



MEMO

DATE 14/03/2023

TO David Fisher
Director, Air Safety Investigations Office (ASIO)

CC Herman Bijl, Director, In-Service Engineering and Technical Support
Nathalie Chabot, Supervisor, In-Service Engineering Systems
Gilles Giguère, Landing Gear Engineer, Product Development
Claude Duchesne, Aircraft Performance, Product Development
Saeed Moshirian, Aircraft Performance, Product Development
Alexander Rapoport, Chief Pilot, Customer Liaison

FROM P. Bissonnette, In-Service Engineering Systems

SUBJECT MSN 7812, Runway Excursion – 5 October 2022 – Factual Report

REF CRJ/ISE/2022/015

Request:

MHIRJ ISE-Systems assistance has been requested to prepare a Factual Report for the subject event. There are some interpretative comments as to “normal” parameters, “significant or not” or “maximization” based on known values and limits. The intent remains to be as factual as possible.

Event Summary:

Summary of event as reported by Air Wisconsin:

Open quote “447 had an event last night where the AC departed the runway and ran through uneven terrain. The AC came to rest on an adjacent taxiway.” End quote

From Aircraft Damage Report Form created by Air Wisconsin:

Open quote “After landing during rollout the aircraft veered from the runway. The aircraft ran through uneven soft terrain (grass & dirt) and came to rest on an adjacent taxiway.” End quote

MX log entry:

Open quote “ON LANDING ROLL OUT ON RNW 24 LEFT IN DAY I VEER IN TO THE RIGHT IN THE GRASS AND HIT SOMETHING THAT CAUSED DAMAGE TO THE LEFT WING. WITH REVERSER OUT, IT STARTED TO SLOWLY VEER TO THE RIGHT, I TOOK THEREVERS OUT THINKING THIS WILL HELP THE SITUATION AND THEN IT CONTINUES MY FIRST OFFICER LAID ON THE BRAKES WITH ME WHEN WE WENT ON THE GRASS AND STOPPED ON THE TAXIWAY BEFORE GOING TO THE OTHER SIDE OF THE TAXIWAY. WE SAW THE #1 BRAKE TEMP MONITOR GO TO 7 AND THE OTHER BRAKE TEMPS STAYED IN THE GREEN. THE AC ACCELERATED ONCE I STOWED THEREVERSES AND BRAKES FELT MUSHY I THINK WE WERE GOING ABOUT 30 TO 40 KNOTS INTO THE GRASS.” End quote

**Pilot Report:**

None provided.

Refer to figures A through C for event runway schematic and photographs.

References:

/1/: FDR File: N447AW (7812) Flt# 3818 IAD-DAY 10-06-22 Skidded Off Rwy 24L on Landing.dat

/2/ ADR for Incident review - RLAB-22-27960206

Runway and weather Conditions:

The runway pavement was dry.

ETAR report at approx. landing time:

KDAY 052256Z 35003KT 10SM SCT250 22/04 A3008 RMK AO2 SLP185 T02170039

Discussion:

A review of the subject aircraft Flight Data Recorder was accomplished. The following is a summary of the findings/observations:

Aircraft: Registration: N447AW, MSN 7812

Flight No.: United Flight # 3818

Landing: The aircraft landed in Dayton International Airport (DAY) at 22:58:54 GMT on runway 24L. See Figure A.

Conditions up to event: All primary parameters appeared to be normal during event. No system fault was reported by operator or recorded by FDR.

Event Date: 5TH October 2022

FDR Analysis (refer to figures 1 through 4):

Note: Time provided is relative time to FDR (Rel. Time 1:10:08 (HH:MM:SS) equals to 22:58:54 GMT). Values with a ~ have been averaged from before and after values or averaged from 2 channels. Speed value is ground speed.

- 1:10:08:
MLGs WOW, heading 239.8°, speed (ground) ~129 kts.
- 1:10:10:
All Gears WOW, heading 239.8°, speed ~125 kts, first RH brake application (OB pressure increase from 46 to 114 PSI).
- 1:10:11:
Heading 239.2°, speed 123 kts, first LH brake application (LB pressure increase from 12 to 160 PSI)

- 1:10:13:
Both Thrust Reversers (TRs) deployed,
LH TR deployed for 6 sec. total (Unlocked 12 sec.) with a Max N1 of 57.3%,
RH TR deployed for 4 sec. total (Unlocked 11 sec.) with a Max N1 of 69.8%,
heading 238.9°, speed 118 kts, differential brake pressure LH/RH (avg OB and IB) ~60
PSI contributing to a pull to the Right.
- 1:10:14:
heading ~239.0°, speed ~113 kts, differential brake pressure LH/RH (avg OB and IB)
~146 PSI favoring Right.
- 1:10:15:
heading 239.2°, speed 108 kts, rudder pedal position ~0.185°R, rudder position
~1.49°R,
differential brake pressure LH/RH (avg OB and IB) of ~0 PSI.
- 1:10:16:
Start of significant increase of left Lateral acceleration (right turn) from 0.075g to
0.301g in 2 sec. later when A/C passed from runway concrete to asphalt (shoulder),
heading 239. 5°, speed ~103 kts, rudder pedal position ~3.14°L, first rudder command
to counter the pull to the right, rudder position ~2.96°L, first rudder move to counter
the pull to the right, Pilot Handwheel position 1.4°L, L Aileron 9.16° LWD, R Aileron
6.19° LWD, differential brake pressure LH/RH (avg OB and IB) ~532 PSI favoring Left.
- 1:10:17:
heading 239. 9°, speed 98 kts, rudder pedal position ~0.77°L, rudder command return
to center, rudder position ~0.27°R, rudder moves to centered position,
Pilot Handwheel position 35.96°L, L Aileron 16.41° LWD. R Aileron 10.81° LWD,
differential brake pressure LH/RH (avg OB and IB) ~443 PSI favoring Left.
- 1:10:18:
heading significant change from 239.9° to 244.1° in 1 sec., speed ~90 kts,
rudder pedal position ~1.44°L, rudder position ~2.5°L, Pilot Handwheel position
10.04°L, Continuation of command to counter the pull to the right, L Aileron 3.81° LWD,
R Aileron 2.22° LWD, differential brake pressure LH/RH (avg OB and IB) ~717 PSI
favoring Left.
- 1:10:19:
heading 348.9°, speed 82 kts, rudder pedal input ~0.86°L, rudder position ~0.19°L,
differential brake pressure LH/RH (avg OB and IB) ~575 PSI favoring Left.
- 1:10:21:
Aircraft exit the runway (Estimated from Normal accel. and exit angle from entry grass
picture), heading 254.4°, speed 66 kts, rudder pedal position ~1.49°L, rudder position
~0.55°L, differential brake pressure LH/RH (avg OB and IB) ~540 PSI favoring Left, RH TR
stowed.
- 1:10:22:
heading ~259.8°, speed ~60 kts, differential brake pressure LH/RH (avg OB and IB) ~746
PSI favoring Left

- 1:10:23:
LH TR stowed, heading 265.2°, speed 54 kts, rudder pedal position ~1.64°L, rudder position ~3.08°L, differential brake pressure LH/RH (avg OB and IB) ~532 PSI favoring Left
- 1:10:24:
heading ~271.8°, speed ~49 kts, differential brake pressure LH/RH (avg OB and IB) ~233 PSI favoring Left.
- 1:10:25:
heading ~278.4°, speed 44 kts, differential brake pressure LH/RH (avg OB and IB) ~201 PSI favoring Left.
- 1:10:26:
Pedals input to the right, heading 287.1°, speed ~39 knots, differential pressure LH/RH (avg OB and IB) ~167 PSI favoring Left.
- 1:10:27:
heading 295.6°, speed 35 kts, differential brake pressure LH/RH (avg OB and IB) ~190 PSI favoring Left.
- 1:10:35: Aircraft stops, heading 336.5°. (96.7° of difference with landing heading).

General info

- The flight and ground spoilers deployed normally at touchdown and remained deployed during 40 sec. and up until 14 sec. after the A/C had stopped.
- All 3 Hydraulic systems pressure remained at ~3000 PSI throughout the event.
- No STEERING INOP message was posted on EICAS, hence not recorded by the FDR. Steering system was ON and not failed per related bit indication.
- NWS Assy position and tiller position are not available to FDR.
- Wind speed was measured by FDR to be between 6 to 8 kts with a direction of 150.5±1.5°.

FDR analysis interpretation:

The aircraft landed smooth at 1:10:08 and remained aligned with runway 24 for 8-9 sec. An approximated path is shown on Fig. A.

The aircraft had a steady alignment until 1:10:16 where lateral acceleration to the left increased more significantly, indicating a yaw to the right.

As the aircraft yawed to the right, it crossed the runway limit with the shoulder and then continue veering to the right onto the grass and then back on the taxiway "E" which is parallel to runway 24. See Fig. 1 and A.

When a yaw to the right was felt (1:10:16), the pilot commanded (for less than 2 sec.) the rudder to the left (4.75°) which slightly reduced the lat. accel. to the left. When pilot commanded the rudder back to center (0.75° R), the lat. accel. increased more significantly. Then the pilot reapplied (for less than 2 sec.)

the rudder to the left (4.19°). The Lat. Accel. flattened for approx. 12 sec. which coincide with the exit of runway into the grass. See Fig. 2.

At approx. the same time as the pilot applied rudder, he also provided two Roll (handwheel) commands to the left for 4 to 8 sec. See Fig 2.

The TRs deployed at 1:10:13. The TRs were deployed for approx. 5 sec. The thrust differential of over 12% was applied for only one second which had a very limited impact if no impact on the deviation to the right. The LH and RH TRs were stowed prior to the entry onto the grass.

A/C exited the runway 5 sec. after the lateral acceleration started to increase significantly. Maximum LH braking was achieved at approx. the same time as the A/C passed the runway to shoulder transit. See Figure 3 yellow band. Prior to A/C exit onto the grass (see Fig 3 red band) the LH and RH brakes were maintained with a less significant differential braking shown by a lateral acceleration that flattened.

After the A/C exit the runway LH and RH brake pressures were reduced with much less significant differential braking pressure. At that time the A/C was on the grass and pilot maintained the A/C in a controlled condition and succeeded to bring back the A/C on paved surface.

During the entire time the brakes were applied it has been observed that:

- for the Left MLG, the outboard brake had more pressure than the inboard brake, showing that there was more friction/pressure induced by the turn to the right.
- for the Right MLG, the inboard brake had more pressure than its outboard brake, showing that there was more friction/pressure induced by the turn to the right.

The A/C finally stopped on taxiway "E" at 1:10:35 with a heading of 336.5° which is 96.7° of difference with landing heading.

NWS ECU NVM analysis:

No NVM data were extracted.

Load sheet:

N/A

RTS MX actions (as reported by Air Wisconsin):

N/A

Supporting graphs:

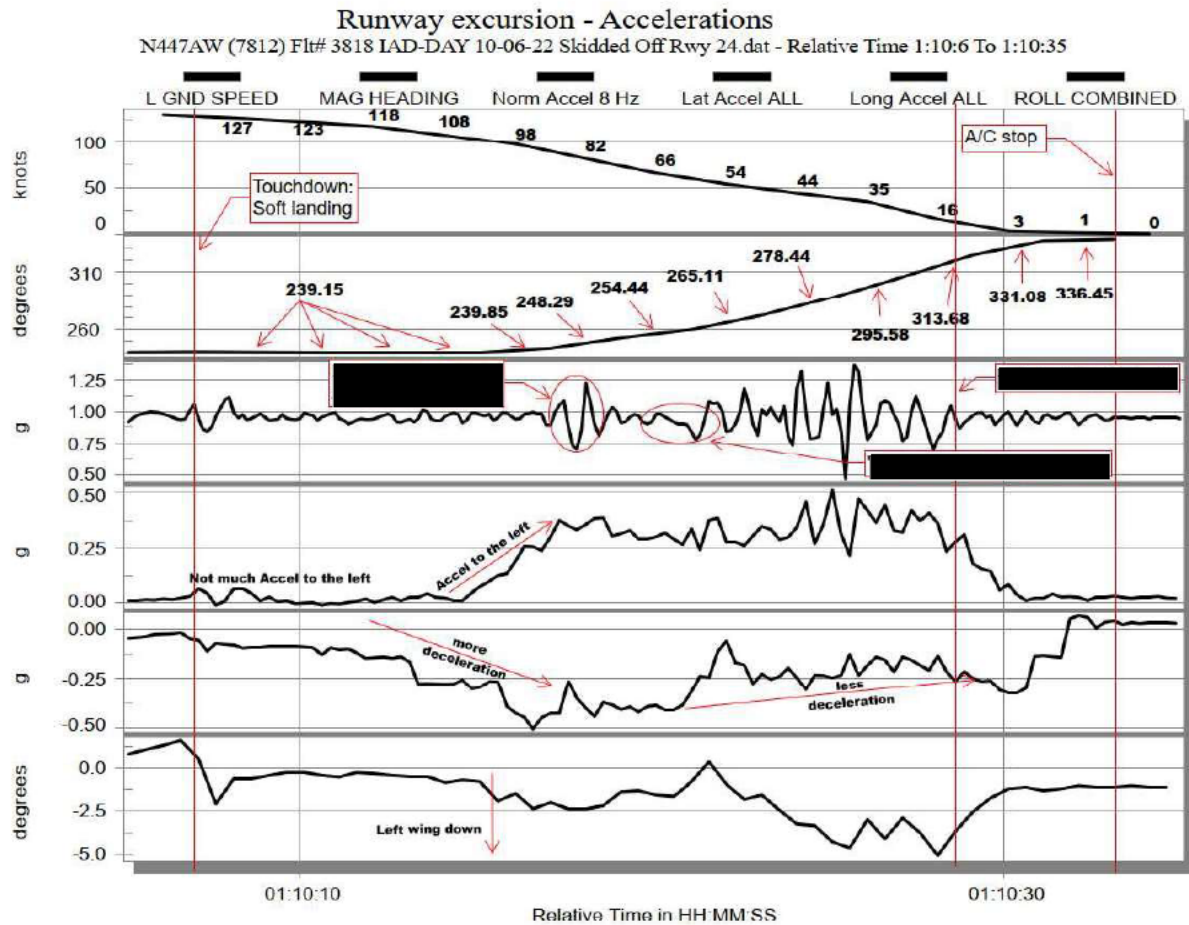


Fig 1: Runway Excursion graph set 1

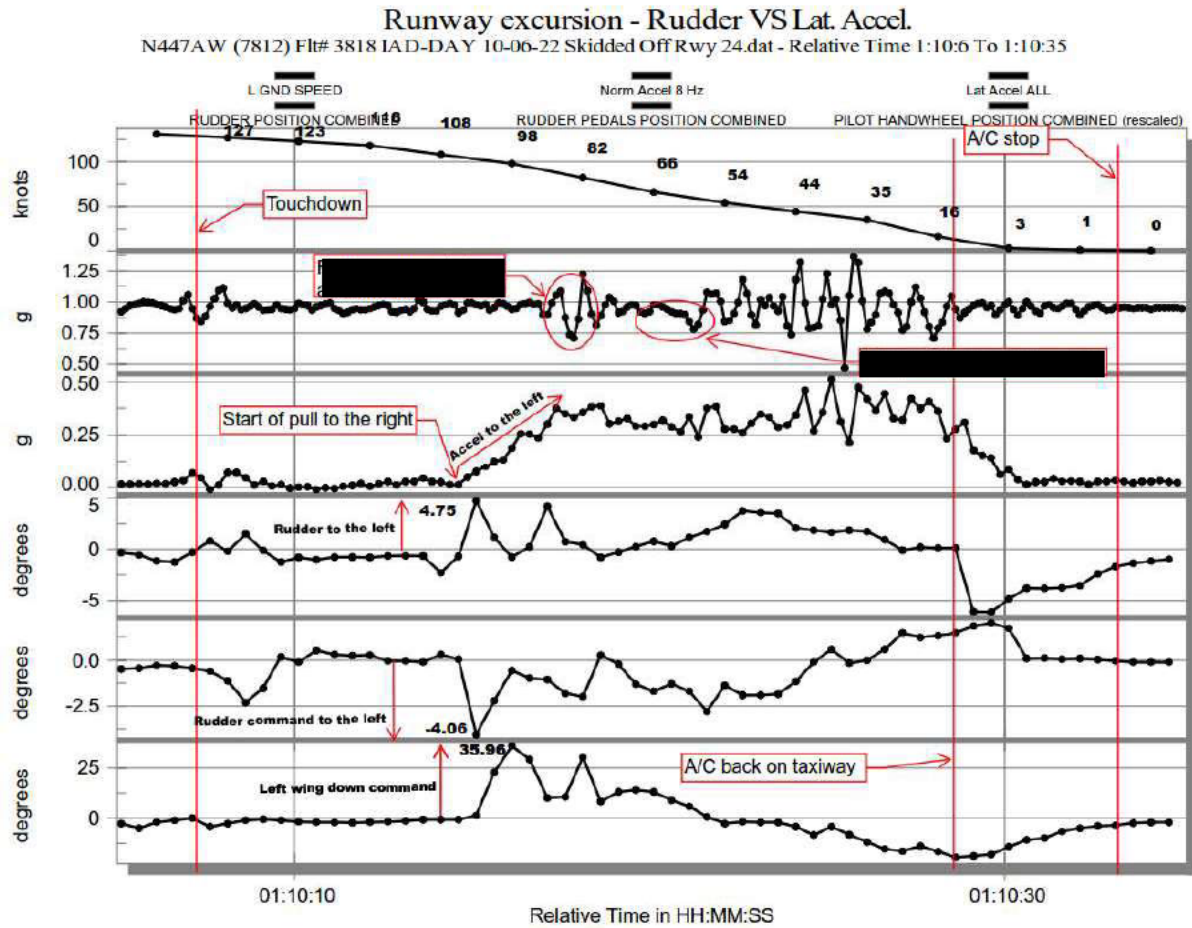


Fig 2: Runway Excursion graph set 2

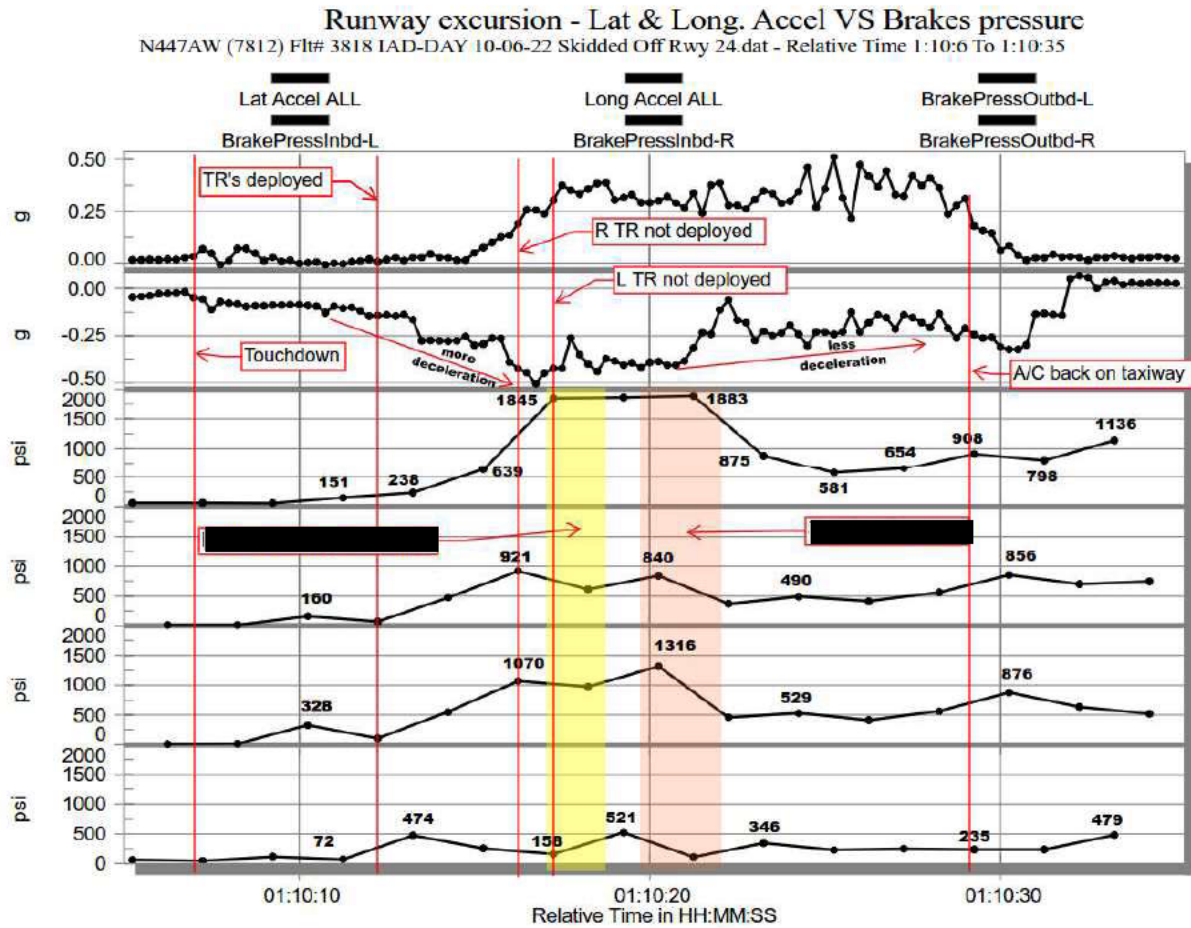


Fig 3: Runway Excursion graph set 3

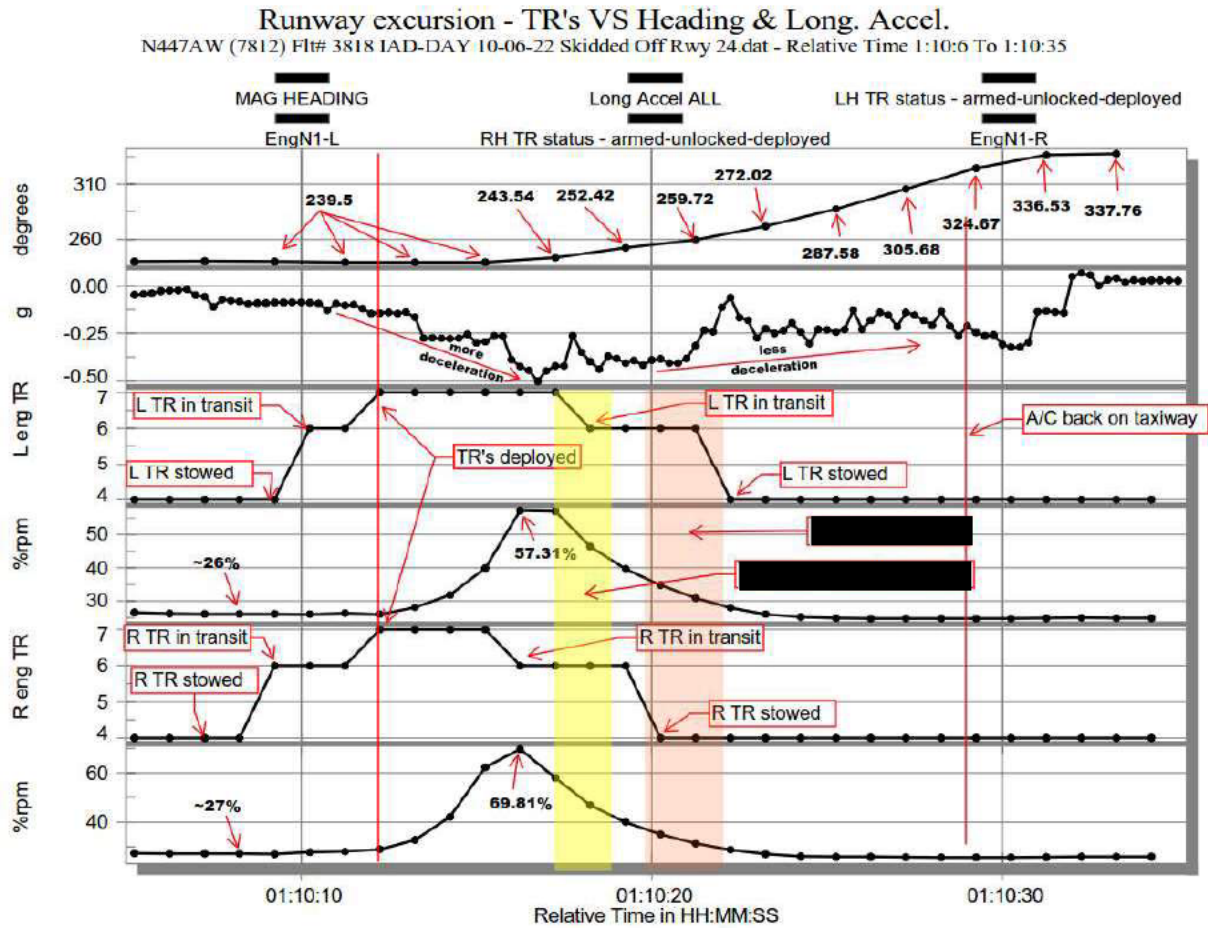


Fig 4: Runway Excursion graph set 4

Supporting pictures:

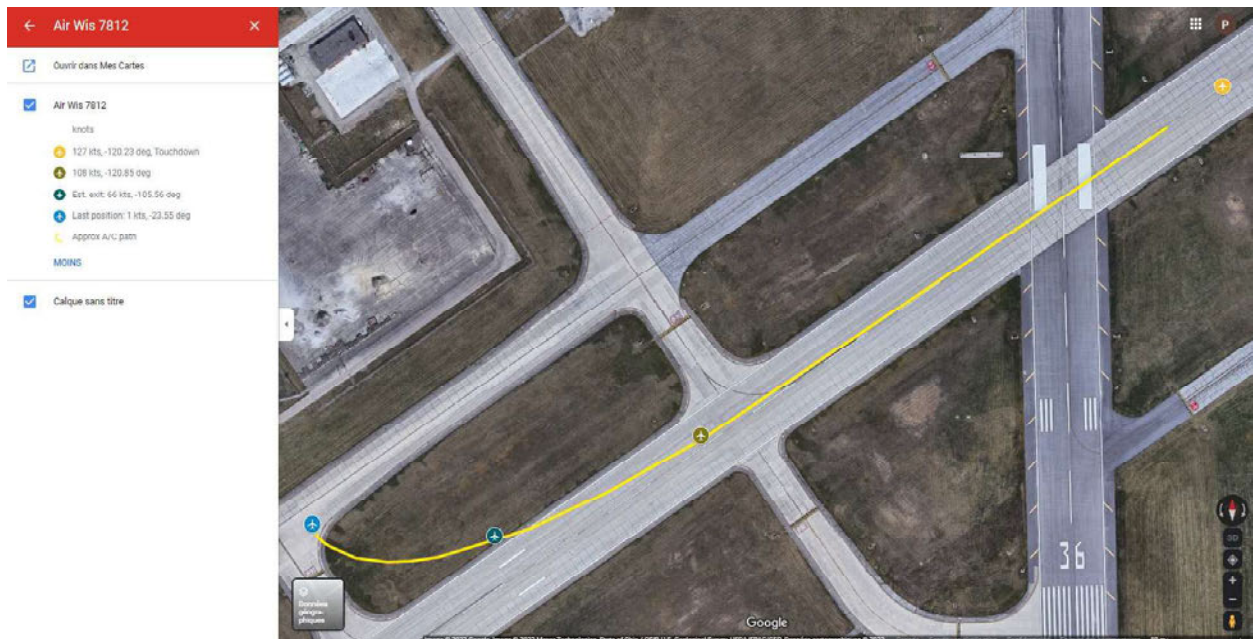


Fig A: Landing (touchdown) and Runway estimated excursion path.

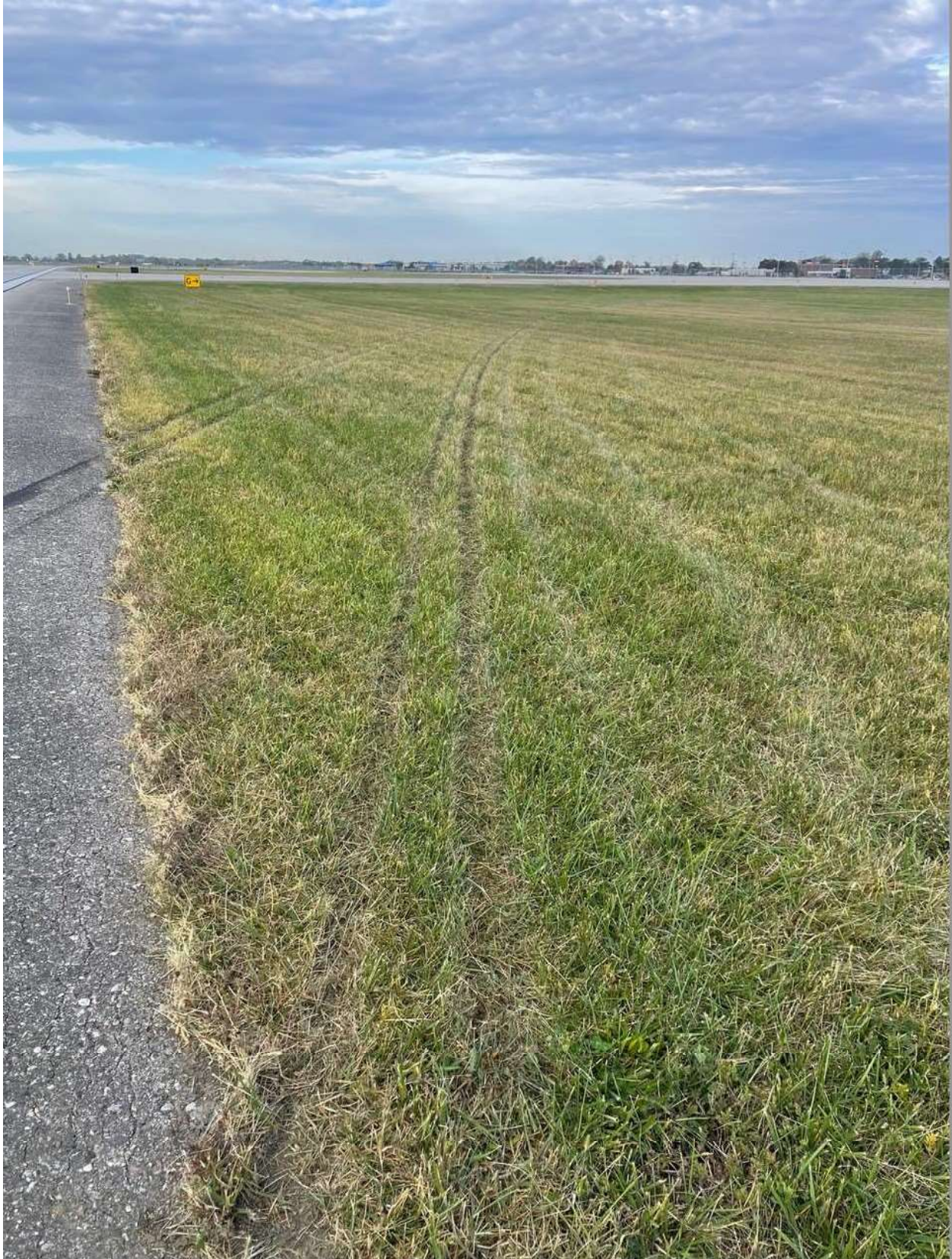


Fig B: Entry onto the grass (picture taken the day after the event)



Fig C: Aircraft stop and exit from grass to taxiway

Conclusion

The FDR data revealed a thrust differential of over 12%, favouring the RH Engine.

Maximum authority of rudder on this aircraft is 25 degrees. The maximum rudder usage (4.75°) was less than 20% of maximum authority and was for a short duration (less than 2 sec).

Full LH rudder was never applied and maintained by the flight crew to counteract the RH lateral deviation.

Maximum braking power is shown to be applied for only one second prior to the shoulder transit. The TRs were being stowed at the time the aircraft exited onto the grass. The RH TR was stowed first, then approximately 2 second later the LH TR was stowed.

The FDR data does not show evidence of a system failure.

[REDACTED]

[REDACTED] there was no remarkable weather reported and the runway condition was dry. Return to service instructions were provided via RIL # 9418. As of March 8th 2023, the aircraft is still grounded due to structural damage and no result from RIL # 9418 have been return to MHIRJ yet.

Patrick [REDACTED]
Bissonnette [REDACTED]
Systems Senior Specialist, In-Service Engineering Systems