



Runway Situation Awareness Tools (RSAT)

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Runway overrun excursions...

Runway excursions are the *first* leading cause of aviation accidents and the *third* leading cause of transport airplane fatalities

Boeing Safety

- A top issue

U.S. NTSB

- Runway safety - top 10 since 1991

Flight Safety Foundation

- A top issue

IATA

- Recognized accident issue

ICAO GRSS in May 2011

- A top issue

Boeing Overrun characteristics...

Stability

Unstable approach
(too high, too fast)

Tailwind

Touch-down

Long landing

High touchdown speed

Deceleration

AB too low

Friction limited or runway contamination

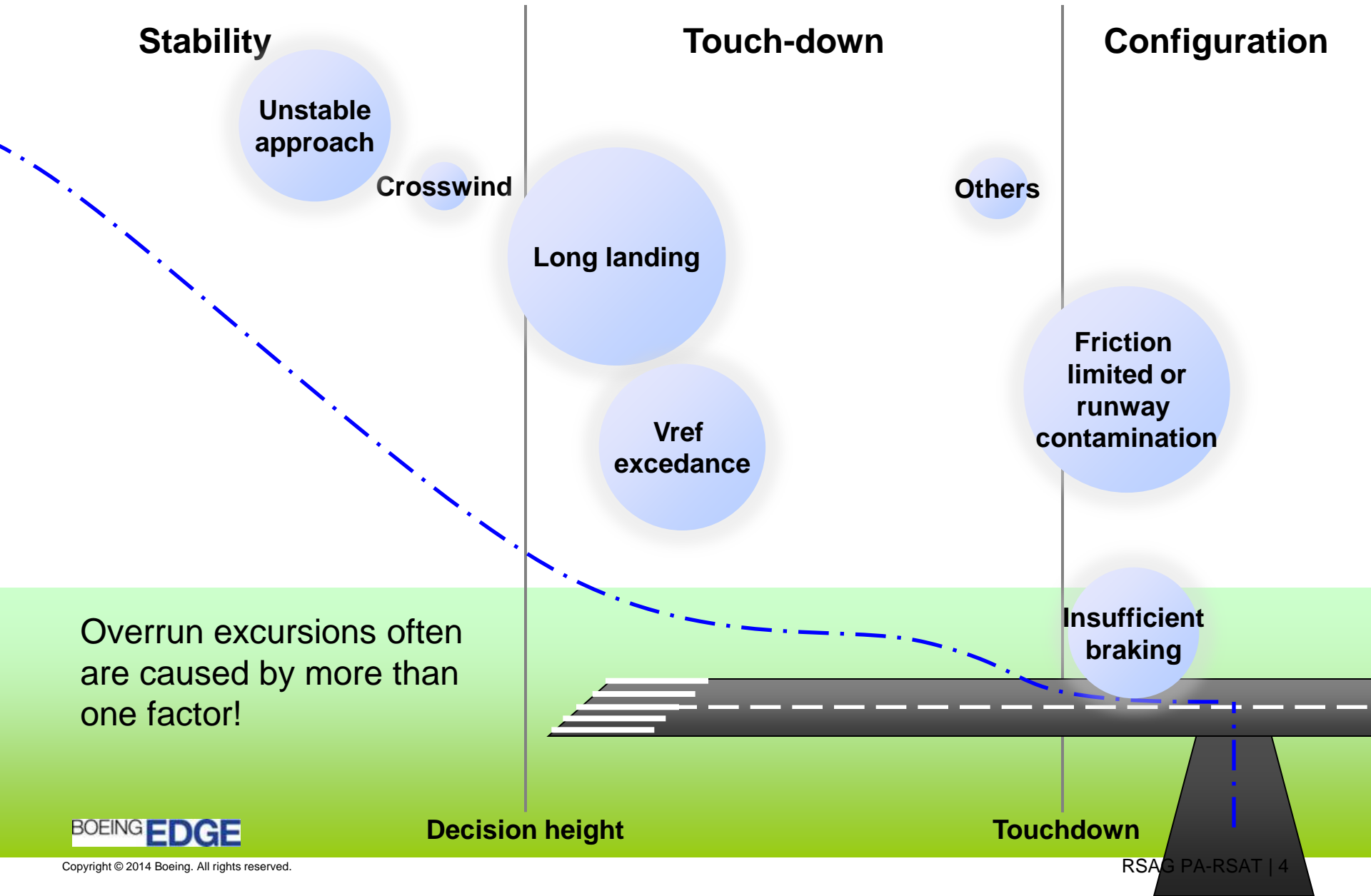
Speedbrakes late or not deployed

Reversers late or not deployed

Reverser level too low or reduced too soon

Runway excursions often are caused by more than one factor

Embraer Overrun Characteristics...

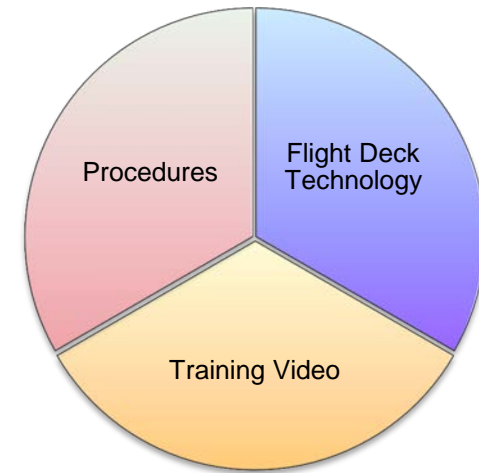


39 Overruns

	Approach	Touchdown Point		Touchdown Speed		Deceleration				Result	
		Point	Runway Used	Airspd >Vref	Tail Wind	Spdbrake	Thrust Reversers		Runway	Overrun Speed	Hull Loss
		(feet)	(% LDA)	(knots)	(knots)	When SB Deployed	When TR Deployed	When TR Reduced	Braking Action	(knots)	
Long	Unstable	7000	72%	22	0	TD	TD + 3	departure	Good	81	yes
	Unstable	6200	70%	12	5	TD	never		Dry	50	no
	Unstable	5630	57%	11	14	TD	TD + 3		Med	100	yes
	Unstable	5300	60%	16	3	TD	TD + 4	departure	Good	35	no
	Unstable	5150	48%	20	0	TD + 5	TD + 7	900	Med	70	no
	Unstable	4700	52%	30	-1	TD	TD + 2	1000	---	100	yes
	Unstable	4500	60%	-3	1	TD	TD + 2	departure	Good	47	yes
	Unstable	4500	56%	6	3	TD	TD + 3	400	Dry	90	yes
	Unstable	4380	55%	46	4	TD	TD + 2	departure	Good	65	no
	Unstable	4000	30%	0	10	TD	TD + 2	departure	Med	40	no
	Stable	3950	44%	0	14	TD	TD + 3	departure	Med	63	yes
	Unstable	3935	49%	7	10	TD	TD + 3	departure	Med	4	no
	Unstable	3840	48%	20	-8	TD	TD + 3	departure	Med	34	no
	Stable	3700	32%	0	10	TD	TD + 2	departure	---	50	no
	Stable	3260	41%	20	-1	TD	TD + 3	2000	Med	40	no
	Stable	3200	48%	-7	4	with TR	TD + 2	departure	Good	30	no
	Stable	3120	42%	10	10	TD	TD + 2	departure	Good	50	no
	Stable	3000	37%	-5	6	TD	TD + 2	departure	Med	30	no
	Stable	3000	34%	3	5	TD	TD + 3	departure	Med	5	no
	Stable	2770	35%	0	12	TD	TD + 2	1000	Good	15	no
Fast		20									
	Stable	1500	20%	20	10	TD	TD + 3	600	Med	5	no
	Stable	1450	20%	11	15	TD	TD + 3	1250	Med	20	no
	Stable	1600	20%	12	10	TD	TD + 27	departure	Good	25	no
	Stable	1500	23%	5	10	TD	TD + 2	1550	Med	30	no
	Stable	1450	20%	6	9	TD	TD + 3	departure	Med	0	no
	Stable	1250	18%	4	11	TD	TD + 2	departure	Poor	45	no
Deceleration				6							
	Stable	2700	30%	0	0	never	never		Med	45	no
	Stable	400	6%	2	-6	never	TD + 22	departure	Med	48	no
	Stable	500	8%	3	4	with TR	TD + 20	departure	Med	32	no
	Stable	1250	21%	0	9	TD	TD + 16	departure	Poor	42	no
	Unstable	1720	27%	6	5	TD + 9	TD + 13	departure	Good	20	no
	Unstable	1800	23%	10	2	with TR	TD + 11	departure	Poor	28	no
	Stable	1900	26%	6	-2	TD	TD + 8	departure	Med	20	no
	Stable	1150	24%	5	-5	TD	TD + 6	100	Med	12	no
	Stable	2900	28%	0	-6	TD + 3	TD + 5	2800	Poor	10	no
	---	1480	20%	0	8	TD	TD + 3	1300	---	30	no
	Stable	2500	31%	0	2	TD	TD + 2	2250	Good	25	no
	Stable	2200	27%	5	7	TD	TD + 2	2000	Med	45	no
	Stable	1250	14%	2	4	TD	TD + 1	2400	Poor	15	no
									13		

Guiding Principles...

- ✓ Mitigate all contributing factors
 - Multiple solutions / technologies
- ✓ Fleet penetration
 - Software-only solutions
 - In- and out-of-production solutions
- ✓ Enhancement implementation
 - Near-term solutions
 - Features and functions incorporation



Boeing and Embraer: Overrun Mitigation...

Runway Situation Awareness Tools (RSAT)

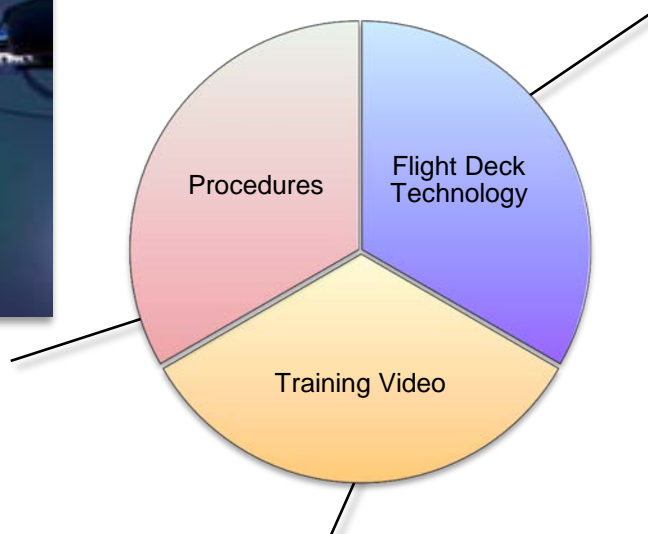
Technology

- Approach planning tools
- Runway positional awareness and
- Runway alerting
- Stability guidance and alerting
- Predicted runway stop location
- Overrun alerting



For every landing:

- Landing distance calculation
- Go-around point
- Utilize appropriate callouts



Training Aid video

- Stable approach
- Runway friction
- Runway available vs. required
- Reported conditions vary
- Approach speed additives
- Proper, timely use of deceleration devices



BOEING **EDGE**

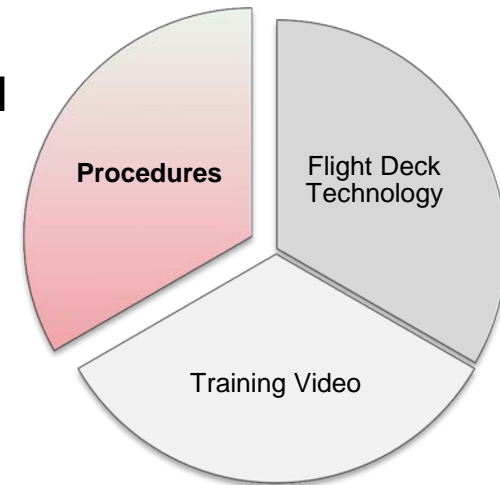
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Procedures...

- ✓ Perform a landing distance calculation and assessment
- ✓ Plan a go-around point or a latest touchdown point
- ✓ Ensure required procedural callouts are made

Note: A thrust reverser callout and a landing distance calculation were added to the FCTM and the FCOM



Inadequate Deceleration Delayed Thrust Reverser (TR) Usage...

Prompt TR command is critical

Ground Idle from Flight Idle

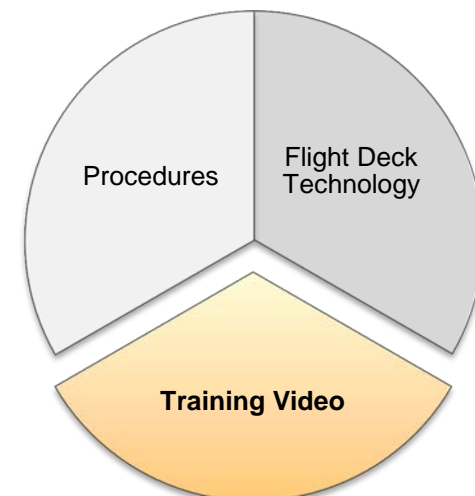
Example from data

When TR commanded	TR deploy & engine spool up	When Max. Reverse achieved
TD + 2	5 sec.	TD + 7
TD + 6	11 sec.	TD + 17

Training Video...

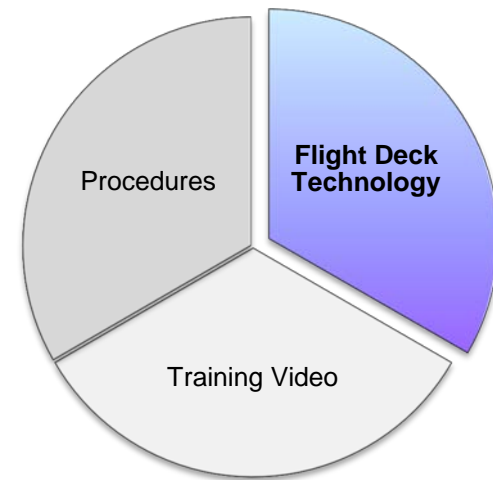
Understanding the relationship among these factors...

- ✓ Flying a stable approach
- ✓ Touchdown Point
- ✓ Landing distance calculation
- ✓ Reported conditions / contamination:
- ✓ Approach speed additives:
- ✓ Proper, timely use of **ALL** deceleration devices



Technology

www.boeing.com/rsat



Planning – Forward Displays...

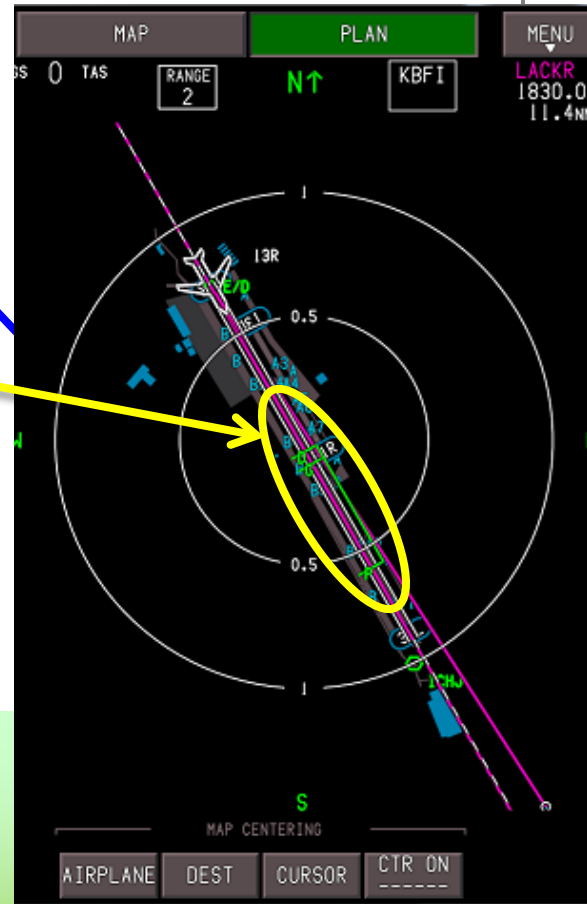
Approach planning



Displayed landing distance – dry or contaminated runways

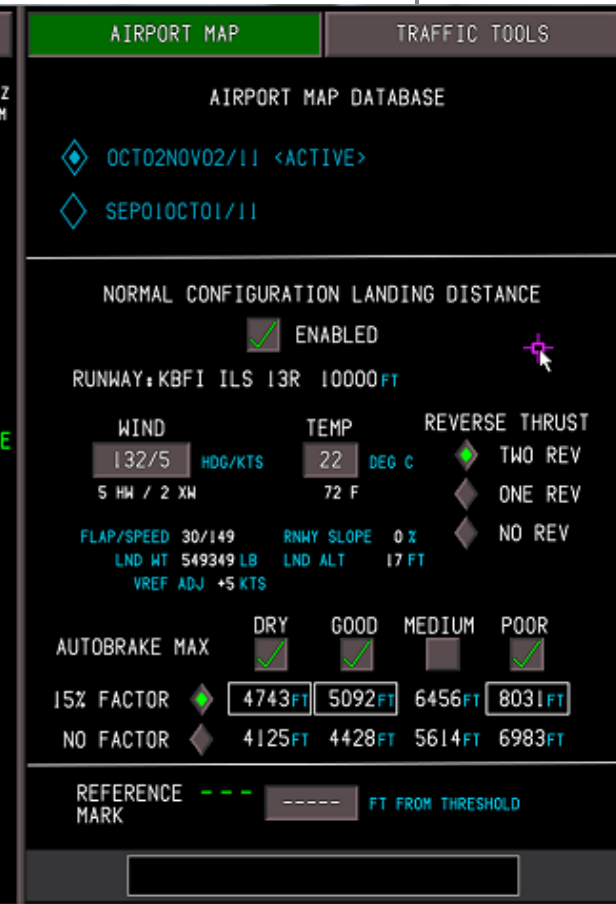
Assessment of runway available versus required

Approach



Touchdown

Deceleration



Planning – iQRH...

Approach planning



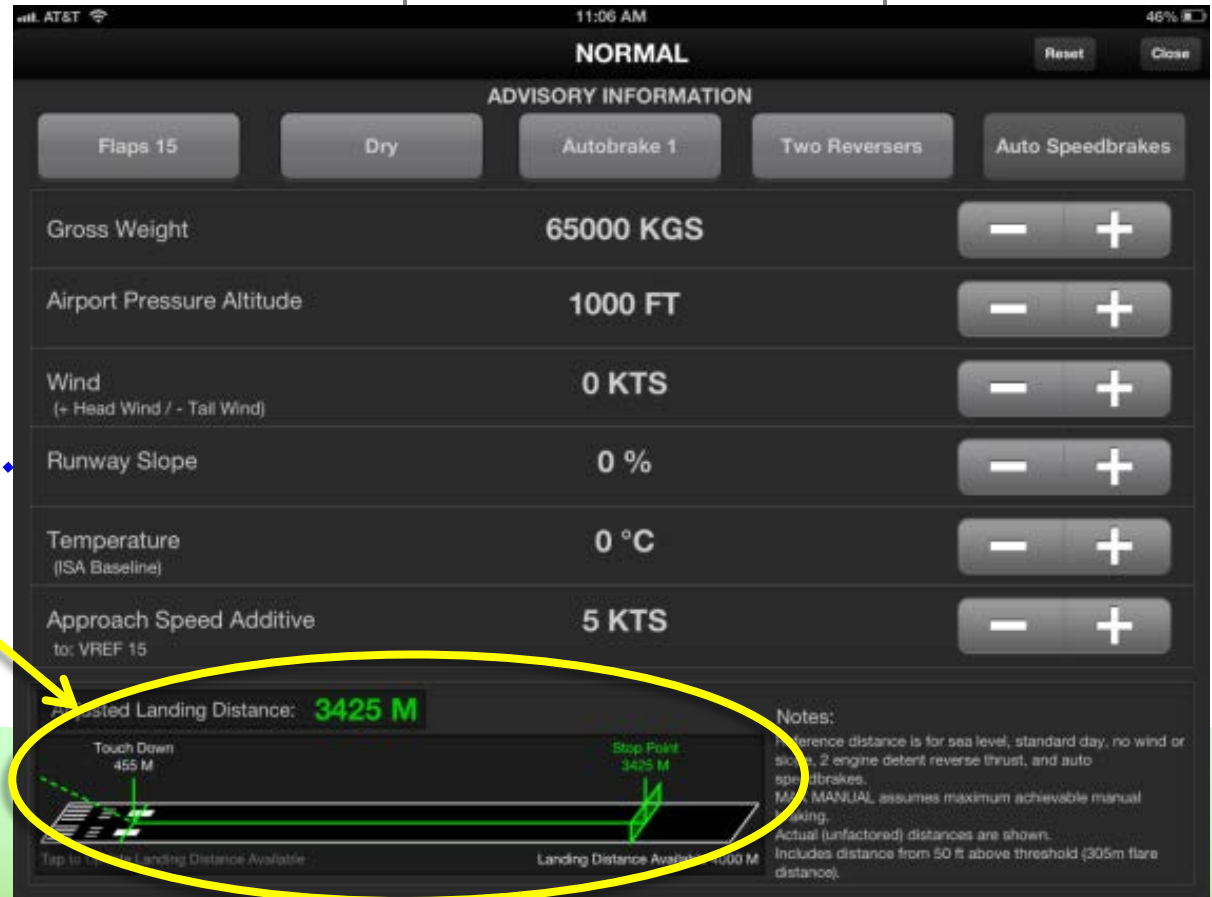
Displayed landing distance – dry or contaminated runways

Assessment of runway available versus required

Approach

Touchdown

Deceleration



Approach...

Approach planning

Approach

Touchdown

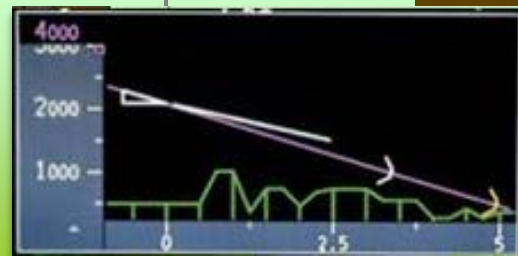
Deceleration



"APPROACHING 28L"

"SHORT RUNWAY"

"TOO HIGH"
"TOO FAST"



BOEING **EDGE**

Flare...

Approach planning



Approach



**"OVERRUN,
GO AROUND"**

Flare

- Landing and flare guidance
- Runway positional awareness
- Long landing alerting

"LONG LANDING"

Deceleration

Touchdown...

Approach planning

Approach



BOEING **EDGE**

Touchdown

Deceleration

- Landing and flare guidance
- Runway positional awareness
- Long landing alerting

"X THOUSAND REMAINING"

"LONG LANDING"



Touchdown...

Approach planning



Approach

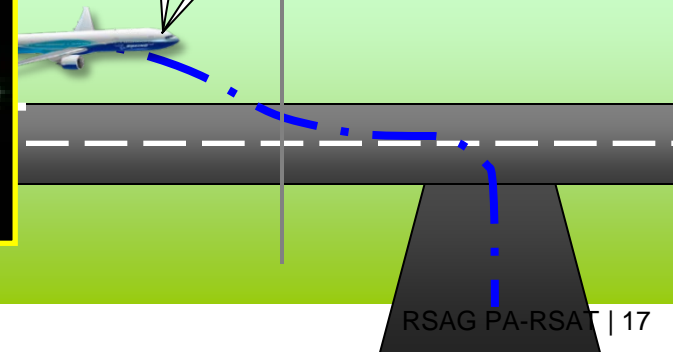


Touchdown

- Landing and flare guidance
- Runway positional awareness
- Long landing alerting

"X THOUSAND REMAINING"

"LONG LANDING"



BOEING **EDGE**

Landing and Rollout...

Approach planning



Approach



Flare

Deceleration

- Runway positional awareness
- Display of calculated stop location
- Overrun alerting
- Speedbrake alerting

"SPEEDBRAKE"

"X THOUSAND REMAINING"
"ONE HUNDRED REMAINING"

"MAX BRAKES, MAX REVERSE"

