NATIONAL TRANSPORTATION SAFETY BOARD

Office of Aviation Safety
Washington, D.C. 20594

October 1, 2014

Attachment 10 – Toulouse, France Simulator Session

OPERATIONAL FACTORS

DCA14MA081

Flight Safety

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Simulator session at Airbus

USAirways #1702

Philadelphia, March 13, 2014

Content

- Accident sequence
- Handling Qualities Review
- Alerts triggered during the take-off roll
- Standard Operating Procedures
- Simulator configuration
- Test program
- Actions

Accident sequence - Crew report versus DFDR

Event	Source crew report	Source DFDR
Late changes before departure	Number 6 → Number 2	N/A
Cleared to runway 27L	Runway error detected and changed at MCDU, 27R → 27L	N/A
Thrust application	FLX power set	Thrust levers set to 34° = FLX PITTO=0 → not in SRS mode ATHRN1=0 → not in thrust mode MAN FLX FCTL=1 → ENG page not displayed
Thrust setting alert	"Thrust not set" Out and back to FLX detent TLA to the red line	ENG THR LEVERS NOT SET not recorded Thrust levers transiently moved below FLX then back
Actual thrust	N1 gauges pretty much at TOGA	Automatic TOGA thrust within 8s (88.6% N1)
TO speeds	No V-speeds	No SCAS → no V2 in FMS
Audio alert	Permanent RETARD	N/A
Warnings	No red warnings	MW=0 → no red warnings
Rotation	As memorized VR 159kt	At 159kt
Aircraft response	Inputs not responding	Response to stick inputs

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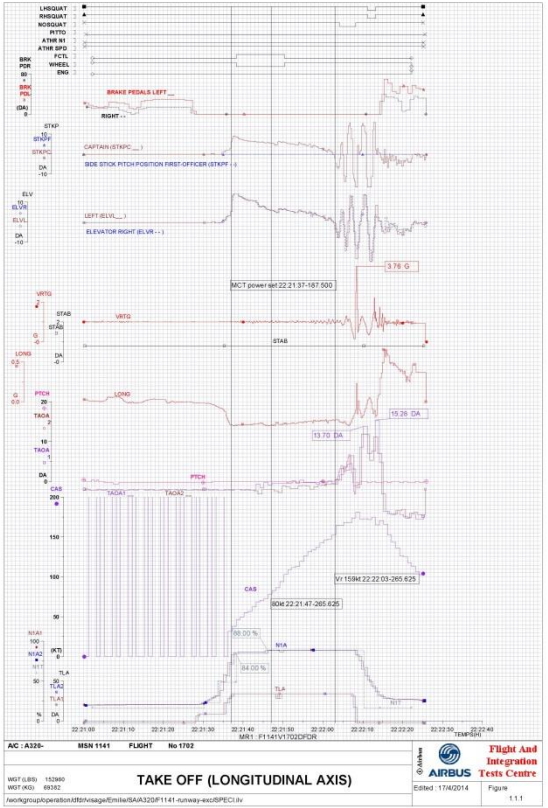
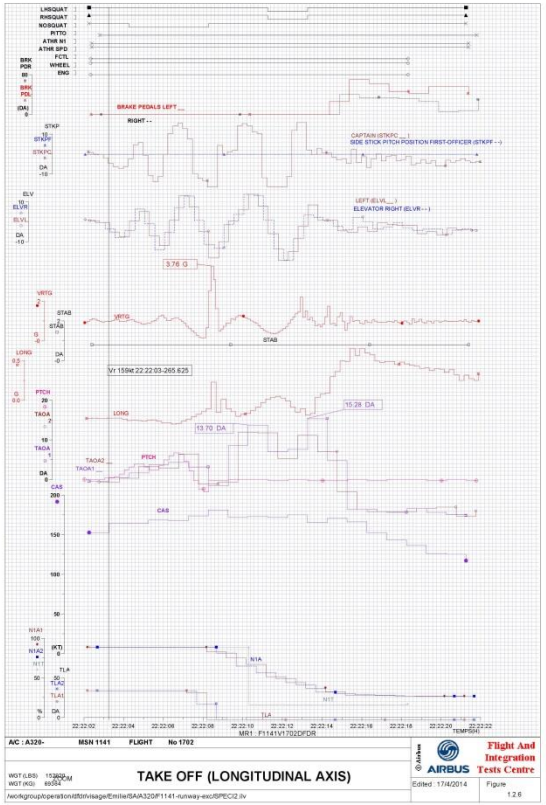
Accident sequence – DFDR figures





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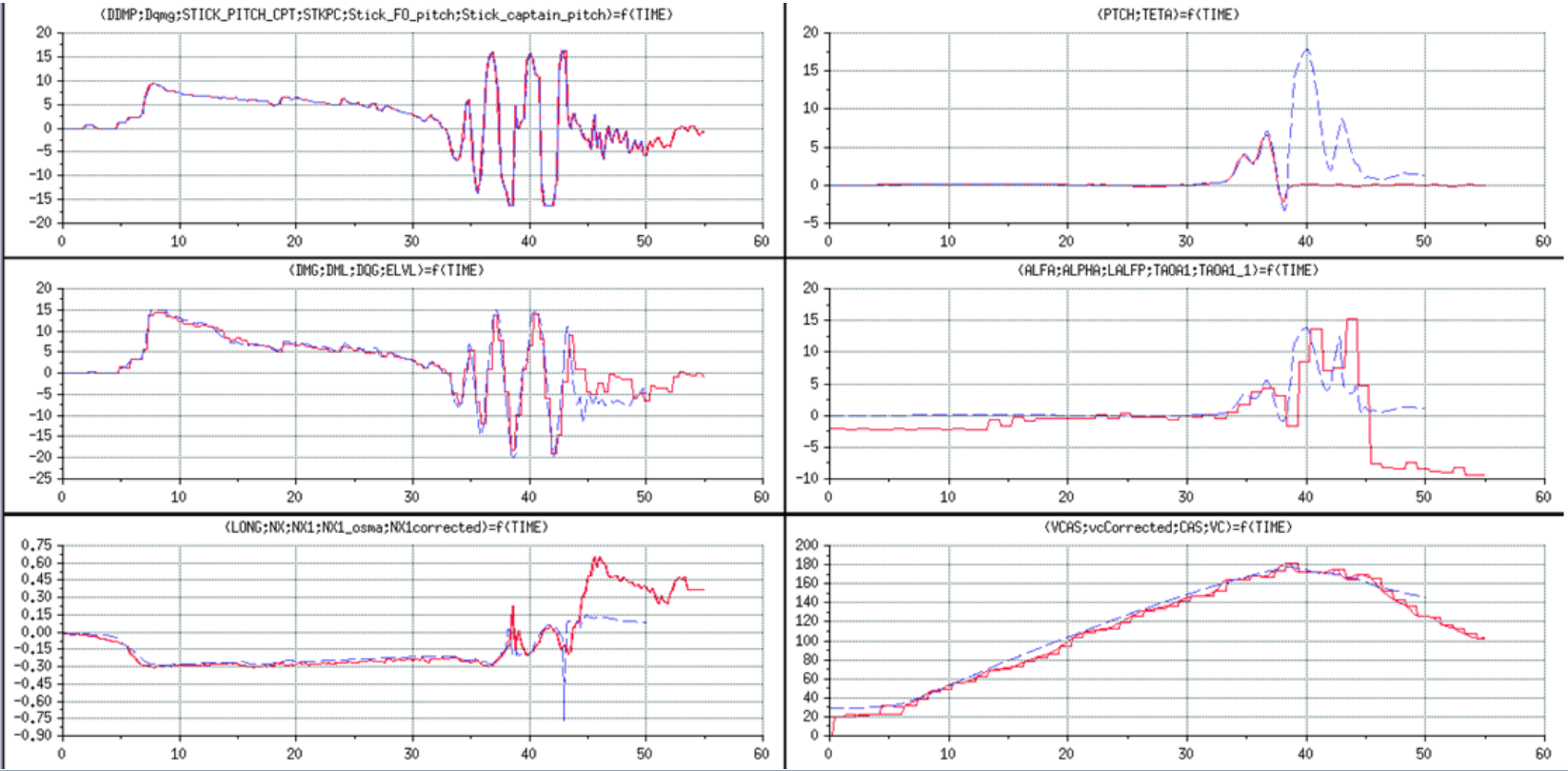
Handling Qualities – Nominal response



DFDR

Model

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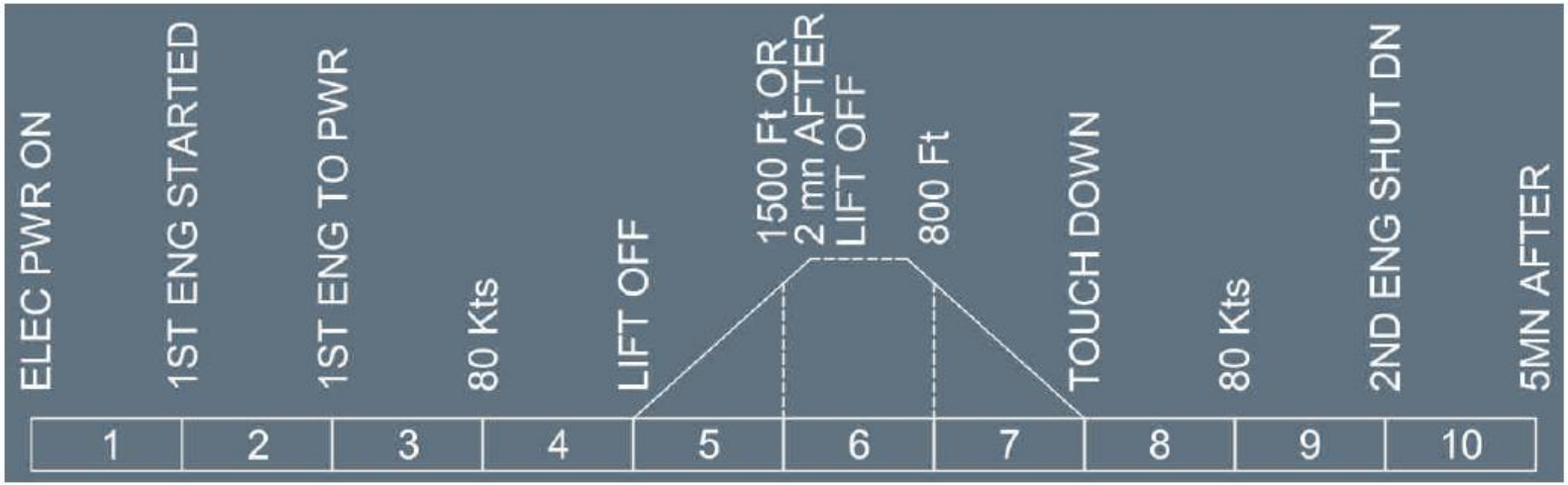
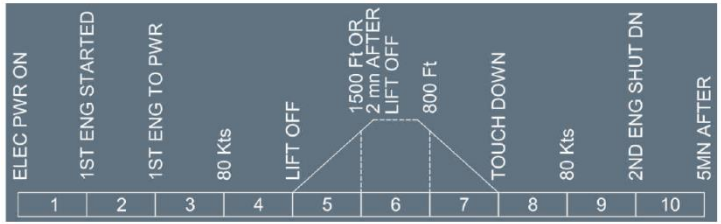
Flight phase computation



- Source parameter for warnings and cautions inhibition during takeoff or landing
  - T.O. INHIBIT(flight phases 3, 4, and 5)
  - LDG INHIBIT (flight phases 7 and 8)

Flight Phase computation during take-off as a function of thrust setting

TO PWR not set
- No transition to PH3 and PH4
- PH2 → PH8 at 80kt



TO run		RTO above 80kt	
PH2 to PH3	PH3 to PH4	PH4 to PH8	PH8 to PH9
Ground status + A/C speed < 80kt + one engine at TO PWR	Ground status + A/C speed > 80kt + one engine at TO PWR	Ground status + A/C speed > 80kt + no engine at TO PWR	Ground status + A/C speed < 80kt + no engine at TO PWR

TO PWR = TOGA or MCT in FLX TO conditions

THR LEVERS NOT SET

ENG THR LEVERS NOT SET

Ident.: PRO-ABN-70-00012307.0014001 / 14 OCT 13
Applicable to: MSN 0844-3633, 3879, 3928, 4086, 4149-4242, 5444-5696

L2 At least one FADEC engaged a takeoff thrust mode that is not in accordance with the position of the thrust levers.

L1 *Note:*
1. *The takeoff thrust mode is engaged when the flight crew sets the thrust levers above the CL position.*
2. *The flex takeoff thrust mode is armed only if the flight crew entered a FLEX TO TEMP on the MCDU that is above the OAT.*

■ **If the flex mode is not armed, and the flight crew sets the thrust levers below or at the MCT/FLX position:**
THR LEVERS..... TO/GA

L2 *If the flight crew does not set the thrust levers to the TOGA position, the FADEC will automatically select TOGA thrust after 8 s.*

L1 ■ **If the flex mode is armed, and the flight crew sets the thrust levers below the MCT/FLX position:**
THR LEVERS ..... MCT/FLX

AURAL WARNING	MASTER LIGHT	SD PAGE CALLED	LOCAL WARNING	FLT PHASE INHIB
SINGLE CHIME	MASTER CAUT			1, 4, 5, 6, 7, 8, 10

- Triggered within 3 seconds upon levers above CL position
- Setting thrust levers to TOGA increments PH2 to PH3
- Auto-TOGA sets thrust but does not increment PH

RETARD audio indicator

AUDIO INDICATORS	MEANING	DURATION	AUDIO INDICATOR CANCELLATION (a)
"RETARD" (synthetic voice)	Thrust levers not in IDLE or REVERSE position for landing	ONE TIME at 20 ft (10 ft in autoland with A/THR ON), Then PERMANENT	All Thrust levers are set to IDLE or REVERSE

- USA1702
  - Ground status + A/C speed > 80kt + no engine at TO PWR → PH8
  - PH8 + all thrust levers above IDLE → Permanent RETARD audio indicator
  - Cancellation
    - At RTO
    - Or with EMER CANCEL pushbutton designed to delete spurious audio alerts and cautions

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SOP's normal procedures - Cockpit preparation

- FMGS Preparation

F-PLN A page.....COMPLETE AND CHECK

The flight crew must check, modify, or insert (as applicable) the F-PLN in the following order, according to the data given by ATIS, ATC, or MET:
- Lateral revision at departure airport. Select RWY, then SID, then TRANS using scroll keys.

FMS PREPARATION..... CHECK

After the PF prepared the FMS, the PNF checks:
- The airfield data.
- All FMS entered data.

SOP's normal procedures - Cockpit preparation

- Take-off briefing

TAKEOFF BRIEFING.....PERFORM

The PF should perform the takeoff briefing at the gate , when the flight crew workload permits, Cockpit preparation has been completed and, before engine start.

The takeoff briefing should be relevant, concise and chronological. When a main parameter is referred to by the PF, both flight crewmembers must crosscheck that the parameter has been set or programmed correctly. The takeoff briefing covers the following:

FCTM

3- Takeoff Perf Page	
TO RWY	
TO CONF	
FLEX / TOGA (1)	(FLEX TOGA on MCDU)
V1, VR, V2 (1)	(V1, V2 on PFD)
TRANS ALT	
THR RED / ACC Altitude	

SOP's normal procedures - Before Pushback or Start

- Before Start Clearance, take-off data / MCDU

FMS T.O DATA..... CHECK/REVISE AS RQRD

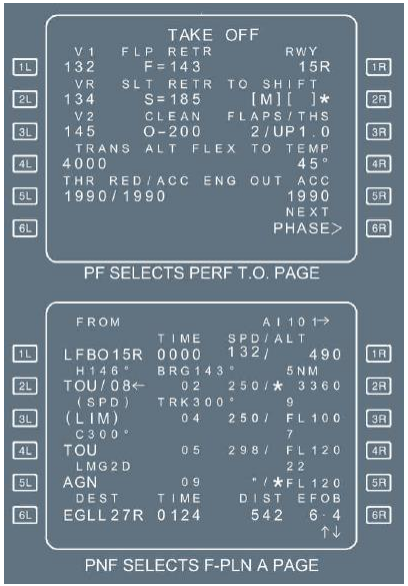
The PF enters or revises the takeoff data in the INIT B and PERF pages of the MCDU.

FMS PERF TO page..... SELECT

It is recommended to display the PERF TO page on the PF side.

FMS F-PLN page.....SELECT

It is recommended to display the F-PLN page on the PNF side



QRH

BEFORE PUSHBACK OR START

4

PF	PNF
LOADSHEET.....CHECK (CM1)	
FOB.....CHECK	FOB.....CHECK
FMS TO DATA.....CHECK/REVISE AS RQRD	REVISED FMS TO DATA.....XCHECK
SEATING POSITION.....ADJUST	SEATING POSITION.....ADJUST
FMS PERF TO page.....SELECT	FMS F-PLN page .....SELECT

SOP's normal procedures - Taxi

- Take-off data / Conditions

If takeoff data has changed, or in case of a runway change, prepare updated takeoff data, as appropriate:

F-PLN (Runway)..... REVISE

FLAPS lever .....AS APPROPRIATE

Select takeoff position.

V1, VR, V2.....REINSERT

FLX TO temperature.....REINSERT

QRH

TAXI	
PF	**PNF**
•ATC clearance obtained:	ATC CLEARANCE.....CONFIRM T.O DATA..... CHECK

SOP's normal procedures – Before Take-off

- Before take-off

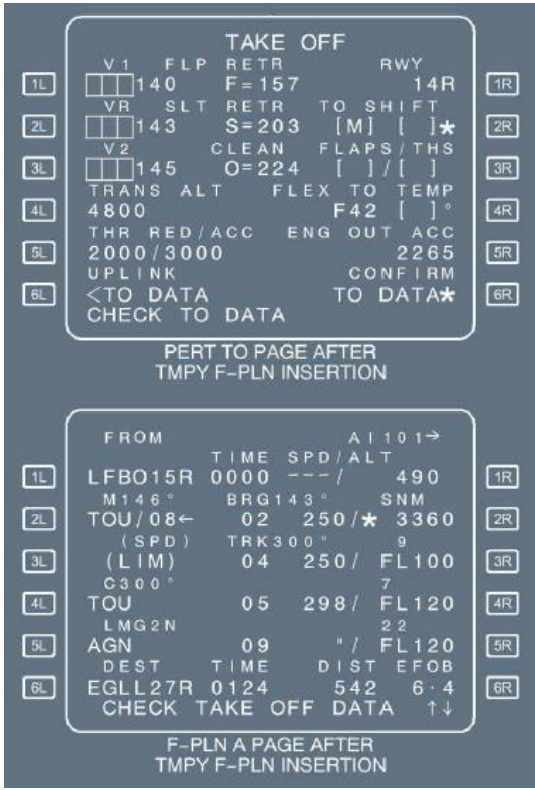
  TAKEOFF RUNWAY.....CONFIRM

QRH

BEFORE TAKEOFF	
PF	**PNF**
TAKEOFF RUNWAY..... CONFIRM	TAKEOFF RUNWAY..... CONFIRM

SOP's systems related – FMS change of runway

- SELECT the new RWY in use.
- The "CHECK TAKE-OFF DATA" message is displayed.
- PRESS the PERF key to access PERF TAKEOFF page.
- CHECK the V1, VR, V2 and FLEX values displayed after the amber boxes.
  - If these values are correct, PRESS [6R] to confirm and insert them.
  - Else, ENTER new values.
- ENTER the new V1, VR, V2, FLEX TEMP or CONF, as appropriate.
- The previously-entered values, adjacent to the boxes, may be re-selected by pressing the CONFIRM TO DATA* on [6R].



SOP's normal procedures – Take-off

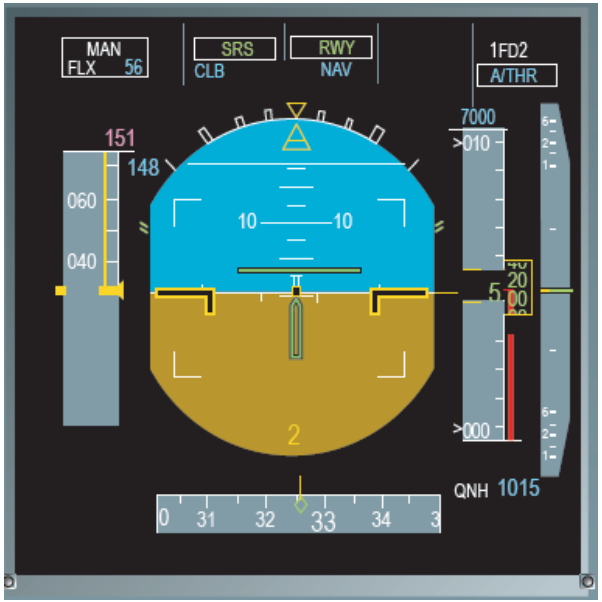
- Thrust setting

  THRUST LEVERS..... FLX or TOGA

  PFD/ND..... MONITOR

  FMA..... ANNOUNCE

Check the FMA on the PFD.
The following modes are displayed:
MAN TOGA (or MAN FLX xx) / SRS / RWY (or blank) / A/THR (in blue).



3. Understand the FMA at all times.

The flight crew must confirm the operational effect of all actions on the FCU, or on the MCDU, via a crosscheck of the corresponding annunciation or data on the PFD and on the ND.

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SOP's abnormal procedures – Rejected Take-off decision management

- Below 100kt

  The decision to reject the takeoff may be taken at the Captain's discretion, depending on the circumstances.

  Although we cannot list all the causes, the Captain should seriously consider discontinuing the takeoff, if any ECAM warning/caution is activated.

  Note: The speed of 100kt is not critical: It was chosen in order to help the Captain make his decision, and to avoid unnecessary stops from high speed.

SOP's abnormal procedures – Rejected Take-off decision management

- Above 100kt and below V1

  Rejecting the takeoff at these speeds is a more serious matter […]. It could lead to a hazardous situation, if the speed is approaching V1. At these speeds the Captain should be "go-minded" and very few situations should lead to the decision to reject the takeoff:

  1. Fire warning or severe damage.
  2. Sudden loss of engine thrust.
  3. Malfunctions or conditions that give unambiguous indications that the aircraft will not fly safely.
  4. Any red ECAM warning.
  5. Any amber ECAM caution listed [none relevant to USA1702]

- Above V1

  Takeoff must be continued, because it may not be possible to stop the aircraft on the remaining runway.

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Simulator configuration

- Simulator fitted with most of USA1702's computer standards
  - FADECs+EIU#2, FMs, FWCs, FAC, SEC: same part numbers
  - EIU#1, FGs, ELACs: similar computers, HW difference but no functional impact foreseen
- Electronic Instrument System
  - EIS2 instead of EIS1 : no functional impact foreseen on FMA, RWY display, EWD and speed indications
  - SDAC simulated : no model issue/lack of representativeness foreseen
- Flight conditions
  - OAT=0°C, QNH=1013, GW=69.5t, CG=32.9%, Wind=18/302
- Initialisation procedure to maintain representativity between runs
  - APU running with APU Bleed & APU GEN ON (for bleed availability & Electrical back up)
  - Systematic Stop/Reinit
  - Both Engine shut down (N2<50%) and relighted then both FWCs reset

Simulator configuration

Computer	USA1702	Simulator
FADEC	5BS2 (rating 5B4)	5BS2 (rating 5B4)
EIU	v14	EIU#1:v15 EIU#2:v14
FMGC (FG/FM)	C12/S6	C12A/S6
FWC	H2-F5	H2-F5
FAC	B0513	B0513
ELAC (HW-SW)	A'-L81	B-L81
SEC	B-104	B-104
DMC	EIS1 v60	EIS2 s12
SDAC	H2-D2	Simulated

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Test program - Objectives

- Review the accident case in the 3 stages of
  - FMS preparation
  - TO run
  - Rotation
- Before TO and during TO run
  - Observe system behavior and audio/visual cues available to the crew when take off performed without TO data insertion to FMS
  - Compare with nominal case
- Rotation
  - Experience handling qualities with accident aircraft status

Test program – Run 1 nominal

FMS preparation	TO run	Rotation
Late runway change F-PLN (Runway)..... REVISE Runway 27L displayed on ND	THRUST LEVERS..... FLX	Perform
CHECK TO DATA	PFD/ND…..... MONITOR	Assess handling qualities
V1, VR, V2.....REINSERT FLX TO temperature.....REINSERT	FMA..... ANNOUNCE MAN FLX / SRS / A/THR (in blue)	
Possible use of “CONFIRM TO DATA” prompt at MCDU when TO data are the same		

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Test program – Run 2 USA1702 scenario

FMS preparation	TO run	Rotation
Late runway change F-PLN (Runway)..... REVISE Runway 27L displayed on ND	THRUST LEVERS..... FLX	Perform
CHECK TO DATA TO DATA not revised	PFD/ND..... MONITOR No V-Speeds on speed tape	Assess handling qualities
FLEX not displayed on EWD page No V-speeds on PFD speed tape	FMA..... ANNOUNCE MAN FLX / SRS / A/THR (in blue) not engaged	
	ENG THR LEVERS NOT SET THR LEVERS..... TO/GA Levers transitorily set below FLX	
	Auto TOGA within 8s from CL	
	Permanent RETARD at 80kt	

Test program – Run 3 USA1702 scenario but transiently above FLX

FMS preparation	TO run	Rotation
Late runway change F-PLN (Runway)..... REVISE Runway 27L displayed on ND	THRUST LEVERS..... FLX	Perform
CHECK TO DATA TO DATA not revised	PFD/ND..... MONITOR No V-Speeds on speed tape	Assess handling qualities
FLEX not displayed on EWD page No V-speeds on PFD speed tape	FMA..... ANNOUNCE MAN FLX / SRS / A/THR (in blue) not engaged	
	ENG THR LEVERS NOT SET THR LEVERS..... TO/GA Levers transitorily set above FLX	
	Auto TOGA within 8s since CL	
	No RETARD if above FLX below 80kt RETARD cancelled if above FLX after 80kt	

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Test program – Run 4 USA1702 scenario but TOGA upon ENG THR LEVERS NOT SET

FMS preparation	TO run	Rotation
Late runway change F-PLN (Runway)..... REVISE Runway 27L displayed on ND	THRUST LEVERS..... FLX	Perform
CHECK TO DATA TO DATA not revised	PFD/ND..... MONITOR No V-Speeds on speed tape	Assess handling qualities
FLEX not displayed on EWD page No V-speeds on PFD speed tape	FMA..... ANNOUNCE MAN FLX / SRS / A/THR (in blue) not engaged	
	ENG THR LEVERS NOT SET THR LEVERS..... TO/GA Levers set to TOGA	
	No permanent RETARD at 80kt	

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Actions at Airbus

- Unexpected RETARD during TO run
  - In-service experience
  - Proportion continue / RTO
  - When RTO, how many have a high energy RTO policy at 80kt
- Review E/W triggered during the TO run that give an instruction to continue
- Experience with Operators departing without V-Speeds
- Briefing notes or operational materials relevant to this accident (RTO decision, TO data)
- Review high energy RTO policy at 80kt

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