ATTACHMENT 2

Boeing Commercial Airplanes Equipment Quality Analysis Report

Examination of Control Stand Thrust Lever Assembly

Equipment Quality Analysis Report

Boeing Commercial Airplanes

TO: Air Safety Investigations (ASI)

EQA NUMBER: AS13021

DATE: December 2, 2019

CUSTOMER: Atlas Air, Inc. (TLS)

MODEL NUMBER: 767-300BCF

AIRPLANE NUMBER: VN064

SUBJECT: ***Examination of Control Stand Thrust Lever Assembly***

IDENTIFICATION:
Part name: Control Stand Thrust Lever Assy.
Boeing part number: 253T5800-33

REFERENCES:
(a) National Transportation Safety Board (NTSB)
Accident No.: DCA19MA086
(b) Component Maintenance Manual CMM-76-11-19
(c) Wiring Diagram Manual D280T199

BACKGROUND:

As described in reference (a), on February 23, 2019, at 12:39 central standard time, Atlas Air flight 3591, a Boeing 767-375BCF, N1217A, entered a rapid descent from 6,000 ft. and impacted a marshy bay area about 40 miles southeast of George Bush Intercontinental Airport (KIAH), Houston, Texas. The two pilots and one nonrevenue jumpseat pilot were fatally injured. The airplane was destroyed and highly fragmented. The airplane was operated as a Title 14 Code of Federal Regulations Part 121 domestic cargo flight, which originated from Miami International Airport (KMIA), Miami, Florida, and was destined for KIAH.

Boeing Equipment Quality Analysis (EQA) support was requested by the NTSB, through Boeing Air Safety Investigations (ASI), to examine the control stand thrust lever assembly recovered from the accident.

Aircraft VN064 was delivered on July 16, 1992, and was reported to have accumulated 91,047 hours and 23,313 cycles as of February 22, 2019.

EXAMINATION:

The thrust lever assembly (TLA) was hand delivered to EQA by the NTSB on June 28, 2019, and secured in the EQA facilities, see Figure 1.

Figure 1 – Shipment as arrived at EQA

The contents of the shipment were removed on August 5, 2019, with an NTSB representative present, for X-ray analysis prior to the scheduled physical examination. The contents of the shipment are shown in Figure 2 and Figure 3. Several annunciator switches were included in the shipment but NTSB representatives requested no examination be performed on these switches.

Figure 2 – Shipment contents

Figure 3 – Shipment contents

The TLA was unwrapped and photo documented prior to X-ray examination, as seen in Figure 4 and Figure 5. EQA was informed by Boeing ASI that the SYS 23 label on the left throttle lever was placed by on-site accident investigation teams for organizational purposes, and has no direct correlation to Boeing systems or part numbers.

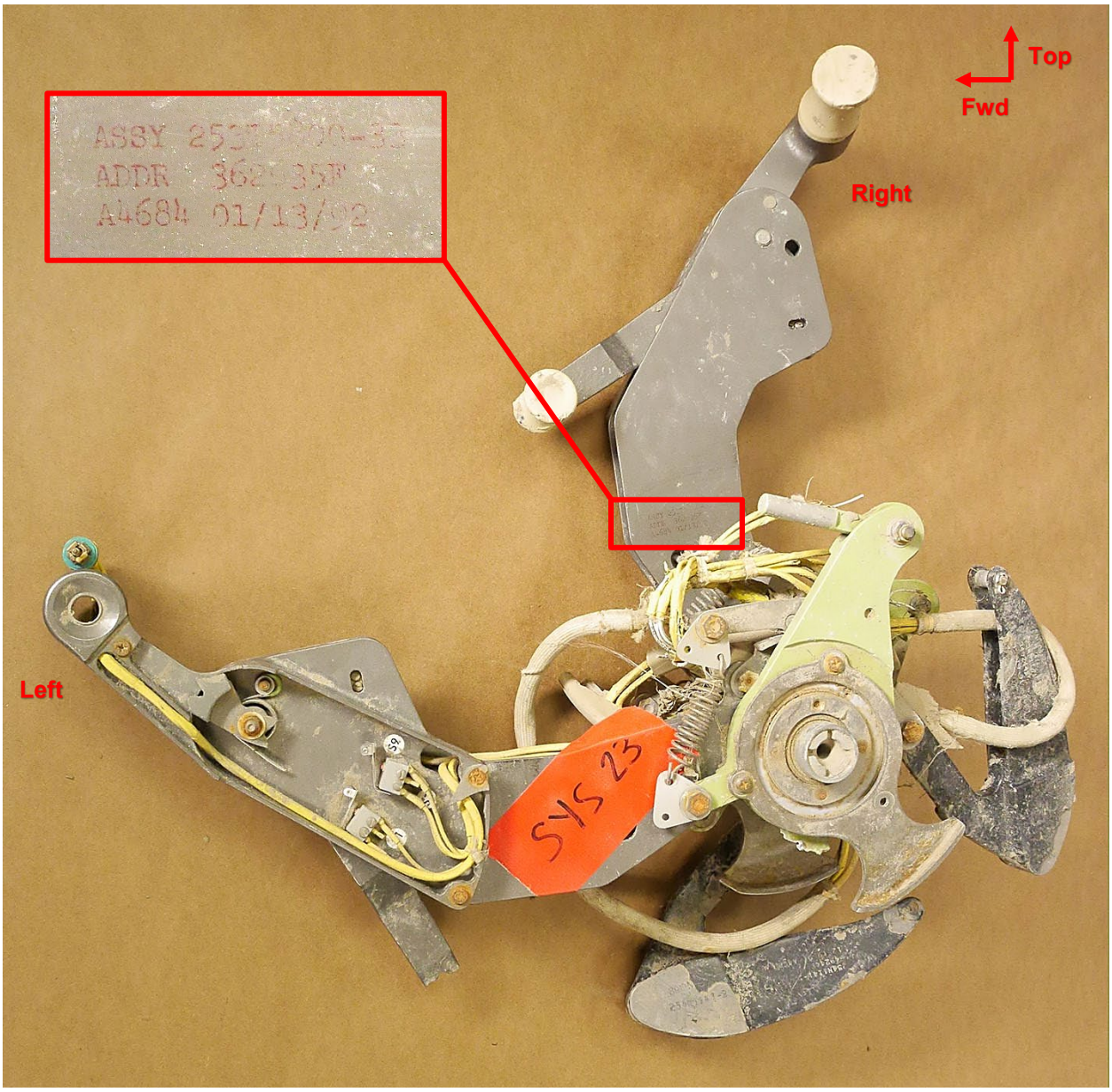

Figure 4 – TLA view from the left side

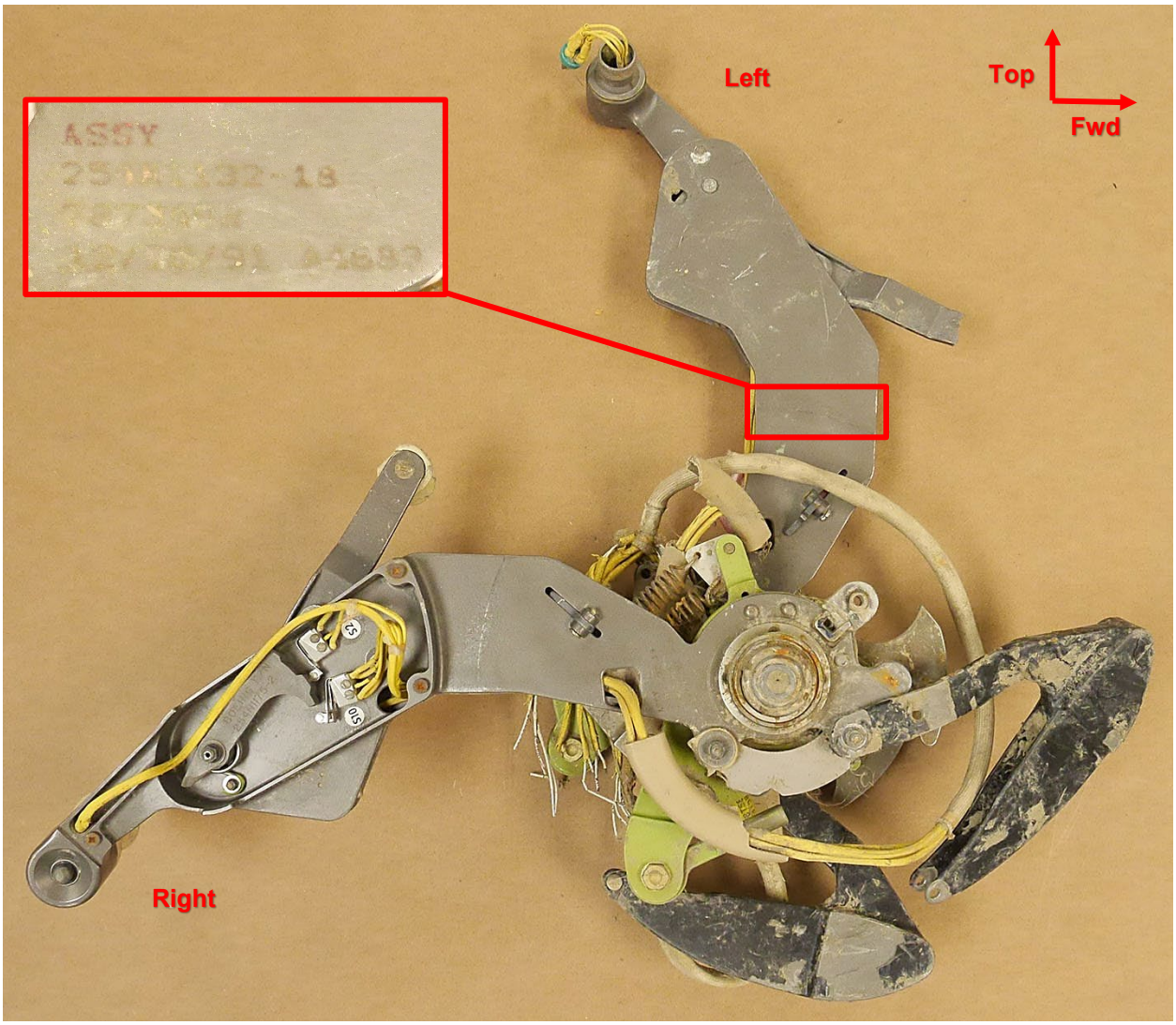

Figure 5 – TLA view from the right side

The TLA was examined using digital radiography (DR) X-ray imagery. A composite of three DR images of the TLA is shown in Figure 6.

Figure 6 – DR composite image of TLA

The primary focus of the DR examination was on the go-around switches in each throttle lever and the associated wiring, as seen in Figure 7 through Figure 13. It was noted that the actuator arm on the right throttle single switch was depressed, depressing the associated switch, as seen in Figure 7. There was also high density material noted in the right throttle where the wiring leaves the switch cavity of the handle, shown in Figure 12. No other anomalies were observed during examination of the go-around switches and switch wiring.

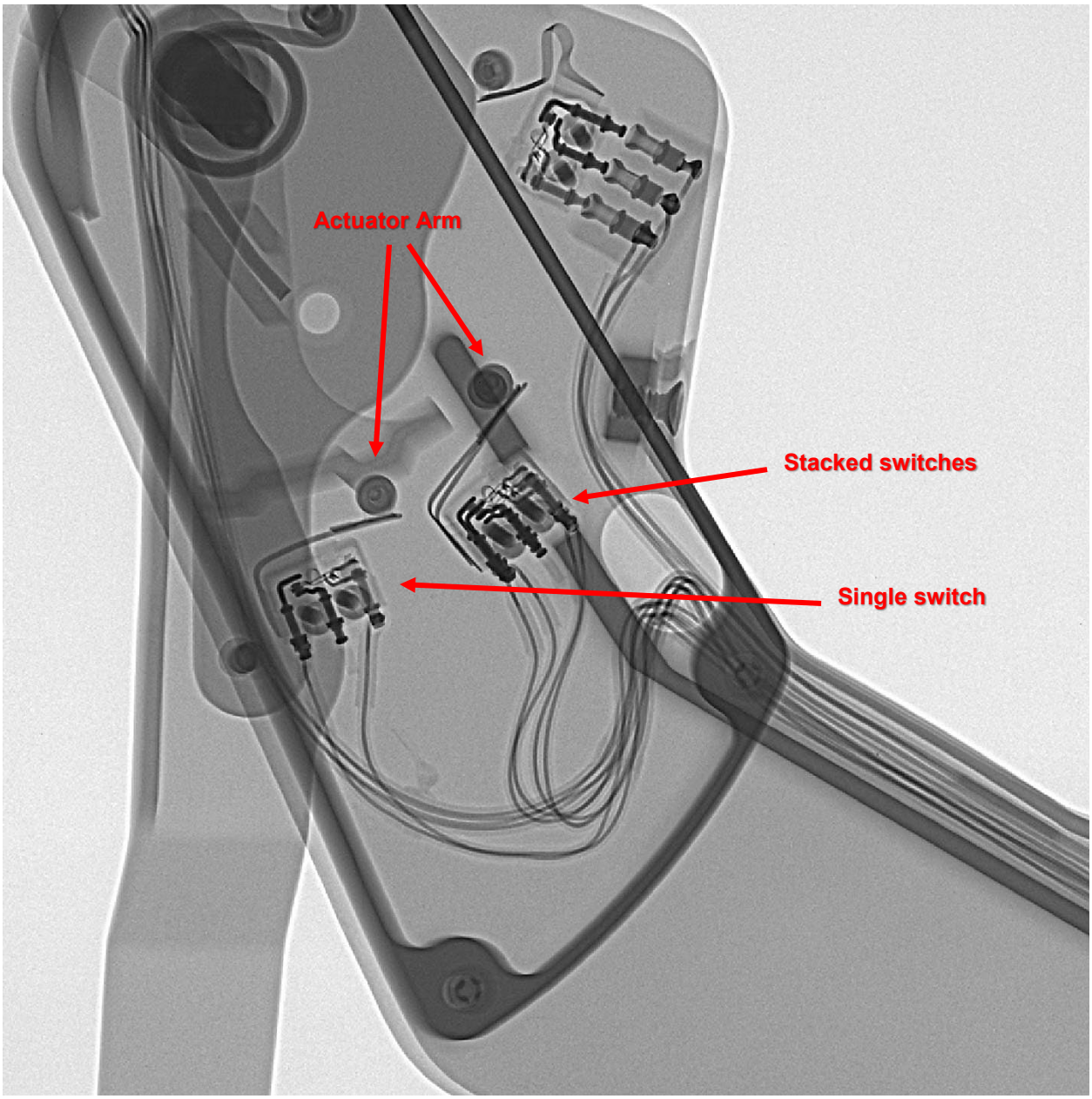

Figure 7 – Right throttle lever

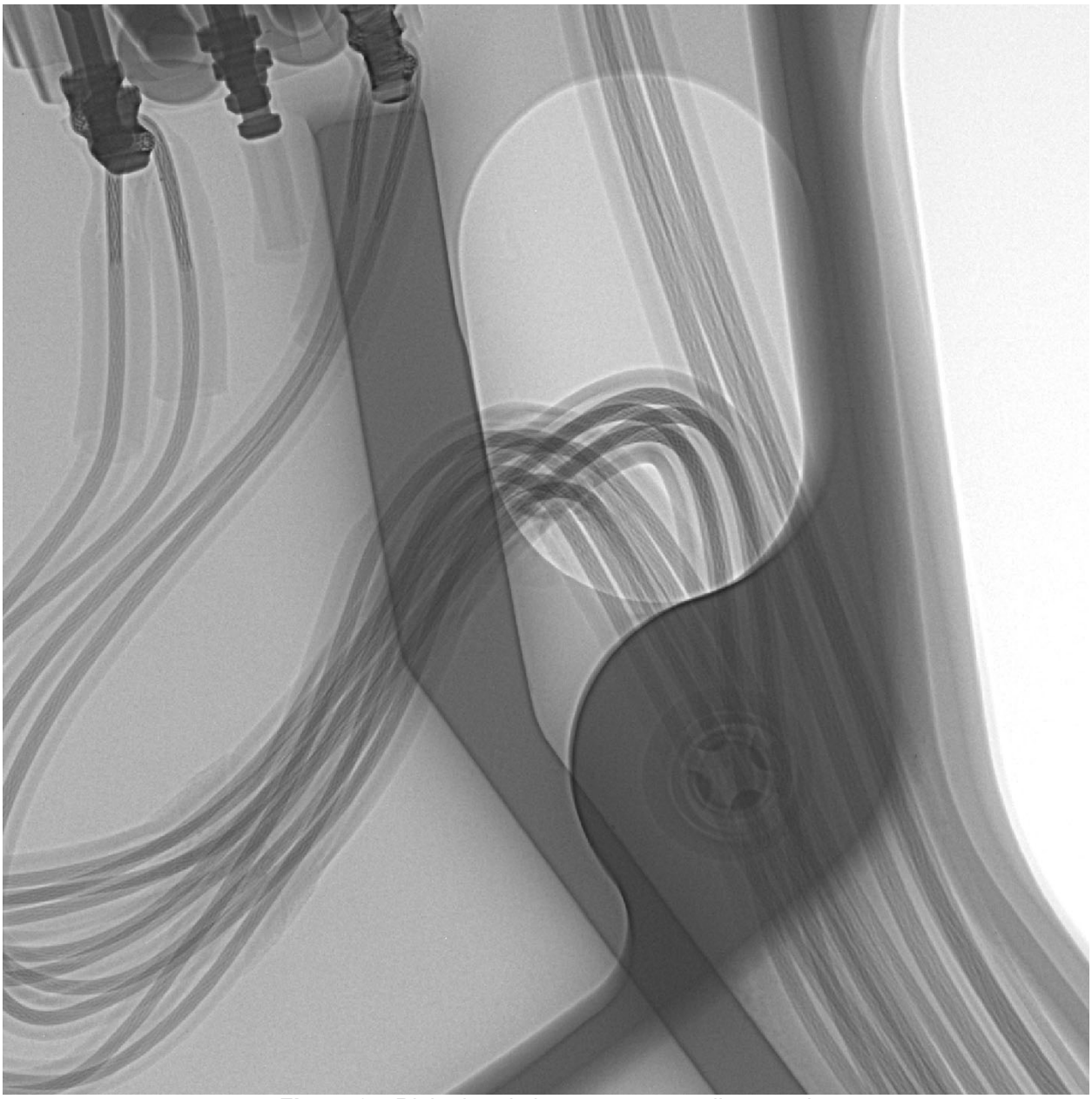

Figure 8 – Right throttle lever – no anomalies noted

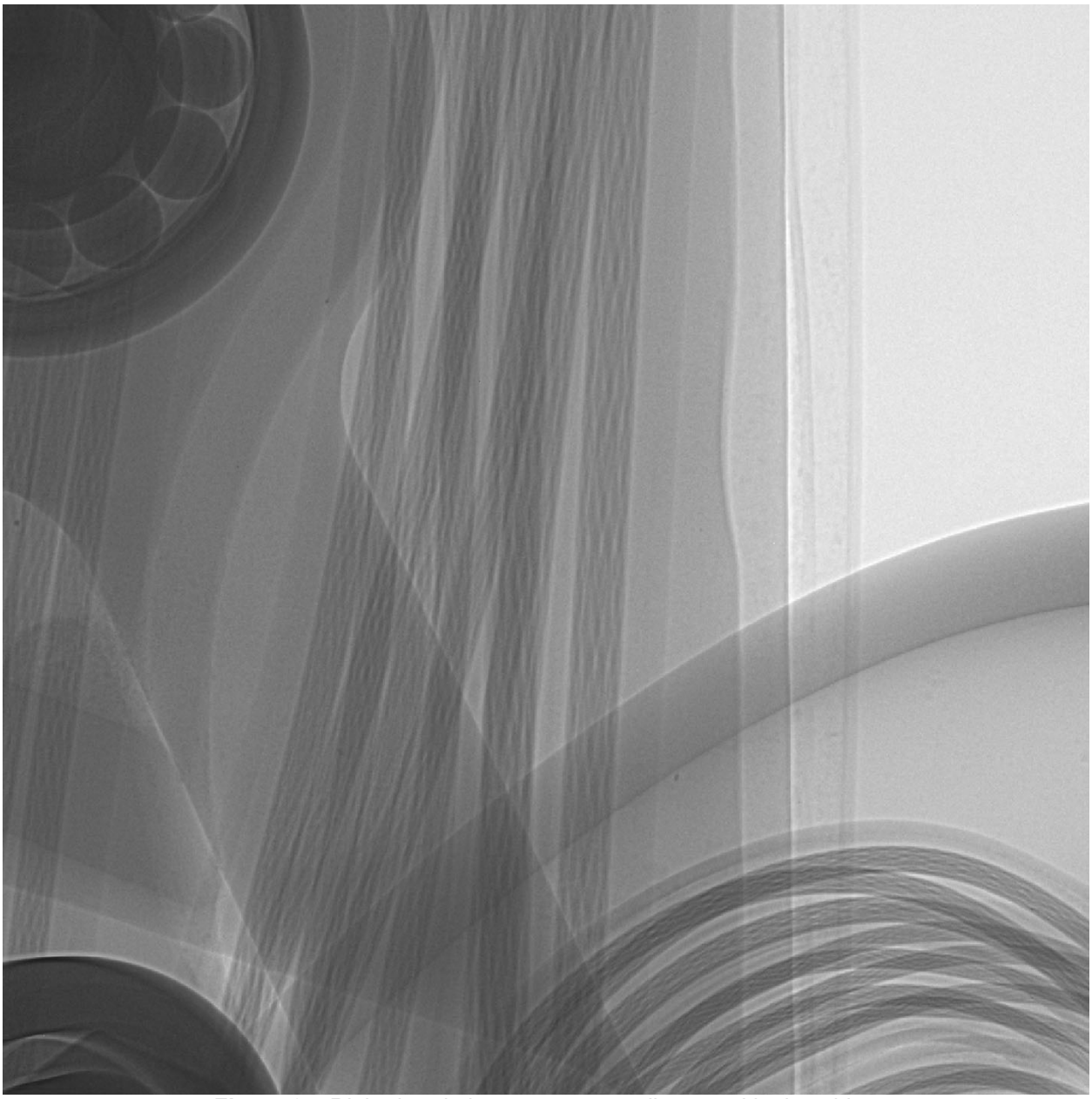

Figure 9 – Right throttle lever – no anomalies noted in the wiring

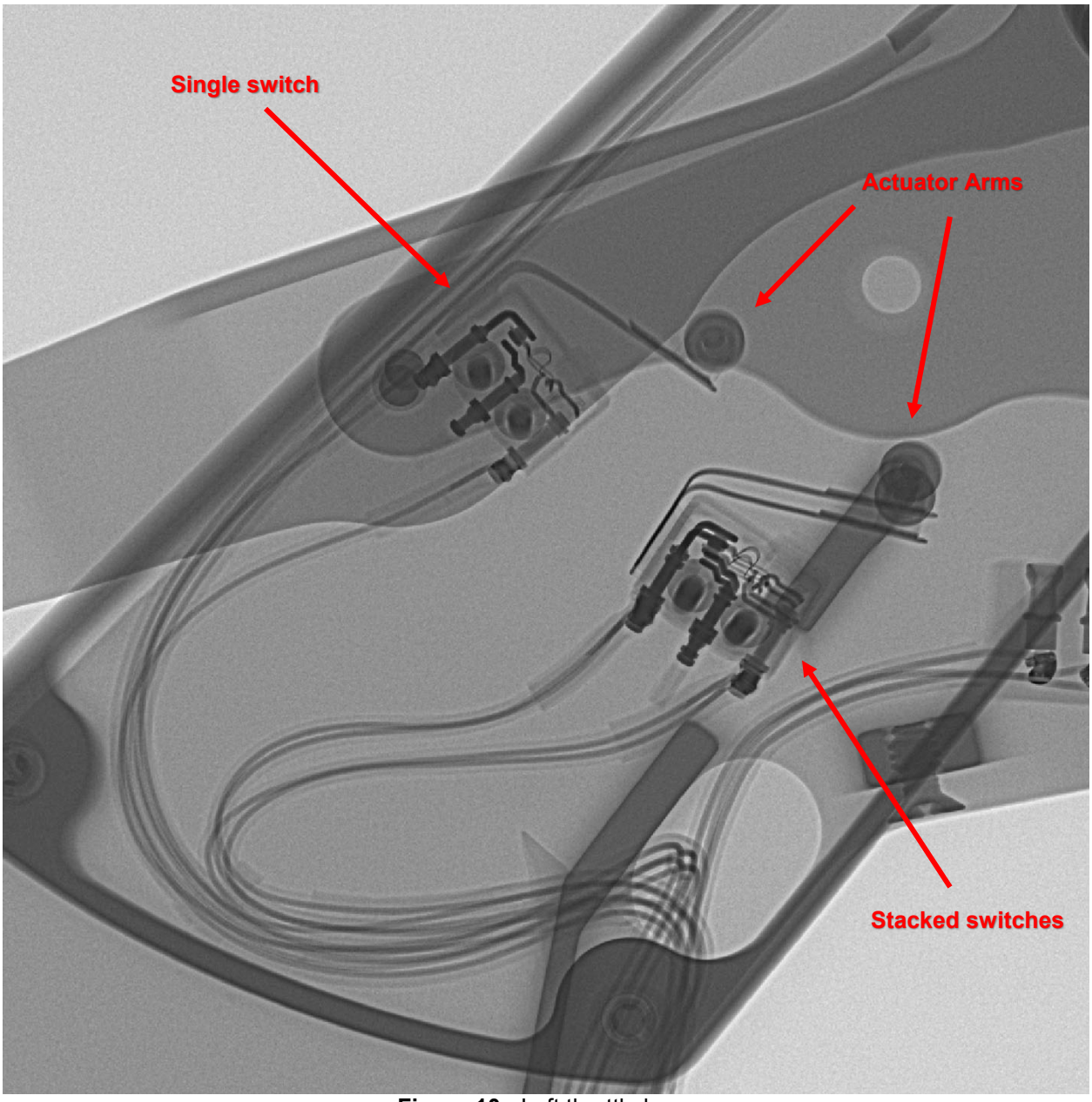

Figure 10 - Left throttle lever

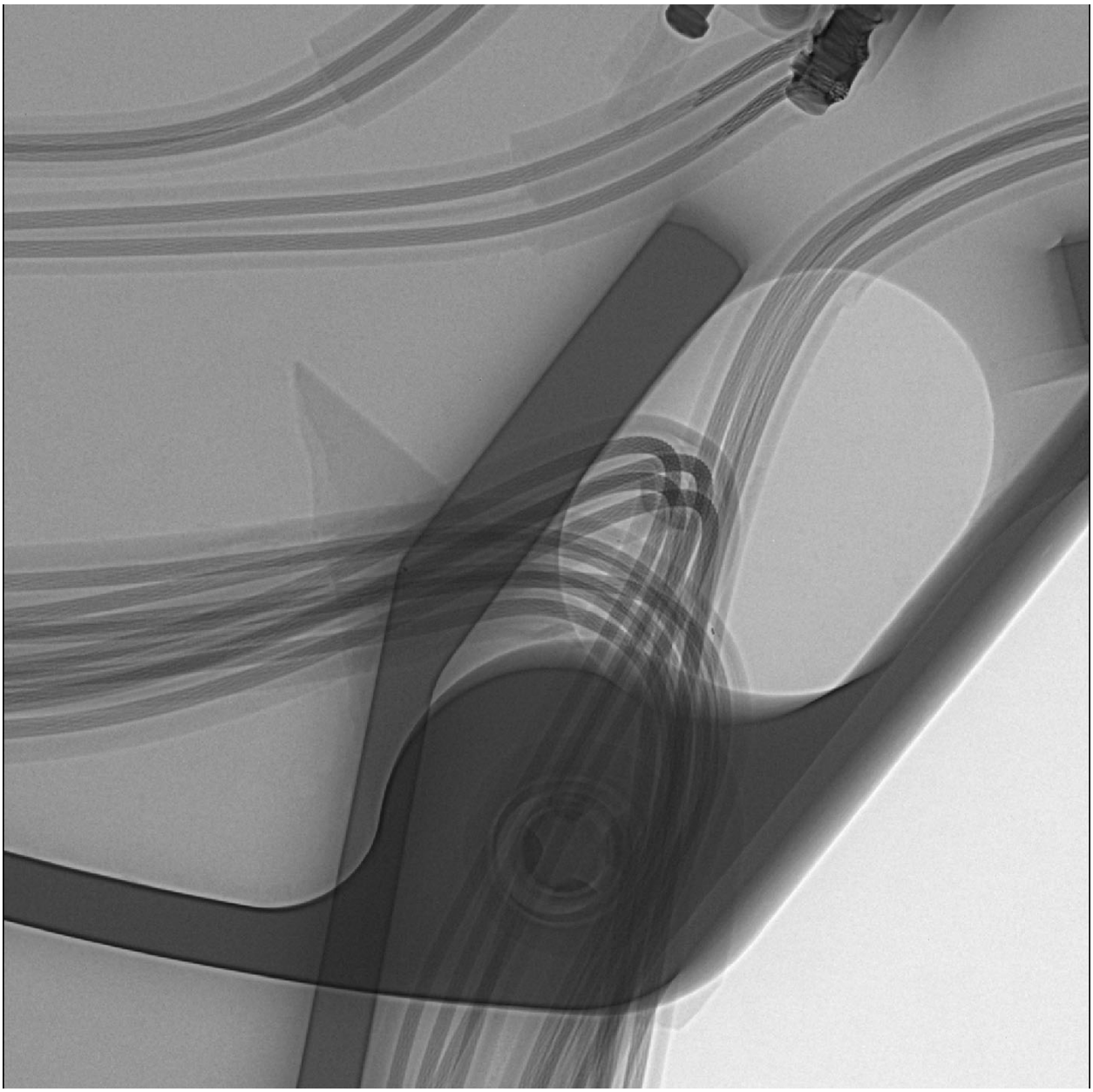

Figure 11 - Left throttle lever – particulates noted around the bend in the wires

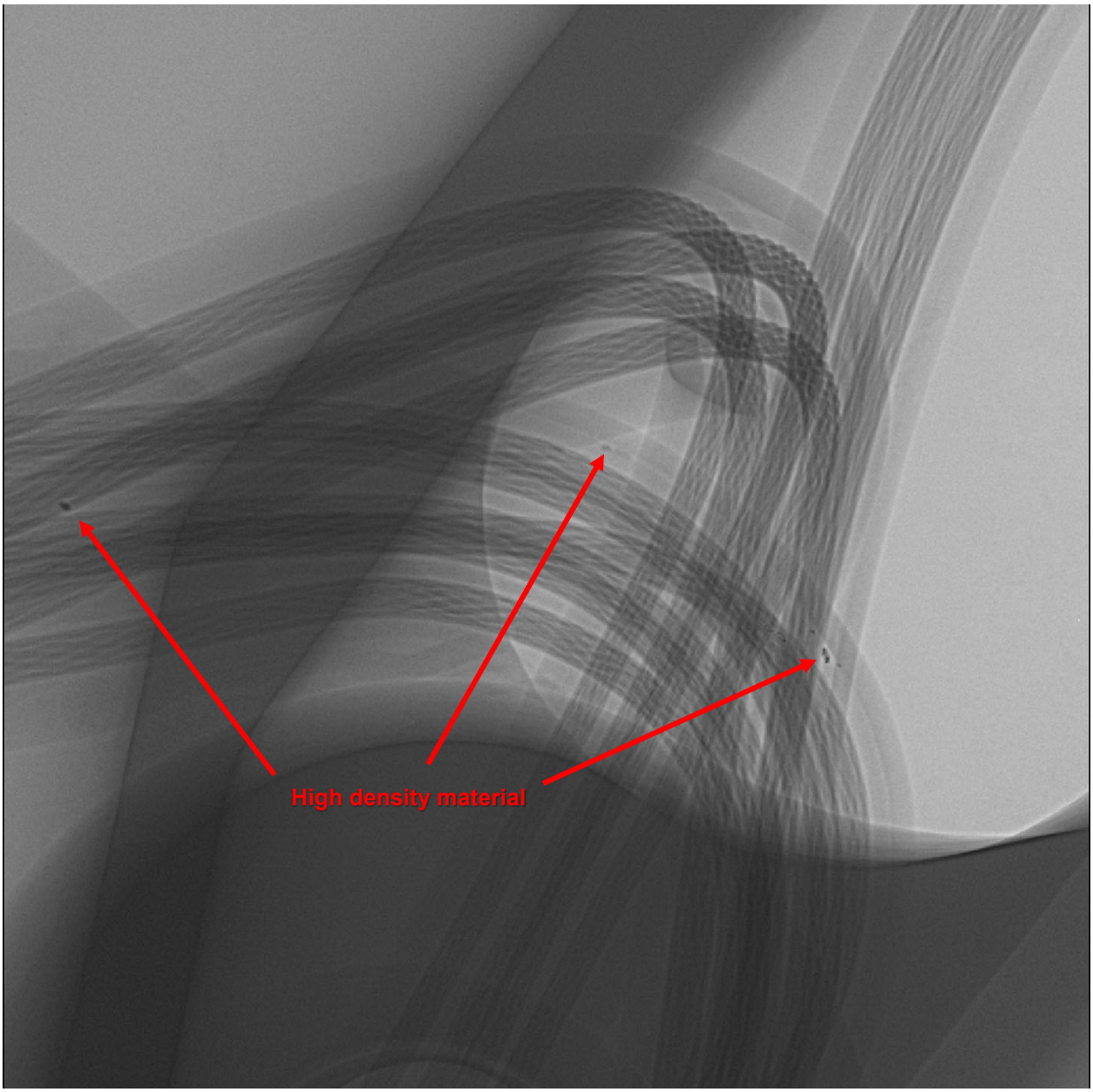

Figure 12 - Left throttle lever – particulates identified

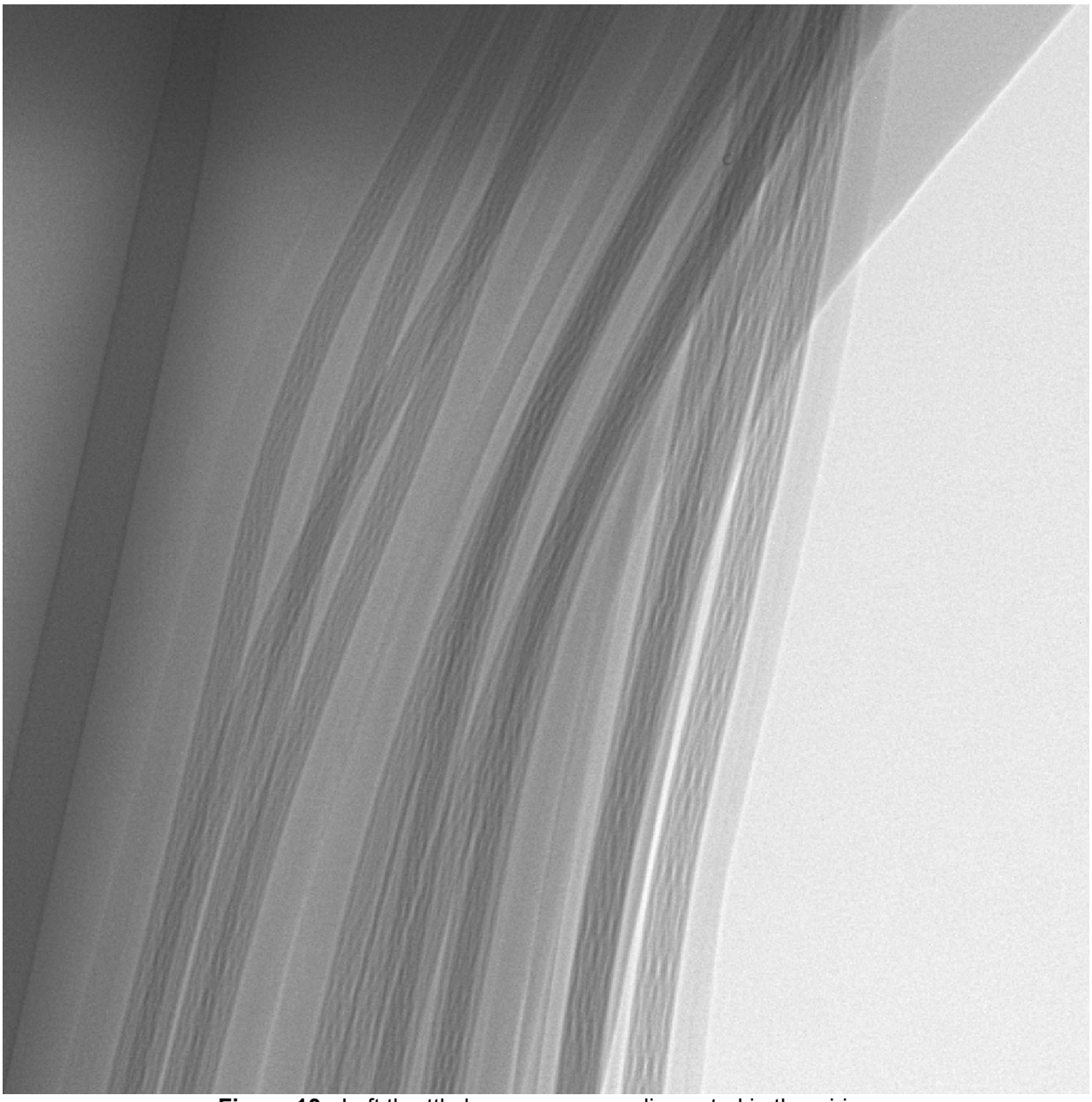

Figure 13 - Left throttle lever – no anomalies noted in the wiring

Computed Tomography (CT) scans were captured of the go-around switch areas of the left and right throttles, shown in Figure 14 through Figure 20. No anomalies were observed concerning the switch bodies, solder joints, and associated wiring, as shown in Figure 14 and Figure 18. CT cross sections of the switch assemblies, Figure 16, Figure 17, Figure 19, and Figure 20, revealed no anomalies or discrepancies. The depressed actuator arm, shown in Figure 7, was depressing the single switch, Figure 19, actuating the internal components and closing the normally open contacts.

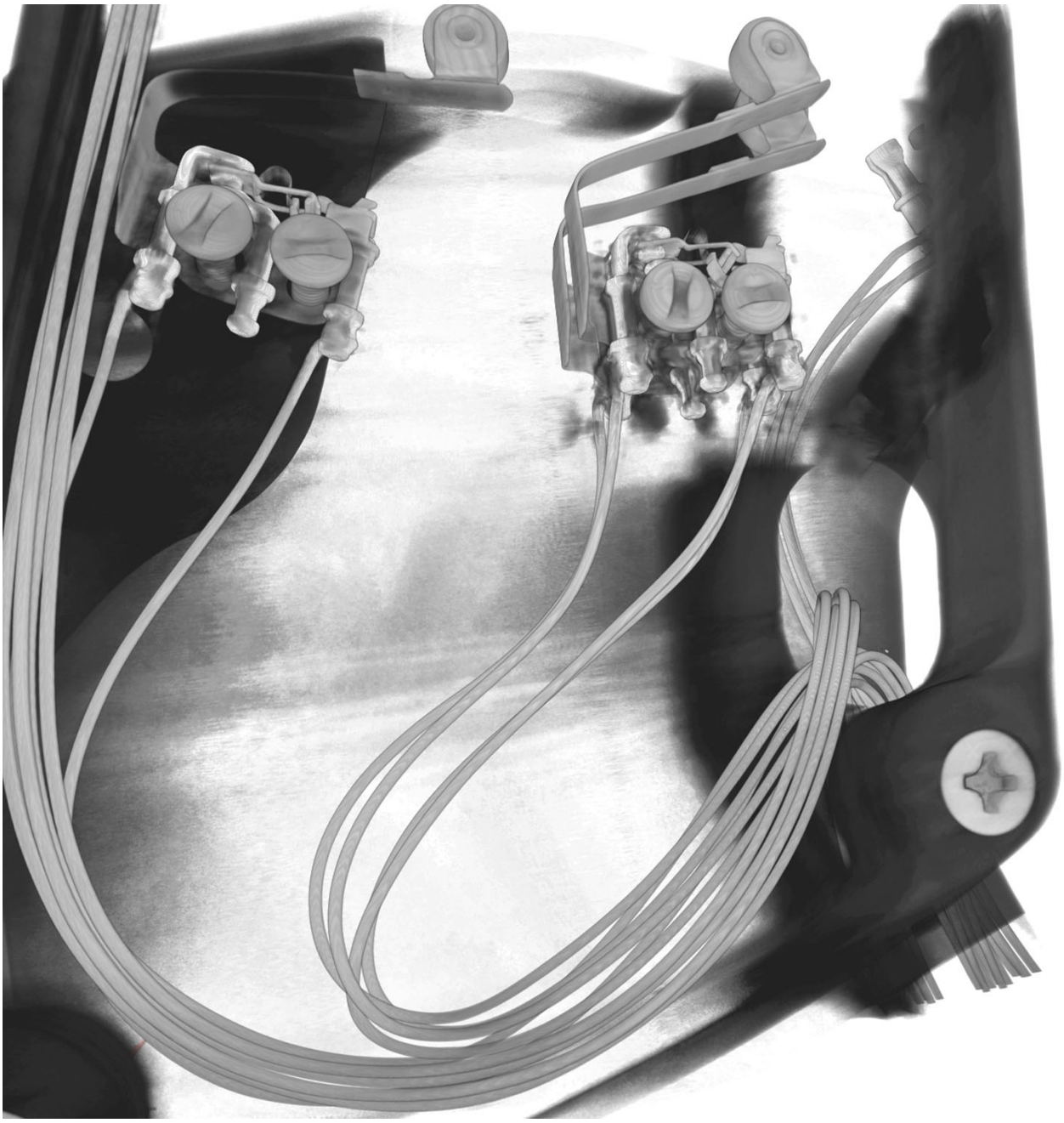

Figure 14 – CT of left go-around switches

The high density material noted in Figure 12 was determined to be outside of the wire insulation and not making contact with the adjacent wiring, as shown in Figure 15.

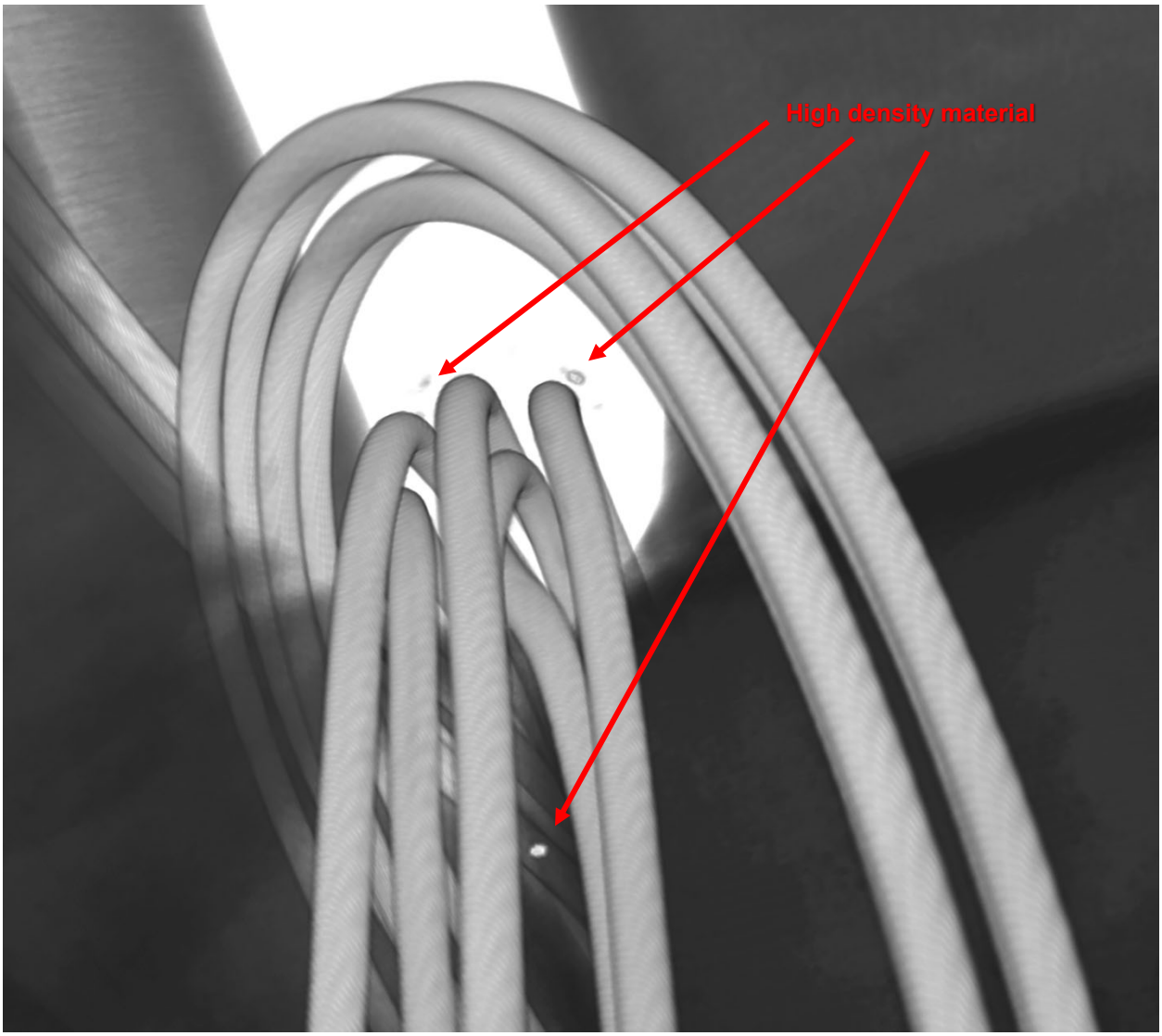

Figure 15 – CT of left go-around switch wiring

Figure 16 – CT cross section of left go-around switches

Figure 17 – CT cross section of left go-around stacked switch

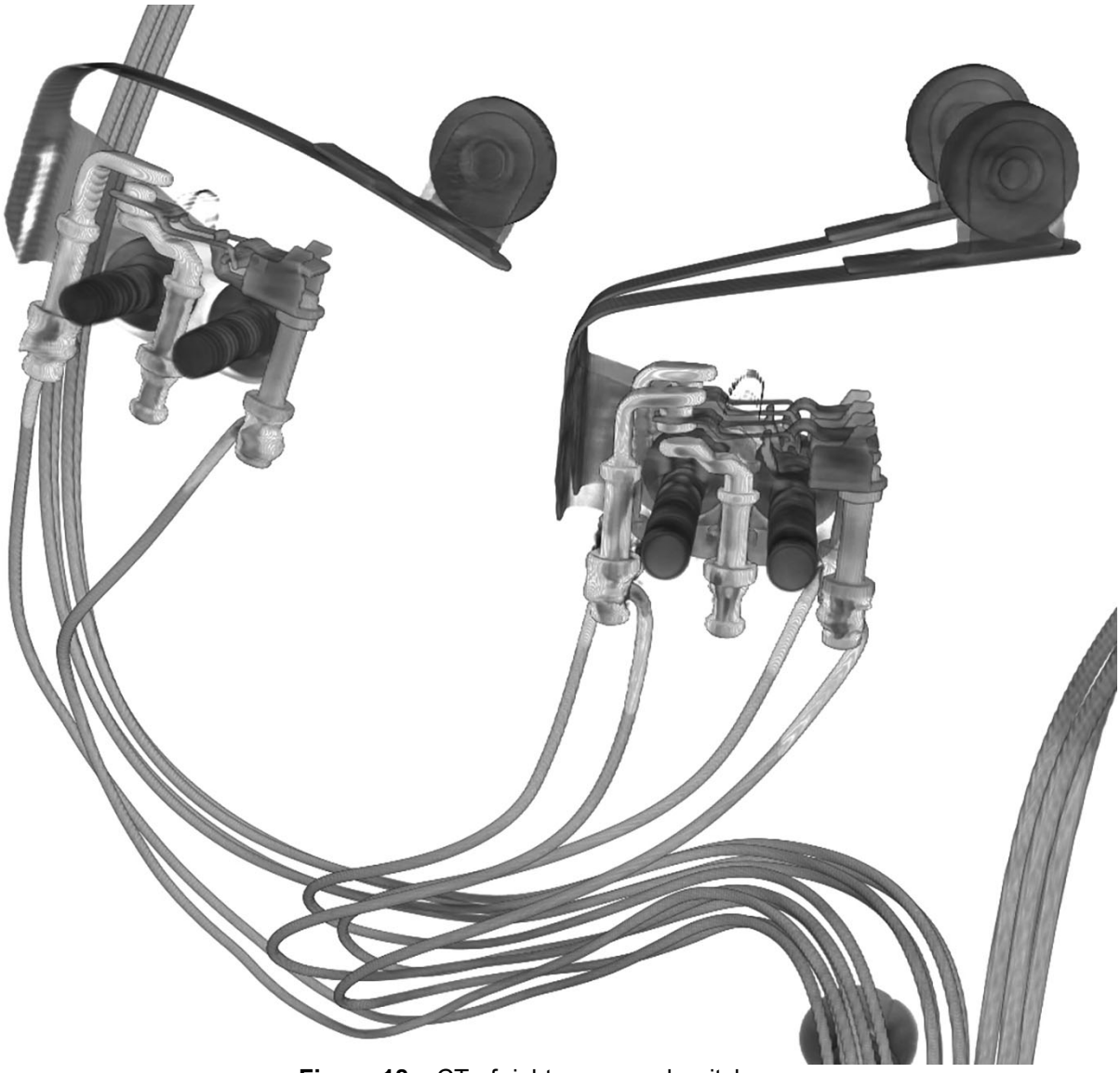

Figure 18 – CT of right go-around switches

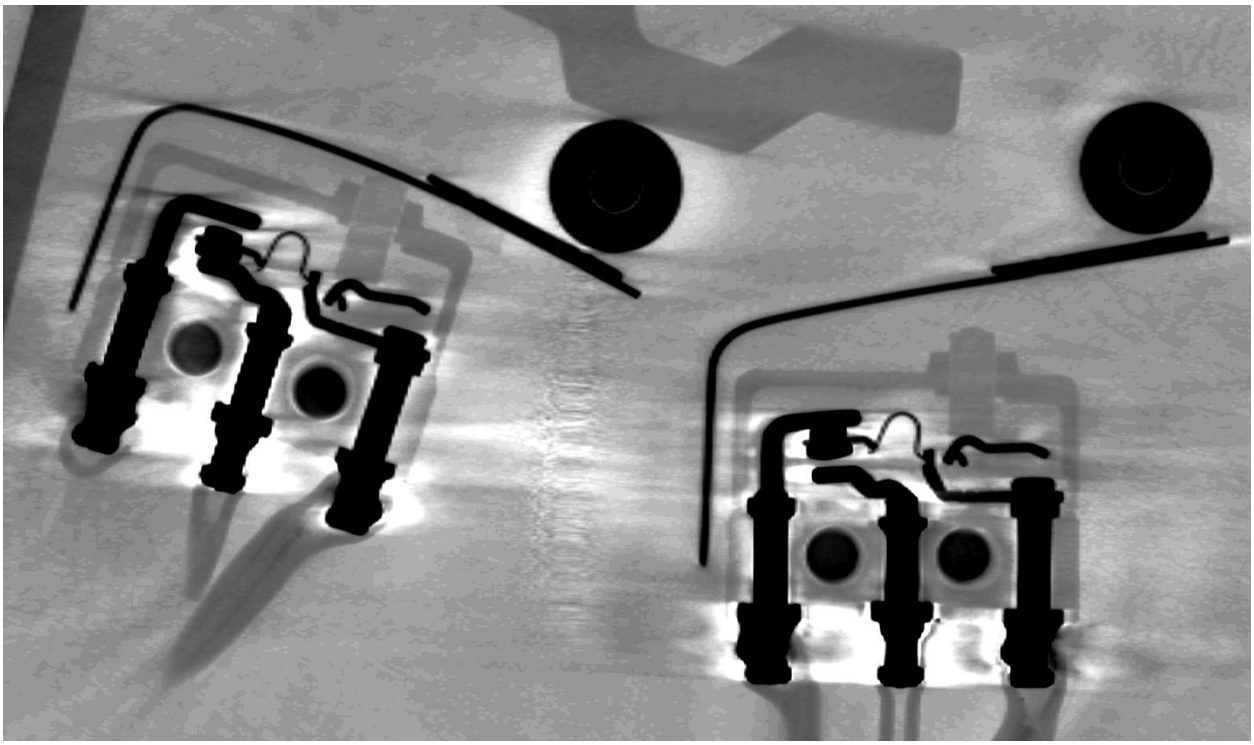

Figure 19 – CT cross section of right go-around switches

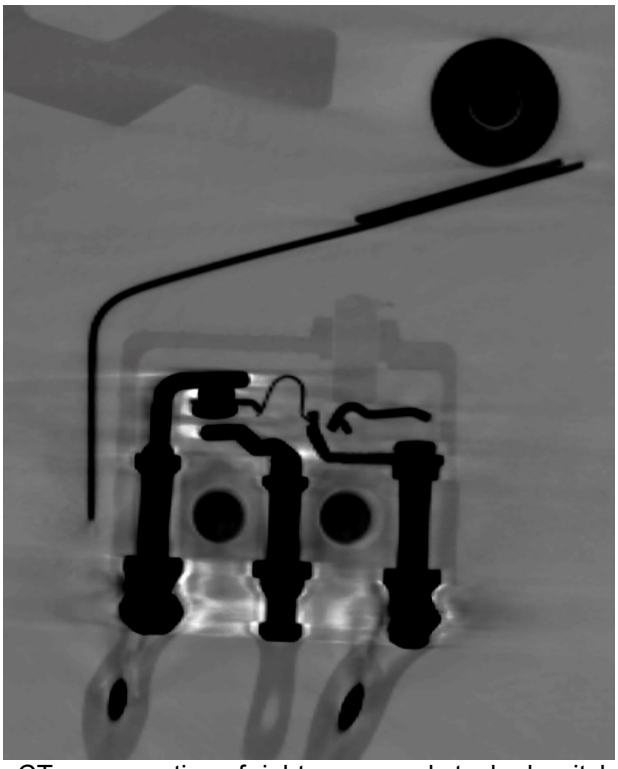

Figure 20 – CT cross section of right go-around stacked switch

Physical examination of the TLA was conducted under direction of the NTSB, and in the presence of representatives from the NTSB, the FAA, and the International Brotherhood of Teamsters, on August 15, 2019. All work was performed using reference (b) as a guide. The plates covering the three go-around switches on both throttles were missing, shown in Figure 21 and Figure 22.

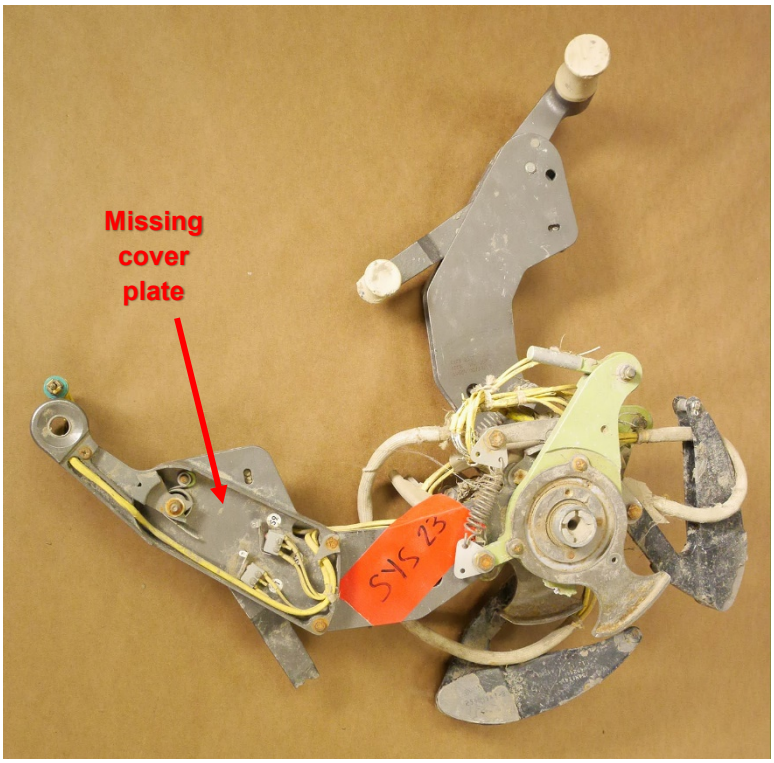

Figure 21 – TLA view from the left side

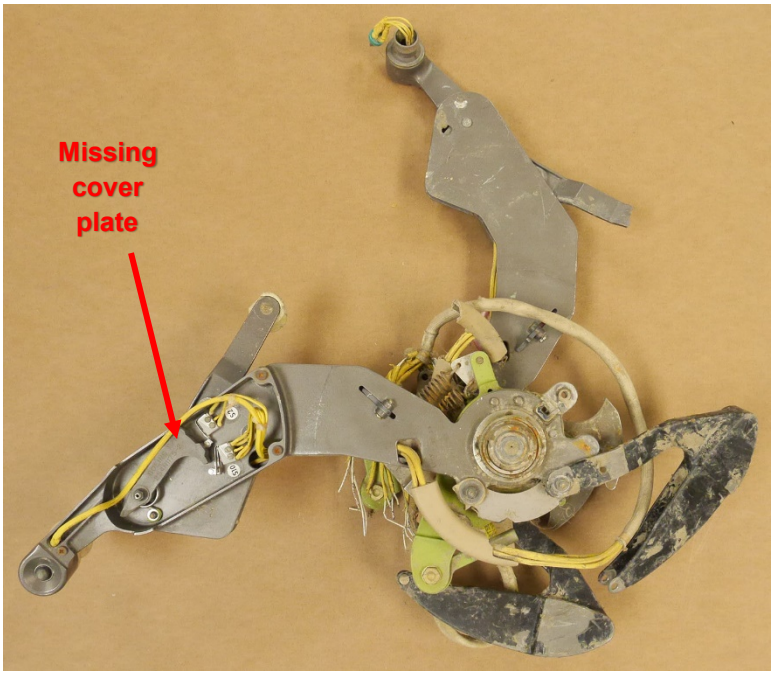

Figure 22 – TLA view from the right side

On the left throttle lever, the go-around trigger was missing except for a portion above the pivot point, and the actuating cam of the trigger assembly was also missing; see Figure 23. The left autothrottle disconnect switch, Figure 23, was noted as separated from the throttle knob but still connected by the wires.

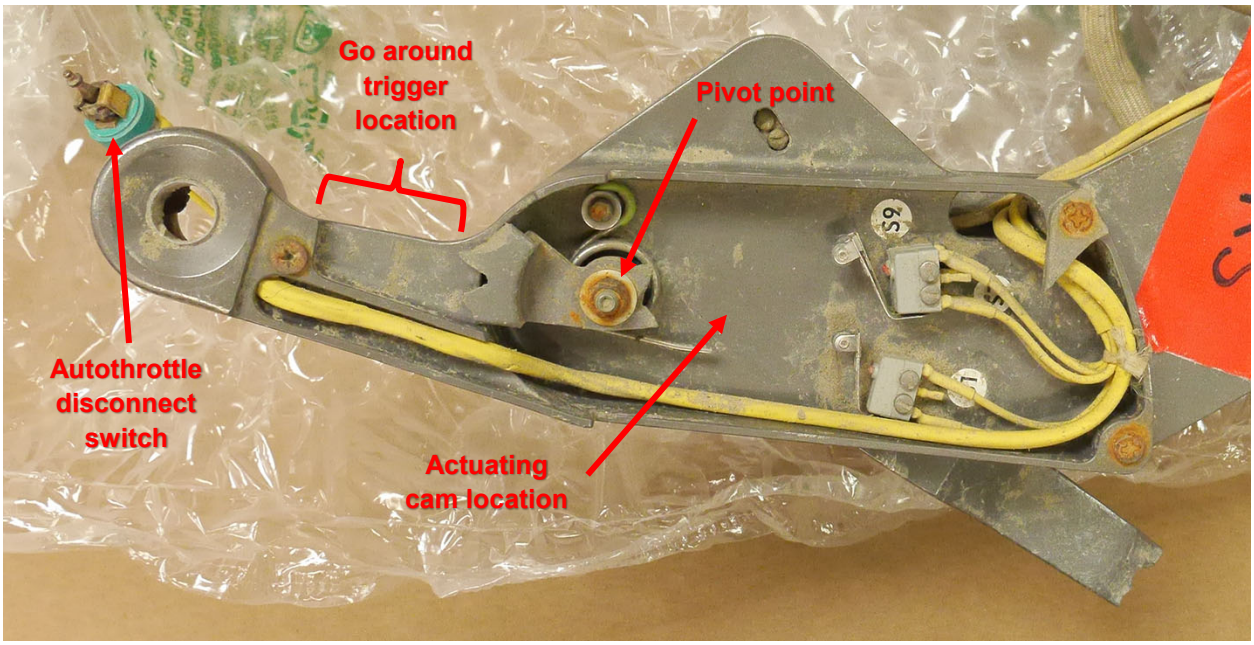

Figure 23 – Left throttle lever

The actuator arm on the S1 go-around switch was misaligned outboard and the S7 actuator arm was bent outboard and contacted the S9 actuator arm, see Figure 24. The S9 actuator arm did not appear misaligned.

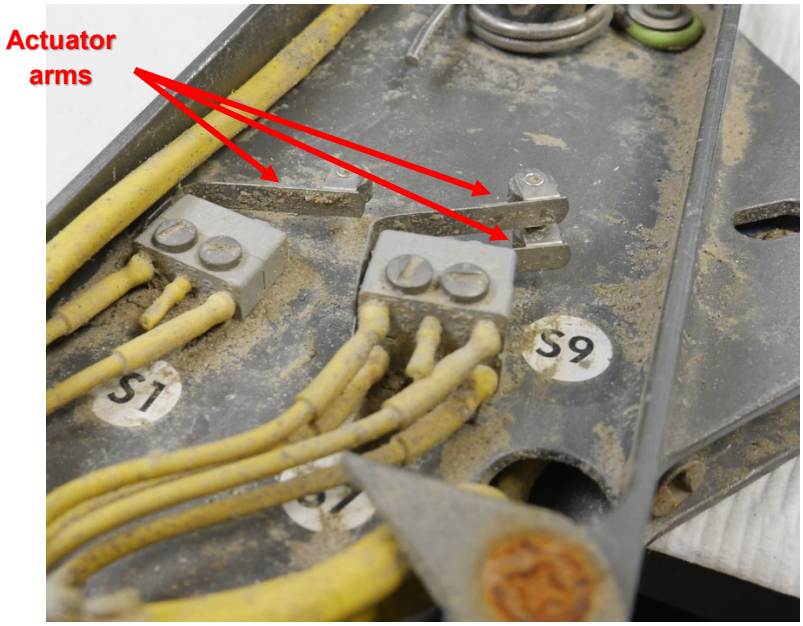

Figure 24 – Left throttle lever

On the right throttle, it was noted that a portion of the cam end of the go-around trigger was rotated “forward” and wedged against the front wall of the lever, see Figure 25. The portion of the trigger also jammed/depressed the S2 switch actuator arm. The right autothrottle disconnect switch, Figure 25, was found intact in the throttle knob.

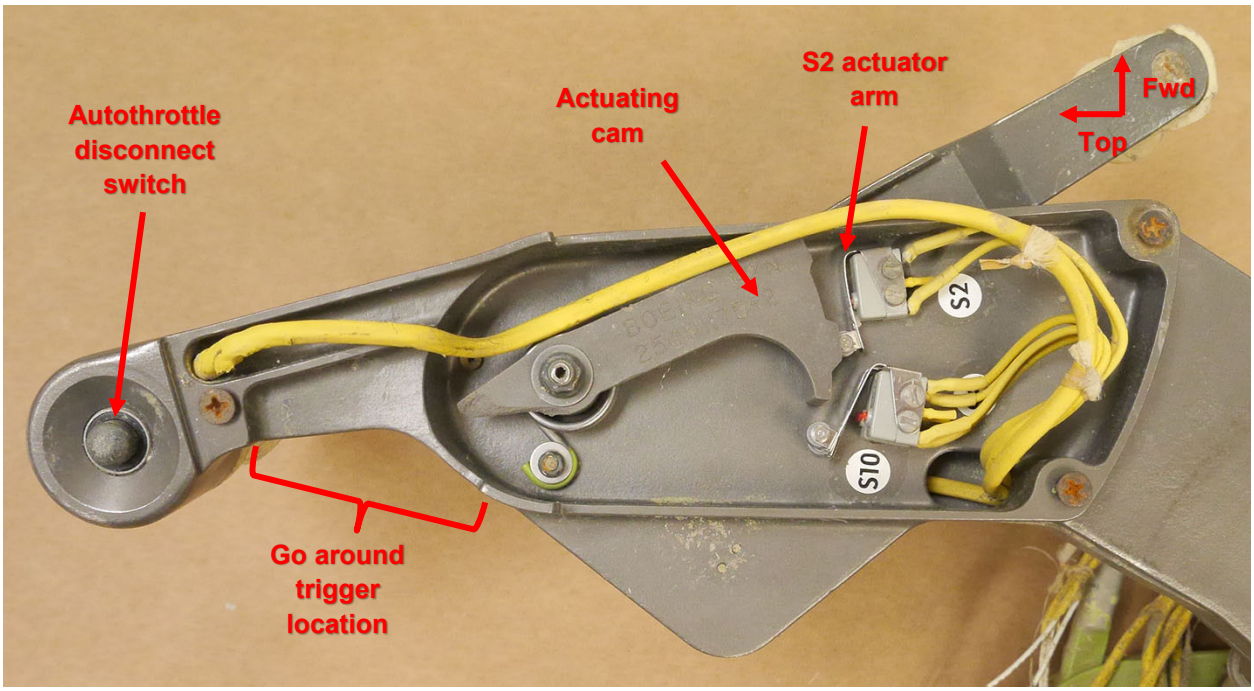

Figure 25 – Right throttle lever

The cam end portion of the go-around trigger was removed under direction of the NTSB and the S2 switch actuator arm was released, see Figure 26. Once released, the S2 actuator arm was free to move and appeared to be properly aligned.

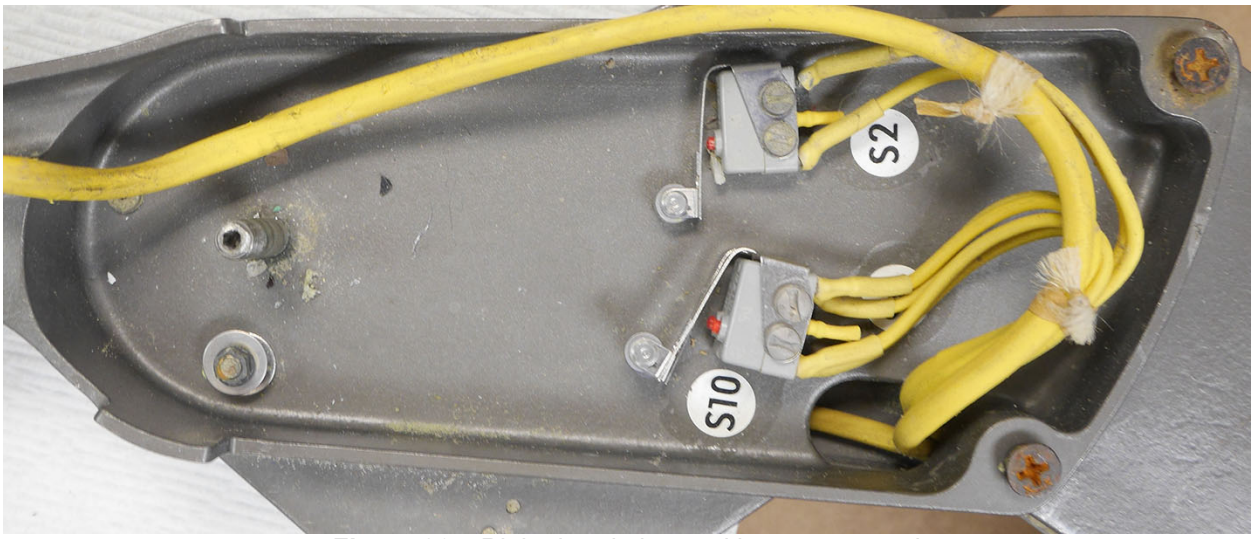

Figure 26 – Right throttle lever with cam removed

Aside from the noted observations, no other visible evidence of damage to any of the six go-around switches was noted.

A continuity check of the six go-around switches was accomplished using a Fluke® Model 289 digital multimeter and reference (c) as a guide. The continuity of each switch was checked at the base of the switch and at the end of the switch's wires, at the end of their respective runs at the base of the throttle levers where the wires were severed, shown in Figure 27. For each check, the switch was actuated by pressing the actuator arm onto the switch plunger. Results of the continuity checks are shown in Table 1 and Table 2.

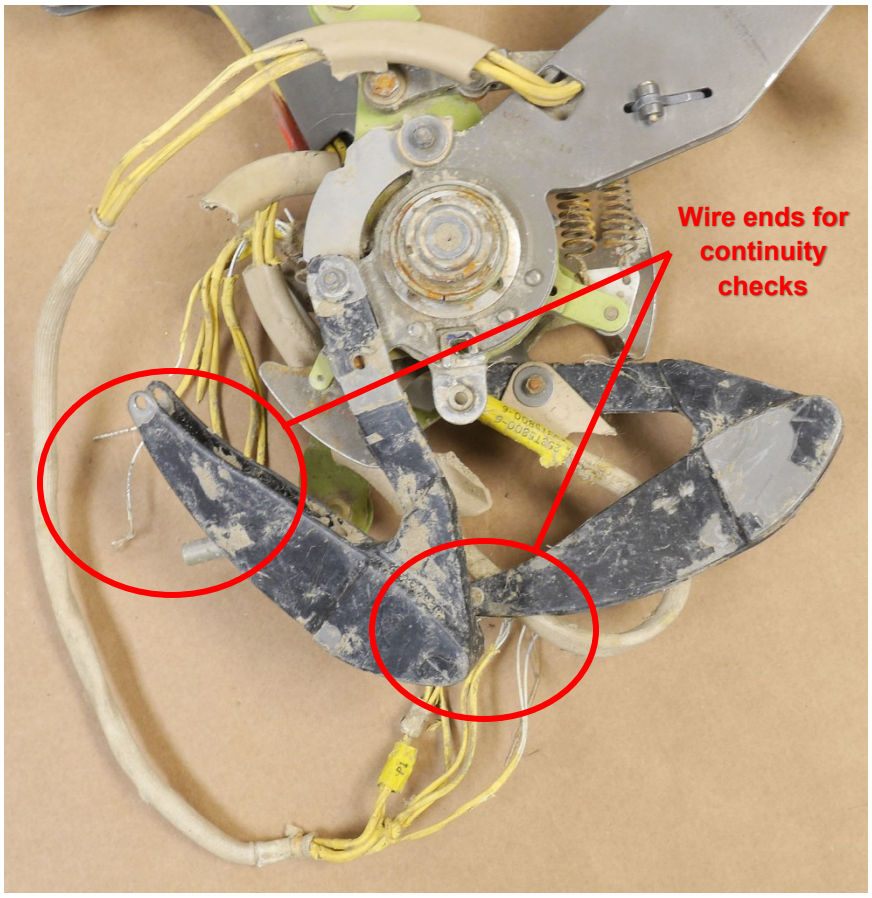

Figure 27 – TLA with wire ties removed

Table 1 – Right throttle lever go-around switch continuity

Switch #	Where measured	Resistance	Actuates?
S10	At Switch	0.06 Ohms	Yes
S10	At End of Wires	0.24 Ohms	Yes
S8	At Switch	0.09 Ohms	Yes
S8	At End of Wires	0.24 Ohms	Yes
S2	At Switch	0.08 Ohms	Yes
S2	At End of Wires	0.24 Ohms	Yes

Table 2 – Left throttle lever go-around switch continuity

Switch #	Where measured	Resistance	Actuates?
S1	At Switch	0.05 Ohms	Yes
S1	At End of Wires	0.23 Ohms	Yes
S7	At Switch	0.04 Ohms	Yes
S7	At End of Wires	0.21 Ohms	Yes
S9	At Switch	0.04 Ohms	Yes
S9	At End of Wires	0.23 Ohms	Yes

A continuity check of the left and right autothrottle disconnect switch wires was accomplished using a Fluke® Model 289 digital multimeter and reference (c) as a guide. The continuity of the wires was checked from the switch ring terminal to switch's wires at the end of their respective runs at the base of the throttle levers where the wires were severed, see Figure 27. The resultant values are shown in Table 3.

Table 3 – Autothrottle disconnect switch wiring continuity

Left Disconnect Switch		Right Disconnect Switch	
Wire Number	**Resistance**	**Wire Number**	**Resistance**
Wire 13	0.15 Ohms	Wire 17	0.15 Ohms
Wire 14	0.20 Ohms	Wire 18	0.16 Ohms
Wire 15	0.12 Ohms	Wire 19	0.15 Ohms
Wire 16	0.16 Ohms	Wire 20	0.15 Ohms

Due to the damaged condition of the left autothrottle disconnect switch, continuity checks of the switch ring terminals could not be performed. The left switch wires were cut under direction of the NTSB to allow examination of the switch under a digital microscope. A small amount of corrosion and particulates were observed. No further examination of the switch was accomplished.

The knob was removed from the right throttle lever under direction of the NTSB, see Figure 28. Continuity checks of the right autothrottle disconnect switch at the ring terminals were performed, but no continuity in either switch position (normal or actuated) was observed.

Figure 28 – Right throttle lever with knob removed for switch access

The switch was examined under a digital microscope and cracking was noted at the base of one of the terminals, shown in Figure 29 and Figure 30.

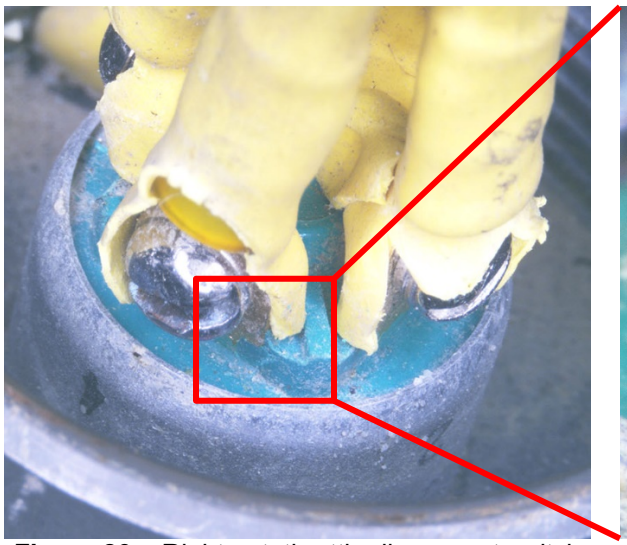

Figure 29 – Right autothrottle disconnect switch

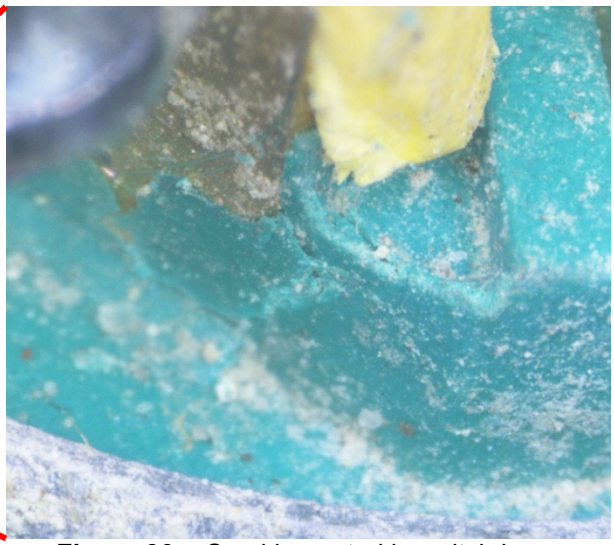

Figure 30 – Cracking noted in switch base

Further examination of the right autothrottle disconnect switch using DR imagery indicated possible misalignment or area of low density between the normally closed contacts, shown in Figure 31 and Figure 32.

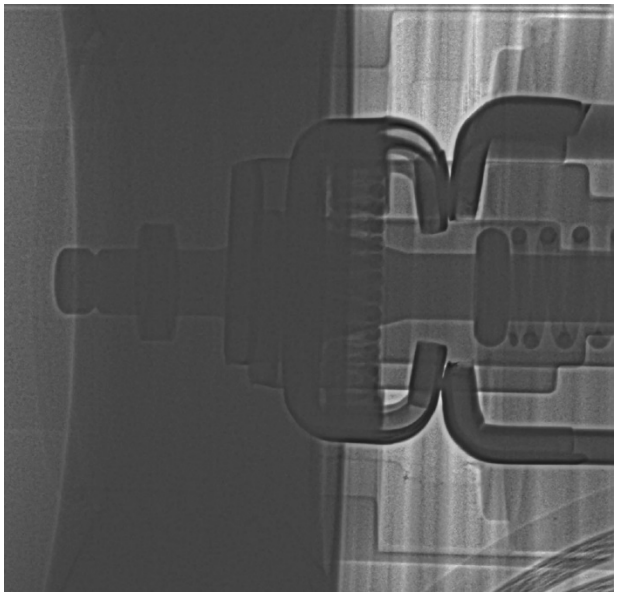

Figure 31 – DR of right autothrottle switch

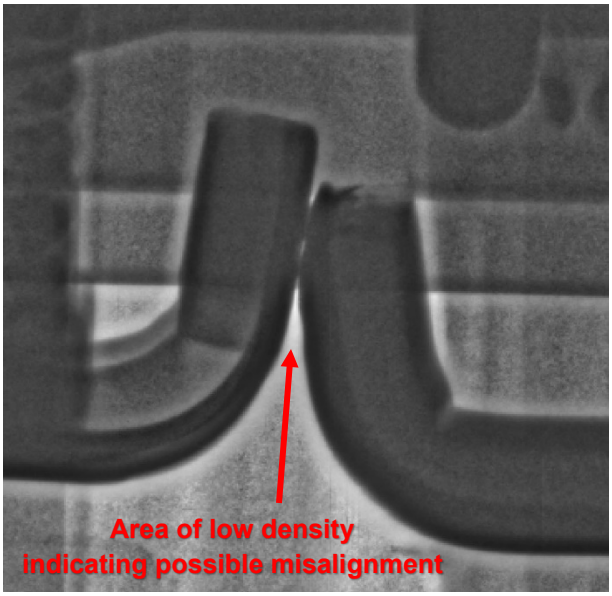

Figure 32 – Magnified view of contacts

An attempt was made to remove the switch from the throttle lever arm, including cutting the four switch wires under direction of the NTSB. Looseness in the ring terminals was noted around wires 17 and 18, and intermittent continuity could be observed by manipulating the terminals by hand. Based on the unsuccessful attempts to remove the switch and the intermittent continuity, the NTSB and the collective group decided no further examination was necessary.

DISPOSITION:

At the end of the examinations, the throttle lever components were placed back into secured storage at Boeing EQA pending further guidance from the NTSB.

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

Signatures on file.