DCA23FA149

OPERATIONAL FACTORS

Attachment 6

SWA Simulator Evaluation

July 31, 2023

TABLE OF CONTENTS

A. INCIDENT 3
B. OPERATIONAL FACTORS & HUMAN PERFORMANCE SIMULATOR EVALUATION 3
C. SUMMARY 3
D. FOLLOW-ON DAILY ACTIVITIES 4
E. SIMULATOR EVALUATION 4

Rules of Engagement

The Simulator work will be used to document procedures, cockpit flows, visual and aural cues available to the pilots.

The Simulator work is NOT to recreate the incident sequence.

The simulator is not the incident airplane.

No videos will be taken during the simulator session.

Still pictures will be taken but will be subject to SWA Approval.

A. INCIDENT

Location: Austin, TX
Date: February 4, 2023
Time: 06:40 Local
11:40 Coordinated Universal Time (UTC)
Airplane: B 737-79P (A1); B767-32LF (A2)

B. OPERATIONAL FACTORS & HUMAN PERFORMANCE SIMULATOR EVALUATION

Group Chair	Warren Abrams NTSB Washington, D.C.
Group Member	Dujuan Sevillian, Ph.D. NTSB Washington, D.C.
Group Member	Kevin Fergerson Southwest Airlines Dallas, TX
Group Member	Craig Jakubowski Southwest Airlines Pilot Association, SWAPA Dallas, TX
Group Member	Matt Rigsby Federal Aviation Administration, FAA Washington, D.C.
Group Member	Mark Diaz Boeing Safety Pilot Seattle, WA

C. SUMMARY

On February 4, 2023, at about 0640 central standard time (CST), Federal Express (FedEx) flight 1432 (FDX1432), a Boeing 767-32LF, and Southwest Airlines flight 708 (SWA708) a Boeing 737- 79P were involved in a runway incursion with overflight that resulted in a loss of separation at the Austin-Bergstrom International

Airport (AUS), Austin, Texas. There were no injuries reported to the 128 passengers and crew onboard the SWA airplane or to the 3 crew members onboard the FedEx airplane. SWA flight 708 was a regularly scheduled international passenger flight operating under the provisions of 14 *Code of Federal Regulations* (CFR) Part 121 from AUS to the Cancún International Airport (CUN), Cancún, Mexico. FedEx flight 1432 was a domestic cargo flight operating under the provisions of 14 CFR Part 121 from Memphis International Airport (MEM), Memphis, Tennessee to AUS

D. FOLLOW-ON DAILY ACTIVITIES

On April 27, 2023, at 1100 local, the Ops Group conducted simulator evaluations of various scenarios at the Wings building at Southwest (SWA) Training Center in Dallas, TX. Scenarios included Normal as well as Non-Normal procedures according to the Southwest 737 Flight Training manual. The running of the Normal Checklist was combined with low visibility procedures and guidelines as found in the SWA Flight Operations Procedure Manual

E. SIMULATOR EVALUATION

Location: Wings building, Southwest Airlines Training Center Dallas, TX
Date: April 27, 2023, 1100 CDT[1]
Overall Objectives:

- Document the simulator fidelity, systems, and alerts.
- Documents any alerts and warnings associated with low visibility procedures.
- Document takeoff preparation in VFR conditions
- Document takeoff preparations in low visibility conditions (Less than 1800 RVR)
- Document and time the stabilization of the engines and instruments in low visibility conditions.

Aircraft: Boeing 737 simulator[2]
Airport: Dallas Love Field, KDAL[3]
Runway: 31L from taxiway C to taxiway C1
Invited Participants:
Warren Abrams NTSB, Operations
Dujuan Sevillian, NTSB Human Performance

[1] All times are Central Daylight Time (CDT)
[2] Able to accommodate only 6 occupants at a time with the motion on.
[3] KAUS was the departure airport, but we will use KDAL because of the simulator KDAL model.

Mike Hauf, NTSB, IIC[4]
Matt Rigsby, FAA
Kevin Fergerson, Southwest Airlines
Craig Jakubowski, SWAPA
Chuck Larson, 737 Simulator Operator
Mark Diaz, Boeing Group member

Initial Simulator Setup:

- Configuration[5]
  - Weight 135,700 lbs.
  - Takeoff CG 22.9
  - Stab Trim 6.3 degrees nose up
  - Assumed Temperature, AT, 51
  - Fuel 24,000 lbs.
  - V speeds, V1 128, Vr 135, V2 139
  - Flaps 1 degrees set for takeoff.
  - Departure Runway, 18L
  - Night
  - Weather
  - HGS/HUD in use on all takeoffs.

Winds calm, visibility 1400 RVR, ceiling at 200 ft agl[6]

- The evaluation will take place in one sim session, but we will have to run the scenarios twice since we are unable to accommodate everyone in the simulator at one time.
- Left seat is Pilot Monitoring (PM): Right seat is Pilot Flying (PF)
- For the evaluation Kevin Fergerson (SWA) and Craig Jakubowski (SWAPA), as the pilot flying and pilot monitoring, respectively.
- Fuel freeze will be utilized during the entire simulator evaluation in order to repetitively simulate the incident flight.
- All runs will be conducted with motion ON unless noted otherwise.

[4] Investigator In Charge
[5] Based on dispatch paperwork completed on 02/04/2023
[6] Above Ground Level

Run 1: At the gate, all checklist completed, all doors closed and pushback.

Procedure

- Night VFR conditions, Calm winds
- Normal Engine Start per SWA SOP
- We will assume that Anti/De-icing has been completed.
- Holdover times are not a factor.
- Engine Anti-Ice, ON
- Taxi to runway 18L
- Crew runs all appropriate checklist.
- Cleared to taxi to Runway 18L via G2, G and B; and hold short of Rwy 18L.
- Complete Takeoff in VFR conditions, Runway heading to 3,000 ft.
- Normal takeoff not to exceed 18° of pitch.
- Engine Run-Up for 17-19 seconds
- For this takeoff, the Captain, in the left seat will be the PF.

	Notes and Observables
	1. Engine indications during taxi: Engine Anti-ice ON 2. Checklist usage: Excellent. Covered all low viz checklist as well as the Anti-ice On checklist. 3. EICAS Messages: None 4. Inhibits, if any: All inhibits, Inhibited. 5. Time how long it takes from Brake Release for takeoff until rolling. (Engine spool up time) 17-19 seconds 6. Normal Takeoff Notes: Nothing noted. 7. Additional notes:

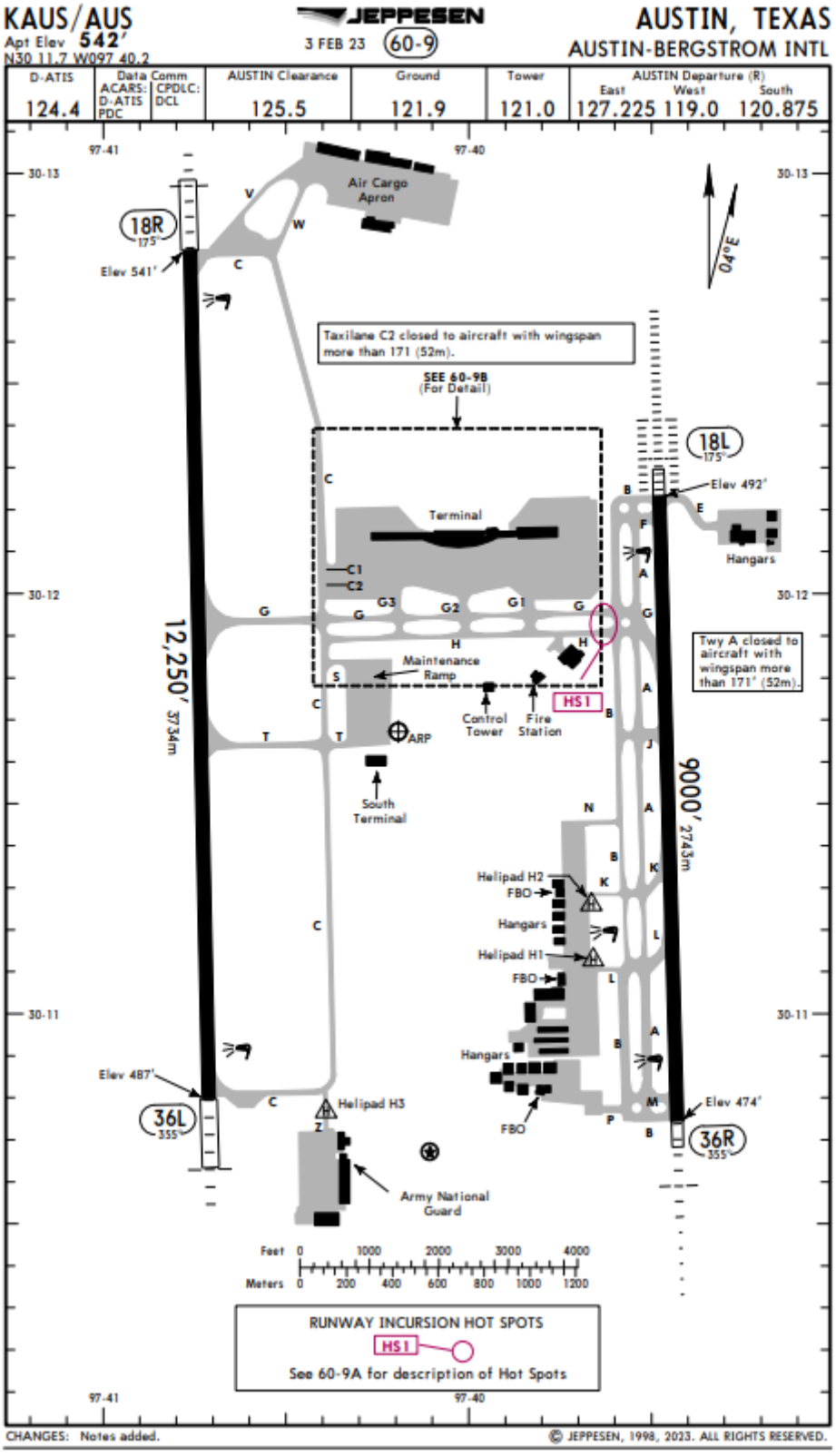


Photo 1: Source, Jeppesen Austin, TX 60-9 chart.

KAUS/AUS JEPPESEN **AUSTIN, TEXAS**

3 FEB 23 (60-9A) **AUSTIN-BERGSTROM INTL**

GENERAL

Birds in vicinity of airport.
During the hours of 0000-0600 LT, arriving aircraft will be assigned Rwy 36L or Rwy 36R and departing aircraft will be assigned Rwy 18L or 18R to avoid noise sensitive areas.
Declared low visibility conditions require ATCT communication prior to push back.
Engine maintenance run ups require airport operations coordination.
People and equipment adjacent to taxiways.
Low-level wind shear alert system.
Prior permission required general aviation aircraft on the passenger terminal apron, call operations.
Prior permission required for non-State of Texas aircraft entering the State Ramp abeam Twy E. Call State Ops 131.375

ADDITIONAL RUNWAY INFORMATION

RWY		USABLE LENGTHS LANDING BEYOND Threshold	Glide Slope	TAKE-OFF	WIDTH
18L	HIRL CL ALSF-II TDZ ❶ PAPI-L grooved RVR		7799'2377m		150' 46m
36R	HIRL CL MALSR TDZ ❶ PAPI-L grooved RVR		8039'2450m		
❶ Angle 3.00°					
18R	HIRL MALS ❷ PAPI-L grooved RVR		10,950'3338m		150' 46m
36L	HIRL MALS ❷ PAPI-L grooved RVR		11,155'3400m		
❷ Angle 3.00°					

RUNWAY INCURSION HOT SPOTS HS1

For information only, not to be construed as ATC instructions.

HS1 Drivers northbound on E service road may be unaware of aircraft from Rwy 36R exiting at Twys G and Twy H.

TAKE-OFF & OBSTACLE DEPARTURE PROCEDURE

Rwy 18L/36R

2 operating RVRs are required. All operating RVRs are controlling.		Adequate Vis Ref	STD	
CL & HIRL	CL, or RCLM & HIRL		3 & 4 Eng	1 & 2 Eng
TDZ RVR 5 Mid RVR 5 Rollout RVR 5	TDZ RVR 10 Mid RVR 10 Rollout RVR 10	RVR 16 or 1/4	RVR 24 or 1/2	RVR 50 or 1

Rwy 18R/36L

Both RVRs are required and controlling.	Adequate Vis Ref	STD	
RCLM & HIRL		3 & 4 Eng	1 & 2 Eng
TDZ RVR 10 Rollout RVR 10	RVR 16 or 1/4	RVR 24 or 1/2	RVR 50 or 1

OBSTACLE DP: Rwy 36L, Climb heading 355° to 1700' before turning left.
Rwy 36R, Climb heading 355° to 1300' before turning left.

TAKE-OFF OBSTACLE NOTES:

Note: Rwy 18L: Lighting 10' from DER, 4' right of centerline, 1' AGL/475' MSL. Trees beginning 491' from DER, 560' left of centerline, up to 43' AGL/499' MSL. Tree 552' from DER, 641' right of centerline, 29' AGL/494' MSL. Trees beginning 562' from DER, 487' left of centerline, up to 44' AGL/501' MSL. Tree 617' from DER, 571' right ofcenterline, 37' AGL/495' MSL. Trees beginning 643' from DER, 472' left of centerline, up to 517' MSL. Tree 674' from DER, 647' right of centerline, 50' AGL/499' MSL. Trees beginning 721' from DER, 523' right of centerline, up to 50' AGL/504' MSL. Trees beginning 756' from DER, 495' right of centerline, up to 64' AGL/508' MSL. Tree 1750' from DER, 523' right of centerline, 75' AGL/519' MSL. Tree 1899' from DER, 810' right of centerline, 75' AGL/526' MSL. Tree 2165' from DER, 458' right of centerline, 85' AGL/529' MSL.

Note: Rwy 18R: Lighting, SIGN beginning 10' from DER, 4' left of centerline, up to 2' AGL/489' MSL. Tree 1006' from DER, 730' right of centerline, 519' MSL. Trees beginning 1919' from DER, 541' left of centerline up to 93' AGL/545' MSL.

Note: Rwy 36L: Lighting beginning 5' from DER, 5' right of centerline, up to 1' AGL/543' MSL.

Note: Rwy 36R: Lighting 10' from DER, 5' LEFT of centerline, 1' AGL/493' MSL. Tree 816' from DER, 663' right of centerline, 528' MSL.

FOR FILING AS ALTERNATE

	ILS Rwy 18L/R ILS Rwy 36L/R	RNAV (GPS) Y Rwy 18L/R RNAV (GPS) Y Rwy 36L/R	RNAV (RNP) Z Rwy 18L/R RNAV (RNP) Z Rwy 36L/R	LOC Rwy 18L/R LOC Rwy 36L/R
A B C D	600-2	800-2		

AMEND 2A

CHANGES: None.

Photo 2: Source, Jeppesen 60-9A chart

Engine Bleed Switches (1 min after rollback) ..... **ON**
After allowing one minute after engine rollback for deice fluid and fume dissipation, configure the engine bleed switches as necessary for takeoff.

Accomplish Normal After Start Procedures

Note: Ensure flaps are set to takeoff setting when the FO announces, "**Standing by Flaps.**"

Perform normal after start flows and procedures. At this point, the aircraft and Flight Deck Crew are ready and configured for the Before Taxi checklist in Block 6 on the Deice/Anti-Ice Procedures Card.

Adjusting Holdover Times

After deicing/anti-icing is complete, when a subsequent weather report indicates a change in the precipitation intensity, mixture, or temperature, a new holdover time or allowance time may apply. The applicable holdover time for the specific brand name must be consulted.

Note: If hail that strikes an aircraft is reported greater than or equal to ¼ inch in diameter, a conditional inspection is required. Contact Dispatch and Maintenance Control to coordinate. If hail is reported as less than ¼ inch in diameter, it is considered small hail, and the HOT app or the Adjusted Allowance Times for SAE Type IV Fluids table can be used.

A new holdover or allowance time that is more restrictive must be applied from the original start time. If the new holdover or allowance time is less restrictive, the original holdover or allowance time must be used. If the Flight Deck Crew determines that the current conditions no longer provide a valid holdover or allowance time, do not takeoff. The aircraft must be deiced/anti-iced again to provide a new holdover time or allowance time.

15.1.11 Pushback and Engine Start

Revised: 06/23/2022

Note: The aircraft should not be pushed from the gate for the purpose of radiant heating deicing with Passengers onboard. Passengers may be onboard the aircraft while radiant heating deicing occurs at the gate.

Engine Start

Start engines using normal procedures.

Unless otherwise directed by an *MEL* procedure or limitation, set the ignition select switch to BOTH before starting the engines if all the following conditions exist:

- First engine start of the day
- Airport elevation at or above 2,000 ft MSL
- Temperature below 5°C/41°F

(NG) The CFM56-7 engine may not light off on the first start of the day or after extended ground time at ambient temperatures below 0°C/32°F. Under this condition, a second start attempt is warranted. Perform the following steps:

1. **(NG)** Comply with the Aborted Engine Start checklist on the Quick Reference Card.
2. **(NG)** Attempt a second engine start, motoring the engine for five minutes before raising the start lever to IDLE.
3. **(NG)** If the engine starts normally, make an Aircraft Logbook Info Only entry. Refer to *FOM* 19 Maintenance.
4. **(NG)** If the second start attempt is unsuccessful, maintenance action is required. Record the fault in the Aircraft Logbook and contact Dispatch and Maintenance Control.

Note: If the engines have been cold soaked for more than one hour at ambient temperatures below -40°C, do not start or motor the engine until contacting Dispatch and Maintenance Control.

Note: If the ambient temperature is below -35°C, operate the engines at idle for two minutes before changing the thrust lever position.

If the START VALVE OPEN alert does not illuminate or an air duct pressure rise is not observed, the start valve solenoid may be frozen. Contact Maintenance Control.

After Engine Start

Engine Instruments ..... **Observe Normal Operation**
The engine instruments should approximate normal indications shortly after reaching idle speed.

Altimeters ..... **Within Tolerances**

WARNING: **Erroneous or unusual altitude and/or airspeed indications may indicate blocked static ports. Do not continue operations unless all altitude and airspeed indications are normal.**

Engine Oil Pressure ..... **Check**

- Initial oil pressure may rise slowly.
- The LOW OIL PRESSURE light may remain illuminated.
- The oil pressure may go above the normal range.
- The OIL FILTER BYPASS light may illuminate.

Note: The engine should be operated at idle thrust until oil pressure returns to the normal range. The OIL FILTER BYPASS light should extinguish as the oil warms and the pressure returns to normal.
(NG) No minimum oil temperature is specified before setting takeoff thrust.
(AFM L) (MAX) After starting, oil temperature rise to at least 31°C must be indicated before setting takeoff thrust.

- As long as there is some indication of oil pressure, up to three and a half minutes may be allowed for oil pressure to reach the minimum operating pressure.
- Oil pressure may temporarily exceed maximum pressure limits.
- Oil pressure may not indicate any increase until the oil temperature rises.
- No oil pressure indication at idle RPM requires immediate engine shutdown. At low ambient temperatures, temporary high oil pressure may be tolerated.
- Slow oil pressure response is common.

Following a precautionary shutdown due to no oil pressure indication, contact Maintenance Control.

Anti-Ice ..... As Required
When starting both engines for taxi, do not select engine or wing anti-ice until rollback of the second engine.

Electrical Power ..... Transfer
In cold weather operations, generators may be slow to produce steady power due to cold oil in the IDG. IDG stabilization usually takes less than one minute, but may require up to five minutes.

Flight Controls ..... Check for Freedom of Movement
An increase in control forces can be expected at low temperatures because of increased resistance in the flight control cables and congealed oil in the snubbers and bearings. Move the flight controls through full range of motion to ensure proper movement.

Flaps ..... Check for Normal Operation

CAUTION: When operating the wing flaps in low temperatures, the flap position indicators and leading edge device annunciator should be closely monitored for positive movement. If the flaps stop moving, the flap handle should be immediately placed to the indicated flap position. The flaps must operate normally prior to takeoff.

Engine Anti-Ice Operation

Engine anti-ice must be on during all flight operations when icing conditions exist or are anticipated, except during climb and cruise when the temperature is below -40°C SAT.

If ice does form on the engine inlet, disturbance of the airflow can produce engine surging, engine vibration indications, high EGT, or flameout. With even a small amount of ice present, turning the engine anti-ice on will cause melting ice to go through the engine, and may cause violent engine surging at intervals of one to two minutes. Thrust lever adjustments should be slow and deliberate to avoid engine flameout.

Engine Anti-Ice Operation (Ground or In Flight)

Engine Start Switches ..... CONT

Note: Place the engine start switches to CONT prior to applying engine anti-ice to avoid possible flameout due to ice ingestion.

Engine Anti-Ice Switches ..... ON
(NG) Ensure that the COWL VALVE OPEN lights illuminate bright, then dim.

(MAX) Ensure that the COWL VALVE amber lights illuminate momentarily, then extinguish.

When Engine Anti-Ice is No Longer Required

Engine Anti-Ice Switches ..... OFF
(NG) Ensure that the COWL VALVE OPEN lights illuminate bright, then extinguish.

(MAX) Ensure that the COWL VALVE amber lights illuminate momentarily, then extinguish.

Start Switches ..... As Required

WARNING: **Do not rely on airframe visual icing cues to activate the engine anti-ice. Delaying the use of engine anti-ice until ice buildup is visible from the flight deck may result in severe engine damage. Use the temperature and visible moisture criteria specified in 15.1.1 Concepts and Definitions.**

Engine Vibration

During icing conditions, an increase in engine vibration may be due to fan blade and/or spinner icing. Refer to Engine Run-ups During Taxi Operations in 15.1.12 Taxi Out for instructions on minimizing engine ice build up.

Wing Anti-Ice Operation

When Wing Anti-Ice is Required:

Wing Anti-Ice Switch..... ON

(NG) Ensure that both VALVE OPEN lights illuminate bright, then dim.

(MAX) Ensure that the L VALVE and R VALVE lights illuminate momentarily, then extinguish.

When Wing Anti-Ice is No Longer Required:

Wing Anti-Ice Switch..... OFF

(NG) Ensure that the VALVE OPEN lights illuminate bright, then extinguish.

(MAX) Ensure that the L VALVE and R VALVE lights illuminate momentarily, then extinguish.

CAUTION: **Do not operate engine or wing anti-ice when the OAT or TAT is above 10°C.**

Wing Anti-Ice Operation on the Ground or In Flight

Ground use is intended to prevent the formation of frost and/or ice on the leading edge slats in the usually brief time interval between engine start and takeoff.

Due to control valves cycling closed, then open in response to thrust setting and duct temperature logic:

(NG) The VALVE OPEN lights may cycle bright, then dim.

(MAX) The L VALVE and R VALVE lights may illuminate momentarily, then extinguish.

It is Southwest Airlines policy that the wing anti-ice switch be turned OFF prior to beginning the takeoff roll.

Note: Do not use the wing anti-ice system on the ground after anti-icing with Type IV fluid; this degrades the anti-icing properties of the fluid.

15.1.12 Taxi Out

Revised: 04/11/2022 FO Bulletin 23-13

Use the following guidelines in addition to those outlined in 8 Taxi Out and *FOM* 8 Taxi Out.

Refer to *FOM* 7.1 Single Engine Taxi for limitations regarding Single Engine Taxi after deicing/anti-icing operations.

CAUTION: **Taxi at a reduced speed. Use smaller nose wheel steering wheel and rudder inputs and apply minimum thrust evenly and smoothly. Taxiing on slippery airport surfaces at an excessive speed or with high crosswinds may start a skid.**

CAUTION: **When operating the engines over a significant amount of standing deicing/anti-icing fluid, limit thrust to the minimum required. Excessive ingestion of deicing/anti-icing fluid can cause the fluid to build up on the engine compressor blades resulting in compressor stalls and engine surges.**

(NG) Engine Run-ups During Taxi Operations

(NG) During periods of prolonged ground operations, when engine anti-icing is required and the OAT is 3°C or below, an engine run-up may be required to minimize ice buildup on the fan spinner and fan blades.

(NG) When conducting an engine run-up, use the following procedure:

- **(NG)** Ensure that the engine inlet and exhaust areas are clear.
- **(NG)** Run-up to a minimum of 70 percent N_1 for approximately a 30-second duration at intervals no greater than 30 minutes.

(NG) During moderate icing conditions (i.e., freezing rain, freezing drizzle, freezing fog, heavy snow), use the following procedure to minimize ice buildup on the fan blades and spinner, and to enhance ice shedding:

- **(NG)** Ensure that the engine inlet and exhaust areas are clear.
- **(NG)** Run-ups to a minimum of 70 percent N_1 for approximately a one-second duration at intervals no greater than 10 minutes.

Note: **(NG)** Fan blade ice buildup is cumulative. If the fan spinner and fan blades were not deiced prior to taxi out, the total time the engines are operated in icing conditions, including taxi in as applicable, must be included in the 30-minute interval.

Note: **(NG)** If airport surface conditions and the concentration of aircraft do not allow the engine thrust level to be increased to 70 percent N_1, set the thrust level as high as practical for the required duration.

(MAX) Engine Run-ups During Taxi Operations

(MAX) During periods of prolonged ground operations, when engine anti-icing is required and the OAT is 3°C or below, or if increased fan vibration due to fan ice accumulation is present, perform an engine run-up to minimize ice buildup on the fan spinner and fan blades.

(MAX) When conducting an engine run-up, use the following procedure:

- **(MAX)** Ensure that the engine inlet and exhaust areas are clear.
- **(MAX)** Increase thrust to a minimum of 50 percent N_1 then decrease to idle. Repeat as necessary or at intervals no greater than 60 minutes.

Note: **(MAX)** Fan blade ice buildup is cumulative. If the fan spinner and fan blades were not deiced prior to taxi out, the total time the engines are operated in icing conditions, including taxi in as applicable, must be included in the 60-minute interval.

Note: **(MAX)** Engine vibration may indicate above the normal operating range up to the maximum display value during ice shedding; however, this will have no adverse effect on the engine.

15.1.13 Before Takeoff

Revised: 12/15/2022

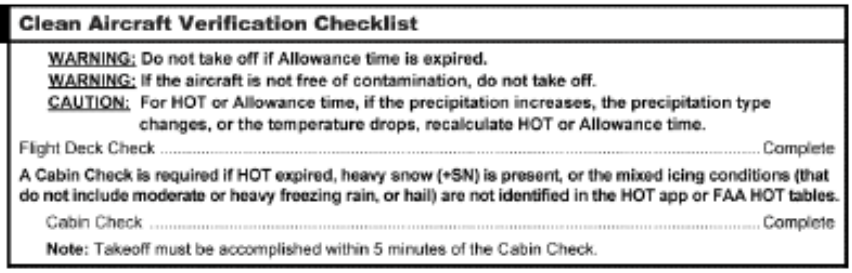
FO Bulletin 23-13

[14 CFR Part 121.629]

Clean Aircraft Verification Checklist

The Clean Aircraft Verification Checklist, as shown in Block 8 on the Deice/Anti-Ice Procedures Card, is described below and must be completed before takeoff to comply with the Clean Aircraft Concept. Refer to 15.1.1 Concepts and Definitions for more information.

Figure 15.9 Clean Aircraft Verification Checklist



WARNING: **Do not take off if Allowance time is expired.**

WARNING: **If the aircraft is not free of contamination, do not take off.**

CAUTION: **For HOT or Allowance time, if the precipitation increases, the precipitation type changes, or the temperature drops, recalculate HOT or Allowance time.**

Flight Deck Check ..... Complete

Refer to 15.1.13.1 Flight Deck Check (Within the Holdover Time or Allowance Time) for more information.

A Cabin Check is required if HOT expired, heavy snow (+SN) is present, or the mixed icing conditions (that do not include moderate or heavy freezing rain, or hail) are not identified in the HOT app or FAA HOT tables.

Cabin Check ..... Complete

Note: Takeoff must be accomplished within 5 minutes of the Cabin Check.

Refer to 15.1.13.2 Cabin Check (Holdover Time Expired, Heavy Snow is Present, or Mixed Icing Conditions Are Not Identified in the HOT App or FAA HOT Tables) for more information.

- **(NG)** The lower fuselage, retractable landing lights (as installed), and wing area.
- **(MAX)** The lower fuselage and wing area.

Slush and/or water can accumulate in the leading edge flaps and freeze during the climb.

If rejecting a takeoff on a slippery runway, the rudder should be used as the primary source of directional control down to 60 kt.

WARNING: **Stopping the aircraft must always be the first priority when rejecting a takeoff on contaminated runways. Maintain reverse thrust as necessary to ensure a safe stop.**

Takeoffs in slush or wet snow can cause freezing of nose gear doors and main gear seals and mechanisms. This does not cause a problem unless a hydraulic failure occurs. A free fall might not be possible if the main landing gear uplocks and associated components are frozen. To prevent this, extend and retract the landing gear once after a stable climb has been established.

After the flaps are up, wing anti-ice should be turned on to melt any accumulation of slush on the leading edge of the wing.

15.1.14.2 Engine Run-up During Takeoff Procedure

Revised: 04/11/2022

(NG) When engine anti-ice is required and the OAT is 3°C or below, accomplish a static engine run-up to a minimum of 70 percent N_1 and confirm stable engine operation before the start of the takeoff roll. A 30-second run-up is highly recommended whenever possible if airport congestion and runway surface conditions allow. If runway surface conditions do not allow for an engine run-up, continue the takeoff normally.

(MAX) When engine anti-ice is required and the OAT is 3°C or below, within five minutes of, or in conjunction with the takeoff, accomplish an engine run-up to a minimum of 50 percent N_1 for a minimum of five seconds, and confirm stable engine operation prior to setting takeoff thrust.

Note: **(MAX)** Engine vibration may indicate above the normal operating range up to the maximum display value during ice shedding; however, this will have no adverse effect on the engine.

Run 2: Start on taxiway B. All checklist completed.

Procedure

- Night, IFR conditions, Calm winds, 1800 RVR
- All RVR's are operable as well as the CL & HIRL lighting.
- Temp and Due point 0/0° C
- Crew runs all appropriate checklist.
- Observe Low visibility taxi procedures.
- Pitch limit. Follow the Flight Director.
- F/O is the PF.

	Notes and Observables
	1. Note when Transponder/ TCAS is turned on. TCAS turned On at the gate during the Before Start Checklist. 2. Checklist usage: Any additional time needed in IRF conditions. Checklist and briefings were completed. 3. EICAS Messages: None 4. Limitations: None 5. Additional notes 6. Note the time it took to complete the Before Takeoff checklist and announce Ready For Takeoff. 25 seconds 7. Note engine Run up to 70% N1 and everything stabilized. Ran Engines up to 70% N1 and held that power setting for 17-19 seconds. 8. Additional Notes. None

Level Turbulence Type	Description	Pilot Action	Flight Attendant Action
Severe	Large, abrupt changes in altitude and/or attitude.	Ensure FASTEN SEAT BELT sign is on. When operationally safe to do so: • Make announcement stating, "Flight Attendants and Passengers be seated immediately and fasten seat belts." • Make announcement to inform Flight Attendants and Passengers when turbulent conditions have subsided. After conditions subside, communicate with Flight Attendants as required.	Stop all service until turbulence is reduced. Secure self in the nearest available seat. If on jumpseat, use seat belt and shoulder harness. "A" Flight Attendant notifies Pilots when cabin is secure and Flight Attendants are seated. When safe to do so: • Stow all galley equipment. • "A" Flight Attendant use PA to ensure Flight Attendants and Passengers are seated. • Check for injuries or damage. "A" Flight Attendant communicates with Flight Deck Crew on cabin conditions, as required.

15.4 Windshear
Revised: 07/21/2016

The section is reserved for future use.

15.5 Low Visibility Taxi
Revised: 07/21/2016

The following subsections outline guidelines for low visibility taxi.

15.5.1 SMGCS—General
Revised: 07/21/2016

Surface Movement Guidance and Control System (SMGCS) refers to equipment installations and control procedures at U.S. airports conducting operations when visibility is less than 1200 RVR. It is designed to minimize confusion on the ground in low visibility conditions.

A surface movement surveillance system (SMSS) should be installed for operations below 600 RVR. Ground radar (ASDE II or III) is installed at some airports to augment visual observation. These systems are the primary means of monitoring airport ground movements. Procedures for establishing aircraft position are required when the SMSS is inoperative.

ATC may initiate or terminate SMGCS procedures when dictated by visibility.

Specific SMGCS procedures are developed for each participating airport. There may be different requirements for operations between 1200 RVR and 600 RVR and operations below 600 RVR.

More information may be found in the *Jeppesen* low visibility taxi route charts for applicable airports. Additional information may be required concerning apron/ramp operations at some airports.

If the RVR value drops below charted SMGCS minima:

- Aircraft that have entered the movement area are permitted to continue to taxi by ATC (i.e., reported visibility of 500 RVR after entering the movement area, with a SMGCS charted minima of "Less than RVR 1200 to 600").
- Aircraft that have either passed the final approach fix or landed may be permitted to taxi by ATC.

15.5.2 Flight Deck Crew Procedures
Revised: 07/21/2016

In the SMGCS environment, the Captain and First Officer must increase their focus on safe aircraft movement and both must monitor radio communications. It may be necessary to delay checklists and flows until the aircraft is stopped. If the aircraft position is in doubt, immediately stop the aircraft and notify ATC. Detailed preflight review of taxi routes and procedures will enhance operational efficiency and safety.

In the SMGCS environment, all ATC clearances must be read back in their entirety. Both Pilots should fully understand each clearance.

When in doubt, verify all movements with ATC.

15.5.3 Definitions
Revised: 07/21/2016

Low Visibility Operations

Refers to movement of aircraft on the airport when visibility is less than 1200 RVR.

Movement Area

Includes runways and taxiways requiring specific ATC approval for entry or operation.

Non-Movement Area

Includes taxiways and apron areas not under ATC control. A vehicle control line separates the non-movement area from the movement area. Ground vehicles should not cross the vehicle control line. The vehicle service road is located on the non-movement side of the vehicle control line.

Apron (Ramp)

Includes aircraft parking positions for loading/unloading Passengers/cargo, taxi lanes for taxiing to/from movement areas, and service and fire lanes for ground vehicles.

Taxi Route

A specific sequence of taxiways or segments between the runway and apron used by aircraft during low visibility operations.

Start/Ready Box

A pink rectangle with a white border and black outline. It is located just prior to reaching the vehicle control line when taxiing from the ramp. Southwest Airlines is responsible for the aircraft from the gate to the start/ready box. A yellow taxi line extends from the start box to the taxiway.

Termination/Stop Box

A pink rectangle with a white border and black outline. It is located just prior to reaching the vehicle control line when taxiing to the gate. Southwest Airlines is responsible for the aircraft from the termination/stop box to the gate. A yellow taxi line extends from the taxiway to the termination box.

Hold Point/Pink Spots

A taxiway location where ATC may hold an aircraft for positive sequencing. Numbered pink spots are located along taxiways and at points where taxiways cross runways.

Clearance Bar

Refers to three in-pavement yellow lights that are perpendicular to the direction of taxi and co-located with a pink spot.

Clearance Line

A yellow dashed line perpendicular to the direction of taxi. The clearance line is co-located with a pink spot. Normally, the order of appearance is clearance bar, clearance line, and hold point/pink spot.

Taxiway Holding Position Lights

Yellow in-pavement lights installed across the taxiway at points where the taxiway intersects a SMGCS runway. Taxiway holding position lights are on when taxiway lights are on and, in low visibility conditions, when RVR is 1200 or less.

Wig-Wag Lights

Elevated yellow lights installed outboard of the taxiway holding position lights. There is one blinking wig-wag light on each side of the taxiway. At most airports, wig-wags are installed wherever a taxiway crosses the SMGCS runway. Wig-wags remain illuminated when red stop bars are extinguished.

Stop Bar Lighting

Red in-pavement lights and elevated red lights on both sides of the taxiway at the point where the taxiway leads to the takeoff position on the runway. The stop bar is co-located with the ILS critical area hold short markings. Stop bar lights are controlled by ATC. Aircraft movement past the stop bar and onto the runway is detected by microwave sensors that automatically turn the red stop bar lights on after the aircraft has passed to prevent the next aircraft from crossing the stop bar. The stop bar lights are not normally used when the RVR is 1200 or greater, but are in use below 1200 RVR. When the aircraft is holding number one for takeoff, the red stop bar is illuminated and the green lead-on lights are off, creating a black hole effect. When ATC clears an aircraft on to the runway, the red stop bars are turned off, while the green lead-on lights illuminate providing guidance into the runway takeoff position. This provides a visual confirmation of the clearance to taxi on to the runway.

WARNING: **Never cross a red illuminated stop bar, regardless of visibility or SMGCS status, even if an ATC clearance has been given to proceed onto or across the runway.**

Lead-On Lights

A segment of green centerline lights from the stop bar to the runway centerline. These lights are illuminated when the stop bar is off. When the lead-on lights illuminate, the stop bars go off, confirming the ATC verbal clearance to taxi onto the runway.

Note: If, after crossing a stop bar, the taxiway centerline lead-on lights inadvertently extinguish, Pilots should hold their position and contact ATC for further instructions.

Lead-Off Lights

A segment of green and yellow centerline lights from the runway centerline to the ILS critical area hold short markings as viewed from an aircraft taxiing off the runway. Once past the ILS critical area, the taxiway centerline lights revert to green. If taxiway centerline lights are not installed, a sign is required to indicate the location of the boundary of this area/zone.

15.5.4 Chart Symbology
Revised: 07/21/2016

Pilots should review symbols by referring to the low visibility taxi route chart legend and *Jeppesen* Introduction.

Low visibility taxi routes are depicted by lines with directional arrows. Centerline lights are depicted as a series of small open circles. Movement/Non-movement Area Boundary is depicted by dashed lines. Stop bars are depicted as a line between two open circles. ILS hold line is depicted as two parallel lines crossing the taxiway (looks like a railroad track). Low Visibility Check Points or Spots are depicted as a number within a circle.

Low visibility taxi route charts should provide the following:

- Stop bar locations
- Pink spots
- Taxiway hold point markings
- Clearance bar locations
- Critical area boundaries
- Location of critical area signs
- Unique airport characteristics and/or procedures

15.5.5 Airport Operational Requirements
Revised: 07/21/2016

When visibility is 1200 RVR or greater, taxi routing is at the discretion of the control tower.

Taxi guidance signs should be installed at taxiway intersections and supplemental taxiway designators should be painted on the pavement. Where signs are not feasible, for example, at a point where the taxiway centerline splits, geographic position markings that identify taxiway hold points should be painted on the pavement.

Most airports use one runway for takeoffs and landings during low visibility operations. Therefore, low visibility taxi routes to and from the runway are uni-directional. For example, at SEA, aircraft taxi northbound on taxiway A or B to or from runway 16. A few airports use more than one runway during low visibility operations, in which case taxi routes may be bi-directional.

Visibility from 1200 RVR Down to 600 RVR Requirements

- Taxiway centerline lights, raised edge reflectors on curves/turns
- Taxiway edge lights

Visibility at 600 RVR or Less Requirements

- Specific airfield lighting, follow-me service, and defined low visibility taxi routes to facilitate ground operations
- Taxiway centerline lights supplemented with edge lights on curves
- Operative stop bar lights

Operations in the non-movement area may not have lighting installations, but must then have provisions for taxiing assistance to Pilots (e.g., towing via a tug, follow-me vehicle, or ground marshal assistance from the taxiway to the gate lead-in line).

9 Takeoff and Initial Climb

Revised: 07/21/2016

This chapter covers the regulations and policies pertaining to the takeoff and initial climb to 3,000 ft AAE.

9.1 Requirements for Takeoff

Revised: 07/21/2016

Ensure the following operational requirements are satisfied before takeoff:

(CA) Do not depart if the flight cannot be completed safely.

If either the Captain or Dispatcher decides that the flight cannot be operated safely, the flight will be delayed, rerouted, or canceled.

Do not exceed takeoff performance limits.

9.1.1 Conditions When Takeoff is Not Authorized

Revised: 04/11/2022

Takeoff is not authorized under the following weather and airfield lighting conditions:

- Weather conditions are below FAA-established minima.
- Wind limitations are exceeded.

  Refer to *B737 AOM* 3 Limitations.
- Observations from the flight deck indicate that takeoff cannot be made by following approved procedures.
- During night operations when all runway lights are inoperative.

  Takeoffs may be allowed with partial runway lighting, provided the Captain, with assistance from Dispatch, determines that the remaining lights are adequate for the conditions existing at the time.

  Note: FAA-approved temporary lighting may be substituted for portions of normal lights, provided corresponding minima reductions are applied.

  Note: Check NOTAMs for runway light outages and/or taxiway/runway closures. Partial runway lighting may not cause the runway to be closed by the airport authority.
- Runway contamination limits are exceeded (e.g., water, slush, snow, braking action).

  Refer to *B737 AOM* 3 Limitations.
- Greater than light freezing rain exists at the airport.

  The precipitation intensity stated in weather reports (e.g., ASOS, ATIS, from weather briefer) or when received from an ATC controller is “moderate” unless it is modified by “light (-)” or “heavy (+).”
- There are known or probable severe icing conditions.

  Consider a combination of forecasts, PIREPs, aircraft types, times, locations, and altitudes. No aircraft will be dispatched when in the opinion of the Captain and/or Dispatcher icing conditions exist or are anticipated that might adversely affect the safety of the flight. Flights may be dispatched into light to moderate icing conditions only if all deicing equipment for the aircraft is in operable condition.
- There is known or probable severe turbulence.

  Consider a combination of forecasts, Turbulence Auto PIREP System (TAPS) reports, PIREPs, aircraft types, times, locations, and altitudes.
- Frost, snow, or ice is adhering to the leading edge devices, any control surface, tab surface, upper wing surface, or winglets.

  14 CFR 121.629 prohibits takeoff when snow, ice, or frost is adhering to wings, control surfaces, engine inlets, vents, ports, and other critical surfaces of the aircraft.

  Note: Refer to *B737 AOM* 15.1.1 Concepts and Definitions, The Clean Aircraft Concept for exceptions.

9.1.2 Intersection Takeoffs
Revised: 06/24/2021

Use RRM guidance and skills to determine if an intersection takeoff is compliant with Southwest Airlines' operational priorities.

P An intersection takeoff may only be performed if the Flight Deck Crew determines that performance data is available and used for that intersection takeoff.

9.1.3 New Pilot Takeoff Restrictions
Revised: 07/21/2016

Refer to 3.1.5 New First Officers.

9.2 Takeoff Minimums
Revised: 04/11/2022

[OpSpec: C056][OpSpec: C070][OpSpec: C078][14 CFR Part 121.637]
Generally, only visibility is required for takeoff. Ceiling is not required, unless specified on the applicable SID or *Jeppesen* -9/-9A page because of obstacles in the takeoff path.

Visibility Reports

Based on airport equipment capabilities, visibility reports are provided in one of the following formats:

- Runway Visual Range (RVR)—Reported in hundreds of feet and is controlling for runways listed as RVR-controlled on *Jeppesen* charts.
- Runway Visibility Value (RVV)—Reported in miles and fractions of miles for a specified runway.
- Prevailing Visibility (PV)—Reported in miles and fractions of miles for an airport and is used for all runways unless a runway is controlled by RVR or RVV.

RVR or RVV reported for one runway cannot be used for another runway.

Note: For international operations, charted minimums and visibility reports may be in meters or kilometers. For conversion information, refer to *IFOM* 2.1.6 Units of Measure.

Standard Takeoff Minimums

The standard takeoff minimums for aircraft with two engines is 5000 RVR or 1 SM. If takeoff minimums are not charted, standard takeoff minimums are authorized by OpSpec C056.

Note: Standard takeoff minimums are authorized for departure from airports not listed in OpSpec C070 for supplemental (charter) operations. Refer to 23.3 OpSpec C070 Airports Authorized for Scheduled Operations.

Higher Than Standard Takeoff Minimums

At some airports, obstructions or other factors require higher than standard takeoff minimums and/or IFR departure procedures. When a departure procedure specifies higher takeoff minimums and does not include verbiage indicating that standard or lower than standard takeoff minimums are applicable, the departure procedure takeoff minimums are applicable (including any specified ceiling and climb gradient).

When a SID is not being used for departure and the *Jeppesen* -9/-9A page does not indicate that standard takeoff minimums apply, then the higher than standard takeoff minimums listed are applicable.

Lower Than Standard Takeoff Minimums

Southwest Airlines is authorized to use lower than standard takeoff minimums per OpSpecs C056 and C078 when the applicability of standard takeoff minimums can be determined. Applicability can be determined by verbiage on the SID or *Jeppesen* -9/-9A page that indicates standard takeoff minimums apply. Additionally, OpSpec C056 authorizes standard and lower than standard takeoff minimums when there is no takeoff minimum published.

Lower than standard takeoff minimums are authorized for a specific runway, under any of the following conditions:

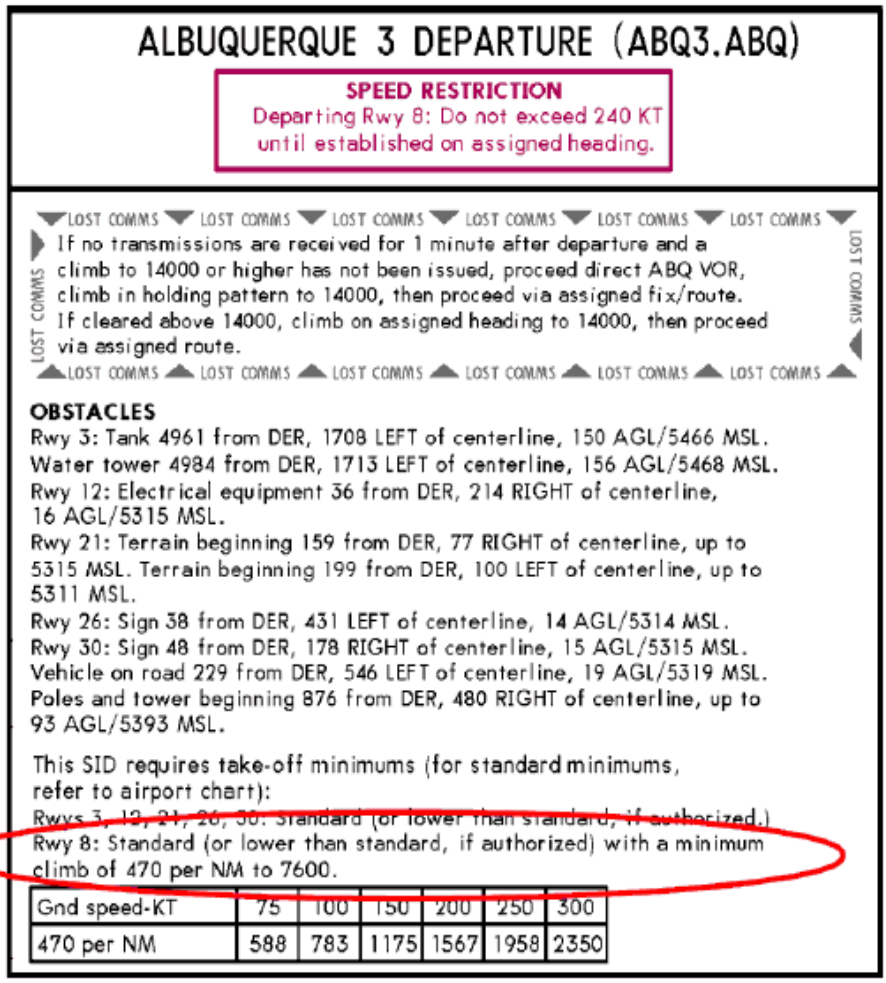
- The SID or *Jeppesen* -9/-9A page includes any of the following terms and the applicable climb gradient can be met:
  - STD
  - Standard
  - Standard (or lower than standard, if authorized)
- A takeoff minimum is not published.

Note: Lower than standard takeoff minimums are authorized for departure from airports not listed in OpSpec C070 for supplemental (charter) operations. Refer to 23.3 OpSpec C070 Airports Authorized for Scheduled Operations.

Note: Lower than standard takeoff minimums are not authorized for departure from airports not listed in OpSpec C070 for domestic and flag operations. In this case, the takeoff minimums are as published; when not published, the takeoff minimums are 800-2, or 900-1 1/2, or 1,000-1, in that order. Refer to 23.3 OpSpec C070 Airports Authorized for Scheduled Operations.

Note: The FAA does not publish takeoff minimums that are lower than standard.

Figure 9.1 SID with Standard Verbiage Example



ALBUQUERQUE 3 DEPARTURE (ABQ3.ABQ)

SPEED RESTRICTION
Departing Rwy 8: Do not exceed 240 KT until established on assigned heading.

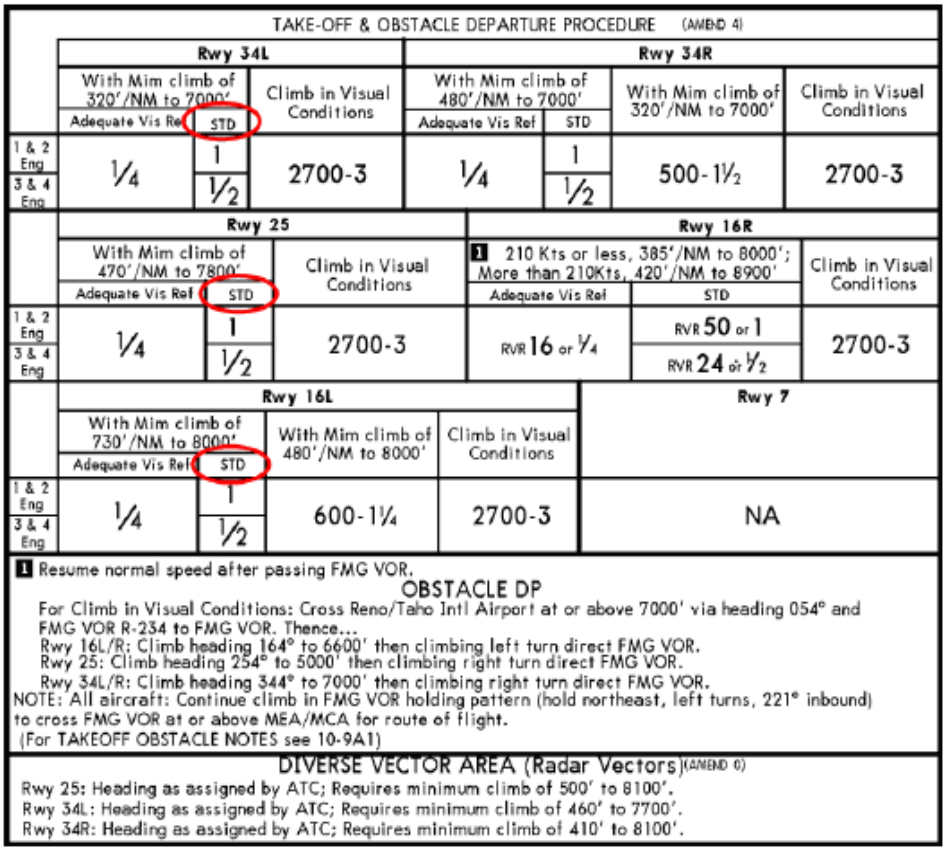
LOST COMMS
If no transmissions are received for 1 minute after departure and a climb to 14000 or higher has not been issued, proceed direct ABQ VOR, climb in holding pattern to 14000, then proceed via assigned fix/route. If cleared above 14000, climb on assigned heading to 14000, then proceed via assigned route.

OBSTACLES
Rwy 3: Tank 4961 from DER, 1708 LEFT of centerline, 150 AGL/5466 MSL.
Water tower 4984 from DER, 1713 LEFT of centerline, 156 AGL/5468 MSL.
Rwy 12: Electrical equipment 36 from DER, 214 RIGHT of centerline, 16 AGL/5315 MSL.
Rwy 21: Terrain beginning 159 from DER, 77 RIGHT of centerline, up to 5315 MSL. Terrain beginning 199 from DER, 100 LEFT of centerline, up to 5311 MSL.
Rwy 26: Sign 38 from DER, 431 LEFT of centerline, 14 AGL/5314 MSL.
Rwy 30: Sign 48 from DER, 178 RIGHT of centerline, 15 AGL/5315 MSL.
Vehicle on road 229 from DER, 546 LEFT of centerline, 19 AGL/5319 MSL.
Poles and tower beginning 876 from DER, 480 RIGHT of centerline, up to 93 AGL/5393 MSL.

This SID requires take-off minimums (for standard minimums, refer to airport chart):
Rwys 3, 12, 21, 26, 30: Standard (or lower than standard, if authorized.)
Rwy 8: Standard (or lower than standard, if authorized) with a minimum climb of 470 per NM to 7600.

Gnd speed-KT	75	100	150	200	250	300
470 per NM	588	783	1175	1567	1958	2350

Figure 9.2 Jeppesen 10-9A Page Example



TAKE-OFF & OBSTACLE DEPARTURE PROCEDURE (AMEND 4)

	Rwy 34L			Rwy 34R			
	With Mim climb of 320'/NM to 7000'		Climb in Visual Conditions	With Mim climb of 480'/NM to 7000'		With Mim climb of 320'/NM to 7000'	Climb in Visual Conditions
	Adequate Vis Ref	STD		Adequate Vis Ref	STD		
1 & 2 Eng	1/4	1	2700-3	1/4	1	500-1½	2700-3
3 & 4 Eng		1/2			1/2		

	Rwy 25			Rwy 16R		
	With Mim climb of 470'/NM to 7800'		Climb in Visual Conditions	1 210 Kts or less, 385'/NM to 8000'; More than 210Kts, 420'/NM to 8900'		Climb in Visual Conditions
	Adequate Vis Ref	STD		Adequate Vis Ref	STD	
1 & 2 Eng	1/4	1	2700-3	RVR 16 or 1/4	RVR 50 or 1	2700-3
3 & 4 Eng		1/2			RVR 24 or 1/2	

	Rwy 16L				Rwy 7
	With Mim climb of 730'/NM to 8000'		With Mim climb of 480'/NM to 8000'	Climb in Visual Conditions	
	Adequate Vis Ref	STD			
1 & 2 Eng	1/4	1	600-1¼	2700-3	NA
3 & 4 Eng		1/2			

1 Resume normal speed after passing FMG VOR.

OBSTACLE DP

For Climb in Visual Conditions: Cross Reno/Tahoe Intl Airport at or above 7000' via heading 054° and FMG VOR R-234 to FMG VOR. Thence...
Rwy 16L/R: Climb heading 164° to 6600' then climbing left turn direct FMG VOR.
Rwy 25: Climb heading 254° to 5000' then climbing right turn direct FMG VOR.
Rwy 34L/R: Climb heading 344° to 7000' then climbing right turn direct FMG VOR.
NOTE: All aircraft: Continue climb in FMG VOR holding pattern (hold northeast, left turns, 221° inbound) to cross FMG VOR at or above MEA/MCA for route of flight.
(For TAKEOFF OBSTACLE NOTES see 10-9A1)

DIVERSE VECTOR AREA (Radar Vectors) (AMEND 0)

Rwy 25: Heading as assigned by ATC; Requires minimum climb of 500' to 8100'.
Rwy 34L: Heading as assigned by ATC; Requires minimum climb of 460' to 7700'.
Rwy 34R: Heading as assigned by ATC; Requires minimum climb of 410' to 8100'.

Jeppesen -9/-9A pages may contain lower than standard takeoff minimums guidance derived from OpSpec C078 authorizations and is intended to provide an easy-to-read format for all users. However, the published minimums may not reflect the full reduction available. It is the responsibility of the Pilot and Dispatcher to determine the applicability of Southwest Airlines' OpSpec C078 authorizations.

NOTAMs Affecting Takeoff Minimums

At times, NOTAMs can affect takeoff minimums. When a NOTAM uses the word *standard*, standard and lower than standard takeoff minimums are applicable if the climb gradient can be met.

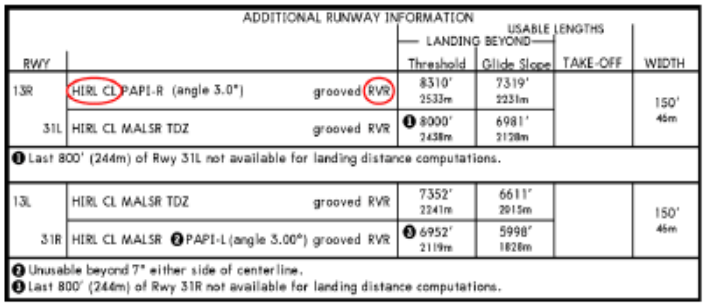
Example: IFDC 8/8928 BWI ODP BALTIMORE/WASHINGTON INTL THURGOOD MARSHALL, BALTIMORE, MD. TAKEOFF MINIMUMS AND (OBSTACLE) DEPARTURE PROCEDURES AMDT 10A...TAKEOFF MINIMUMS: RWY 33L, STANDARD WITH MINIMUM CLIMB OF 268 FT PER NM TO 2000. ALL OTHER DATA REMAINS AS PUBLISHED. 1804131306-1811231306EST

In the above example, when not using a SID, a 268 ft per NM to 2,000 ft climb gradient is required for standard takeoff minimums to be applicable. If the climb gradient can be met, standard or lower than standard takeoff minimums are authorized.

Visibility Reports, Lighting and Visual Aids, and Equipment Requirements

Visibility reports are normally provided through ATIS and/or METAR reports. However, in rapidly changing conditions, ATC may be queried to provide the most current visibility reports and/or number of reporting RVR systems. The availability of lighting and visual aids can be determined by referencing the *Jeppesen* -9/-9A page and current NOTAMs.

Figure 9.3 Lighting and Visual Aids Example



ADDITIONAL RUNWAY INFORMATION

RWY			USABLE LENGTHS — LANDING BEYOND — Threshold	Glide Slope	TAKE-OFF	WIDTH
13R	HIRL CL PAPI-R (angle 3.0°)	grooved RVR	8310' 2533m	7319' 2231m		150' 46m
31L	HIRL CL MALSR TDZ	grooved RVR	❶ 8000' 2438m	6981' 2128m		
❶ Last 800' (244m) of Rwy 31L not available for landing distance computations.						
13L	HIRL CL MALSR TDZ	grooved RVR	7352' 2241m	6611' 2015m		150' 46m
31R	HIRL CL MALSR ❷PAPI-L (angle 3.00°)	grooved RVR	❸ 6952' 2119m	5998' 1828m		
❷ Unusable beyond 7° either side of centerline. ❸ Last 800' (244m) of Rwy 31R not available for landing distance computations.						

When lower than standard takeoff minimums are authorized, the level of takeoff minimums for a specific runway is determined by the following:

- Type of visibility report available
- Number of reporting RVR stations
- Runway lighting
- Runway visual aids (markings)
- Ability to comply with the climb gradient, if required

After determining the reported visibility, availability of lighting and visual aids, and aircraft equipment capabilities, use Table 9.1 Lower Than Standard Takeoff Visibility Requirements to determine the authorized level of lower than standard takeoff minimums for the planned runway.

Table 9.1 Lower Than Standard Takeoff Visibility Requirements

Visibility				Lighting and Visual Aids	Remarks
¼ mile				HIRL or CL or RCLM or adequate visual reference	RVR (if reporting) takes precedence over PV or RVV for that runway.
TDZ	**Mid**	**Rollout**	**Far End**		
≥1600 C	A	A	A	HIRL or CL or RCLM	Mid may be substituted for TDZ if not reporting.
Below 1600 RVR (TDZ): Minimum of two reporting RVR systems are required.					
1200 C	1200 C	1000 C	A	Day: RCLM or HIRL or CL; Night: HIRL or CL	
1000 C	1000 C	1000 C	A	CL, or HIRL and RCLM	
500 C	500 C	500 C	A	HIRL and CL	
300 C	300 C	300 C	A	HGS, HIRL, and CL	Authorized only if *Jeppesen* -9A lists HGS 300 RVR.
A = Advisory, C = Controlling, if reporting					

RVR reports, when available for a particular runway, shall be used for all takeoff operations on that runway. All takeoff operations based on RVR must use RVR reports from the locations along the runway as follows:

- For operations at or above 1600 RVR (500 m):
  - The TDZ RVR report, if available, is controlling.
  - The Mid RVR report may be substituted for an unavailable TDZ report.
- For operations below 1600 RVR (500 m):
  - A minimum of two operative RVR reporting systems are required.
  - All available RVR reports are controlling, except for a Far End RVR report, which is advisory only.

Extremely long runways use four RVR sensors: TDZ, Mid, Rollout, and Far End. When a fourth Far End RVR value is reported, it is not controlling and is not to be used as one of the two required operative RVR systems.

Lower than standard takeoff minimums are as follows:

- **1600 RVR/¼ mile:** Takeoff is authorized with visibility down to TDZ 1600 RVR, or visibility or RVV down to ¼ mile, provided one of the following visual aids is available:
  - Operative high intensity runway lights (HIRL)
  - Operative runway centerline lights (CL)
  - Serviceable runway centerline markings (RCLM)

  In circumstances where none of the above visual aids are available, visibility or RVV down to ¼ mile may still be used if other runway markings or runway lighting provide adequate visual reference to continuously identify the takeoff surface and maintain directional control throughout the takeoff roll.

  Note: The maximum crosswind component is 35 kt (25 kt for narrow runway).

- **1200 RVR:** Takeoff is authorized with less than TDZ 1600 RVR down to TDZ 1200 RVR, Mid 1200 RVR, and Rollout 1000 RVR, provided RVR equipment and one of the following visual aids combinations is available:
  - Daylight Hours: Serviceable RCLM or HIRL or operative CL lights
  - Nighttime Hours: HIRL or operative runway CL lights

  Note: The maximum crosswind component is 20 kt.

- **1000 RVR:** Takeoff is authorized with visibility less than TDZ 1200 RVR down to 1000 RVR, Mid 1000 RVR, and Rollout 1000 RVR, provided RVR equipment and one of the following visual aids combinations is available:
  - Serviceable RCLM and HIRL
  - Operative runway CL lights

  Note: The maximum crosswind component is 20 kt.

- **500 RVR:** Takeoff is authorized with visibility less than TDZ 1000 RVR down to 500 RVR, Mid 500 RVR, and Rollout 500 RVR, provided RVR equipment and both of the following visual aids are available:
  - HIRL
  - Operative runway CL lights

  Note: The maximum crosswind component is 20 kt.

- **300 RVR:** Takeoff is authorized with visibility less than TDZ 500 RVR down to 300 RVR, Mid 300 RVR, and Rollout 300 RVR, using the HGS Takeoff and Departure procedure in *B737 AOM* 9.2.6 HGS Takeoff and Departure, provided all of the following requirements are met:
  - *Jeppesen* -9/-9A page authorizes a 300 RVR takeoff with HUD (i.e., HGS)
  - Operative HIRL and CL lights

  Note: The maximum crosswind component is 10 kt.

9.2.1 Determining Takeoff Minimums—Domestic Procedures

Revised: 03/28/2019

[OpSpec: C056][OpSpec: C078][14 CFR Part 121.637]

To determine takeoff minimums at domestic airports, accomplish the following:

1. Review the clearance to determine if a SID has been assigned for the planned runway.
   - If no SID is assigned, proceed to Step 2.
   - If a SID is assigned, proceed to Step 3.
2. Review the *Jeppesen* -9/-9A page (Takeoff Minimums and Obstacle Departure Procedures or Diverse Vector Area sections, as applicable) to determine takeoff minimums and/or climb gradient requirements for the planned runway.
   - If standard takeoff minimums are authorized, then lower than standard takeoff minimums are authorized by OpSpec C078. Comply with the runway-specific climb gradient and proceed to Step 4.
   - If standard takeoff minimums are not authorized, comply with the runway-specific higher than standard takeoff minimums (i.e., ceiling, visibility requirement, climb gradient). Steps are complete.
3. Review the SID to determine if takeoff minimums are required for the planned runway.
   - If standard takeoff minimums are authorized, then lower than standard takeoff minimums are authorized by OpSpec C078. Comply with the runway-specific climb gradient and proceed to Step 4.
   - If standard takeoff minimums are not authorized, comply with the runway-specific higher than standard takeoff minimums (i.e., ceiling, visibility requirement, climb gradient). Steps are complete.
   - If the SID does not list takeoff minimums, then lower than standard takeoff minimums are authorized. Comply with the *Jeppesen* -9/-9A page climb gradient and proceed to Step 4.

FLIGHT OPERATIONS MANUAL
Takeoff and Initial Climb

4. Use Table 9.1 Lower Than Standard Takeoff Visibility Requirements to determine lower than standard takeoff minimums.
   - Review the weather report to determine the type of visibility reports available and number of reporting RVRs, if applicable.
   - The availability of lighting and visual aids can be determined by referencing the *Jeppesen* -9/-9A page.

Note: Reference published NOTAMs for inoperative RVR equipment and visual aids.

Note: Adequate visual reference refers to runway markings or runway lighting that provides the Pilot with adequate visual reference to continuously identify the takeoff surface and maintain directional control throughout the takeoff run.

Run 3: Start on taxiway B. All checklist completed.

Procedure

- Night, IFR conditions, Calm winds, RVR 1400/600/1400
- All RVR's are operable as well as the CL & HIRL lighting.
- Temp and Due point 0/0° C
- Crew runs all appropriate checklist.
- Observe Low visibility taxi procedures.
- Pitch limit. Look through the F/D and limit pitch to 10°.
- F/O is the PF

	Notes and Observables
	1. Note when Transponder/ TCAS is turned on. Turned ON during the Before Takeoff Checklist. 2. Checklist usage: Any additional time needed in IRF conditions. 3. EICAS Messages: None 4. Limitations: None 5. Additional notes 6. Note the time it took to complete checklist and announce Ready For Takeoff. 25 seconds 7. Note engine Run up to 70% N1 and everything stabilized. Ran Engines up to 70% N1 for 17-19 seconds before releasing the toe brakes. 8. Additional Notes. Entered a TCAS Event on the second running .

Run 4: Start on taxiway B. All checklist completed.

Procedure

- Night, IFR conditions, Calm winds, RVR 600/600/600
- All RVR's are operable as well as the CL & HIRL lighting.
- Temp and Due point 0/0° C
- Crew runs all appropriate checklist.
- Observe Low visibility taxi procedures.
- Pitch limit. Look through the F/D and limit pitch to 10°.
- At 400 feet, offset 15° to the right.
- F/O is the PF.

	Notes and Observables
	1. Note when Transponder/ TCAS is turned on. TCAS turned on during the Before Start Checklist at the gate. 2. Checklist usage: Any additional time needed in IRF conditions. Previously noted. 3. EICAS Messages: None 4. Limitations: None 5. Additional notes 6. Note the time it took to complete checklist and announce Ready For Takeoff. 35 seconds 7. Note engine Run up to 70% N1 and everything stabilized. 17-19 seconds 8. Additional Notes. During second Run, the FO Flight Director was turned off at 400 feet.

Run 5: Start on taxiway B. All checklist completed.

Procedure

- Night, IFR conditions, Calm winds, RVR 600/600/600
- All RVR's are operable as well as the CL & HIRL lighting.
- Temp and Due point 0/0° C
- Crew runs all appropriate checklist.
- Observe Low visibility taxi procedures.
- Pitch limit. Follow the Flight Director.
- At 400 feet, offset 15° to the right.
- F/O is the PF.

	Notes and Observables
	1. Note when Transponder/ TCAS is turned on. TCAS is turned on during the reading of the Before Start Checklist. 2. Checklist usage: Any additional time needed in IRF conditions. Previously noted. 3. EICAS Messages: None 4. Limitations: None 5. Additional notes 6. Note the time it took to complete checklist and announce Ready For Takeoff. 30 seconds 7. Note engine Run up to 70% N1 and everything stabilized. 17-19 seconds 8. Additional Notes. Takeoff Thrust 85.1 % N1

Run 6: Start on taxiway B. All checklist completed.

Procedure

- Night, IFR conditions, Calm winds, RVR 600/600/600
- All RVR's are operable as well as the CL & HIRL lighting.
- Temp and Due point 0/0° C
- Crew runs all appropriate checklist.
- Observe Low visibility taxi procedures.
- Pitch limit. Follow the Flight Director.
- Engine Run Up for 30 seconds per SWA procedures.
- F/O is the PF.

	Notes and Observables
	1. Note when Transponder/ TCAS is turned on. TCAS is turned on during the reading of the Before Start Checklist. 2. Checklist usage: Any additional time needed in IRF conditions. Previously noted. 3. EICAS Messages: None 4. Limitations: None 5. Additional notes 6. Note the time it took to complete checklist and announce Ready For Takeoff. 30 seconds 7. Note engine Run up to 70% N1 and everything stabilized. 17-19 seconds 8. Additional Notes. Takeoff Thrust 85.1 % N1 9. Airplane/sim shook terribly when doing a 70% N1 Run Up for 30 seconds,

Test and Observation Complete

Submitted by:

Warren Abrams
Operations Group Chairman

INTENTIONALLY LEFT BLANK