

Modified Handling Qualities Rating Method (MHQRM)

SC-VTOL AMC to Handling Qualities

10-DEC-2019

Hamdy SALLAM

Modified Handling Qualities Rating Method

What are the Handling Qualities and why do we need them to be Satisfactory?

Which requirements from SC VTOL are addressed

Overall description of the Method

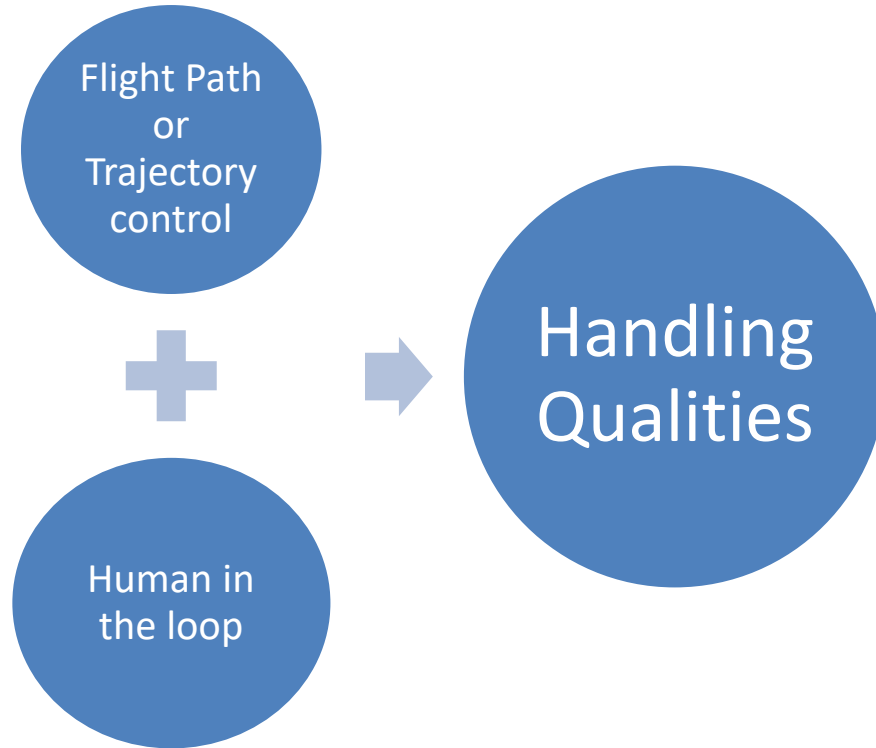
Definitions:

- Handling Qualities Rating;
- AMC SC.VTOL 2510;
- Cooper Harper Rating Scale.

Minimum Handling Qualities Table from SC VTOL

Probability definitions and determination

What are the HQ and why SAT? 1/2



What are the HQ and why SAT? 2/2



Handling
Qualities

Aircraft is
controlled
and
manoeuvred
to:

Mental and or
Physical
compensation
is required

- Cope with any adverse weather conditions
- Avoid late detected obstacles or traffic
- Reduced excess workload capacity
- Fatigue, increase chances of error

Requirements from SC VTOL

VTOL.2110
Flight
Envelopes

VTOL.2115
Take-off
performance

VTOL.2130
Landing

VTOL.2135
Controllability

VTOL.2140
Control Forces

VTOL.2145
Flying qualities

VTOL.2150
Stall

VTOL.2160
Vibration

VTOL.2300
Flight control
systems

VTOL.2305
Landing gear
systems

Description of the Method 1/2



AMC is for ENHANCED category. BASIC category will need to modify the Minimum HQR

Based on HQRM from AC25-7D Appendix E and MTEs of ADS-33.

It's an AMC, applicants may choose other Methods for showing compliance

Description of the Method 2/2

Combination of probability to determine for a given phase of flight the possible Flight Conditions (FltC) that have a probability greater than 10^{-9}



For each FltC a Minimum HQR (MHQR) is assigned based on the SC VTOL requirements



A tool will be used to show compliance to the MHQR for that given FltC

Flight testing an operationally relevant maneuver giving a Cooper Harper Rating

Simulator

Other evidence



Not all the FltC need to be flight tested!

Definitions 1/4

Handling Qualities Rating (HQR)	Description	AMC SC.VTOL 2510 Failure Conditions Classifications	Cooper Harper Rating Scale (CHR)
Satisfactory (SAT)	Handling Qualities allow achievement of <u>desired performance</u> criteria met without exceptional piloting skills and <u>minimal pilot compensation</u> .	No Safety Effect	1-3
Adequate (ADQ)	Handling Qualities allow achievement only <u>of adequate performance</u> criteria, or desired performance criteria <u>with moderate pilot compensation</u> , without exceptional piloting skills.	Minor up to Major	4-6
Controllable (CON)	Handling Qualities DO NOT allow achievement of adequate performance criteria WITHOUT exceptional piloting skills. Allows however <u>continued safe flight and landing without exceptional piloting skills</u> , after a transient condition or reconfiguration to retain control if necessary.	Hazardous	7-9

Definitions 2/4

Flight Envelope - FE

Flight Envelope	Notes	Probability X_{FE}
Normal Flight Envelope (NFE)	Generally associated with routine operational and/or prescribed conditions.	10^0
Operational Flight Envelope (OFE)	Generally associated with warning onset; outside the normal flight envelope.	TBD
Limit Flight Envelope (LFE)	Generally associated with aircraft design limits.	TBD

Definitions 3/4

Atmospheric Disturbance - AD

Atmospheric Disturbance	Notes	Probability X_{AD}
Light:	No appreciable turbulence and steady state winds less than 3 kts with no appreciable gusts.	10^0
Moderate:	Light to moderate turbulence. Changes in altitude and/or attitude occur. Usually causes variations in indicated airspeed.	TBD
Severe:	Turbulence that causes large, abrupt deviations in altitude and/or attitude. Usually causes large variations in indicated airspeeds.	TBD

Definitions 4/4

Aircraft or System Failure Condition affecting HQ - FC

Failure Condition	Notes	Probability X_{FC}
Nominal Operation:	No failures	10^0
Probable up to Remote Failure Conditions:	Failures associated with an effect that affect HQR up to MAJOR.	Up to 10^{-7}
Extremely Remote Failure Conditions:	Failures associated with an effect that affect HQR of HAZARDOUS.	Less than 10^{-7} up to 10^{-9}

Minimum Handling Qualities Rating

Phase of flight: CRUISE									
FltC X _{FE} * X _{FC} * X _{AD}	Atmospheric Disturbance (AD)								
	Light			Moderate			Severe		
	Flight Envelope (FE)								
Failure Condition (FC)	NFE	OFE	LFE	NFE	OFE	LFE	NFE	OFE	LFE
Nominal Condition	SAT	SAT	SAT	SAT	SAT	ADQ NOTE 1	SAT	ADQ NOTE 1	CON NOTE 1
Probable up to Remote Failure Conditions:	SAT	SAT	SAT	SAT	ADQ NOTE 1	CON	ADQ NOTE 1	CON NOTE 1	CON NOTE 1
Extremely Remote Failure Conditions:	SAT	ADQ NOTE 1	CON	ADQ NOTE 1	CON NOTE 1	NOTE 2	CON NOTE 1	NOTE 2	NOTE 2

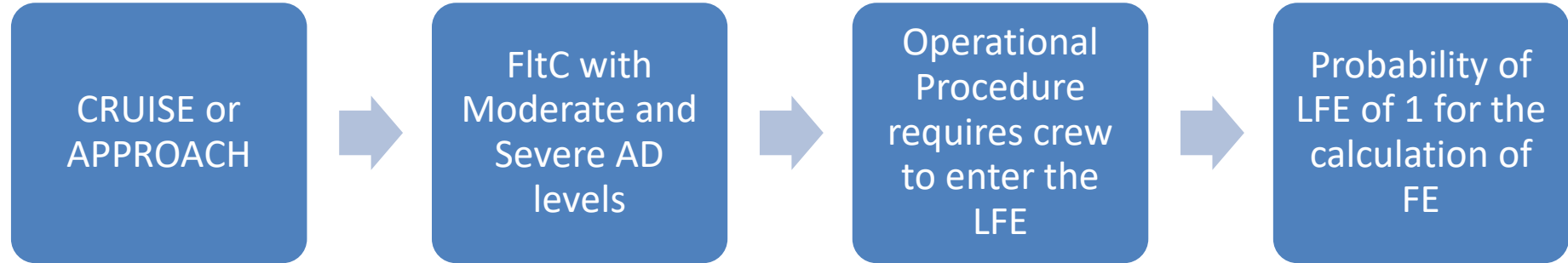
Probability with interrelationships

The following probabilities in the tables apply when they are considered separately

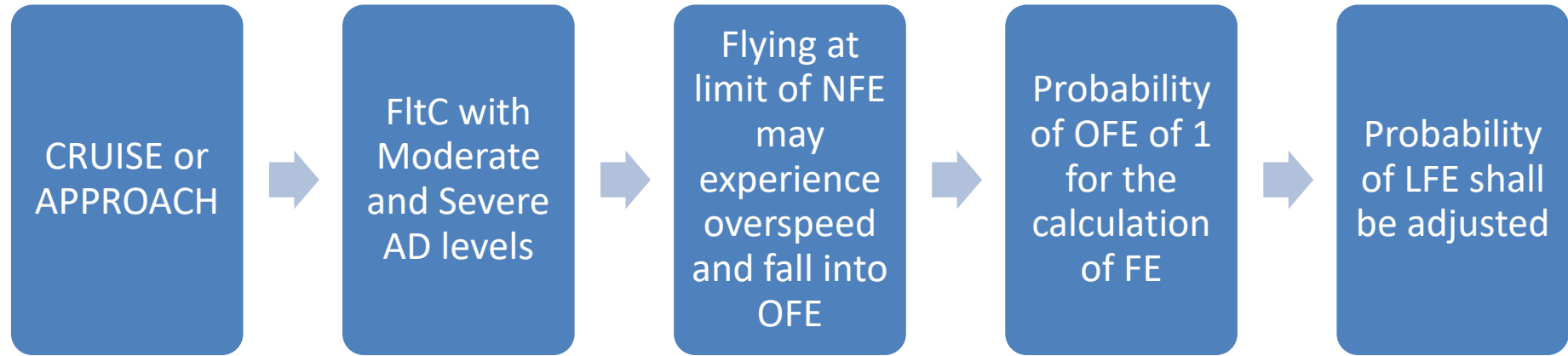
When obvious interrelationships exist due to the design or the intended or expected operation of the aircraft

within MHQRM is to MODIFY THE FE PROBABILITY VALUE

Interrelationships example 1/3

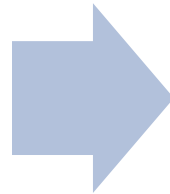


Interrelationships example 2/3



Interrelationships example 3/3

Failure Condition
with associated loss
of Warning or
Envelope Protection



OFE and LFE
probability should
be adjusted
accordingly

Thank you for your attention!

Any further question?

easa.europa.eu/connect



Your safety is our mission.

An Agency of the European Union 