TAKEOFF SAFETY

TRAINING AID

ISSUE 2 - 11/2001

AIRBUS

Flight Operations Support & Line Assistance

Introduction

The purpose of this brochure is to provide the Airlines with Airbus data to be used in conjunction with the TAKEOFF SAFETY TRAINING AID published by the Federal Aviation Administration. Airframe manufacturer's, Airlines, Pilot groups, and regulatory agencies have developed this training resource dedicated to reducing the number of rejected takeoff (RTO) accidents.

The data contained in this brochure are related to section 4 of TAKEOFF SAFETY TRAINING AID document and provide information related to reverse thrust effectiveness, flight manual transition times, line up distances, brake pedal force data, reduced thrust examples as well as the effect of procedural variations on stopping distances.

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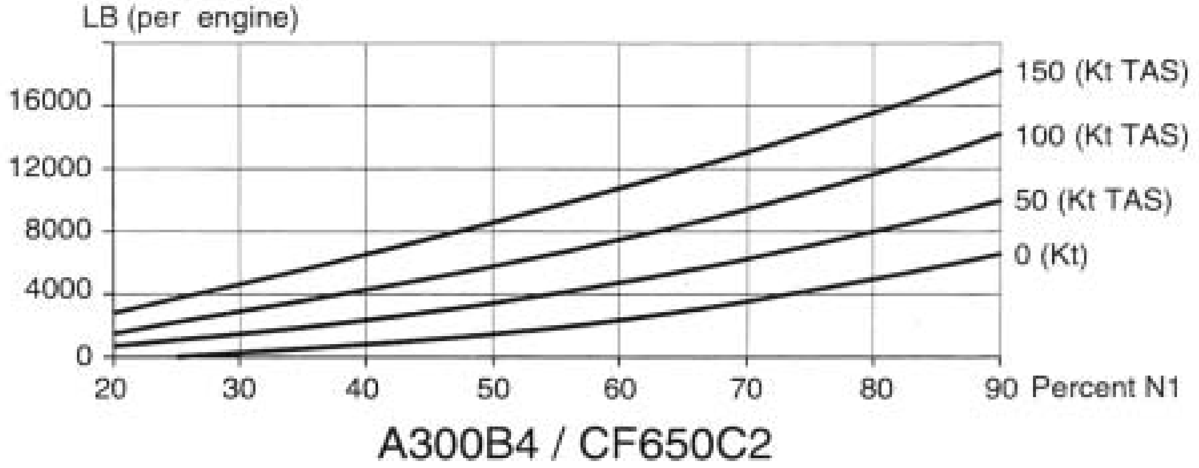
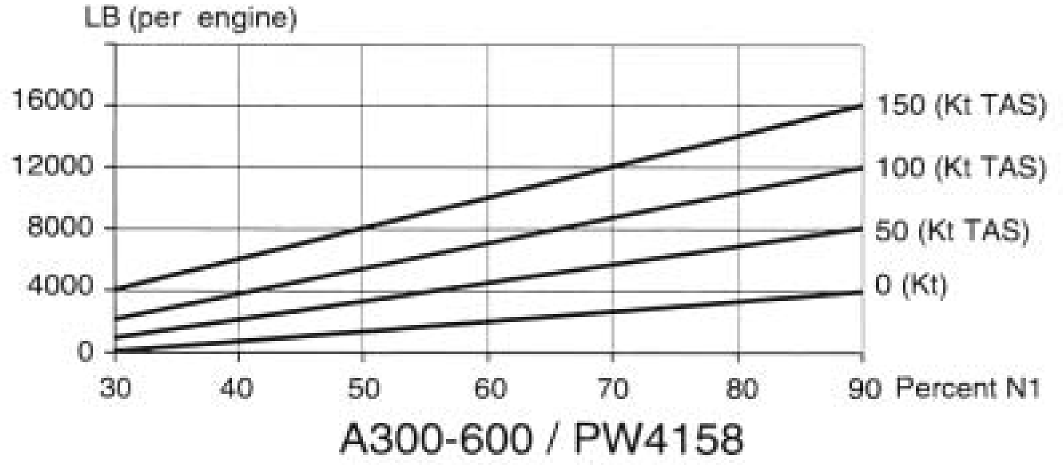
Reverse Thrust Effectiveness

Sea level – Standard day

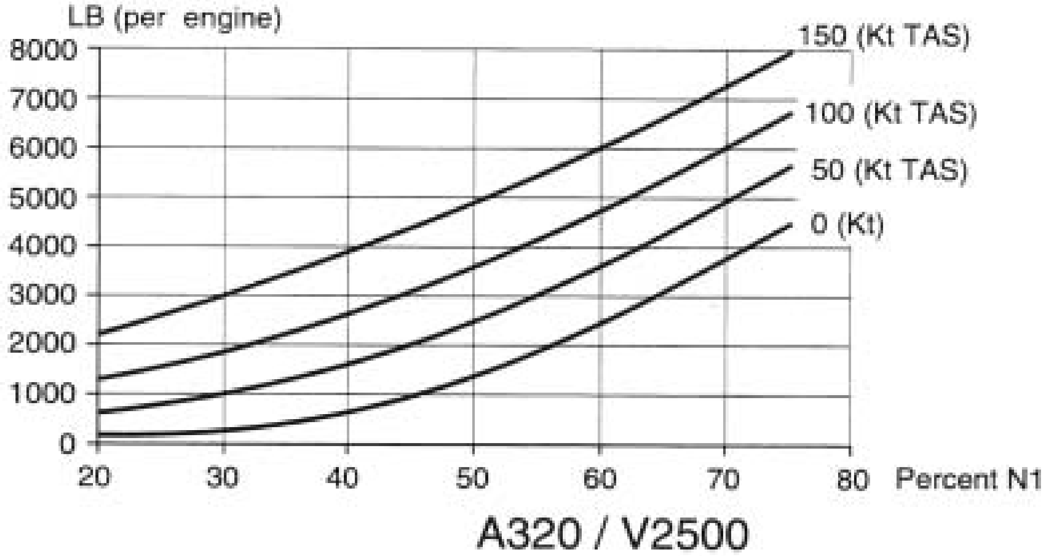


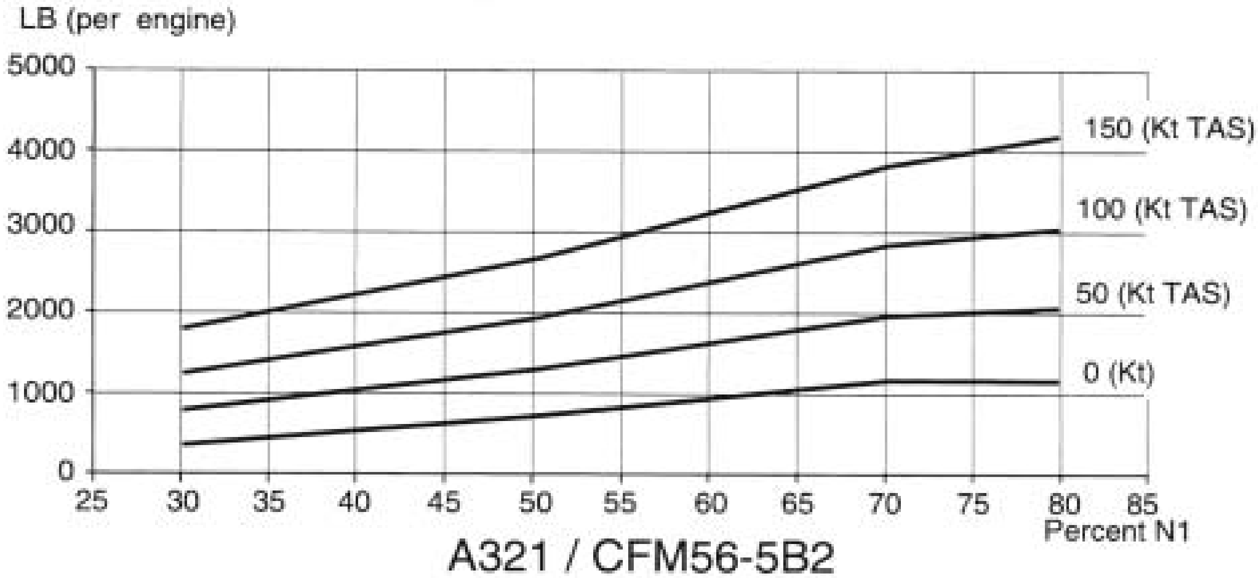


Training information only – Net reverse thrust

Reverse Thrust Effectiveness

Sea level – Standard day

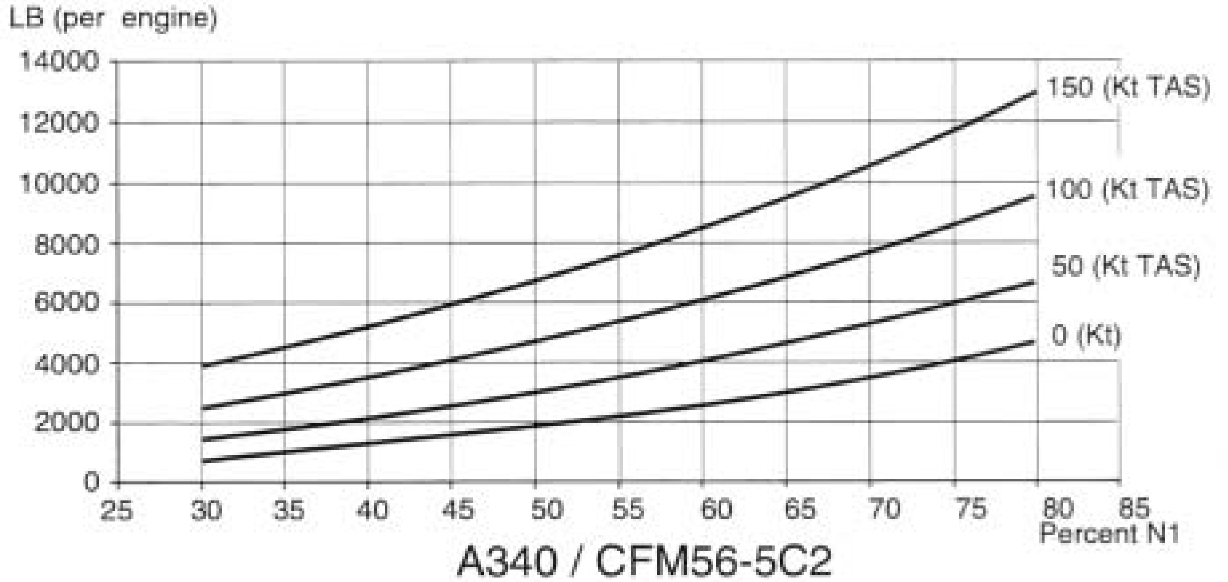


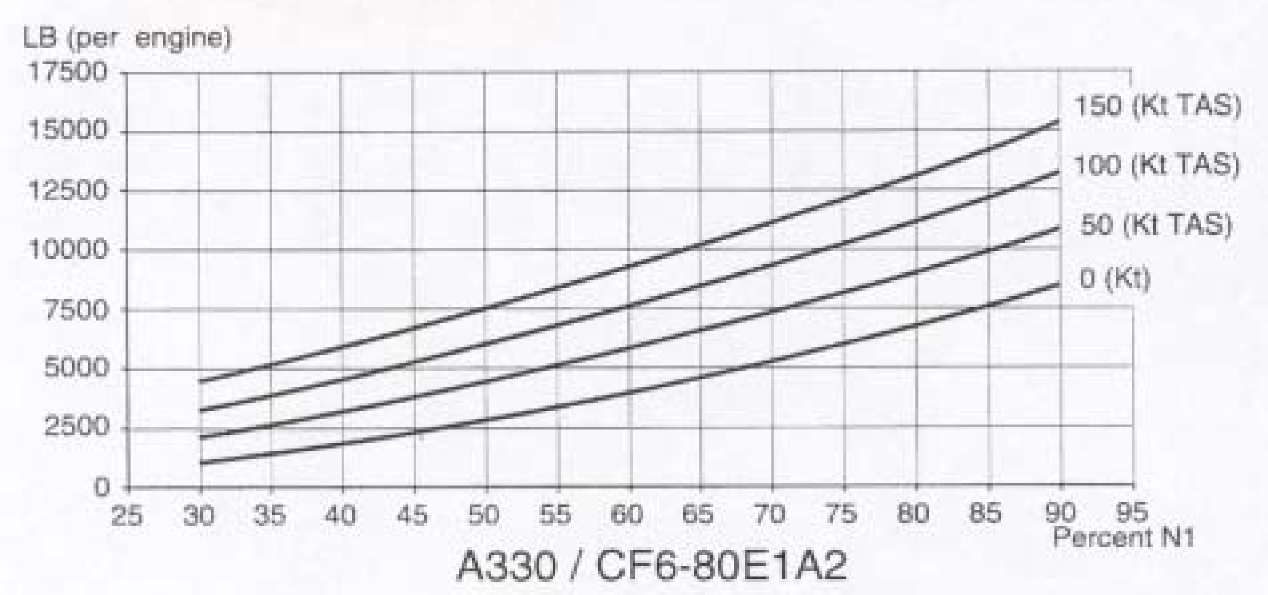


Training information only – Net reverse thrust

Reverse Thrust Effectiveness

Sea level – Standard day





Training information only – Net reverse thrust

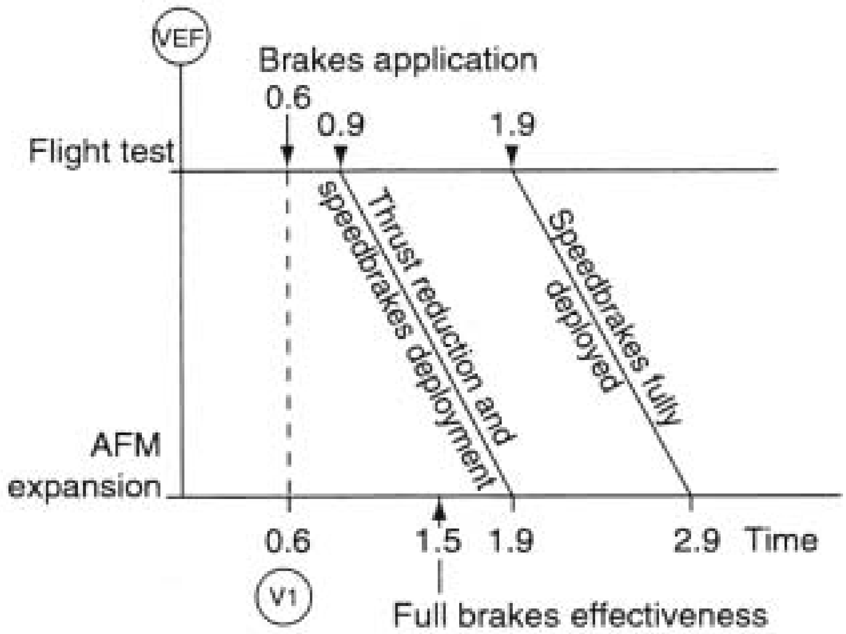
Airplane Flight Manual Transition Time Details

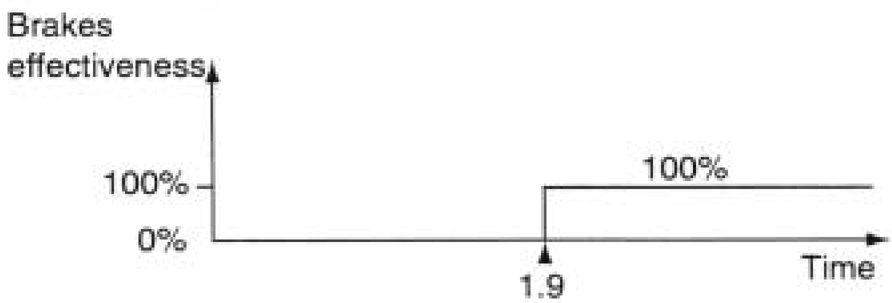
The data in this appendix is provided as a reference for the instructor. The individual diagrams show the relationship between the average time required to reconfigure the airplane for an RTO in the certification flight tests and the expanded times used in the computation of certified takeoff performance in the AFM.

Airplane Flight Manual Transition Time Details

A300

- **Without Amendment 42**





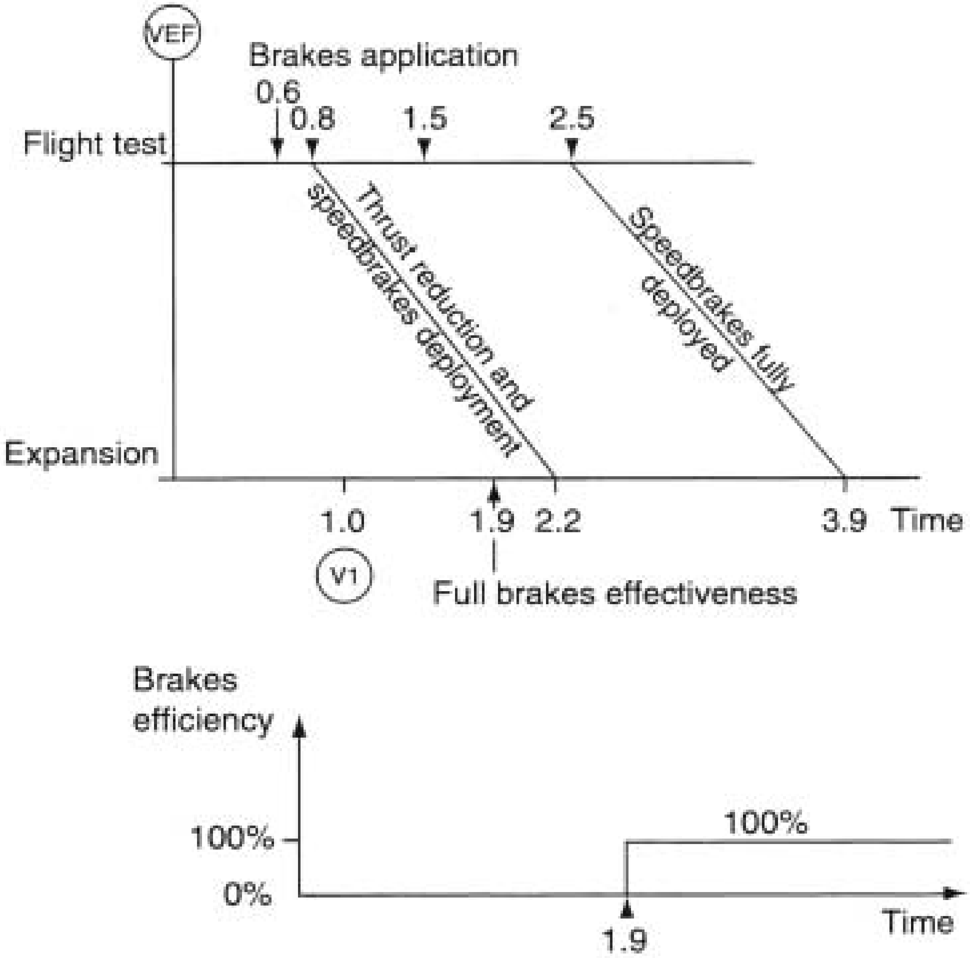
	Flight test	AFM Expansion
Recognition	-	0.6
Brakes on	0.6	-
Brakes fully efficient	-	1.5
Thrust reduction	0.9	1.9
Speedbrakes fully deployed	1.9	2.9

For certification purposes, braking effectiveness is nulled until 1.5 seconds where 100% braking is considered as effective.

Airplane Flight Manual Transition Time Details

A310

- **Without Amendment 42**
- **Steel brakes**



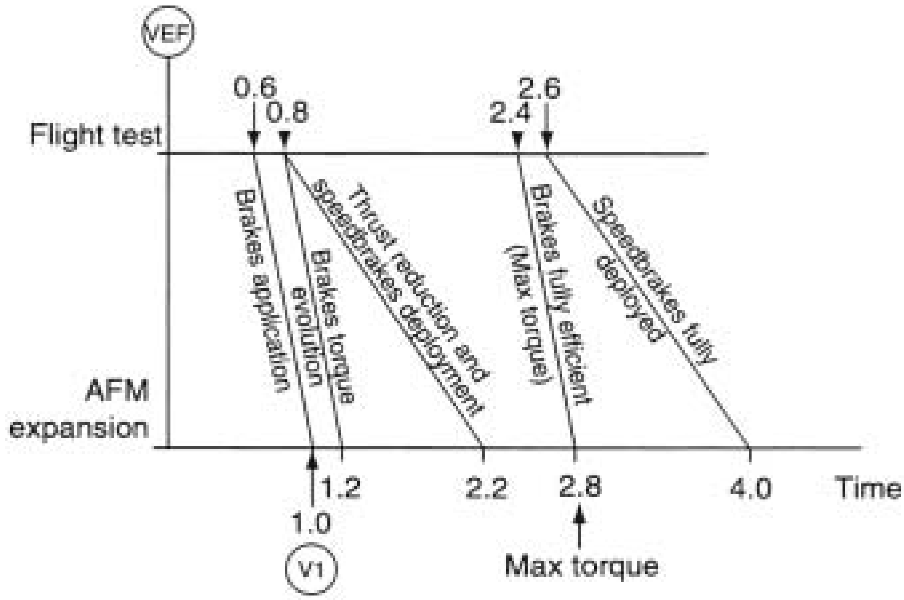
	Flight test	AFM Expansion
Recognition	-	1.0
Brakes on	0.6	-
Brakes fully efficient	-	1.9
Thrust reduction	0.8	2.2
Speedbrakes fully deployed	2.5	3.9

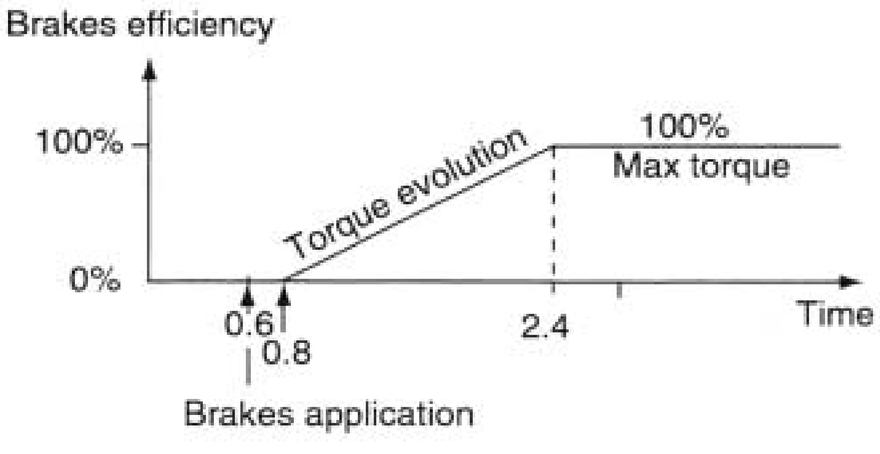
For certification purposes, braking effectiveness is nulled until 1.9 seconds where 100% braking is considered as effective.

Airplane Flight Manual Transition Time Details

A310 – A300-600

- **Without Amendment 42**
- **Carbon brakes**



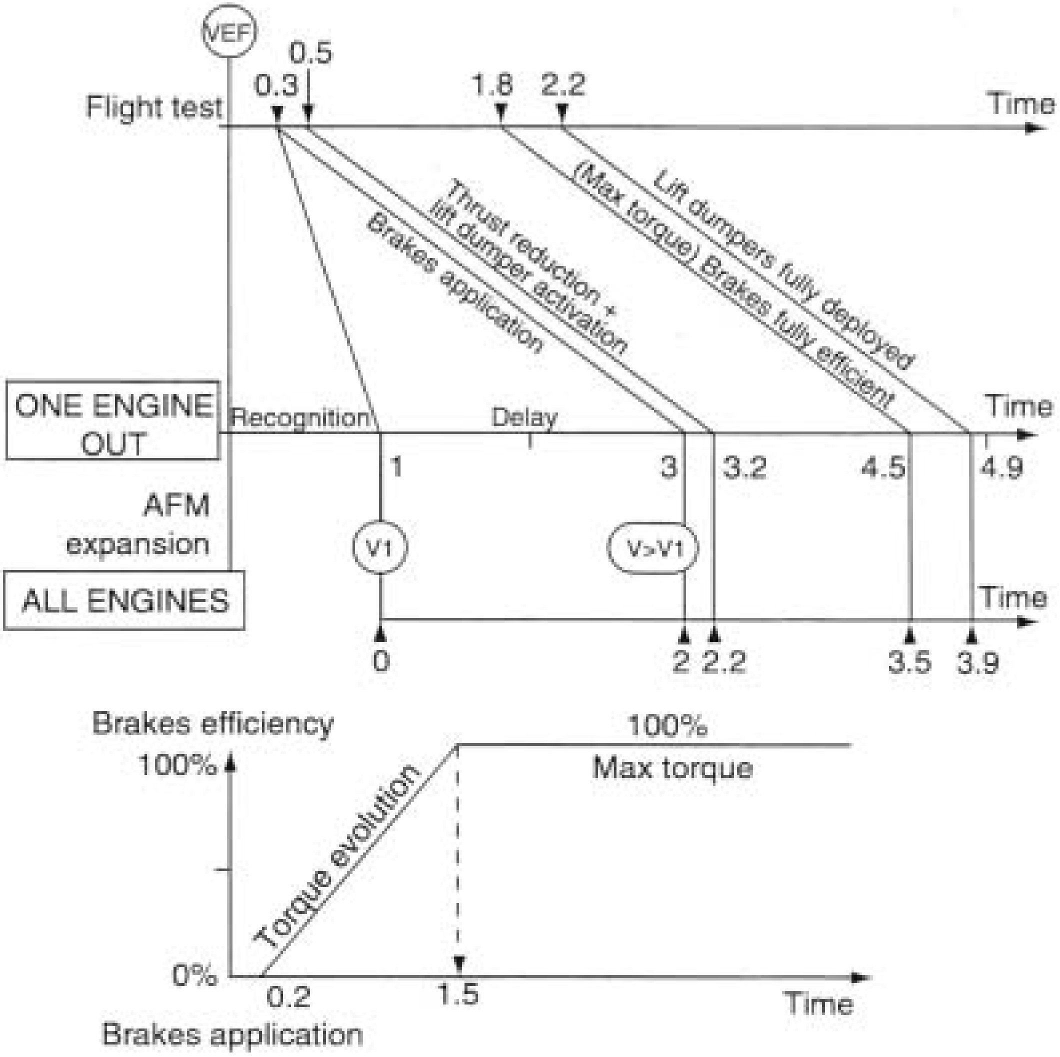


	Flight test	AFM Expansion
Recognition	-	1.0
Brakes on	0.6	1.0
Brakes fully efficient	2.4	2.2
Thrust reduction	0.8	2.8
Speedbrakes fully deployed	2.6	4.0

Airplane Flight Manual Transition Time Details

A320

- **With Amendment 42**
- **Carbon brakes**

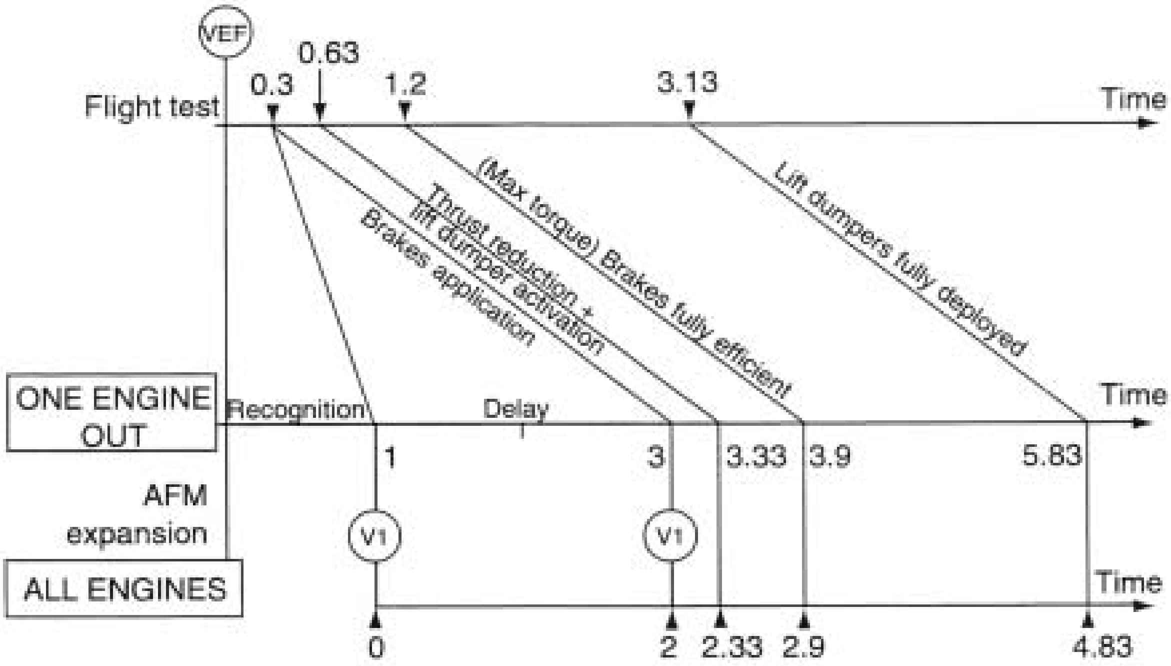


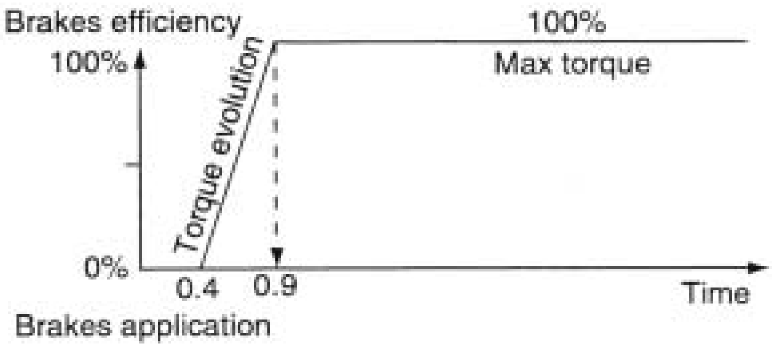
	Flight test	AFM Expansion	
		One engine OUT	All engines
Engine failure	0	0	-
Recognition	0.3	1	0
Delay (Amendt. 42)	-	3	2
Brakes on	0.3	3	2
Thrust reduction & lift dumper activation	0.5	3.2	2.2
Brakes fully efficient	1.8	4.5	3.5
Lift dumpers fully deployed	2.2	4.9	3.9

Airplane Flight Manual Transition Time Details

A321

- **Post Amendment 42**
- **Carbon brakes**



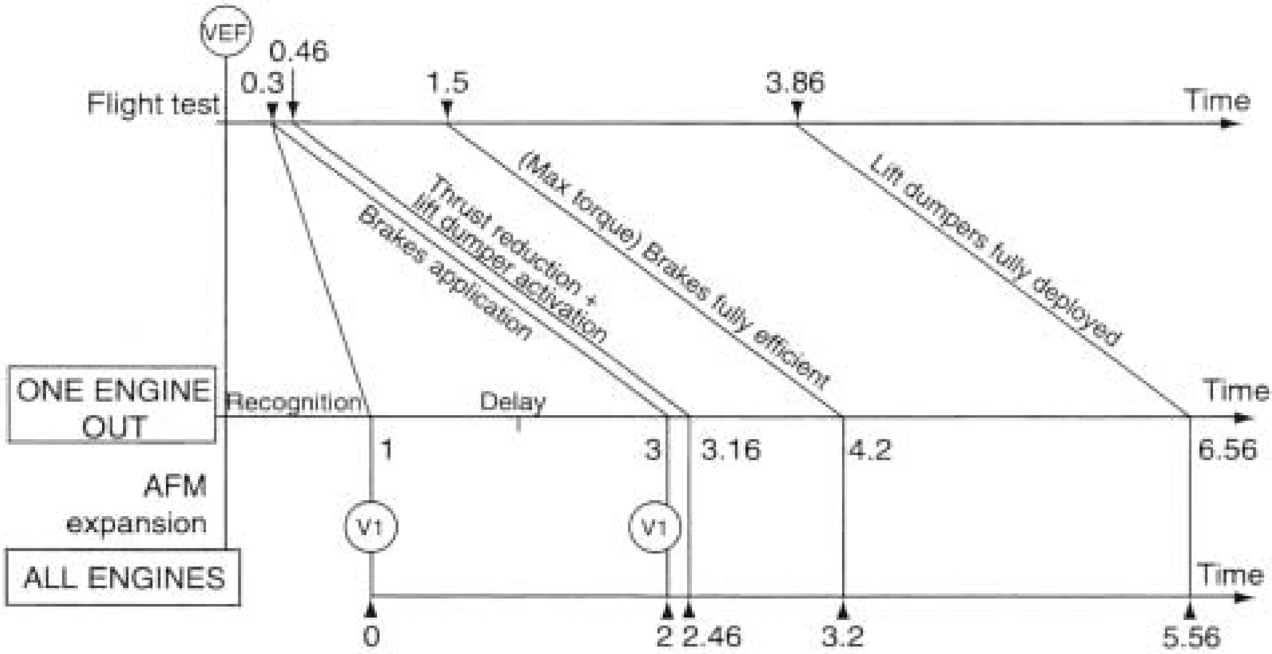


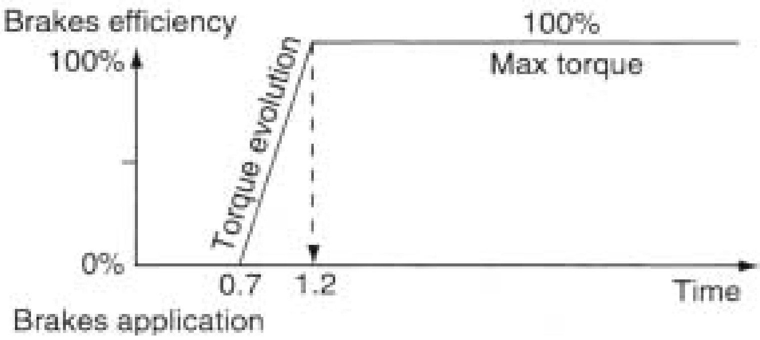
	Flight test	AFM Expansion	
		One engine OUT	All engines
Engine failure	0	0	-
Recognition	0.3	1	0
Delay (Amendt. 42)	-	3	2
Brakes on	0.3	3	2
Thrust reduction & lift dumper activation	0.63	3.33	2.33
Brakes fully efficient	1.2	3.9	2.9
Lift dumpers fully deployed	3.13	5.83	4.83

Airplane Flight Manual Transition Time Details

A330

- **Post Amendment 42**
- **Carbon brakes**



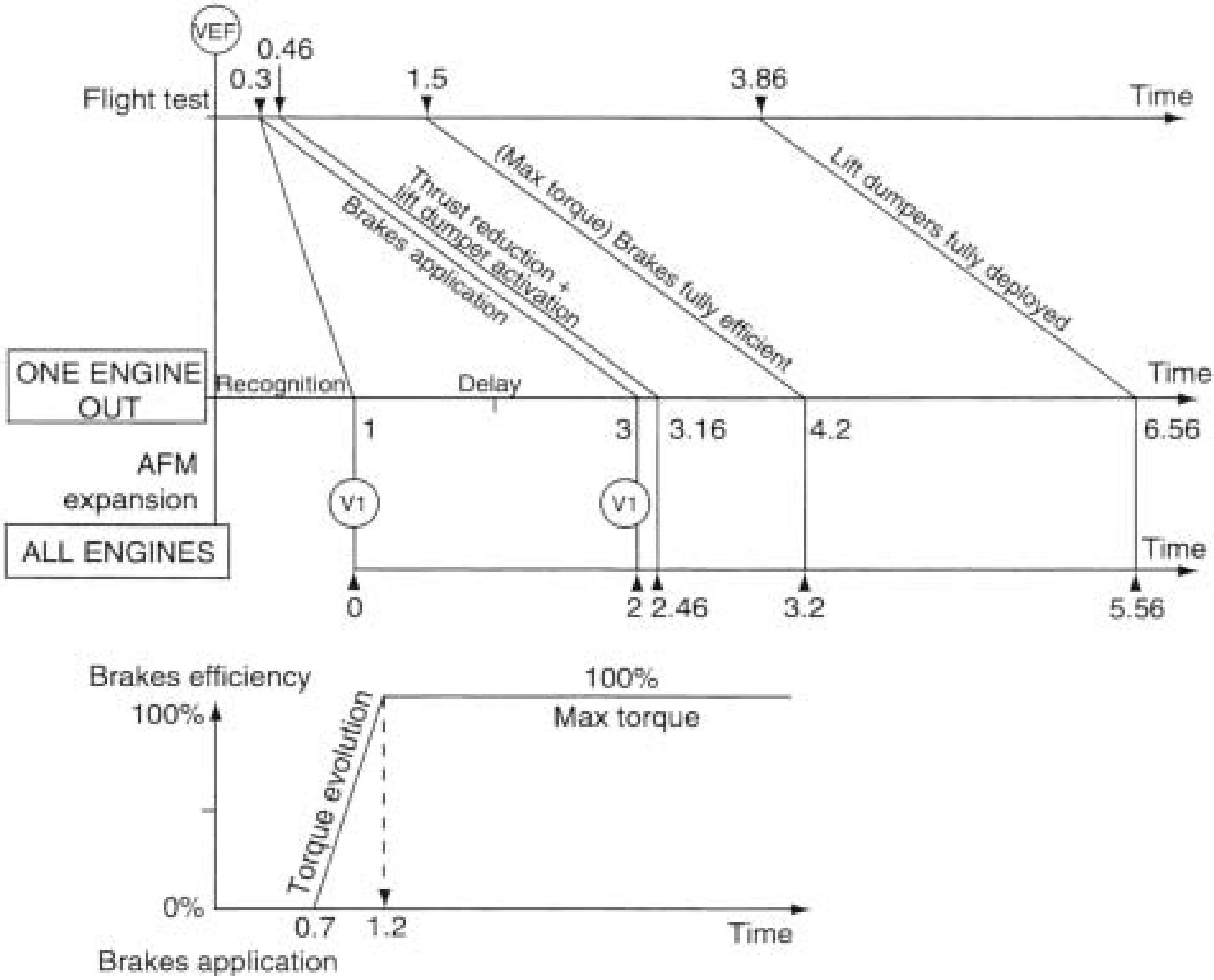


	Flight test	AFM Expansion	
		One engine OUT	All engines
Engine failure	0	0	-
Recognition	0.3	1	0
Delay (Amendt. 42)	-	3	2
Brakes on	0.3	3	2
Thrust reduction & lift dumper activation	0.46	3.16	2.16
Brakes fully efficient	1.5	4.2	3.2
Lift dumpers fully deployed	3.86	6.56	5.56

Airplane Flight Manual Transition Time Details

A340

- **Post Amendment 42**
- **Carbon brakes**



	Flight test	AFM Expansion	
		One engine OUT	All engines
Engine failure	0	0	-
Recognition	0.3	1	0
Delay (Amendt. 42)	-	3	2
Brakes on	0.3	3	2
Thrust reduction & lift dumper activation	0.46	3.16	2.16
Brakes fully efficient	1.5	4.2	3.2
Lift dumpers fully deployed	3.86	6.56	5.56

Brake Pedal Force Data

The data in this appendix is provided as a reference for the instructor. The individual charts show the brake pedal force required to apply full brake system pressure, to set the parking brake, and to disarm the RTO autobrake function, if applicable.

	Pedal force (Lb)			Handle force (Lb)
	To disarm* RTO autobrake		To apply full system pressure	To set parking brakes
	Low. med mode	Mode max		
A319/A320/A321	31	*51	90	Small (1)
A310	34	56	90	24
A300-600	34	56	90	
A300 B2/B4	N/A		90	
A330/A340	44	58	95	Small (1)

* Disarmement by two pedals

(1) Parking : Parking brakes is electrically activated on these models.

Reduced Thrust Examples

If the performance limited weight using full takeoff thrust exceeds the actual weight of the airplane, the possibility may exist that the takeoff can still be performed within the certification limitations but at lower thrust setting. Takeoffs conducted in this manner are generically referred to as reduced thrust takeoffs or FLEX takeoffs. The use of reduced takeoff thrust to enhance engine reliability and reduce maintenance costs is a standard practice used by nearly all commercial airlines today. In some cases, the use of reduced thrust is so common that the less-than-full-thrust is referred to as "Standard Thrust" or "Normal Thrust". The name that is chosen to describe a reduced thrust takeoff is not as important as is understanding the basis for the thrust used on any given takeoff.

There are essentially two methods of accomplishing this beneficial thrust reduction. The first is by restricting the engine operation to a lower certified trust rating. This is referred to as "derate" reduced thrust. Operation of the airplane with derate takeoff thrust will produce performance margins indentical to that described in Section 4.3.3 of the basic document.

A more frequently used method of reducing takeoff thrust is to tabulate the performance limit weights for a given runway at the full rated thrust, such as is displayed in a typical airport runway analysis presentation. Then the temperature and thrust is determined, at wich the actual airplane weight would become the performance limit weight. This method of thrust reduction, referred to as the Assumed or Flexible Temperature Method, is of special interest because, unlike "derate thrust takeoffs", additional "GO" and "STOP" margins exist, beyond those of the basic certification rules.

There are essentially two sources of additional performance potential, or "margins", inherent to takeoffs performed using the assumed temperature method to reduce thrust. First, since the takeoff performance was initially calculated using full takeoff thrust, the applicable minimum control speed restrictions at full thrust have already been accounted for in determining the limits weights and speeds. Therefore, if at any time during the takeoff, the pilot decides that the safety of the takeoff is in question, the engine thrust may be increased to the full-rated value, without danger of exceeding the minimum control limits.

The second source of additional performance in a flexible temperature takeoff is due to the true airspeed difference that exists between actual temperature and the higher flexible temperature. This results in less actual distance being required for the airplane to reach 35 feet or to come to a stop in an RTO. This appendix contains examples which illustrate these additional margins that are inherent to reduced thrust takeoff calculations using the flexible temperature method.

Reduced Thrust Examples

Airbus Model A300B4-203

And example of the conservatism inherent in the use of the assumed (flexible) temperature method of reduced thrust calculation.

Conditions A300B4
GE CF6-50C2
Sea level
O A T = 15°C
8900ft runway
Actual airplane weight = 148 T permits assumed (flexible) temperature of 40°C

Parameters	Actual temp is 15°C and assumed (flexible) temp is 40°C	Actual temp is 40°C	Margin
N1 (%)	111	111	
V1 (KIAS/TAS)	153 / 153	153 / 159	- 6 KTAS
VR (KIAS/TAS)	155 / 155	155 / 161	- 6 KTAS
V2 (KIAS/TAS)	160 / 160	160 / 167	- 7 KTAS
Thrust at V1, Lbs per engines	37.760	37.760	0 Lbs
Far field length ---ft	8398	8860	462 ft
Accelerate-stop distance (engine-out) ---ft	8148	8860	732 ft
Accelerate-go distance (engine-out) ---ft	8398	8860	462 ft
Accelerate-go distance (all-engine) ---ft	7735	8300	564 ft
Second segment gradient %	2.69	2.52	0.0 %
Second segment rate of climb ---ft per minute	407	425	- 18 Fpm

Reduced Thrust Examples

Airbus Model A310-300

And example of the conservatism inherent in the use of the assumed (flexible) temperature method of reduced thrust calculation.

Conditions A310-300
GE CF680-C2A2
Sea level
O A T = 15°C
10000ft runway
Actual airplane weight = 155 T permits assumed (flexible) temperature of 40°C

Parameters	Actual temp is 15°C and assumed (flexible) temp is 40°C	Actual temp is 40°C	Margin
N1 (%)	105.4	105.4	
V1 (KIAS/TAS)	161 / 161	161 / 168	- 7 KTAS
VR (KIAS/TAS)	164 / 164	164 / 171	- 7 KTAS
V2 (KIAS/TAS)	167 / 167	167 / 174	- 7 KTAS
Thrust at V1, Lbs per engines	40.320	40.320	0 Lbs
Far field length ---ft	9420	9987	567 ft
Accelerate-stop distance (engine-out) ---ft	9111	9987	876 ft
Accelerate-go distance (engine-out) ---ft	9420	9987	567 ft
Accelerate-go distance (all-engine) ---ft	8233	8937	704 ft
Second segment gradient %	2.54	2.54	0.0 %
Second segment rate of climb ---ft per minute	431	449	- 18 Fpm

Reduced Thrust Examples

Airbus Model A300-600

And example of the conservatism inherent in the use of the assumed (flexible) temperature method of reduced thrust calculation.

Conditions A300-600
GE CF680-C2A5
Sea level
O A T = 15°C
10000ft runway
Actual airplane weight = 168 T permits assumed (flexible) temperature of 40°C

Parameters	Actual temp is 15°C and assumed (flexible) temp is 40°C	Actual temp is 40°C	Margin
N1 (%)	108.2	108.2	
V1 (KIAS/TAS)	158 / 158	158 / 165	- 7 KTAS
VR (KIAS/TAS)	161 / 161	161 / 168	- 7 KTAS
V2 (KIAS/TAS)	164 / 164	164 / 171	- 7 KTAS
Thrust at V1, Lbs per engines	43.527	43.527	0 Lbs
Far field length ---ft	9432	9980	548 ft
Accelerate-stop distance (engine-out) ---ft	9065	9980	915 ft
Accelerate-go distance (engine-out) ---ft	9432	9980	548 ft
Accelerate-go distance (all-engine) ---ft	7979	8661	681 ft
Second segment gradient %	2.65	2.51	0.0 %
Second segment rate of climb ---ft per minute	417	435	- 18 Fpm

Reduced Thrust Examples

Airbus Model A320-200

And example of the conservatism inherent in the use of the assumed (flexible) temperature method of reduced thrust calculation.

Conditions A320
GE CFM56-5A1
Sea level
O A T = 15°C
9500ft runway
Actual airplane weight = 72 T permits assumed (flexible) temperature of 40°C

Parameters	Actual temp is 15°C and assumed (flexible) temp is 40°C	Actual temp is 40°C	Margin
N1 (%)	95.5	95.5	
V1 (KIAS/TAS)	150 / 150	150 / 156	- 6 KTAS
VR (KIAS/TAS)	151 / 151	151 / 157	- 6 KTAS
V2 (KIAS/TAS)	154 / 154	154 / 161	- 7 KTAS
Thrust at V1, Lbs per engines	17.744	17.744	0 Lbs
Far field length ---ft	9002	9468	466 ft
Accelerate-stop distance (engine-out) ---ft	8760	9468	708 ft
Accelerate-go distance (engine-out) ---ft	9002	9468	466 ft
Accelerate-go distance (all-engine) ---ft	7236	7811	575 ft
Second segment gradient %	2.68	2.68	0.0 %
Second segment rate of climb ---ft per minute	419	438	- 19 Fpm

Reduced Thrust Examples

Airbus Model A321-112

And example of the conservatism inherent in the use of the assumed (flexible) temperature method of reduced thrust calculation.

Conditions A321-112
CFM56-5B2
Sea level
O A T = 15°C
9459ft runway
Actual airplane weight = 85 T permits assumed (flexible) temperature of 40°C

Parameters	Actual temp is 15°C and assumed (flexible) temp is 40°C	Actual temp is 40°C	Margin
N1 (%)	93.6	93.6	
V1 (KT IAS/TAS)	150 / 147	150 / 153	- 6 KTAS
VR (KT IAS/TAS)	158 / 155	158 / 162	- 7 KTAS
V2 (KT IAS/TAS)	159 / 158	159 / 165	- 7 KTAS
Thrust at V1, Lbs per engines	23.451	23.451	0 Lbs
Far field length (ft)	8859	9459	600 ft
Accelerate-stop distance (engine-out) ---ft	8547	9459	912 ft
Accelerate-go distance (engine-out) ---ft	8859	9459	600 ft
Accelerate-go distance (all-engine) ---ft	7393	7970	577 ft
Second segment gradient %	2.4	2.4	0.0 %
Second segment rate of climb ---ft per minute	387	401	- 14 Fpm

Reduced Thrust Examples

Airbus Model A330-301

And example of the conservatism inherent in the use of the assumed (flexible) temperature method of reduced thrust calculation.

Conditions A330-301
CF6-80E1A2
Sea level
O A T = 15°C
9710ft runway
Actual airplane weight = 212 T permits assumed (flexible) temperature of 40°C

Parameters	Actual temp is 15°C and assumed (flexible) temp is 40°C	Actual temp is 40°C	Margin
N1 (%)	102.5	102.5	
V1 (KT IAS/TAS)	148 / 148	148 / 155	- 7 KTAS
VR (KT IAS/TAS)	150 / 150	150 / 156	- 6 KTAS
V2 (KT IAS/TAS)	155 / 155	155 / 162	- 7 KTAS
Thrust at V1, Lbs per engines	50.347	50.347	0 Lbs
Far field length (ft)	9103	9710	607 ft
Accelerate-stop distance (engine-out) ---ft	8916	9710	794 ft
Accelerate-go distance (engine-out) ---ft	9103	9710	607 ft
Accelerate-go distance (all-engine) ---ft	8363	9013	650 ft
Second segment gradient %	2.4	2.4	0.0 %
Second segment rate of climb ---ft per minute	376	394	- 18 Fpm

Reduced Thrust Examples

Airbus Model A340-311

And example of the conservatism inherent in the use of the assumed (flexible) temperature method of reduced thrust calculation.

Conditions A340-311
CFM56-5C2
Sea level
O A T = 15°C
12267ft runway
Actual airplane weight = 257 T permits assumed (flexible) temperature of 40°C

Parameters	Actual temp is 15°C and assumed (flexible) temp is 40°C	Actual temp is 40°C	Margin
N1 (%)	90	90	
V1 (KT IAS/TAS)	148 / 148	148 / 154	- 6 KTAS
VR (KT IAS/TAS)	155 / 155	155 / 162	- 7 KTAS
V2 (KT IAS/TAS)	161 / 162	161 / 168	- 7 KTAS
Thrust at V1, Lbs per engines	23.376	23.376	0 Lbs
Far field length (ft)	11358	12267	909 ft
Accelerate-stop distance (engine-out) ---ft	11174	12175	1001 ft
Accelerate-go distance (engine-out) ---ft	11322	12175	853 ft
Accelerate-go distance (all-engine) ---ft	11358	12267	909 ft
Second segment gradient %	3	3	0.0 %
Second segment rate of climb ---ft per minute	490	509	- 19 Fpm

Lineup Distance Charts

Lineup Distance Charts

Lineup corrections should be made when computing takeoff performance anytime the access to the runway does not permit positioning of the airplane at the threshold. The data contained in this appendix is based on the manufacturer's data for minimum turn rad consistent with the turning conditions shown in figure 2 and 3. Operators can use the data in this appendix to develop lineup corrections appropriate to any runway run geometry. However the use of data in this appendix does not supersede any requirements that may be already be in place for specific regulatory agencies. If further assistance is required, the operator should contact the appropriate manufacturer and regulatory agency to assure compliance with all applicable regulations.

Definitions of terms

The takeoff distance (TOD) adjustment is made based on the initial distance from the main gear to the beginning of the runway since the screen height is measured from the main gear, as indicated by distance "A" in Figure 1. The accelerate-stop distance (ASD) adjustment is based on the initial distance from the nose gear to the beginning of the runway, as indicated by distance "B" in Figure 1.

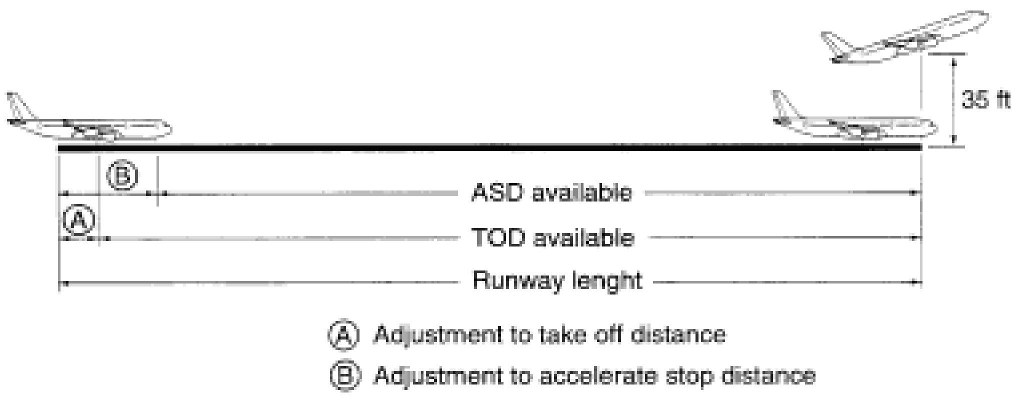


Figure1

When determining a runway lineup allowance, the characteristics for maneuvering **each** airplane model onto **each** runway should be used in calculating the required corrections. For example, runways with displaced take off thresholds or ample turning aprons should not need further adjustment as shown in Figure 2, runways that require a 90 degree turn-on taxiing on the runway with a 180 degree turn at the end, Figure 3 and 4, may require a lineup adjustment. This appendix contains the appropriate minimum lineup distance adjustments to both the accelerate-go (TOD) and accelerate-stop (ASD) cases that result from a 90 degree turn onto the runway and a 180 degree turn maneuver on the runway.

Lineup Distance Charts

90 Degree Runway Entry

90 Degree Runway Entry					
Aircraft Model	Maximum effective steering angle	Minimum line up distance correction			
		On TODA ft (m)		On ASDA ft (m)	
A300	58.3°	70.6	21.5	132.0	40.2
A310	56°	66.9	20.4	117.8	35.9
A320	75°	35.9	10.9	77.3	23.6
A319	70°	37.8	11.5	74.0	22.6
A321	75°	39.5	12.0	94.9	28.9
A330-200	62°	73.7	22.5	146.5	44.7
A330-300	65°	75.1	22.9	158.4	48.3
A340-200	62°	76.3	23.3	152.5	46.5
A340-300	62°	80.1	24.4	164.0	50.0
A340-500	65°	77.4	23.6	169.1	51.6
A340-600	67°	80.7	24.6	189.6	57.8

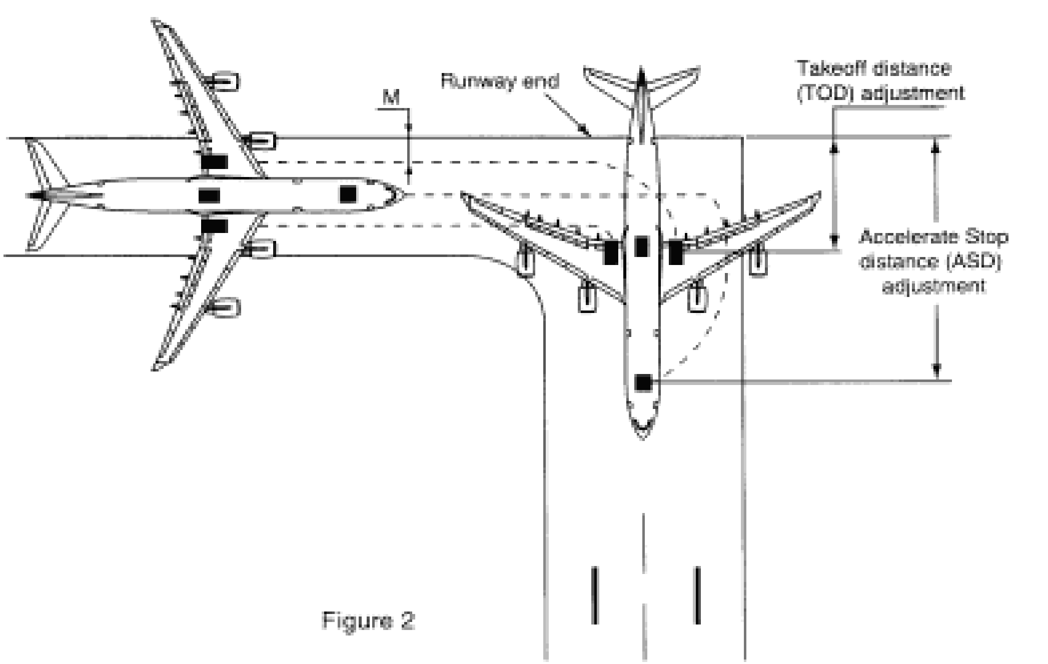


Figure 2

Lineup Distance Charts
180 Degree Turnaround

180 Degree Turnaround										
Aircraft Model	Minimum Lineup Distance Correction				Required min runway width		Nominal lineup distance on a 60m/197’ runway width			
	TODA		ASDA				TODA		ASDA	
	ft	m	Ft	m	ft	m	ft	m	ft	m
A300	86.9	26.5	148.2	45.2	217.0	66.1	124.6	38.0	186.0	56.7
A310	76.3	23.3	127.2	38.8	202.2	61.6	95.1	29.0	146.0	44.5
A320	54.0	16.5	95.4	29.1	94.2	28.7	As minimum			
A319	49.6	15.1	85.8	26.2	102.0	31.1	As minimum			
A321	68.4	20.9	123.9	37.8	108.7	33.1	As minimum			
A330-200	98.8	30.1	171.6	52.3	223.8	68.2	142.2	43.3	215.0	65.5
A330-300	108.8	33.2	192.1	58.5	229.7	70.0	157.2	47.9	240.4	73.3
A340-200	103.4	31.5	179.7	54.8	234.3	71.4	155.5	47.4	231.7	70.6
A340-300	111.8	34.1	195.8	59.7	249.3	76.0	175.0	53.3	259.0	78.9
A340-500	117.8	35.9	209.5	63.9	238.8	72.8	173.3	52.8	265.0	80.8
A340-600	134.8	41.1	243.8	74.3	251.3	76.6	199.3	60.7	308.2	93.9

Note 1: These values have been computed following the conditions shown on the figures below. They differ from the recommended turning technic, published in the flight crew operating

Note 2: A340-600 requires turning technique described in FCOM to achieve180° turn on 60m wide runway

manual, for which smaller runway width can be obtained.

** Runway width to turn 180 degrees at maximum effective steering angle and end aligned with the centerline of the pavement. Includes minimum edge safety distance (M) as required in FAA AC150/5300-13 and ICAO annex 14 (10ft for A319, A320 and A321 15ft all others).

*** Lineup distance required to turn 180 deg. and realign the airplane on the runway centerline on a 60 meter/197 ft wide runway with at least the minimum edge safety distance

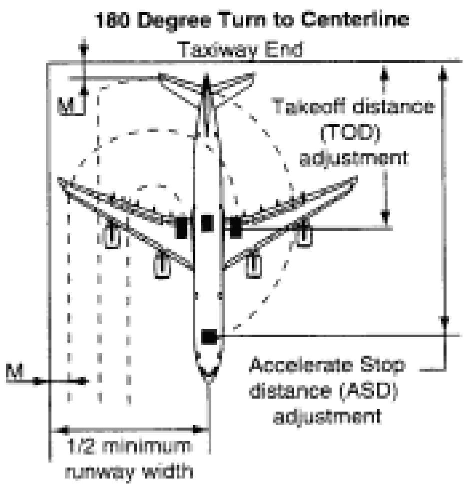


Figure 3

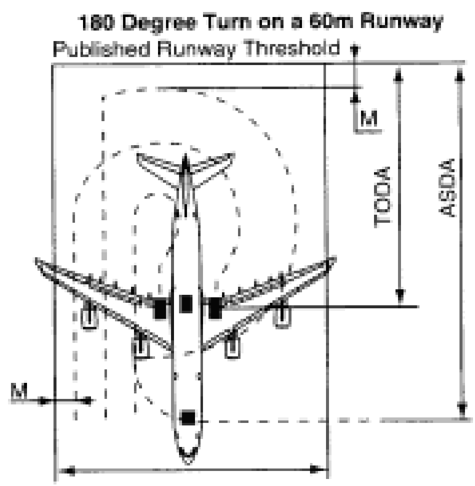


Figure 4

The Effect of Procedural Variations on Stopping Distance

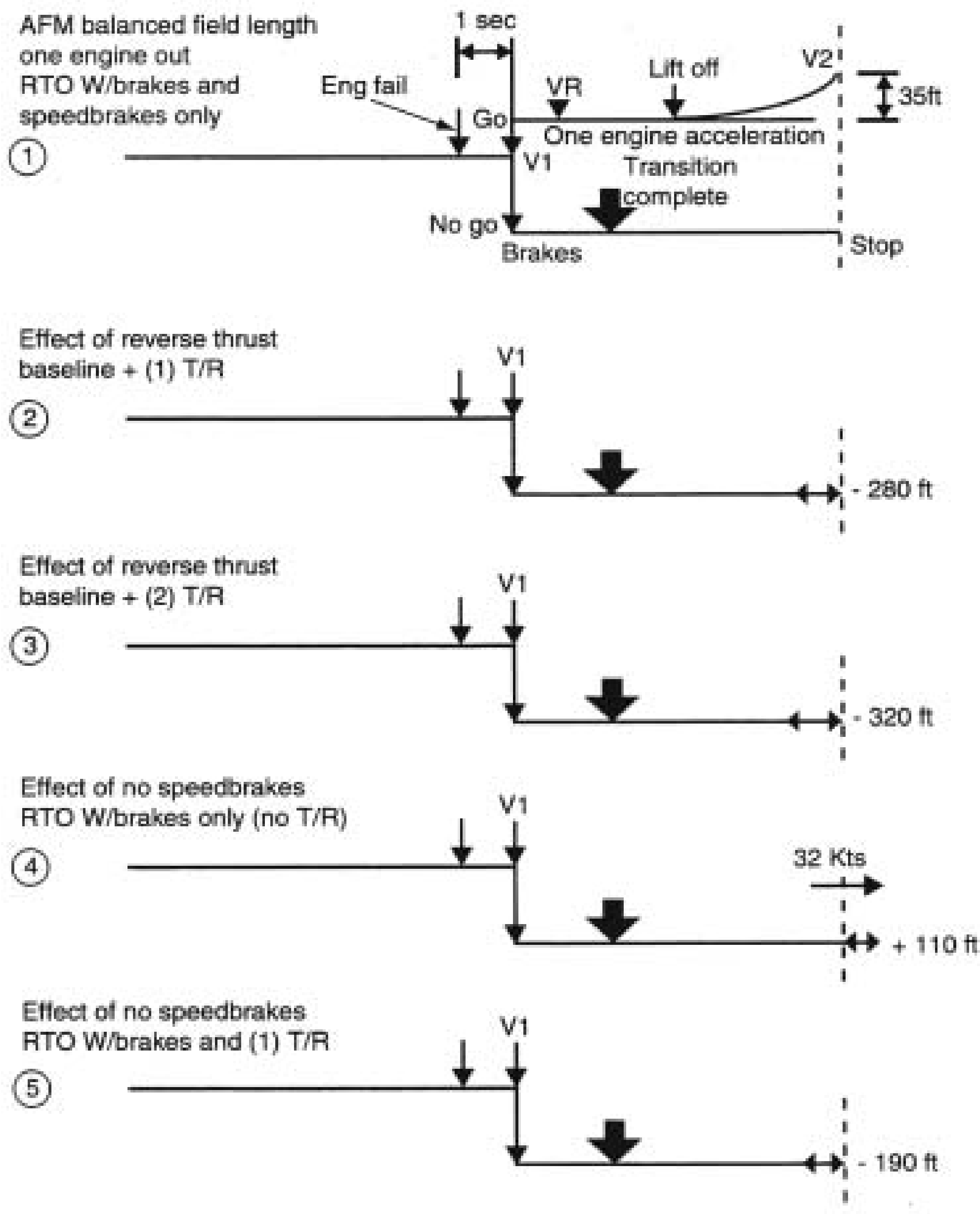
The data in this appendix is provided as a reference for the instructor. The individual diagrams show the approximate effects of various configuration items and procedural variations on the rejected takeoff stopping performance of the airplane.

The Effect of Procedural Variations on Stopping Distance

A300B4-203

Available runway

Dry runway baseline

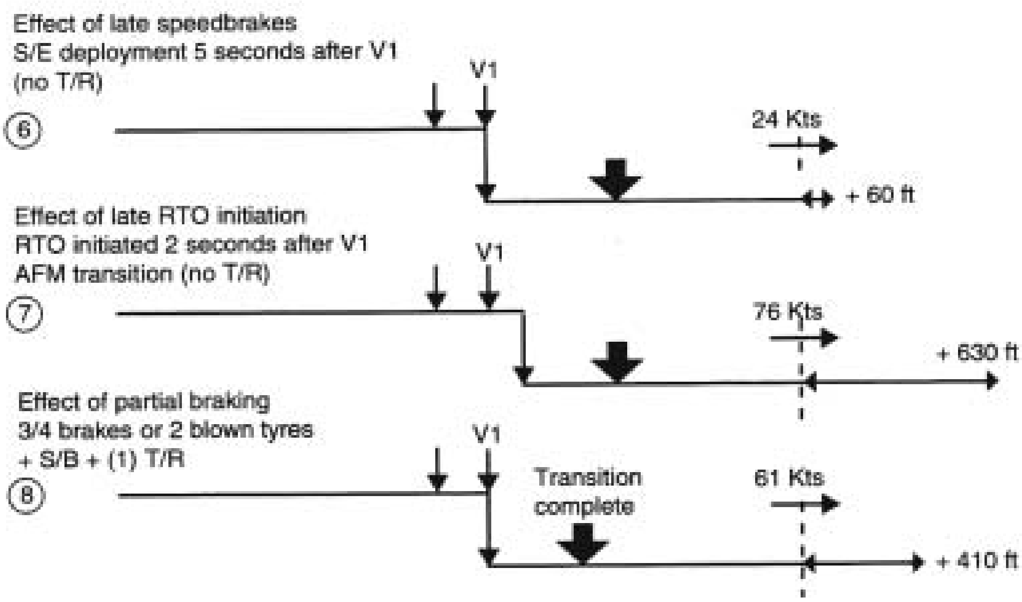


The Effect of Procedural Variations on Stopping Distance

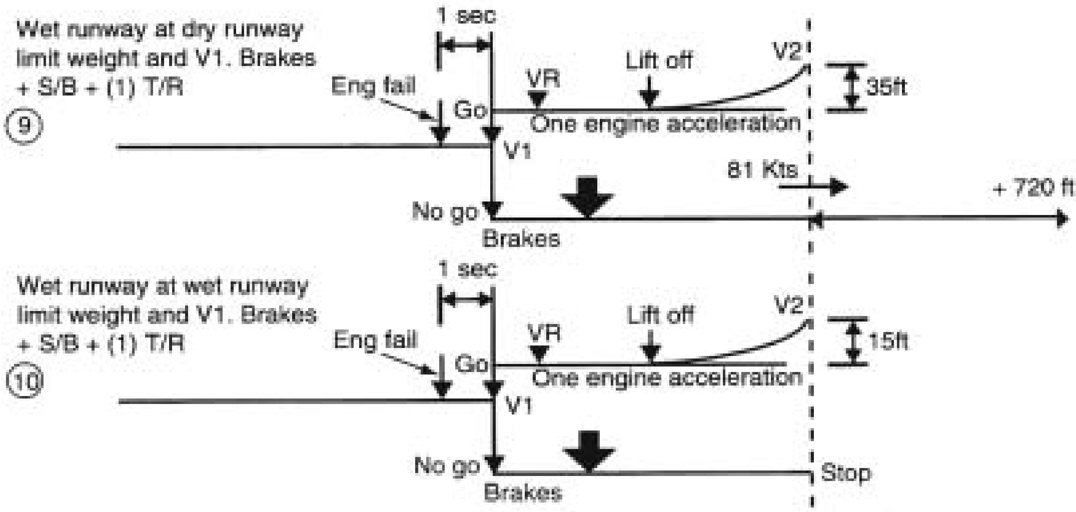
A300B4-203 (cont'd)

Available runway

Dry runway baseline



Wet runway

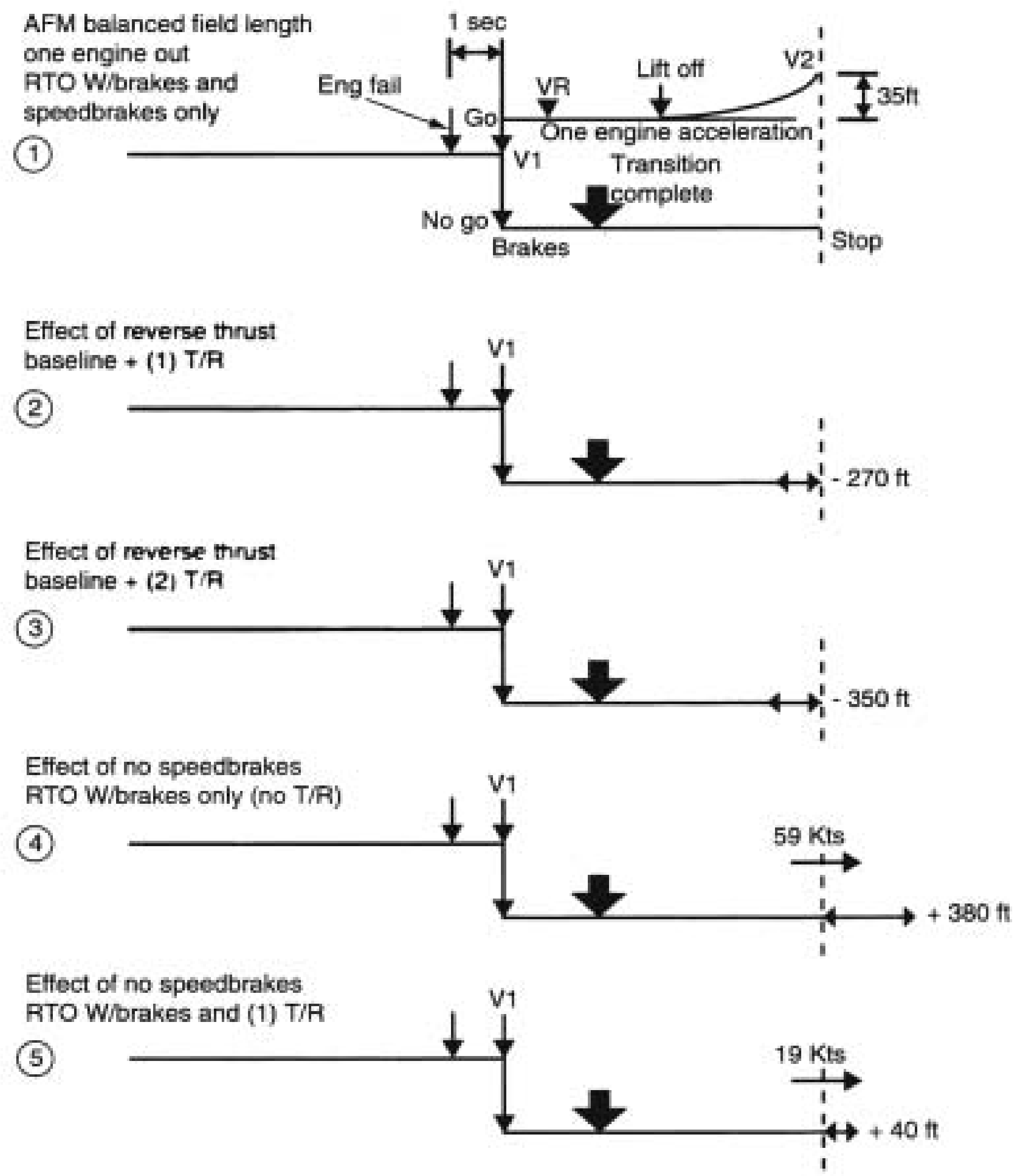


The Effect of Procedural Variations on Stopping Distance

A310-304

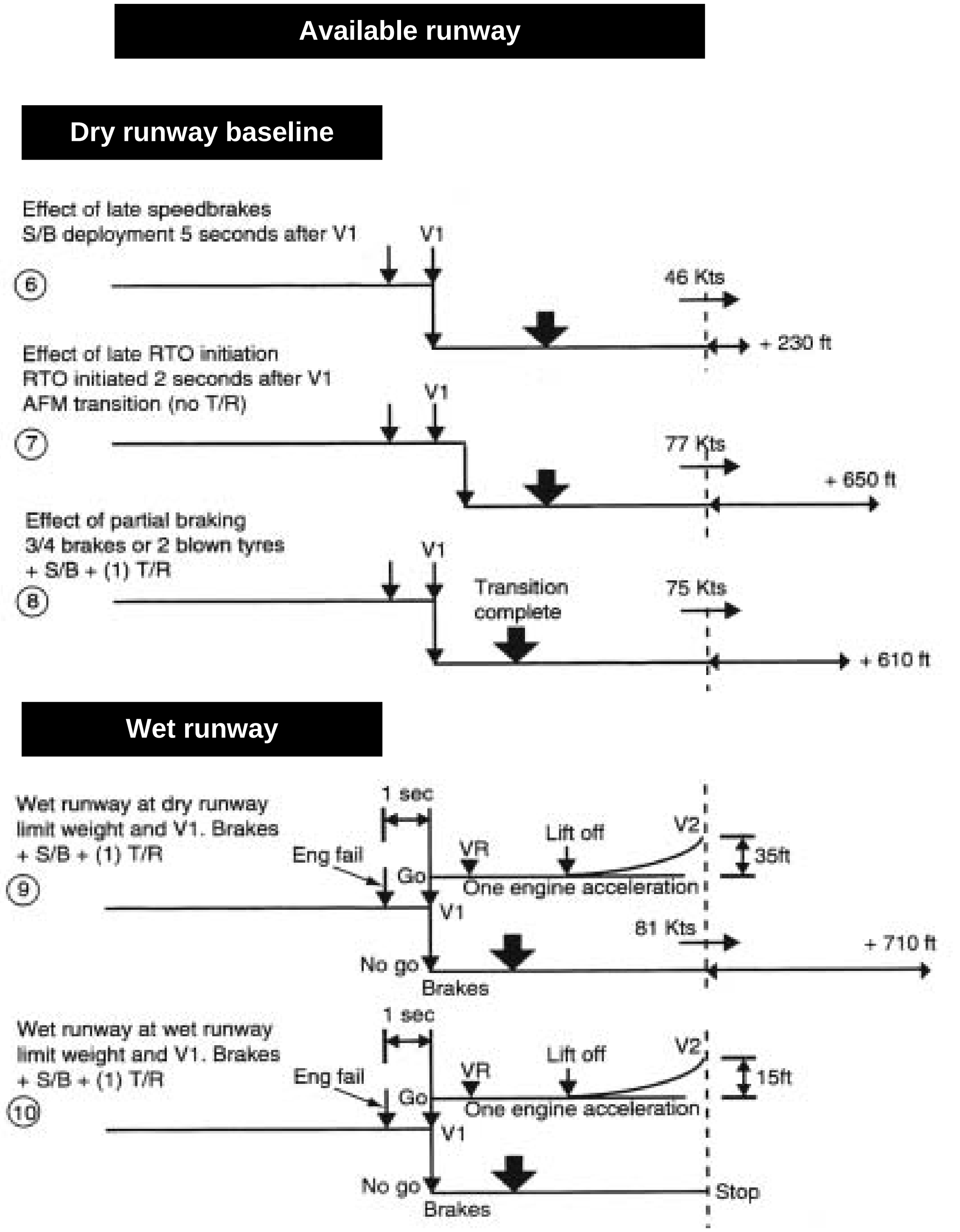
Available runway

Dry runway baseline



The Effect of Procedural Variations on Stopping Distance

A310-304 (cont'd)

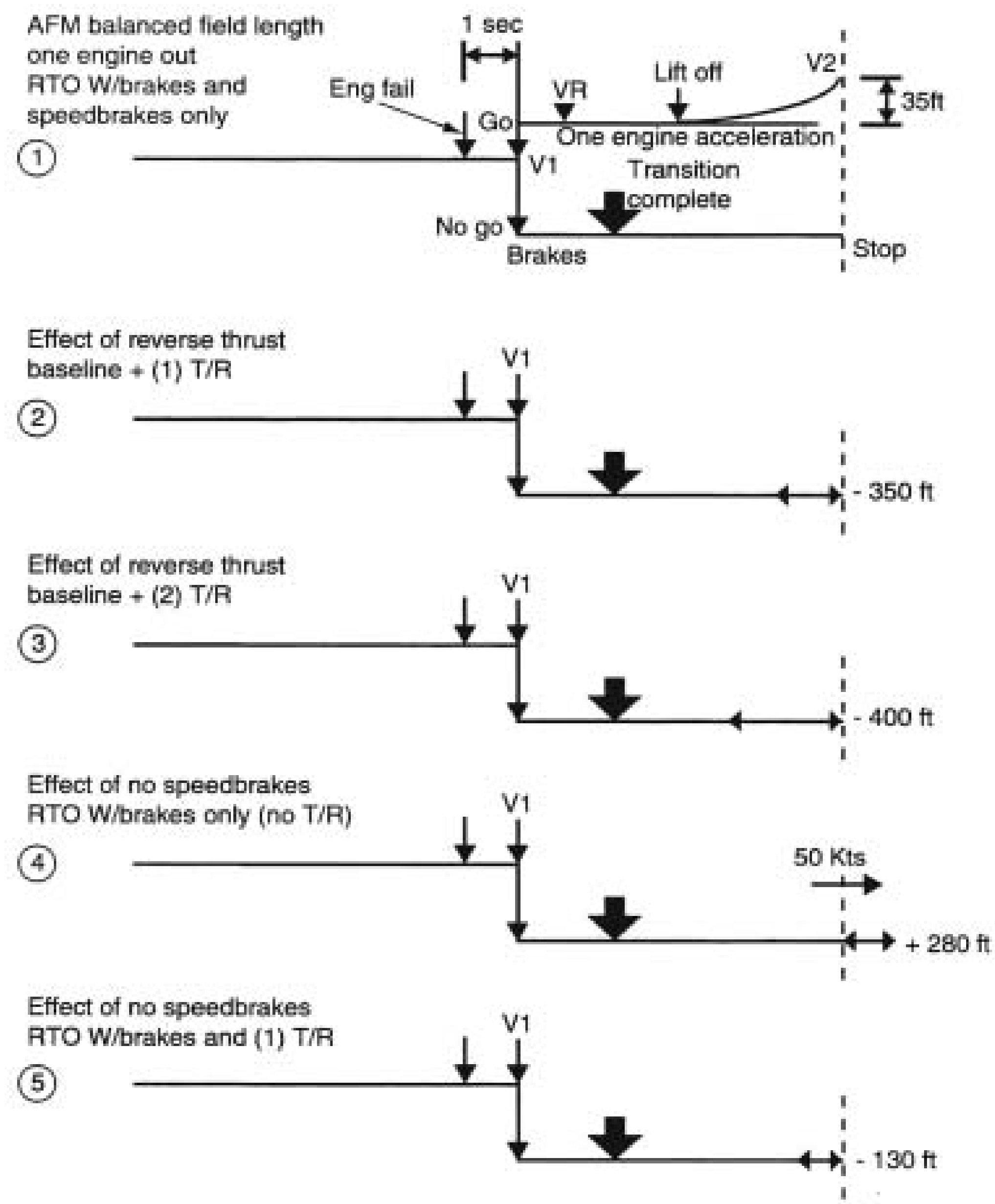


The Effect of Procedural Variations on Stopping Distance

A300-605

Available runway

Dry runway baseline

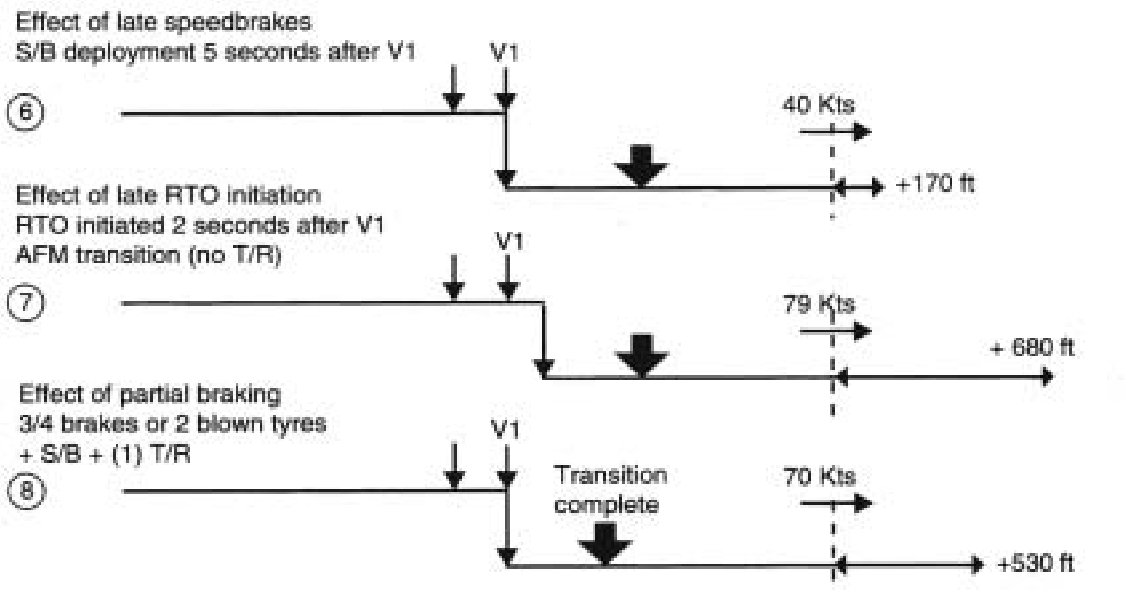


The Effect of Procedural Variations on Stopping Distance

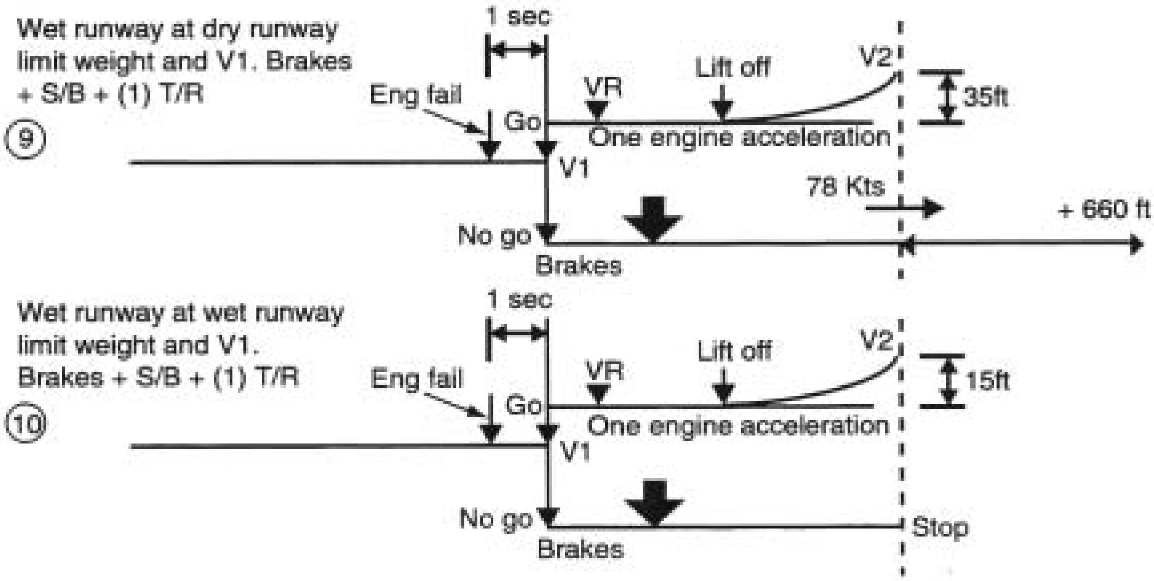
A300-605 (cont'd)

Available runway

Dry runway baseline



Wet runway

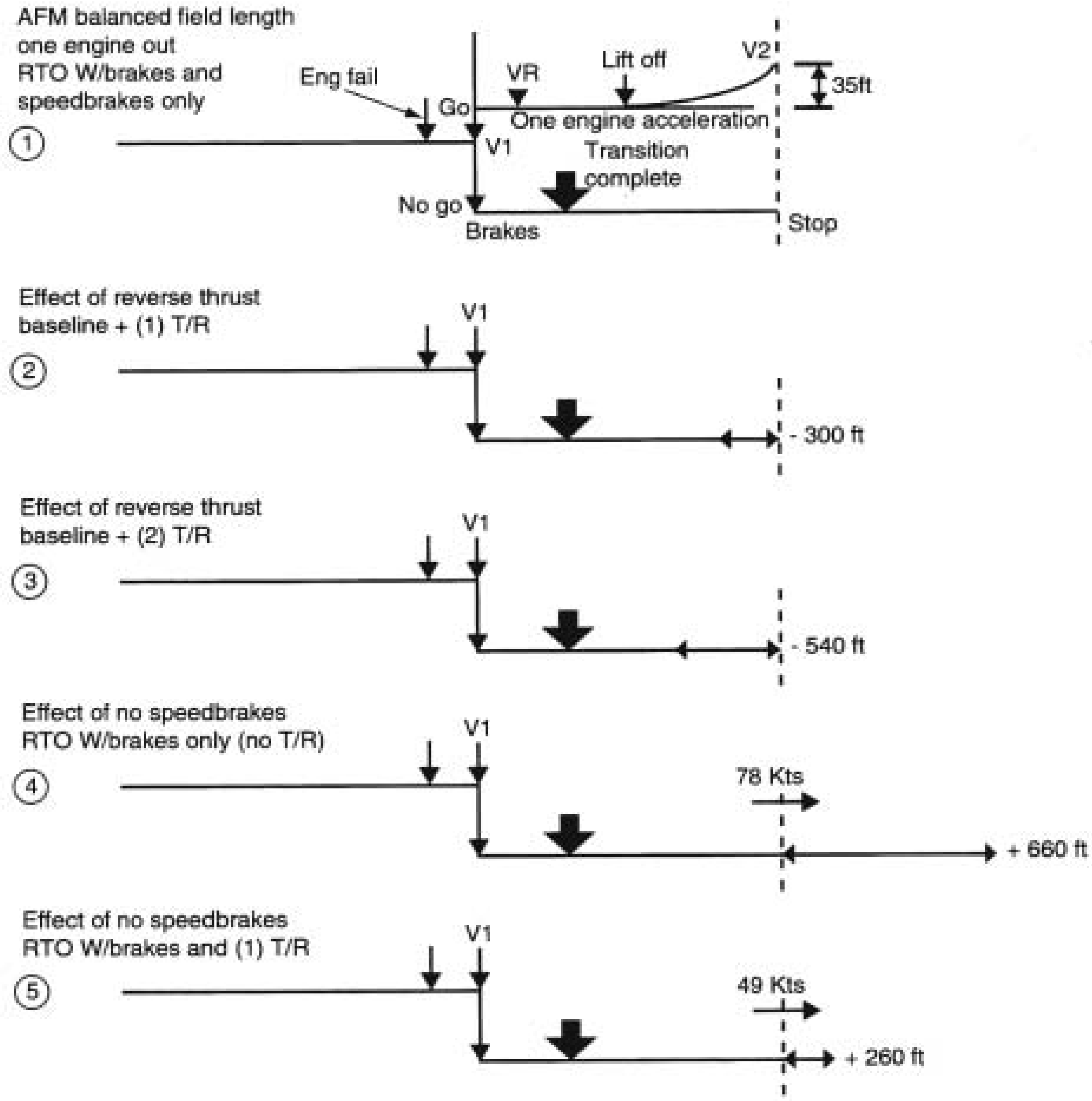


The Effect of Procedural Variations on Stopping Distance

A300-211

Available runway

Dry runway baseline

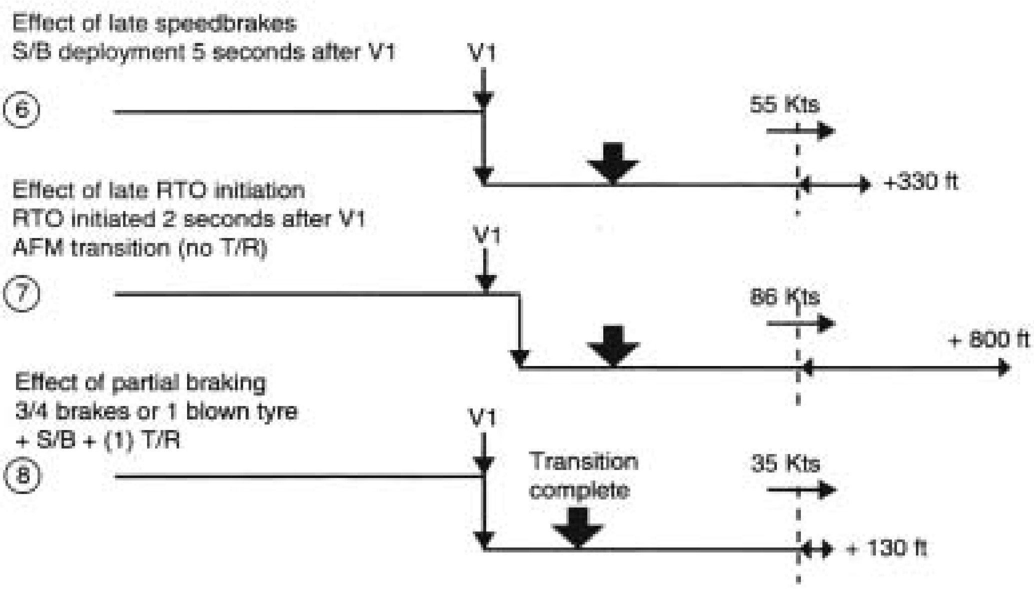


The Effect of Procedural Variations on Stopping Distance

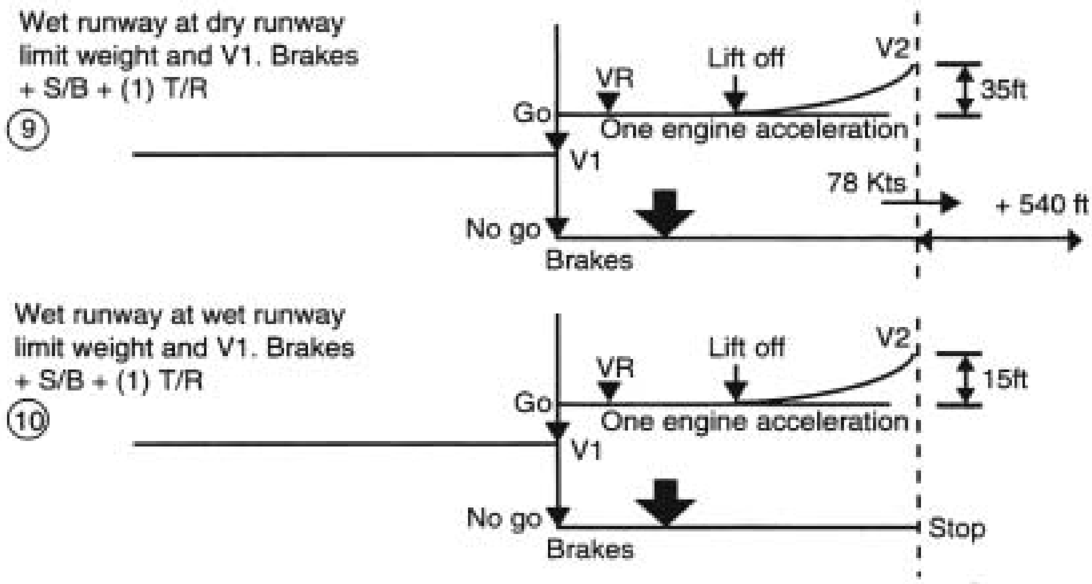
A320-211 (cont'd)

Available runway

Dry runway baseline

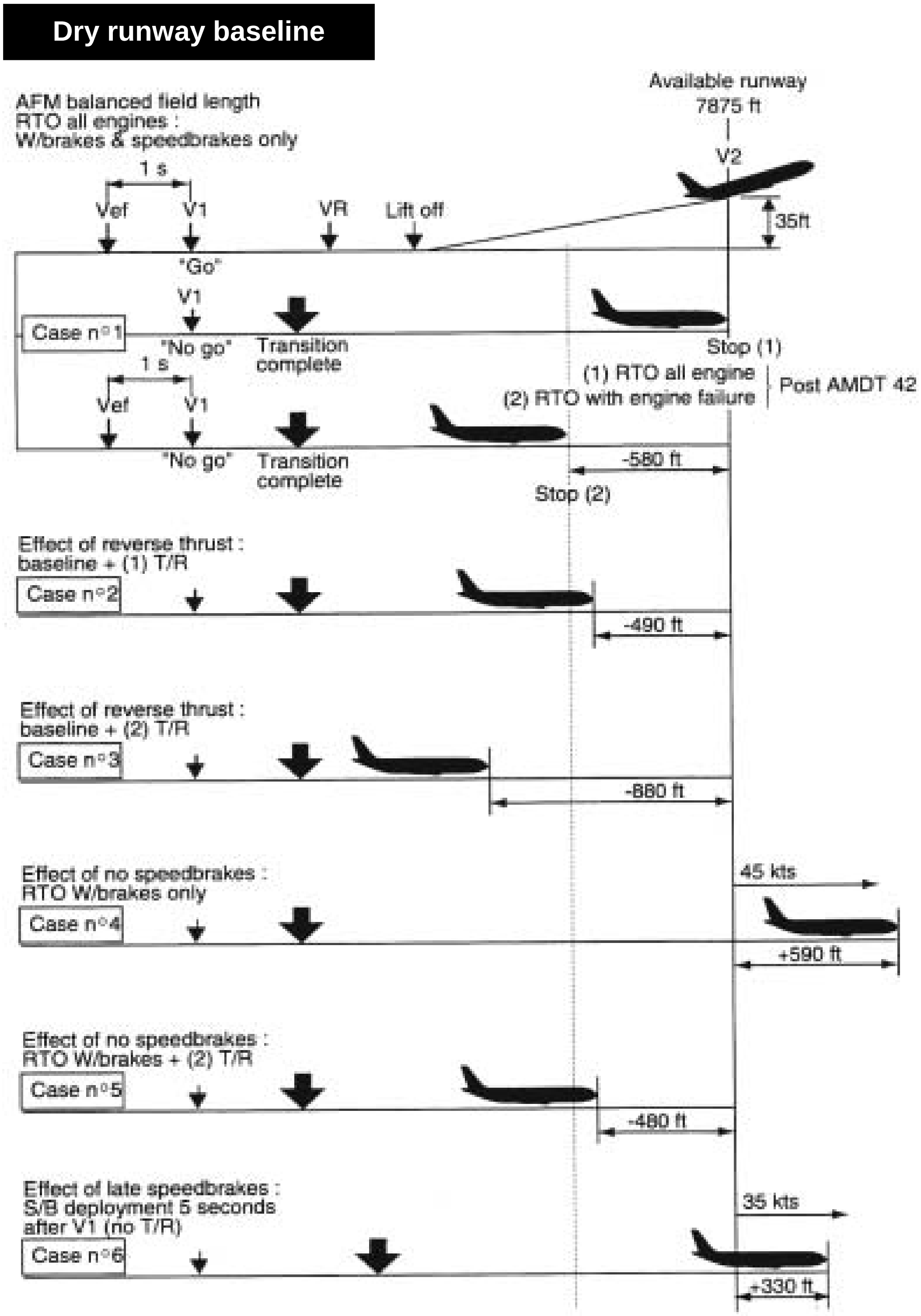


Wet runway



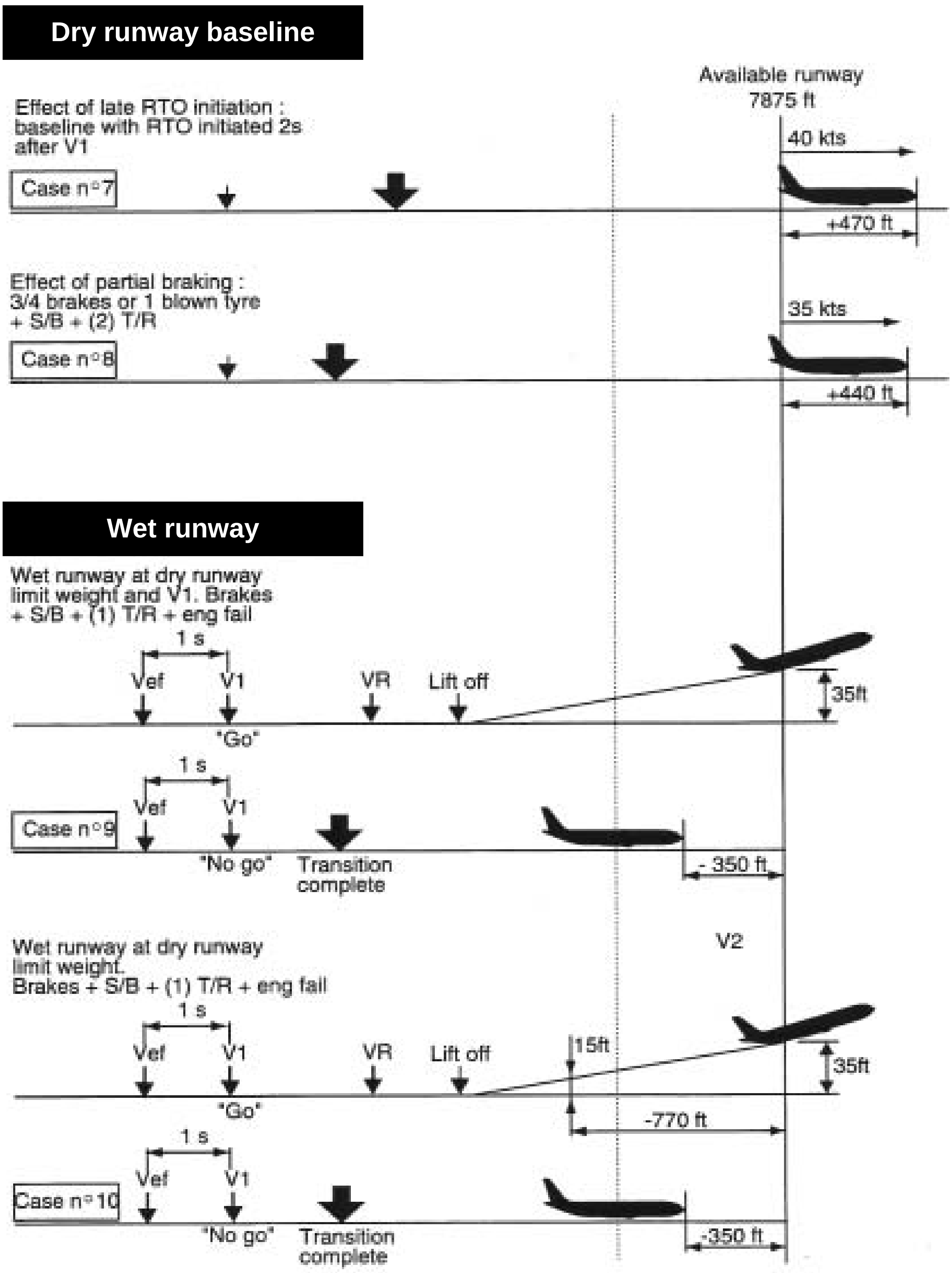
The Effect of Procedural Variations on Stopping Distance

Airbus model A321-112



The Effect of Procedural Variations on Stopping Distance

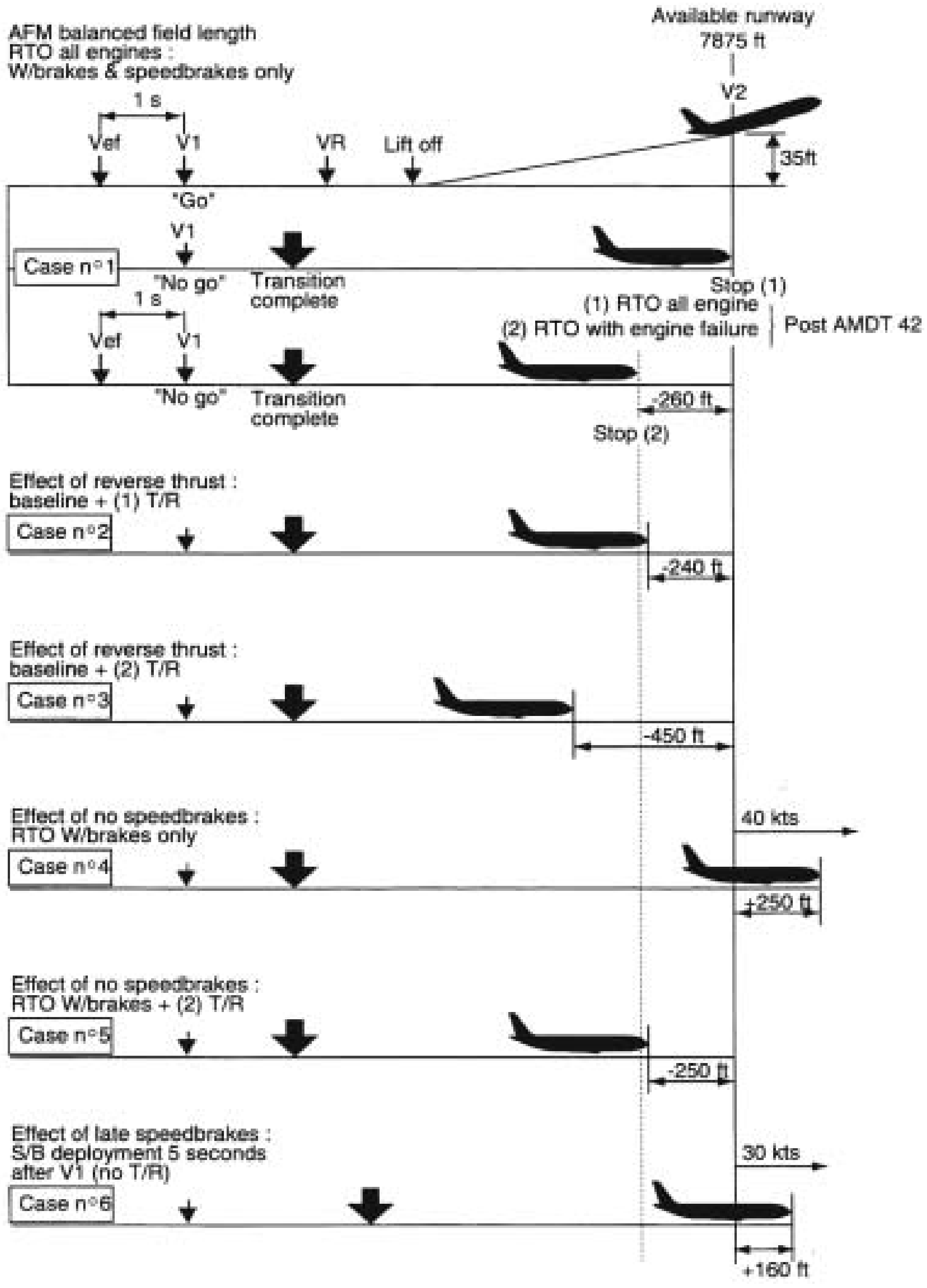
Airbus model A321-112 (cont'd)



The Effect of Procedural Variations on Stopping Distance

Airbus model A330-301

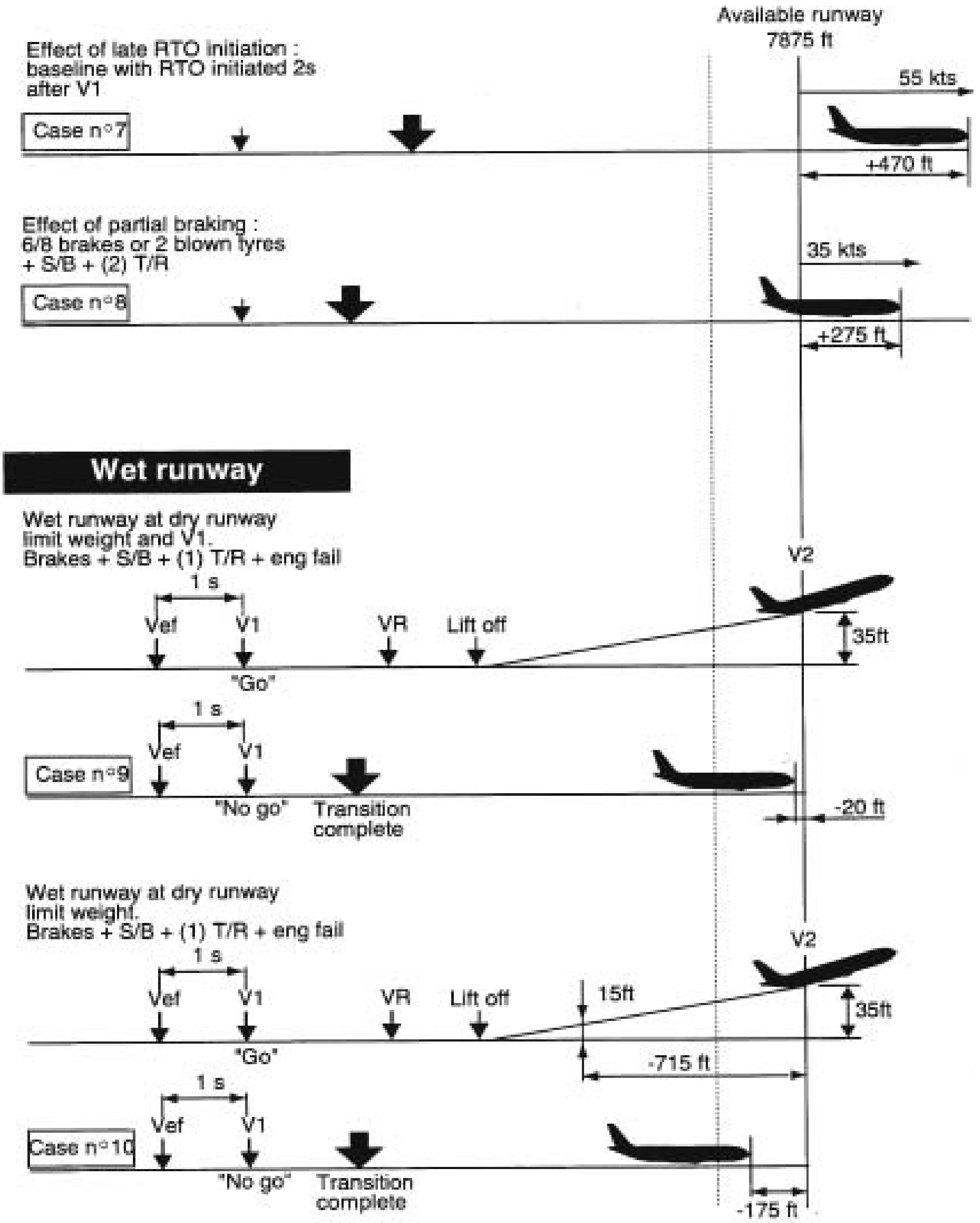
Dry runway baseline



The Effect of Procedural Variations on Stopping Distance

Airbus model A330-301 (cont'd)

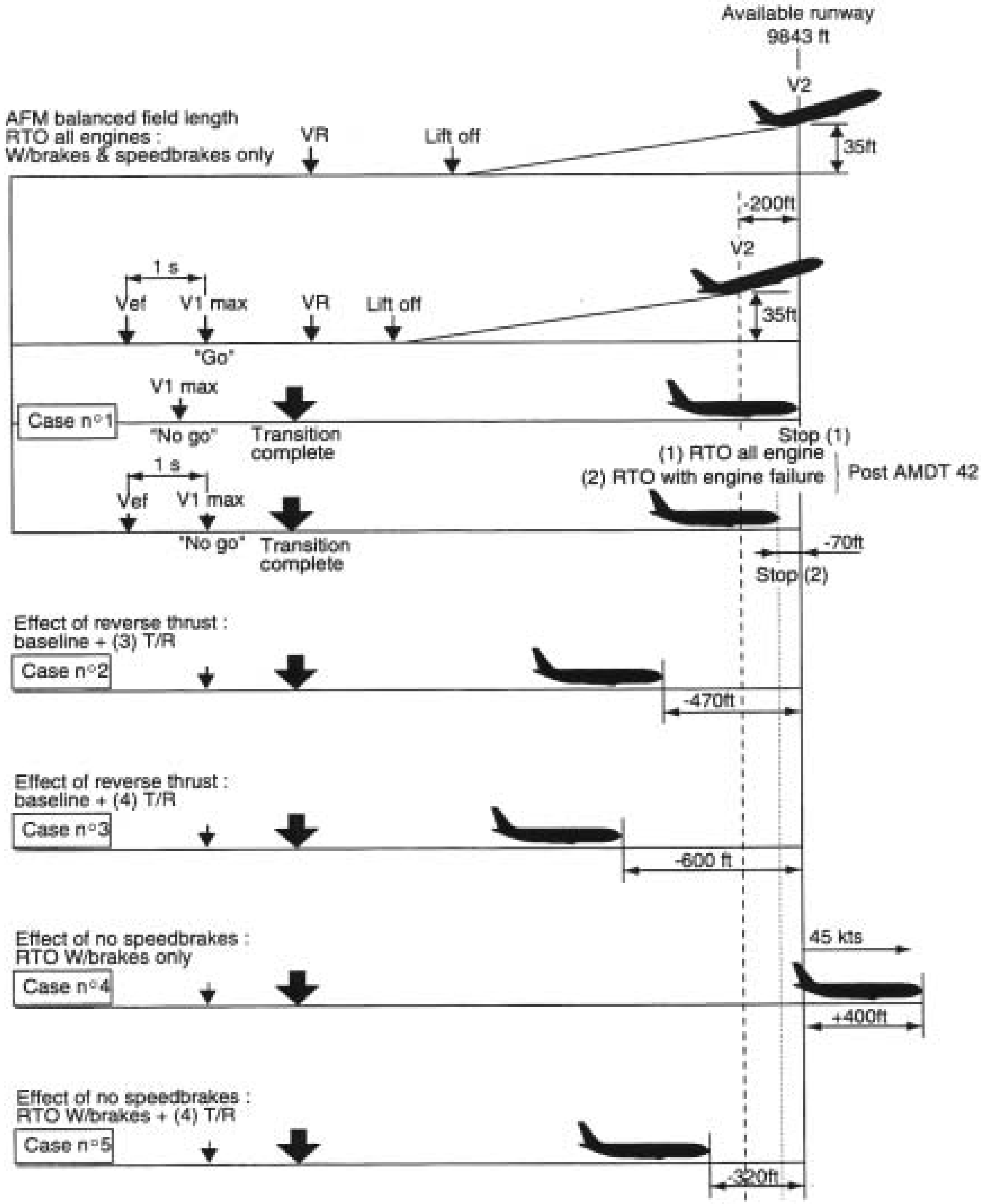
Dry runway baseline



The Effect of Procedural Variations on Stopping Distance

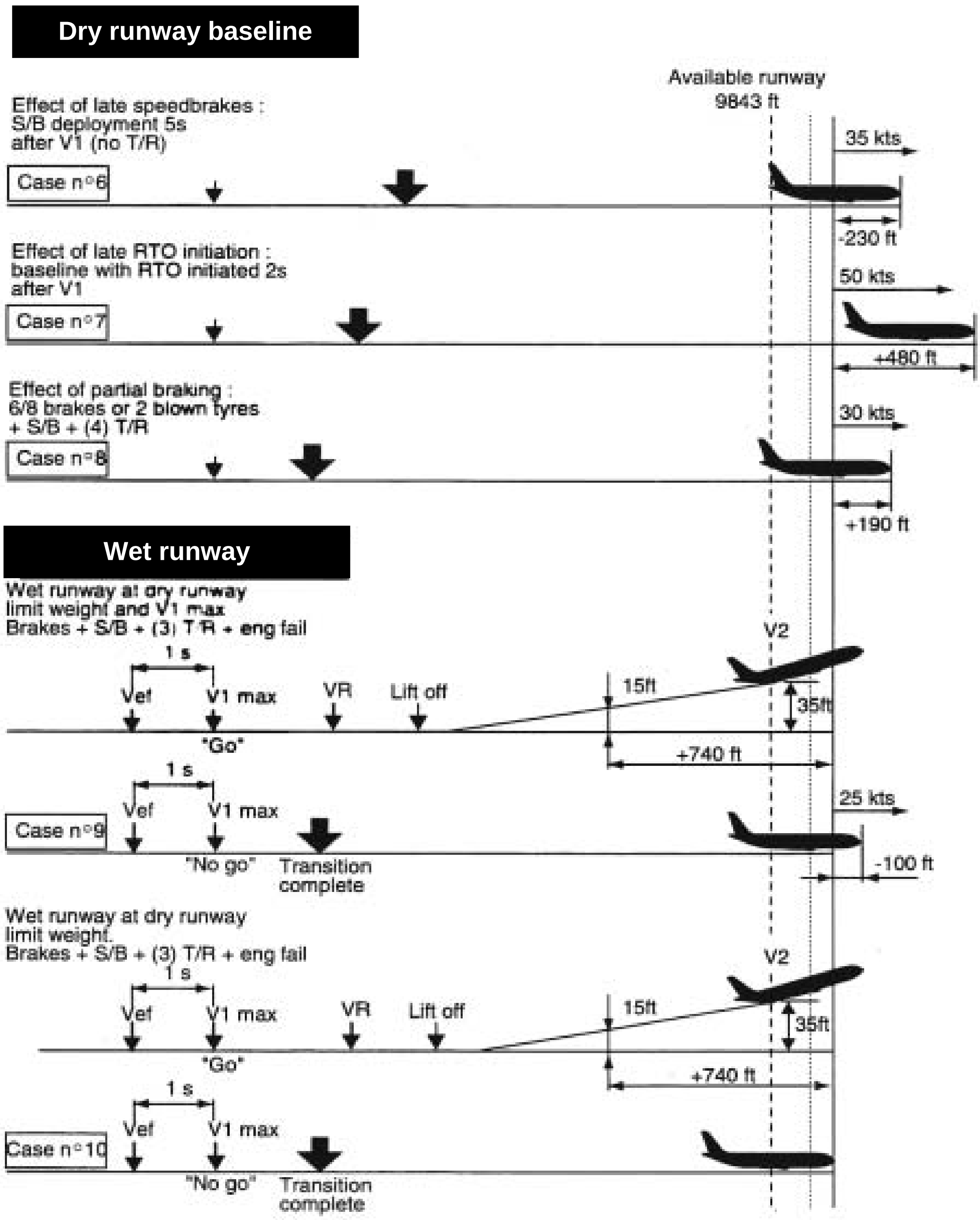
Airbus model A340-311

Dry runway baseline



The Effect of Procedural Variations on Stopping Distance

Airbus model A340-311 (cont'd)



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