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

Group Chairman's Factual Report of Investigation – Airworthiness

February 27, 2017

A. INCIDENT DCA17IA020

Location:	LaGuardia Airport, Flushing, New York
Date:	October 27, 2016
Time:	1942 Local Time
Aircraft:	Eastern Air Lines flight 3452, a Boeing 737-7L9, registration N278EA

B. GROUP

Chairman:	Tom Jacky National Transportation Safety Board Washington, D.C.
Member:	Pablo Perez Eastern Air Lines Miami, Florida
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C. SUMMARY

About 1942 local time, N278EA, a Boeing 737-7L9, a charter flight operated by Eastern Air Lines overran runway 22 during landing at LaGuardia Airport, Flushing, New York. Instrument meteorological conditions prevailed at the time and an instrument flight plan was filed. The aircraft had minor damage and there was no fire. The 11 crewmembers and 37 persons on board were not injured. The flight originated at Ft. Dodge, Iowa.

The group met at LaGuardia Airport from October 28-30, 2016 to document the relevant aspects of the airplane powerplants, structure and systems. At the time of the group's arrival the airplane had been moved from the airport field (incident site) to a remote ramp parking stand, near

the intersection of Taxiways D and F. The group documented the airplane at the parking stand, using access from The Port Authority of New York and New Jersey Police Department Building.

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

1. Flight Data Recorder (FDR)
2. Cockpit Voice Recorder (CVR)

After the airplane was cleaned, the airlines provided documentation of additional damage to the airplane's skin not previously noted.

During the investigation, the group did not identify a fault or anomaly of the airplane's systems, structures, or powerplants prior to the incident flight landing.

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

D. DETAILS OF INVESTIGATION

The airplane was identified as a Boeing 737-7L9 as follows:

Serial Number:	28006
Line Number:	26
Date of Manufacture:	May 15, 1998

The airplane had entered the engineered materials arrestor system (EMAS) at the departure end of Runway 22. As a result, pulverized EMAS material was noted on portions of the exterior of the aircraft as a gray, powdery residue. The lower and forward portions of the airplane – fuselage, landing gear, antennas, etc. - were coated with a dried residue resulting from the mixture of the EMAS material and water. In addition, pieces of a matting material used in the EMAS were found in various locations of the airplane.

Based on the circumstances of the incident, the group identified and documented the relevant aspects of the airplane's systems, structures, and powerplants as follows:

1. AIRPLANE SYSTEMS

During the investigation, electrical power was provided to the airplane via a ground power unit attached to the external power receptacle. The ground power receptacle was cleaned of the dried EMAS material before the ground power unit was attached. No electrical anomalies were noted.

The group documented the pertinent airplane systems according to the following categories:

A. Passenger Cabin Equipment and Furnishings

The following observations were made during the examination of the passenger cabin equipment and interior furnishings (all observations were made looking forward in direction of travel):

- At seat row 13, left hand side, the window interior plastic pane had multiple cracks in the lower area.
- At seat row 13, right hand side, the window shade assembly was displaced at the forward lower corner.
- At seat row 15 on the left-hand side, the sidewall panel was displaced at the aft lower corner.
- On the left-hand side class divider panel, the upper inboard attach point was loose.
- None of the evacuation slides or overwing exits were opened or displayed evidence of use.
- No visible damage or displacement was noted on any of the passenger seats, overhead bins, or passenger oxygen units.
- Two megaphones were noted in their normal, stowed positions: one in a front overhead bin and one in an aft overhead bin.

B. Flight Controls

B.1 Primary Flight Controls

No primary flight control position assessment was available. Each of the primary flight control surfaces was found in a faired or neutral position. No visible evidence of a primary flight control surface jam, malfunction, or damage was noted.

The recorded primary flight control inputs - control column, control wheel, and rudder pedals – were examined. No evidence of a malfunction or jam were noted.

B.2 Secondary Flight Controls

Upon arrival of the group, all the secondary flight control surfaces – leading edge flaps, slats, trailing edge flaps, and flight and ground spoilers – were retracted. No visual assessment of the airplane's landing configuration was available.

No visual damage to the leading edge flaps, leading edge slats, ground or flight spoiler panels was observed.

B.2.1 Auto Ground Spoiler System

Spoilers 1, 6, 7, and 12 (of twelve total spoiler panels on the airplane wings) are ground spoilers. Spoilers 1 and 6 are located on the left wing and Spoilers 7 and 12 are located on the right wing. Spoilers 6 and 7 have two actuators, while Spoilers 1 and 12 have one actuator.

The auto speedbrake system automatically controls the ground spoilers. Alternately, the flight crew can use the speedbrake lever to deploy the ground spoilers manually. The ground spoilers can only move (deploy) when the speedbrake lever moves while the airplane is on the ground. Alternately, while in flight, the speedbrake lever operates only the flight spoilers.

The auto speedbrake module controls the automatic operation of the speedbrakes. In addition, the module controls the green "SPEED BRAKE ARMED" light[1] and the amber "SPEEDBRAKE DO NOT ARM" light on the Left Forward (P1) Panel. The lights are located above the captain's right display unit with the "SPEED BRAKE ARMED" light on top. The "DO NOT ARM" light is illuminated when the auto speed brake system is unavailable, an abnormal condition when the flaps are raised, or, during landing, when wheel speed is below 60 knots and the speedbrake lever is not in the full forward (stowed) position.

The flightdeck speedbrake control components were examined. The speedbrake handle was noted in the full forward position, with a paper sticker wrapped around the base of the handle. The sticker indicated the system was inoperative (See Figures 1 and 2). All spoiler panels, including the ground spoilers, were found in the down or retracted position. No damage was noted to any of the ground spoilers.

Figure 1 - Overview of the Center Pedestal in Flightdeck.

[1] The auto speedbrake module sends "on" or "off" signals to the flight data acquisition unit (flight recorder system).

Figure 2 - Close Up of the Speedbrake Handle and INOP Sticker.

The white sticker wrapped around the speedbrake handle was marked INOP due to a maintenance procedure conducted on the auto speedbrake system. For additional information regarding the maintenance activity, please see Section 4.0, Airplane Maintenance Records.

C. Hydraulic Power

No evidence of a hydraulic power malfunction was noted. No evidence of damage was noted to any of the visible hydraulic lines.

With the airplane attached to ground power, the hydraulic system quantities were noted on the flight deck center display unit. The hydraulic system quantities were noted as follows:

Hydraulic System A: 82%
Hydraulic System B: 84%

See Figure 3.

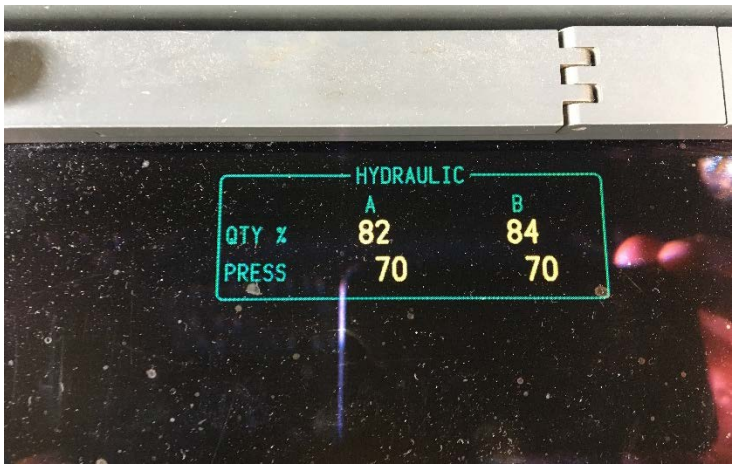

Figure 3- Hydraulic Quantity and Pressure (Hydraulic Systems Not Powered)

The left and right hydraulic systems were exercised during the autobrake exercise with no anomalies noted. See Section D.1.I, Landing Gears.

D. Ice & Rain Protection

Both windscreen wiper blades were still attached to structure with no visible damage.

E. Instruments

The flight deck instrument panels and circuit breakers were examined.

The following items of interest were noted:

- P1 Left Forward Instrument Panel: The “SPEEDBRAKE DO NOT ARM” and the “SPEEDBRAKE ARMED lights were noted. See Figure 4.


Figure 4 - The "SPEEDBRAKE ARMED" and "SPEEDBRAKE DO NOT ARM" lights on the P1 Panel (circled).

- P2 Center Instrument Panel: The Auto Brake Rotary Switch – Position 3 (See Figure 5).

Figure 5 - Autobrake Control Panel with Position 3 Selected

- P6-2 Circuit Breaker Panel: B9, AUTO SPD BRK – Open (Aside from flight recorder circuit breakers, this was the only open circuit breaker noted.)
- When power was applied to the airplane, the "NO ANTISKID" lamp was not illuminated.
- Flap handle was in the zero detent.
- No evidence of faults or malfunctions were observed.

The airplane's external probes and ports exhibited EMAS debris accumulation. The static ports and ram air probes also accumulated debris. See Figures 6, 7, and 8.

Figure 6 - Example of EMAS debris on Static Port

Figure 7 - Example of EMAS debris on Static Port.


Figure 8 - Example of EMAS debris on External Port.

F. Landing Gear

The airplane was fitted with two landing gear systems – nose and main landing gear.

F.1 Nose Landing Gear

The nose wheel assembly and tires were coated with dried EMAS material and mud. Portions of the nose wheel well were also covered with dried EMAS material. The left and right nose wheel tires showed cut damage.

The nose wheel landing gear and associated assemblies were examined, with no visible damage or malfunction noted. See Figures 9A and 9B.

Figure 9A/B - Nose Landing Gear and EMAS debris.

With ground power attached and the hydraulic systems operating, the nose landing gear was centered using the flightdeck hand tiller. No faults or anomalies were noted.

The nose landing gear tire pressures were measured as follows:

Left Nose Wheel Tire Pressure:	190 pounds per square inch (psi)
Right Nose Wheel Tire Pressure:	195 psi

The tire pressures were measured using an Eastern Air Lines tire pressure gauge, serial number: 20160330-005, with a calibration date of 04/20/2016, and next calibration due on 04/20/2017.

F.2 Main Landing Gear

Both two main landing gear assemblies were coated with dried EMAS material. Pieces of the EMAS matting material were also noted in the landing gear assemblies. Portions of the wheel wells and adjacent areas were also covered with the EMAS materials. See Figures 10A/B/C and 11A/B/C.

Figure 10A, B, and C - Left Main Landing Gear and EMAS Debris

Figure 11A, B, and C - Right Main Landing Gear and EMAS Debris

A preliminary visual examination of the main landing gear strut, doors, assemblies, associated hydraulic lines, and antiskid components did not reveal evidence of physical damage. However, after the airplane was cleaned of EMAS debris and the main landing gears retracted, physical damage was noted on the underside of each gear strut. Eastern Airlines indicated that the Left and Right Main Landing Gear Lower Wire Bundle Support Bracket were each damaged. In addition, on the Left Main Landing Gear, the wire conduit sleeve was damaged as well. See Figures 12A and B (Left Main Gear) and 13 (Right Main Gear).

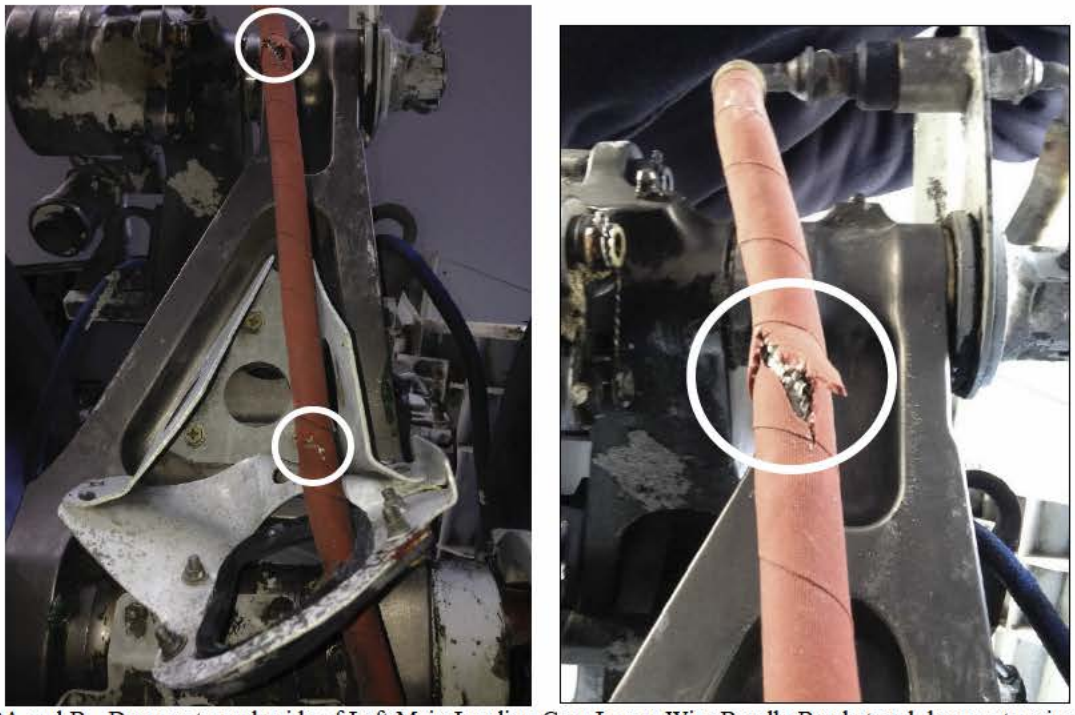

Figure 12A and B - Damage to underside of Left Main Landing Gear Lower Wire Bundle Bracket and damage to wire conduit. Damaged areas of conduit are circled.

Figure 13- Damage to underside of Right Main Landing Gear Lower Wire Bundle Bracket.

F.2.1 Main Landing Gear Wheels

Each of the four main wheel tires (numbers 1 and 2 on left main landing gear, numbers 3 and 4 on right main landing gear) showed cut damage in addition to normal wear. For example, the outboard sidewall of tire number 1 had a cut (See Figure 14) and tire number 3 had a cut with a piece of clear glass imbedded in it. None of the observed cuts were deep enough to reach the tire treads.

Figure 14 - Cut on the outboard sidewall of Tire Number 1.

No flat spots or other evidence of hydroplaning was noted on any of the tires.

The tire pressure was measured using the same gauge used for the nose gear tires. The following pressures were measured:

Tire #1: 180 psi
Tire #2: 185 psi
Tire #3: 190 psi
Tire #4: 150 psi

The depth of each tire's treads was measured with a scale. The treads were numbered from left to right, airplane looking forward, as noted in the table below:

		Tire Number			
		1	2	3	4
Tread "Number"	1	2/32"	2/32"	2/32"	2/32"
	2	2/32"	3/32"	2/32"	2/32"
	3	2/32"	3/32"	2/32"	2/32"
	4	2/32"	3/32"	2/32"	1/32"

F.2.2 Main Landing Gear Brakes

Each of the four brake assemblies were examined. No evidence of physical damage or hydraulic leaks were noted.

The brake pin length was measured for each wheel as follows:

Wheel # 1 Brake Pin Length: 1"
Wheel # 2 Brake Pin Length: ¼"
Wheel # 3 Brake Pin Length: 1"
Wheel # 4 Brake Pin Length: ½"

F.2.3 Autobrake System Description and Examination

The autobrake system is part of the airplane's hydraulic brake system. After landing, the autobrake system monitors the airplane's deceleration and meters hydraulic pressure to the brake to achieve the level of deceleration selected on the flight deck autobrake select switch[2]

To operate the autobrake system, the flight crew selects a rate of deceleration to the AACU for landing or (rejected) takeoff. Upon landing, when all conditions are correct, the AACU controls hydraulic pressure to the brakes via the autobrake pressure control module[3]. The AACU regulates the hydraulic pressure so the airplane's deceleration matches the flightcrew-selected deceleration rate. A manual brake application by either flightcrew member will override and disarm the autobrake system.

The flightcrew selects a deceleration rate by use of the auto brake rotary switch on the center instrument panel (See Figure 5, above). The selectable positions are 1, 2, 3, and MAX. According to the Boeing 737-600/700/800/900 Aircraft Maintenance Manual, Document D633A101-MRS, Chapter 32-42-00, Task "Autobrake Pressure Control Module Functional Test" (32-42-00-400-801), Paragraphs 6.D(14) [Subtask 32-42-00-860-051], an autobrake selector position of "3" will result in an initial hydraulic pressure of 2,000 +/- 250 psi delivered to each brake. According to Paragraph 6.D(15), an autobrake selector position of "MAX" will result in an initial hydraulic pressure of 3,000 +/-250 psi delivered to each brake.

The antiskid system controls the brakes to prevent the wheels from skidding during the braking action. An antiskid transducer is located in each main landing gear axle to provide the

[2] The autobrake system is also operational during a rejected takeoff.
[3] The AACU also sends information to the auto speedbrake module when the wheel speed is more than 60 knots.

system with rotational wheel speed. The system monitors the speed and meters hydraulic pressure to each brake to prevent a skid condition.

With power applied to the airplane, the autobrake and antiskid systems were examined via the Antiskid/Autobrake Control Unit (AACU). For the test, the Boeing 737-600/700/800/900 Fault Isolation Manual (dated June 15, 2013), Section 32-42, Task 801" Antiskid/Autobrake Control Unit Built In Test (BITE) Procedure was conducted. The BITE function was initiated via the front panel of the AACU. The BITE functions were completed with no faults found. In addition, no pre-existing faults were recorded in the AACU. The following messages, determined to be Software Revision Display Messages[4], were noted on the AACU screen during the tests:

1-4 0300
2-3 0300

See Figure 15.

Figure 15 - Testing the Antiskid/Autobrake Control Unit (AACU) Using the BITE Function. A Software Revision Display Message is shown on the AACU Display.

G. Flight Recorders

The airplane's flight data recorder and cockpit voice recorder were removed from the airplane and retained by the NTSB for further examination. The recorders were sent to the NTSB's Recorder Laboratory in Washington, DC for readout.

2. AIRPLANE STRUCTURES

Although much of the forward and lower portions of the airplane were coated with the EMAS material, grass, and mud, the examination by the group noted little visible physical damage on the airplane structure.

[4] According to the Crane Hydro-Aire, Inc. Component Maintenance Manual for the Antiskid/Autobrake Control Unit, Part Number 42-935, Revised July 10, 2003.

The airplane's structure was examined as follows:

A. Doors

At the arrival of the group, all airplane passenger and access doors were closed. The forward left passenger door (1L) was closed and sealed. No evidence was noted that any of the passenger emergency doors or evacuation systems had been operated following the incident flight. A visual inspection noted no anomalies to the forward left passenger door (1L).

B. Fuselage

The runway barrier debris (EMAS material) was noted on the lower fuselage surfaces and inside all of the wheel wells. See Figures 16A/B and 17.

Figure 16A/B - Dried EMAS Material and Grass on Right Hand Side of Fuselage

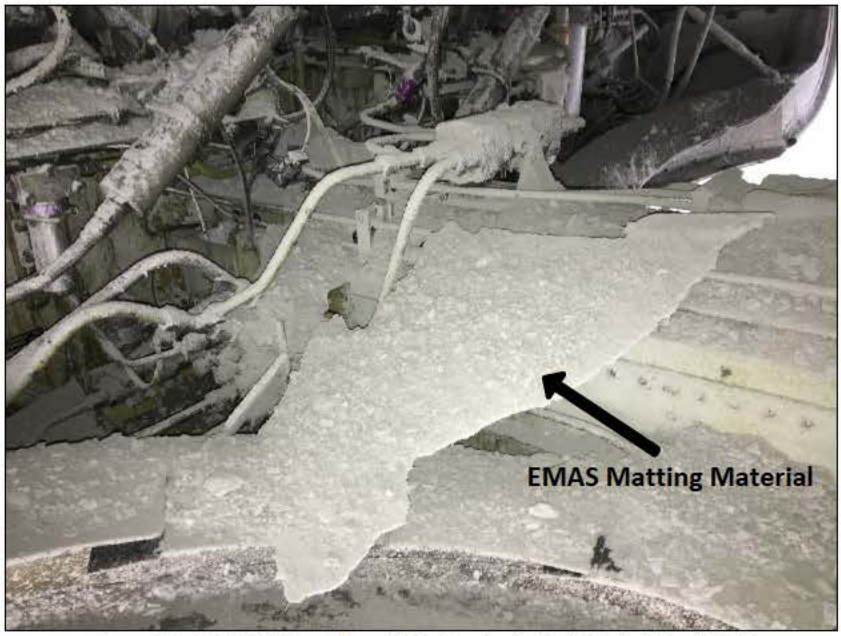

Figure 17 - EMAS Material and Matting in the Left Main Wheel Well

In general, the EMAS material was noted from the window line and lower. However, no significant physical damage was noted on the fuselage.

After the airplane was cleaned, damage was found on the Left Hand Forward Wing to Body Fairing (Panel 191CL). See Figure 18.

Figure 18 - Damage Found on Left Hand Forward Wing to Body Fairing.

C. Stabilizers, Windows, and Wings

The flight deck windows were coated with dried EMAS material. See Figure 19.

Figure 19 - Right Side Flight Deck Windows with EMAS

The leading edge interior exhibited accumulation of EMAS material and matting. See Figures 20A and B.

Figure 20 A/B - EMAS debris on the underside and interior of wing leading edge.

The left hand trailing edge flap exhibited impact damage at the lower, underside surface area. The damage was noted in the area near the outboard section of the number 3 flap “canoe” fairing. The damage was noted as a gouge of approximately 2” long and 1/16” wide that penetrated the flap skin. See Figure 21.

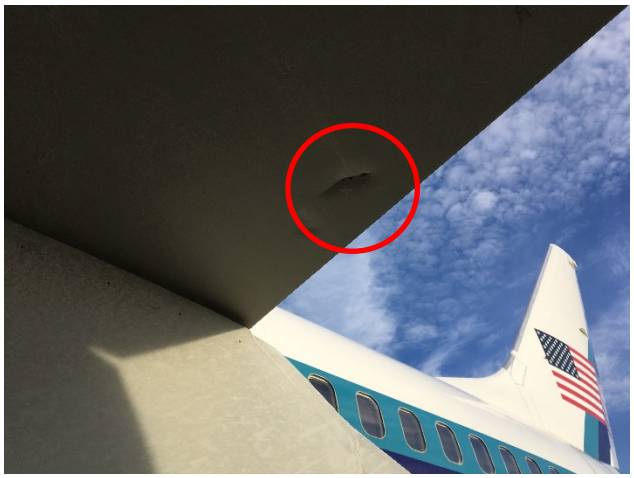

Figure 21 - Impact Damage Noted on Underside of Number 3 Trailing Edge Flap Surface

No visible damage was noted on the horizontal or vertical stabilizers.

3. AIRPLANE POWERPLANTS

The airplane was fitted with two powerplants, one mounted on the bottom of each wing.

The powerplants were identified as follows:

Engine Number 1 (Left Engine)

Engine Manufacturer:	CFM International (CFMI)
Model:	CFM56-7B22
Serial Number:	874663

Engine Number 2 (Right Engine)

Engine Manufacturer:	CFM International (CFMI)
Model:	CFM56-7B22
Serial Number:	892702

Each engine was visually examined.

A. Engine Number 1 Examination

Engine Number 1 showed evidence of EMAS material and matting on the engine inlet and internal components. See Figures 22 and 23.

Figure 22- Overview of Left Engine (Engine #1).


Figure 23 - Inboard side of Left (Number 1) Engine

The left engine sustained fan blade damage, including four blades bent in the direction opposite of rotation, at the tip corner. See Figure 24.

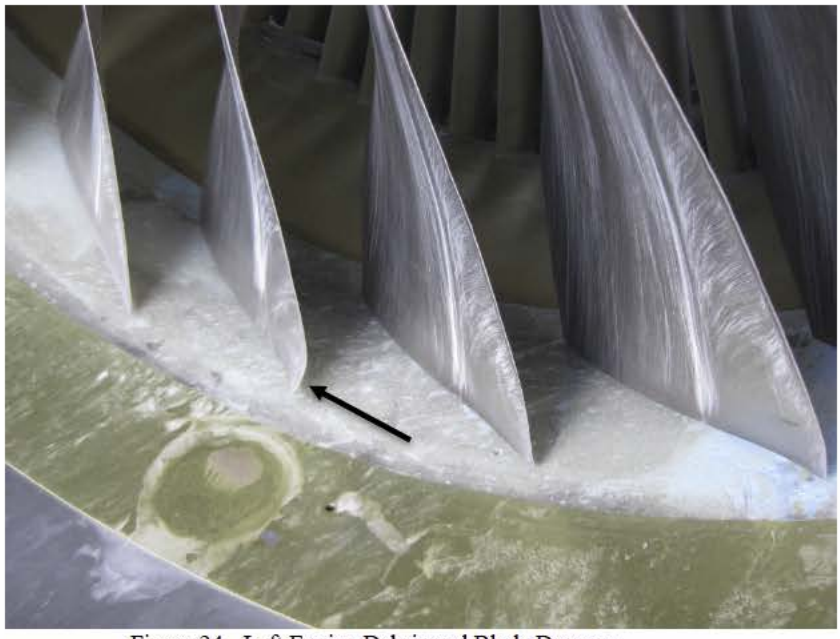

Figure 24 - Left Engine Debris and Blade Damage

Eastern Airlines indicated that the left engine was removed from the airplane (while still parked at LaGuardia Airport) on December 1, 2016.

B. Engine Number 2 Examination

Engine Number 2 (right hand) showed evidence of EMAS material and matting on the engine inlet and internal components. See Figures 25, 26, and 27.

Figure 25 - Number 2 (right) engine intake

Figure 26 – Inboard (left) side of Engine 2 with EMAS debris

Figure 27 - Port with EMAS debris on inboard Number 2 (right) Engine.

No visible blade damage was noted on the right-hand engine.

Eastern Airlines indicated that the right engine was removed from the airplane (while still parked at LaGuardia Airport) on December 1, 2016.

C. Engine Controls

The flight deck engine controls were examined with no anomalies noted.

D. Thrust Reversers

A visual examination of both thrust reversers was conducted, with no anomalies noted. All the thrust reverser cascades showed evidence of EMAS material debris. Examination of the thrust reverser hardware did not reveal any physical damage or anomalies.

Eastern Airlines indicated that, after cleaning and deploying the thrust reversers, damage was found on the inboard thrust reverser sleeves and blocker doors for both engines.

The left engine inboard thrust reverser sleeve (Figure 28):

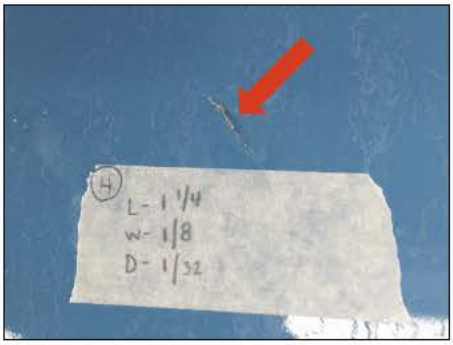

Figure 28- Damage to the inboard thrust reverser sleeve, left engine.

Damage to the left engine blocker doors number 2 and 5 (see Figures 29A, B, and C):

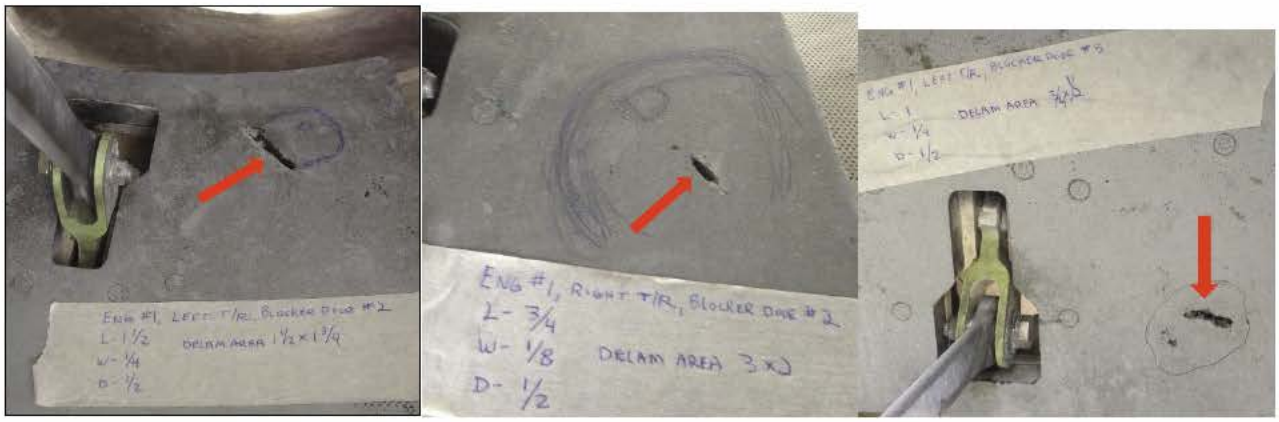

Figure 29A, B, C - Damage to Left Engine Blocker Doors

Damage to the right engine inboard thrust reverser sleeve (see Figures 30A and B):

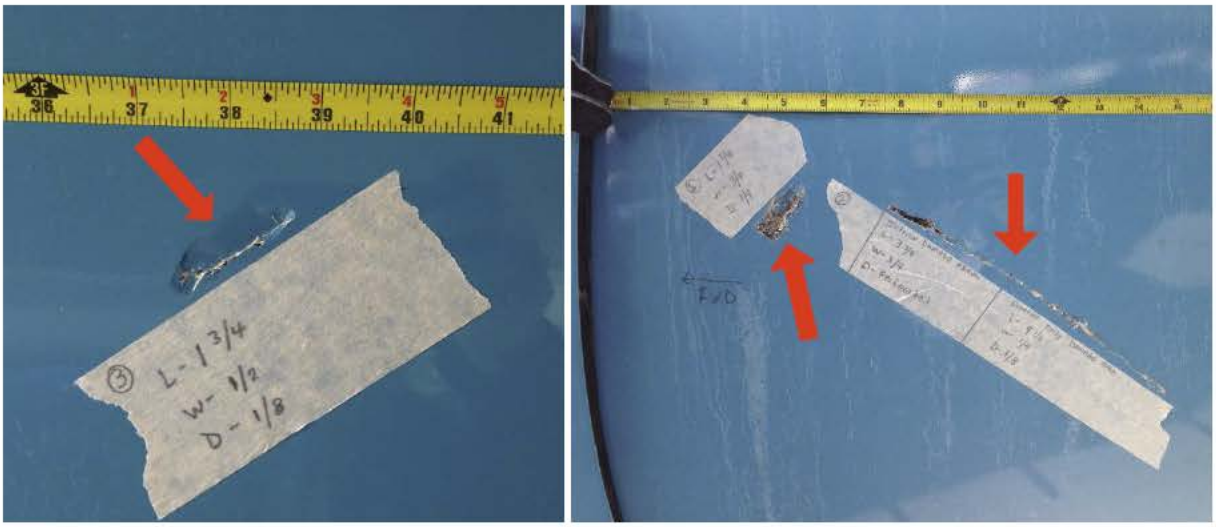

Figure 30A and B - Damage to right engine inboard thrust reverser sleeve.

Damage to the right engine blocker door number 2 (Figures 31A and B)

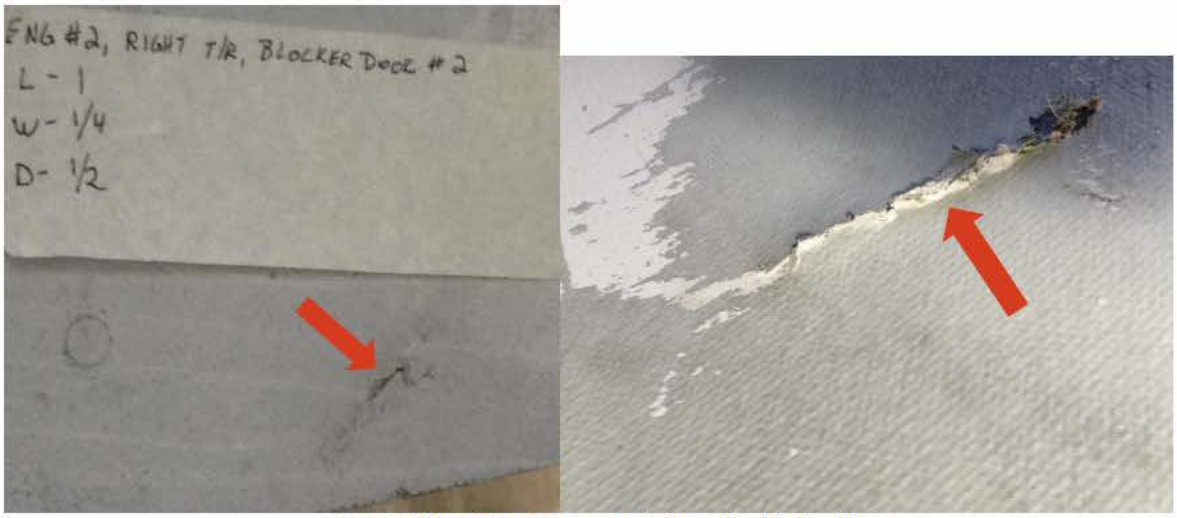

Figure 31A and B - Damage to right engine blocker doors.

4. AIRPLANE MAINTENANCE RECORDS

The group examined the airplane's logbook and noted activity related to the Auto Ground Spoiler System.

The automatic ground spoiler system had been de-activated prior to the incident flight by the operator's maintenance department. According to the airplane's logbook page 0005315, the auto speed brake module had been deactivated on October 25, 2016 (at Mansfield, Ohio), by use of the Boeing 737-600/700/800/900 Fault Isolation Manual, Section 27-62, Task 801 and given Control Number 201610251444. The initiating discrepancy was noted as "Auto Spoiler did not deploy on landing". The item was entered into Eastern Air Lines Minimum Equipment List (MEL) section 27-07 as a Section C item. The corrective action was deferred until November 4, 2016. The logbook item corresponded to the "INOP" sticker placed on the flight deck speed brake handle.

See Figure 32.

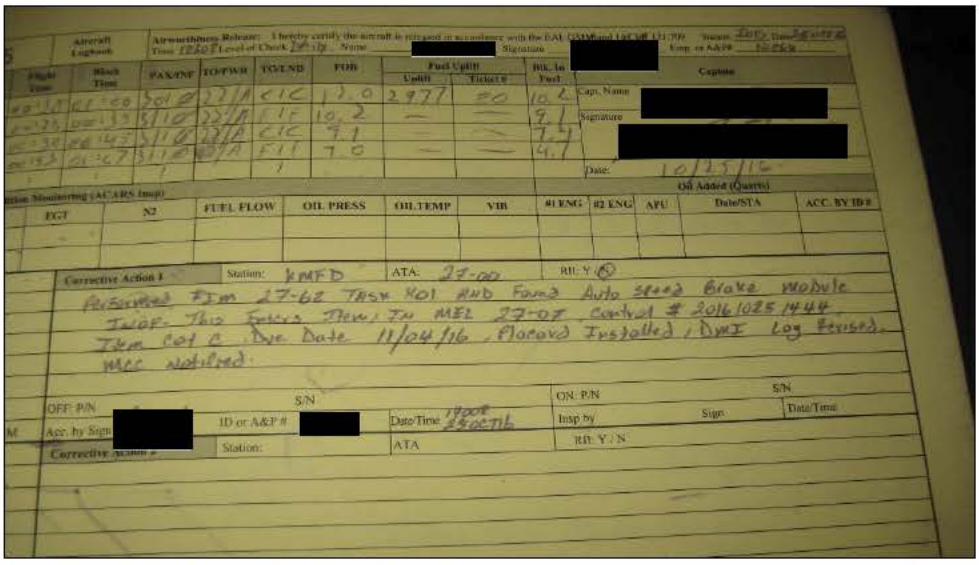

Figure 32- Portion of Airplane's Logbook Detailing Task to De-activate the Auto Speed Brake Module.

According to the airlines, the ground spoilers could still be deployed manually, by use of the handle.

No other pertinent flight deck logbook entries were noted.

5. REVIEW OF FLIGHT RECORDER DATA

The flight data recorder was sent to the NTSB Recorder Laboratory in Washington, DC for readout and evaluation. A review of the parametric data from the incident flight revealed the following:

1. For the last ten flights recorded on the FDR, the discrete state for both the "Speed Brake Do Not Arm Light" and the "Speed Brake Armed Light" parameters stayed at "On". This included the entire incident flight. Information received from Eastern Airlines indicated that, after the auto ground spoiler module was deactivated, data is no longer sent to the flight data acquisition system. Therefore, the resultant data for the two discrete parameters would be "zero".

   For both discrete parameters, the zero state is decoded as "On".

2. For the same final ten flights, the "Auto Speed Brake Extend" discrete parameter state stayed at "Not Extend".

3. During the incident flight landing, the Ground Spoilers "Panels Up" parameter changed state from "Not Up" to "Panels Up" approximately 4 seconds after the Left and Right Gear Weight on Wheels (WOW) discrete changed state from "Air" to "Ground".

4. During the incident landing, at the time the Ground Spoilers “Panels Up” state change occurred, the Nose Landing Gear WOW discrete parameter state was “Air”, but had already changed state from “Air” to “Ground” and back to “Air” prior to the “Panels Up” state change.

5. The “Auto Brake Deploy” parameter did not change state during the incident approach and landing; the state remained at “No Auto Brk” for the landing roll out.

6. After the main landing gear touchdown during the incident flight, the Left and Right Brake Pressure values increased to and remained at approximately 3,000 psi.

Tom Jacky
Aerospace Engineer