.



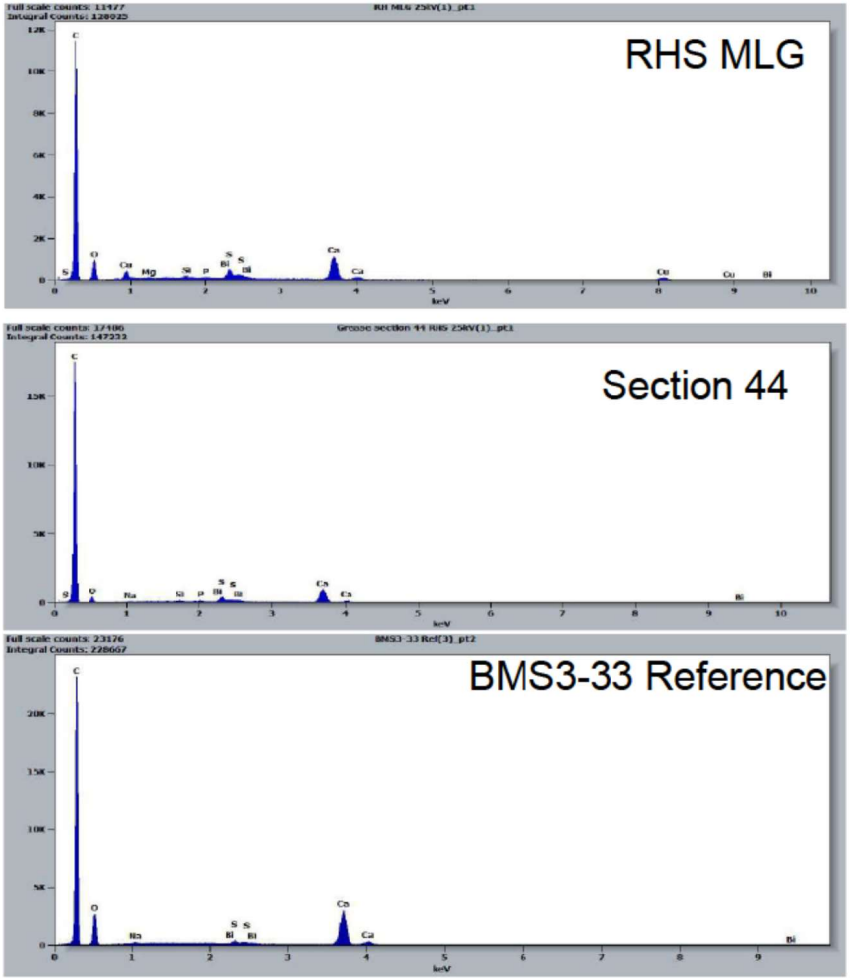
Both grease samples are consistent with a grease with an ester-modified saturated hydrocarbon base oil and lithium soap complex thickener such as BMS3-33 grease.



Both greases were similar in chemistry and are consistent with BMS3-33; however, the “Grease RHS MLG” contains copper which wasn’t observed in the “Grease Section 44 RHS” sample



Both greases are consistent with BMS3-33.



Methods

- **Fourier transform infrared (FTIR) spectroscopy analysis was performed using an iS50 benchtop FTIR spectrometer equipped with a diamond attenuated total reflectance (DATR) sampling accessory. The grease was placed directly onto the diamond sampling window without further modification.**

- **Energy dispersive x-ray spectroscopy (EDS) analysis was performed using Thermo Fisher Pathfinder EDS on a JEOL JXA-8530F Electron Probe Microanalyzer. The grease was placed onto conductive carbon adhesive and was carbon coated prior to analysis to reduce specimen charging effects.**