Managing Threats and Errors during Approach and Landing

How to avoid a runway overrun

This presentation provides an overview of the prevention strategies and personal lines-of-defense related to runway overruns. It is intended to enhance the reader's awareness but it shall not supersede the applicable regulations or airline's operational documentation; should any deviation appear between this presentation and the airline's AFM / (M)MEL / FCOM / QRH / FCTM, the latter shall prevail at all times.

Landing Overruns

This presentation is primarily for self-study and reviews the threats and errors that could lead to a landing overrun. It provides guidance of how to manage threats and errors, thus how to avoid an overrun accident.

A threat is usually a physical aspect that may affect the safety of an operation; an error is normally a consequence of human involvement either in the presence of threats or without any hazard present at all.

A wet runway is a threat to a landing operation – more landing distance required.

The failure of the crew to understand the need for more landing distance or to adjust the level of braking would be an error related to the threat.

Experience is what you learn just after you needed it.

Speakers notes provide additional information, they can be selected by clicking the right mouse button, select Screen, select Speakers notes.

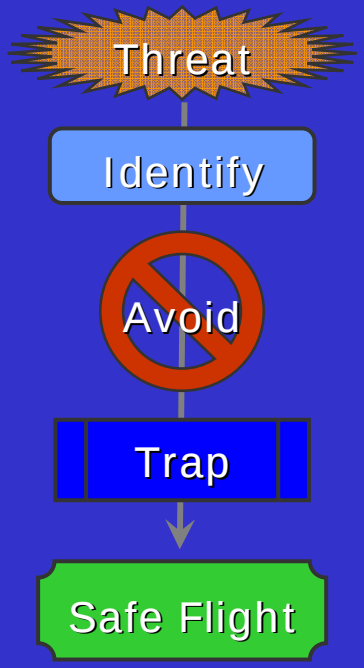
This presentation can be printed in the notes format to provide a personal reference document.

Managing Threats and Errors during Approach and Landing

Section 1 - Threats

A threat or hazard is any situation, event, or circumstance that may affect the safety of flight:

- The effects of threats occur in the future – so plan ahead
- Threats are not errors, but they increase the potential for error



The process of managing threats involves:

- Identifying and classifying a threat
- Avoiding the threat or threat situations
- Trapping the threat and resolving or mitigating any effects or consequences

Landing Threats

Analysis of worldwide landing incidents showed that a landing overrun is more likely if:-

- The approach was fast and landing attempted in excess of Vref +15kts
- The approach was high, exceeding the recommended threshold crossing height
- The aircraft ‘floated’ or is held off the runway for a smooth touchdown
- The touchdown point is ‘long’, often beyond the normal landing area
- The runway surface is wet or contaminated
- There is a tailwind

These threats may result in an accident; they can be managed:

Detected

Avoided

Trapped

Landing overrun

A landing overrun occurs when the aircraft landing distance exceeds the distance available. The distance required to land and stop an aircraft is effected by many factors in each of four phases; any single factor or combination can create a threat that may result in an overrun.

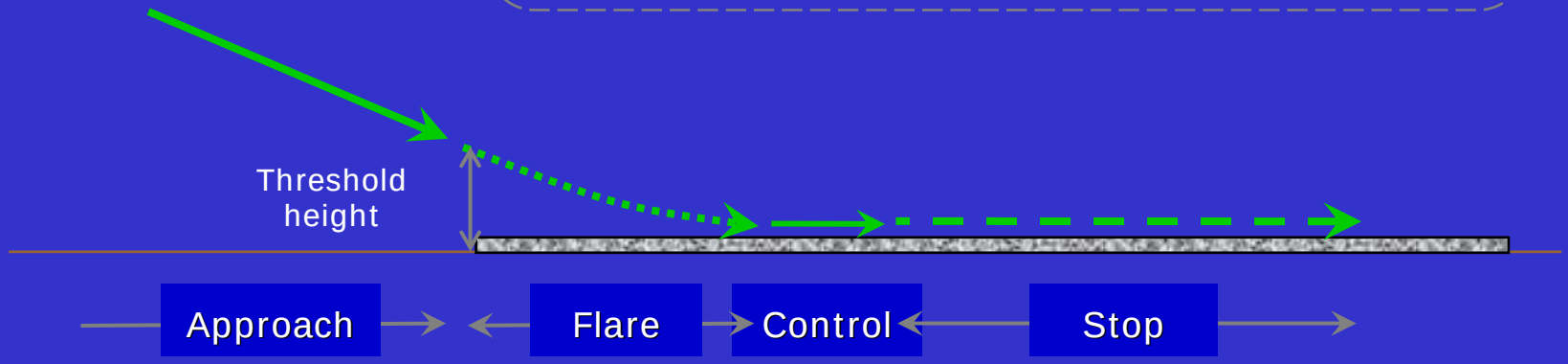
1. Approach
2. Flare
3. Control
4. Stopping

The manufacturers landing distance is based on crossing the threshold at 50 ft, at the landing reference speed, Vref.

The runway is dry, with known friction coefficient.

Maximum braking is applied after touchdown.

Certificated landing distances have additional safety factors to account for operational variability and runway conditions.



First – Plan Ahead

Carefully review the expected landing performance during the approach briefing. The pre-planned data uses forecasts and predictions made at the time of dispatch. Recheck these and consider:-

- Choice of runway – available length, surface condition, dry / wet / contaminated * Similar runway surfaces may not have the same level of friction
- Wind - a downwind landing can significantly increase landing distance. Factors of 150% are applied to the landing distance
- Maximum landing weight allowed - note the considerable differences in allowable landing weight between into-wind and downwind landings
- Check how close (%) the actual landing weight is to the allowed landing weight; adjust the planned braking level accordingly
- Consider any effects of non normal operations (MEL)
- Carefully recheck the pre-planned performance when landing at alternate or diversion airports

* Attempts to land on contaminated runways involve considerable risk and should be avoided whenever possible.

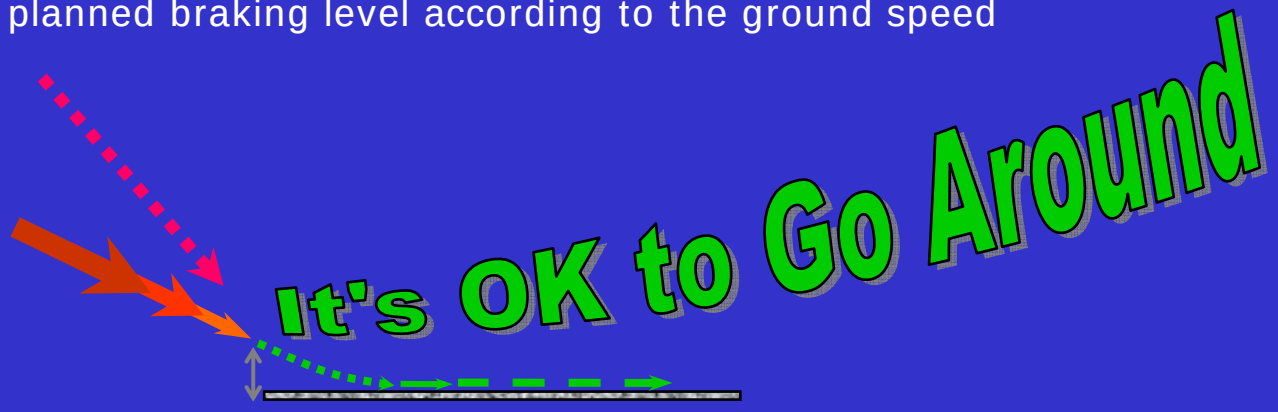
Approach threats

The most significant threats during the approach are:

- Fast approach airspeeds - in excess of the planned value
- High groundspeeds – not appreciating wind effects
- High and / or steep approach above the desired flight path

High energy is the combination of these conditions; early control of energy can reduce these threats:

- Plan and brief the approach; use ‘approach gates’ that define the distance or height where the correct airspeed and height (energy) must be achieved
- Consider the effect of any speed correction for:- Gusting wind, Windshear, and Icing conditions, recheck the landing distance required, adjust the planned braking level according to the ground speed



Approach management

A stabilised approach provides a basis for a good landing, it provides the crew with the optimum conditions to flare, land, and stop the aircraft

An approach must be stabilised by 1,000 ft in IMC and by 500 ft in VMC

1. The aircraft must be on the correct flight path
2. Only small changes in heading and pitch are required to maintain the correct flight path
3. The aircraft speed is < Vref+20 kts, < Vref + 15 kts at the threshold
4. The aircraft is in the landing configuration
5. Sink rate < 1,000 feet per minute
6. Power setting appropriate for configuration
7. All briefings and checklists have been performed
8. Instrument landing system (ILS) approaches - must be flown within the equivalent of one dot of the glideslope or localizer
9. Visual approaches - wings must be level on final before 500 ft
10. Circling approaches - wings must be level on final before 300 ft

Landing Flare

A fast approach and / or excess height at the threshold are significant threats to a safe landing:

- The speed element of energy is the most important threat

$$\text{Energy} \sim \text{Mass} \times \text{Speed}^2$$ (Energy is proportional to Mass x Speed x Speed)

- An extended flare leads to a long ‘deep’ touchdown, lengthening the landing and roll out distances
- De crabbing the aircraft in a crosswind uses up landing distance

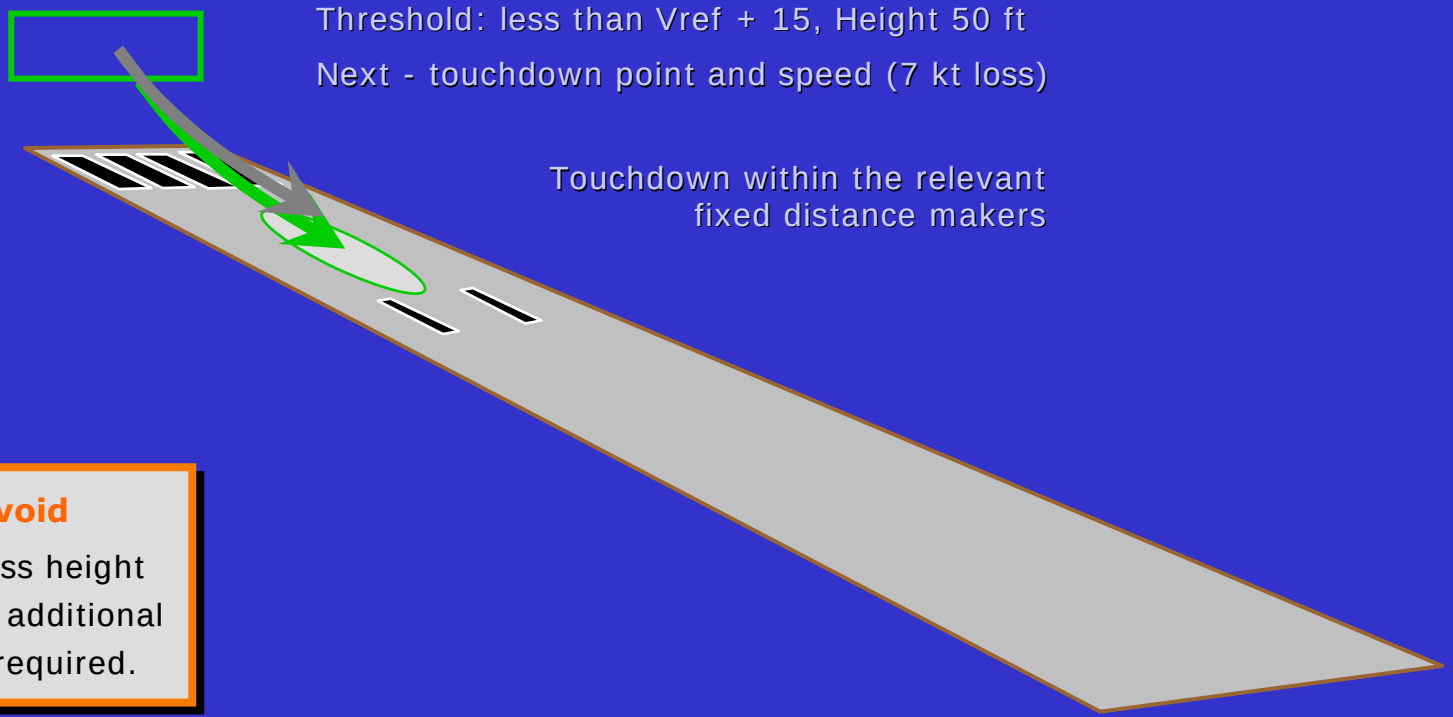
Accurate speed and flight path control provides the optimum conditions for a flare. Aim to touchdown within the relevant fixed distance markers.

Aircraft decelerate quicker on the ground than in the air.

It's OK to Go Around

Flare management

- Correct airspeed gives consistent aircraft feel for all landings
- Aim for the ideal touchdown point on every landing
- Aim for a ‘safe’ landing; not always a ‘soft’ landing
- Downhill slopes may give a long touchdown



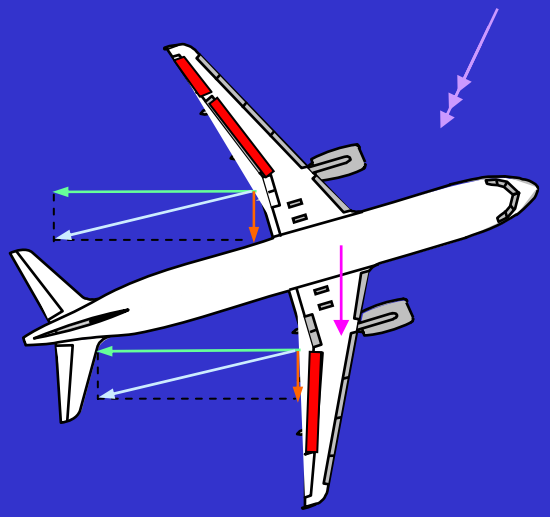
Amber threats - avoid

For every 10 ft excess height at the threshold, an additional 200 ft of runway is required.

Control on the runway

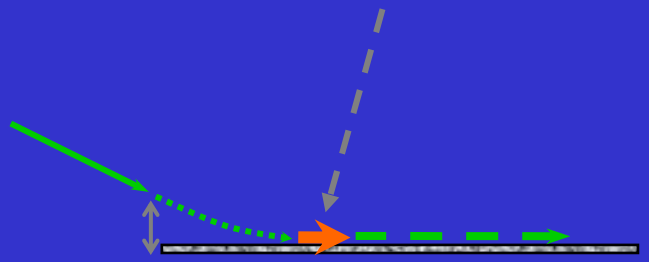
As soon as the aircraft is safely on the runway, commence the deceleration; brakes, spoiler, thrust reverse. Effective landing distance available may reduced due to:-

- Delayed nose-wheel lowering
- Late application of brakes or reverse
- Failed or late application of lift dump / spoilers



The 'control' phase of a landing is often overlooked, but when the aircraft is at its highest ground speed, any delay in deceleration uses significant landing distance

Respect wet runway crosswind limits



100 kts uses 169 ft of runway every second

Manage deceleration threats

Do not delay lowering the nosewheel. Braking depends on ground reaction, this requires all wheels on the runway.

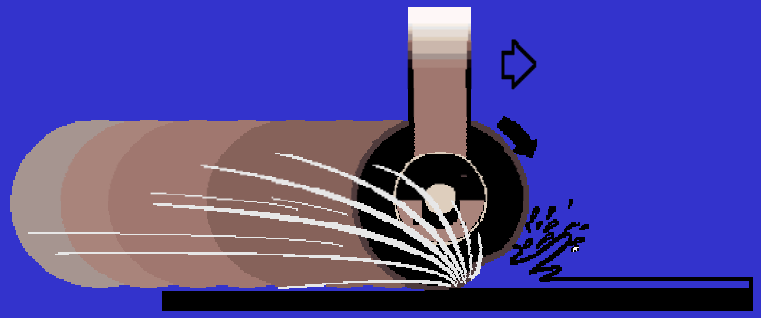
- Automatic spoiler / brake may depend on ‘weight’ switches
- Make a firm touchdown especially on a wet or contaminated runway
- Be prepared for aquaplaning with ground speeds above

$$9 \times \sqrt{\text{tyre pressure}}$$

- Anticipate increased rudder input to control any crosswind effects
- Check spoiler / thrust reverse deployment

Amber threats - avoid

For every 1 kt excess speed above Vref, an additional 2% of runway is required.

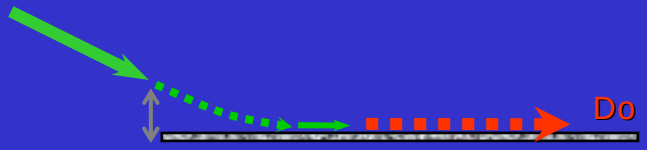


Stopping the aircraft

The main threats to stopping the aircraft is the lack of braking effectiveness; this depends on:-

- Level of braking
  - » Plan and use of the required level of braking for the conditions
  - » Commence braking at high speed, dissipate energy early
  - » Use full braking when required; safety before comfort
- Runway friction
  - » Wet runways have much lower friction levels than a dry runway
  - » The friction depends on the runway surface, materials, and condition
  - » Contamination (water, slush, snow, or ice) reduces friction to very low levels

Level of braking
Brake for safety
not for comfort



Do not leave braking until the end

Manage all threats - every landing

Threats:

- Fast; above Vref+15
- High at the threshold
- Wet Runway
- Long landing

Management:

- Plan - self briefing, crew briefing
- Stabilised approach - through the gates
- Adjust braking levels - wet runways, tailwind

Managing Threats and Errors during Approach and Landing

Section 2 - Errors

Errors:-

- are usually the result of past activities, they are consequences of an action or inaction
- reduce the margin of safety and increase the probability of accidents or incidents

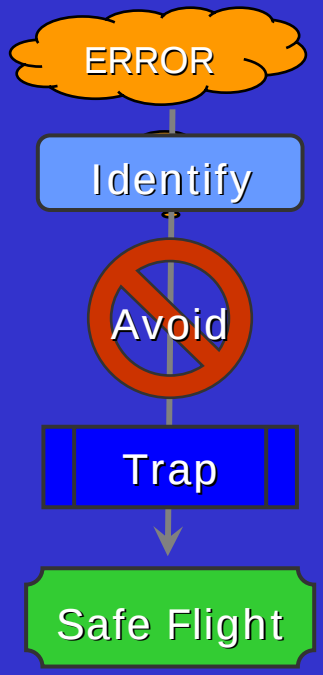
Errors in situation awareness - not understanding the situation, which leads to a wrong decision; due to poor knowledge, time management, or lack of attention

Decision errors - choosing the wrong course of action; due to failures of discipline, memory, or training, or by violating rules and procedures, or giving in to peer pressure

Error Management

It is human nature to make errors, thus error management is a vital safety device; the process is similar to threat management:

1. Identify situations that could lead to errors
2. Avoid these situations and circumstances that promote errors
3. Identify an error, trap the error, take corrective action, and check effectiveness



Most flying activities follow this process, many of the actions are subconscious

We learn from errors, from our own and from other people

Error management requires conscious thought to provide awareness and understanding. Rules enable us to avoid hazards; procedures trap residual errors

Not understanding the situation

Pilots may fail to recognise an uncommon or deteriorating situation; there are many reasons for this:

- The visual scene is ambiguous – illusions, poor weather, not scanning instruments
- Unaware of runway conditions – landing risks mis-assessed or underestimated
- Warning signs ignored - complacency, bad habit, lack of knowledge
- Lack of time – time available underestimated, rushed decision, " press–on-itis "

No pilot intentionally chooses failure

The actual situation:	What we think the situation is: Common	What we think the situation is: Uncommon
Uncommon	Failure to recognise the situation **Hazardous Error** Land when you should not	Recognise an uncommon situation **Success** Go Around when you should
Common	Recognise a common situation **Success** Land when you should	Conservative error Failure Go Around without need

Swauger 'The recognition trap'

Expecting ‘a situation’

No two landings are the same!

- The smallest change in conditions may overcome the plan
- Because one ‘marginal’ landing was successful does not mean that the next attempt will be
- Avoid complacency, you may not be able to land and stop:
  Yes an accident can happen to you
- Do not tolerate SOP deviation:
  Avoid short cuts or thinking that you know better
- Resist peer pressure:
  It <u>is</u> OK to Go Around

First be aware of your errors, then other people’s errors

Monitor the environment, the aircraft and crew for changes or errors in the plan

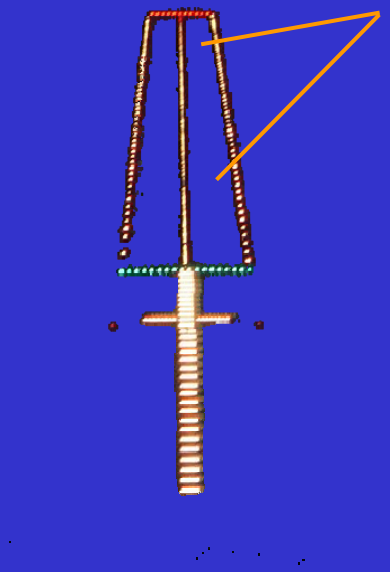
Avoid hazardous error provoking situations

Situation Awareness

Avoiding situation assessment errors:

Situation cues provide a mental model of what is happening; cues have to be sought out and understood

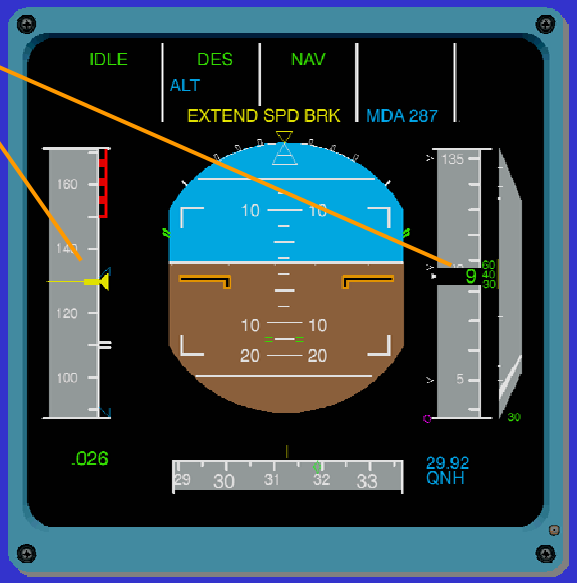
- See to understand; deliberately scan the situation to gain information, compare this with the expected or the normal parameters
- Know what to see and when to see it; be aware of distractions, focus attention on landing threats and opportunities for error



‘See to understand’
Know what to see and
when to see it

Airspeed, Altitude
Runway length
Surface conditions
Wind, Wet

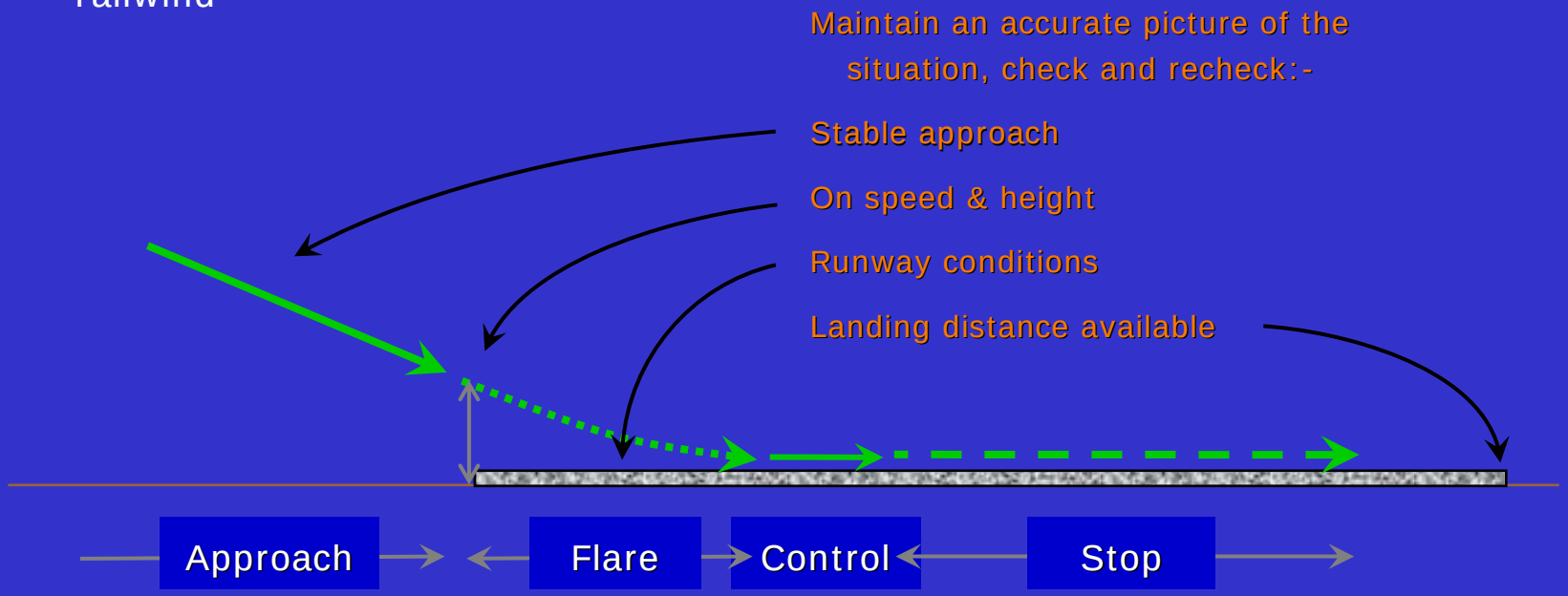
Do not judge the situation
on just one parameter



Acquiring Situation Awareness

Important situation cues for landing are:

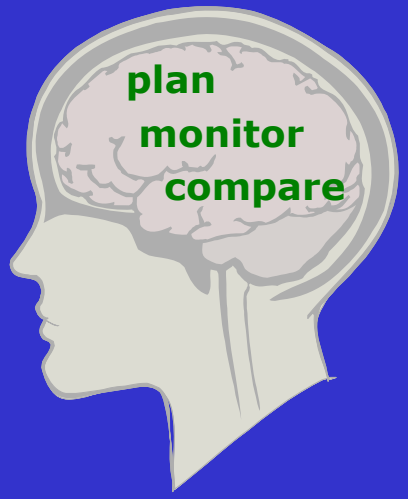
- The aircraft's actual approach path and airspeed in comparison with the ideal flight path and the target air speed
- The runway conditions, friction, and the required level of braking
- The landing distance available for the ambient conditions, the aircraft weight and configuration
- Tailwind



Maintaining Situation Awareness

Planning and think ahead

- Create the plan in the landing briefing;
  - Aircraft weight – speed – landing distance required
  - Surface conditions – landing distance required
  - Wind – landing distance required
- Readjust the plan if conditions change
  - Change the course of action
  - Be aware that apparently familiar situations hide change



Compare with the SOP

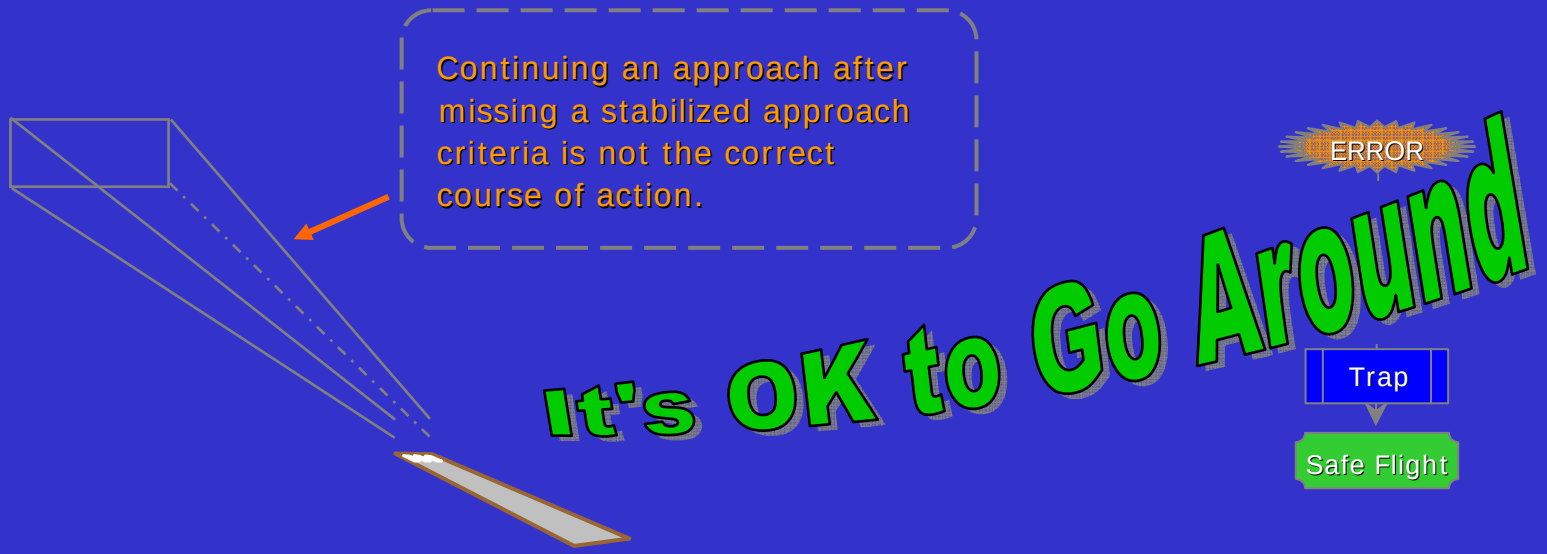
- Landing gates, stabilised approach, speed / ht over threshold
  - Anticipate the next part of the plan
  - Go Around if unstable, if missing a gate, or fast at the threshold
  - Beware of bad habits – do not deviate from the plan or SOPs
- Change the course of action if a rule is violated

Situation Awareness
Plan
Monitor
Compare

Decisions – a course of action

A course of action is the result of a decision. Errors occur due to failures of discipline, biased memory, or a weakness in training

- In routine or time critical events, actions may become automatic; avoid bad habits - landing fast or long, be aware of tailwind, wet runway, low braking levels
- Most flight activity uses a mixture of assessment and action; these are the basis of standard operating procedures (SOPs) – follow all SOPs
- Complex or unusual situations requires more thought; it is essential to have good situation awareness and knowledge, and ‘make time’ to think



Know the Risks

Risk = Threat or Error x Vulnerability x Consequence

Landing risks may be mis-assessed which may bias judgment:

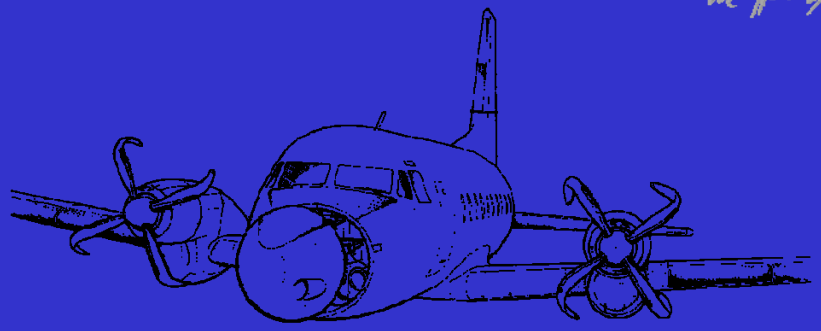
- » Low awareness of personal vulnerability to error making
- » Not considering the consequences

Landing risks are bounded by knowledge:

- » High energy approaches are high risk manoeuvres
  - Respect boundaries of speed and height
    - – Approach Gates
  - Respect cross wind and tailwind limits
    - – Company SOPs
- » Wet runways require more landing distance
  - Adjust braking levels to suit surface conditions
    - – Personal SOPs
  - Do not copy or repeat bad habits
    - – Personal risk management

Consider the Consequences

- Possible fatalities or severe injuries
- Probable collateral damage
- Probable aircraft ‘hull loss’
- Certain disruption, delay
- Consequential cost
- Dented pride

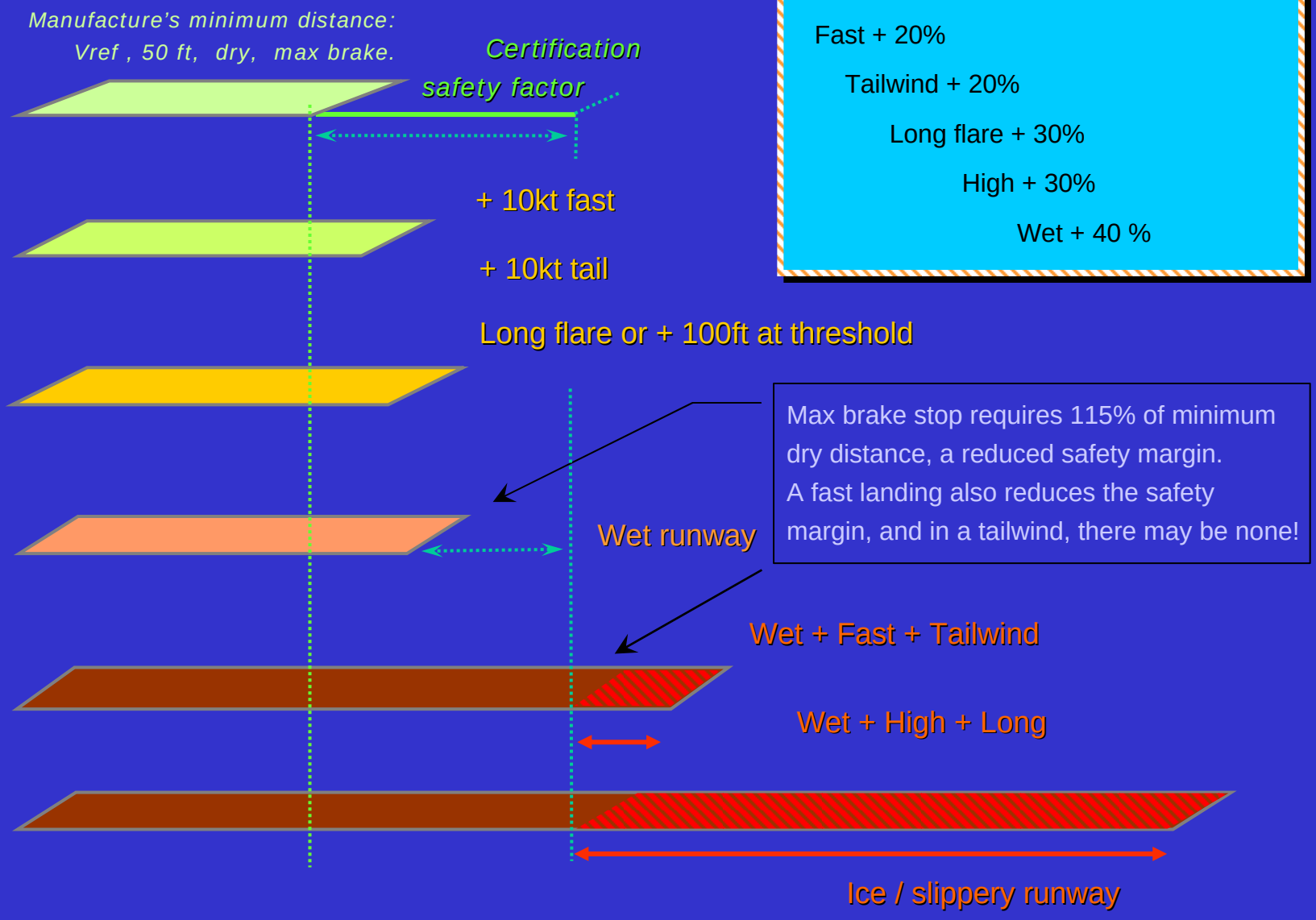


Most overruns <u>are</u> accidents; fatalities, injury, damage

Think about, and lower the risk factors before you have an accident

More knowledge - lower risk, better decisions

Relative Landing Distances:



Be aware of <u>additive</u> values:-

Fast + 20%

Tailwind + 20%

Long flare + 30%

High + 30%

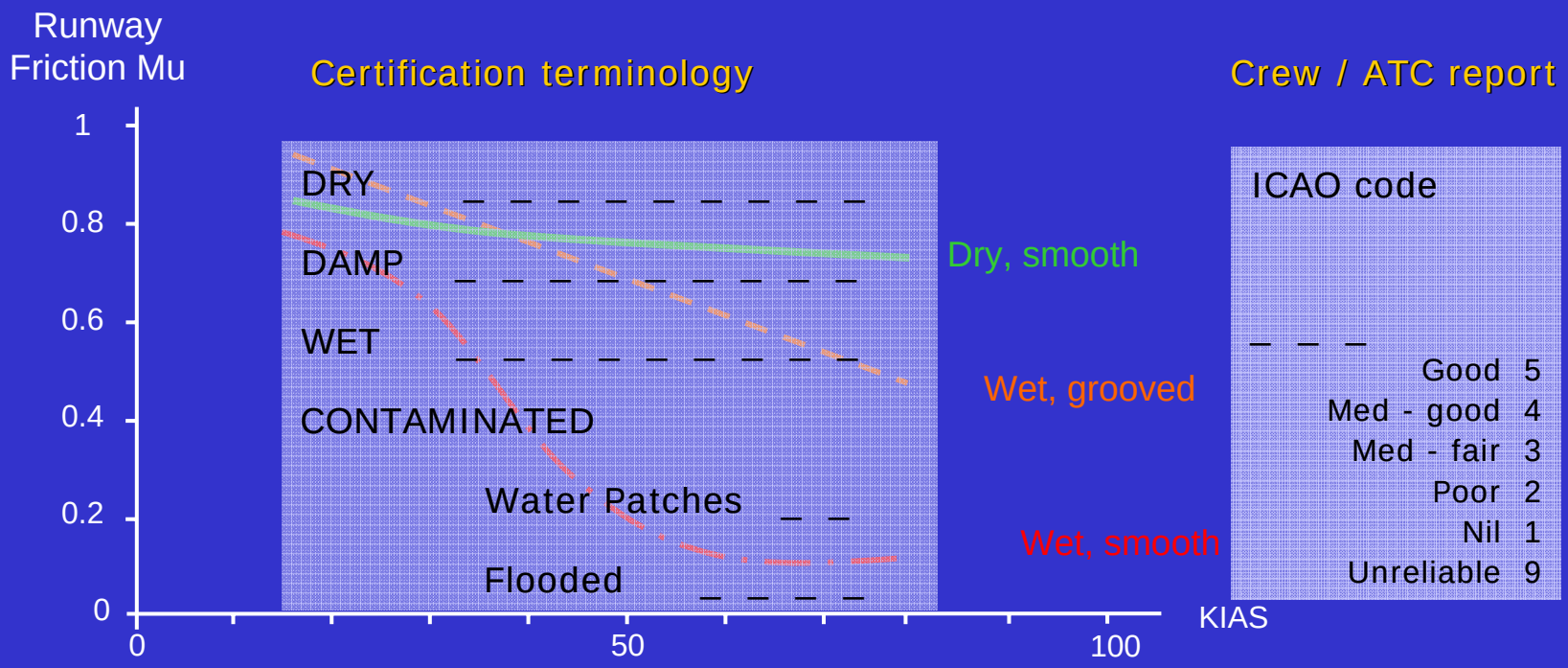
Wet + 40 %

Max brake stop requires 115% of minimum dry distance, a reduced safety margin.
A fast landing also reduces the safety margin, and in a tailwind, there may be none!

More knowledge - lower risk, better decisions

Friction coefficient of runway surfaces:

Type of surface, condition of surface (rubber deposits) , dry, wet, contaminated



ICAO Codes are relative to the runway conditions, thus good is only good for a wet runway, which may already have a reduced safety margin

Grey areas: There is no overall accepted certification / operational correlation between mu meters and airplanes

Water, Slush, Wet Snow, Dry Snow, Compacted Snow, Ice

Make the decision, your decision

Decisions depend on:

- Understanding the situation – take a wider view of the situation
- Knowledge and risk assessment – compare the situation with SOPs
- Identifying safe courses of action – don't focus on just one option
- Choose the safest option, and then take action to correct any error

Don't depend on previous aircraft landing reports;
braking effectiveness varies with aircraft type,
equipment availability, and use of brakes

Don't have an accident by helping someone else,
it is OK to say 'No' to ATC
– 'unable to comply'

Your Decision
Scan for situation cues
Use knowledge wisely
Assess risks
Consider consequences
Take action, do what is right

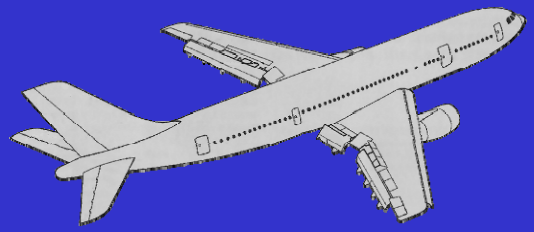
Decision, a problem of choice

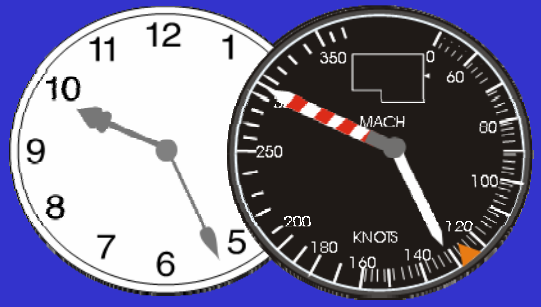
Deciding involves a choice, the choice of the safest option; choice involves recall of memory and comparison of facts:

- Memory can be biased to fit the apparent facts – crosscheck and monitor the situation, especially in a rapidly changing situation
- False memories may be recalled from previous ‘bad habit’ operations or inappropriate procedures from other aircraft types – refer to current SOPs
- Previous low consequence decisions can develop into high consequence situations that require revised decisions – continually reassess earlier decisions
- Complex situations may indicate a failing course of action – reassess, crosscheck, and intervene if an error is detected

Make time

Reduce speed early; 180 kts is approx 3 nm/min (900ft/min), whereas 120 kts is 2 nm/min (600 ft/min)





Summary

Avoiding a landing overrun

- Identify, avoid, and trap threats and errors.
  - Maintain good situation awareness: airspeed, runway friction
  - Have a plan, give a briefing: compare the situation with the plan
  - Knowledge of ‘no-go’ areas: flooded & contaminated runways
  - Speed above Vref+15, long landings, strong tailwinds
  - Follow SOPs: use approach gates, speed / height
  - Do not tolerate violations, beware of bad habits
  - Resist peer pressure
  - Brake for safety not for comfort

- Manage the consequences of error
  - Revise the plan - *it is OK to go around*
  - Make time
  - Have a safe landing before an ‘on time’ landing

Every landing

A Safe Landing

"A good landing Captain"

is a good example for everyone

How heavy is the aircraft

How long is the runway

How fast is the aircraft

How wet is the runway

Head / Tailwind

'On Speed'

Respect the stabilized approach criteria

Height over the threshold

How much braking to use