EASA
European Union Aviation Safety Agency

Cologne, 10th-11th December 2019

HIRF/IEL VTOL.2520/2515 AMCs

Rotorcraft Symposium 2019

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IEL Requirements VTOL.2515 vs 27.1316

VTOL.2515	CS 27.1316
Unless it is shown that exposure to lightning is unlikely: (a) Each electrical or electronic system that performs a function, the failure of which would prevent continued safe flight and landing **for Category Enhanced, or a controlled emergency landing for Category Basic**, must be designed and installed such that: (1) The function at the aircraft level is not adversely affected during and after the time the aircraft is exposed to lightning; and (2) The system recovers normal operation of that function in a timely manner after the aircraft is exposed to lightning unless the system's recovery conflicts with other operational or functional requirements of the system.	(a) Each electrical and electronic system that performs a function whose failure would prevent the continued safe flight and landing of the rotorcraft must be designed and installed in a way that: (1) the function is not adversely affected during and after the rotorcraft's exposure to lightning; and (2) the system automatically recovers normal operation of that function in a timely manner after the rotorcraft's exposure to lightning unless the system's recovery conflicts with other operational or functional requirements of the system that would prevent continued safe flight and landing of the rotorcraft.
(b) Each electrical and electronic system that performs a function, the failure of which would reduce the capability of the aircraft or the ability of the flight crew to respond to an adverse operating condition, must be designed and installed such that the system recovers normal operation of that function in a timely manner after the aircraft is exposed to lightning.	(b) **For rotorcraft approved for instrument flight rules operation,** each electrical and electronic system that performs a function whose failure would reduce the capability of the rotorcraft or the ability of the flight crew to respond to an adverse operating condition must be designed and installed in a way that the function recovers normal operation in a timely manner after the rotorcraft's exposure to lightning.

Text in red: Differences between VTOL.2515 and CS 23.2515

~~**Text in red:**~~ Removed from CS 23.2520

Text in blue: Differences between CS 27.1316 and VTOL.2515

HIRF Requirements VTOL.2520 vs 27.1317

VTOL.2520	CS 27.1317
(a) Each electrical and electronic system that perform a function, the failure of which would prevent continued safe flight and **landing for Category Enhanced, or a controlled emergency landing for Category Basic**, must be designed and installed such that: (1) The function at the aircraft level is not adversely affected during and after the time the aircraft is exposed to the HIRF environment; and (2) The system recovers normal operation of that function in a timely manner after the aircraft is exposed to the HIRF environment, unless the system's recovery conflicts with other operational or functional requirements of the system.	(a) Each electrical and electronic system that performs a function whose failure would prevent the continued safe flight and landing of the rotorcraft must be designed and installed in a way that: (1) the function is not adversely affected during and after the rotorcraft's exposure to HIRF environment I as described in Appendix D; (2) the system automatically recovers normal operation of that function in a timely manner after the rotorcraft's exposure to HIRF environment I as described in appendix D unless the system's recovery conflicts with other operational or functional requirements of the system that would prevent continued safe flight and landing of the rotorcraft; **(3) the system is not adversely affected during and after the rotorcraft's exposure to HIRF environment II as described in Appendix D; and** **(4) each function required during operation under visual flight rules is not adversely affected during and after the rotorcraft's exposure to HIRF environment III as described in Appendix D.**
(b) ~~**For airplane approved for instrument flight rules (IFR) operations,**~~ Each electrical and electronic system that performs a function, the failure of which would reduce the capability of the aircraft or the ability of the flight crew to respond to an adverse operating condition, must be designed and installed such that the system recovers normal operation of that function in a timely manner after the aircraft is exposed to the HIRF environment.	(b) Each electrical and electronic system that performs a function whose failure would significantly reduce the capability of the rotorcraft or the ability of the flight crew to respond to an adverse operating condition must be designed and installed in a way that the system is not adversely affected when the equipment providing the function is exposed to equipment HIRF test level 1 or 2 as described in Appendix D.
	(c) Each electrical and electronic system that performs a function whose failure would reduce the capability of the rotorcraft or the ability of the flight crew to respond to an adverse operating condition must be designed and installed in a way that the system is not adversely affected when the equipment providing the function is exposed to equipment HIRF test level 3 as described in Appendix D.

Documentation/Guidances to draft IEL/HIRF AMCs for VTOL:

- ✓ **AMC 20-158** (HIRF Guidance for CSs 23.1308/25.1317/27.1317/ 29.1317)
- ✓ **AMC 20-136** (IEL Guidance for CSs 23.1306/25.1316/27.1316/29.1316)
- ✓ **SAE AE-2 White Paper** – Recommended Lightning & HIRF Test Levels for Small Airplanes
- ✓ **PS-ACE-23-10** - FAA Policy for HIRF/Lightning Compliance Demonstration for Part 23 (14 CFR 23.1306/1308 and 23.2515/2520)
- ✓ **Draft ASTM** (WK61550) - Standard Practice for Simplified Method addressing HIRF/Lightning Requirements
- ✓ **CATA HIRF Report**

Applied Principles :

- ✓ **Clarification** (Interpretation of the requirements, Perimeter of the system, Likelihood of Lightning exposure)
- ✓ **Simplification** (Less A/C testing, more equipment testing, LCL/HCL Allocation Alleviation)
- ✓ **Proportionality** (Higher Categories with more rigorous approach (more severe environments, real transfer function/attenuation, Level B and/or C system not considered for lower Categories and/or VFR Operation)
- ✓ **Consistency** between IEL and HIRF Approaches

IEL/HIRF Groups:

	VTOL Categories			
	Basic (max passenger seating configuration)			Enhanced
	0-1	2-6	7-9	
IEL/HIRF Groups	**I**	**II**	**III**	**III**

IEL/HIRF Groups correspond for a given VTOL Category to a Compliance Verification Method

Likelihood of Exposure to Lightning:

Operational Condition	Likelihood
VFR Day (with weather Report without Significant Cloud) OR VFR (with Detection Means; WX Radar/Stormscope)	Unlikely
Other VFR Operations or VFR without Detection Means	Likely
IFR	Very Likely

- ✓ **With operational limitations; VFR Day with weather reports stating the absence of significant clouds for the flight, the exposure to lightning can be so avoided. These operational limitations could be removed in VFR with the installation of detection means (Weater Radar, Stormscope…)**
- ✓ **Otherwise whatever the Flight Rule Conditions (VFR/IFR) the exposure to lightning is likely**

Rates of Lightning Strike per IEL Groups (VTOL Categories) (1):

A/C Group	IEL Groups I VFR (2)(3)	IEL Groups I IFR (2)(3)	IEL Groups II VFR (2)(3)	IEL Groups II IFR (2)(3)	IEL Group III VFR (2)(3)	IEL Group III IFR (2)(3)
$R_{\text{Lightning Strike}}$ /FH	5.10^{-6}	5.10^{-5}	8.10^{-6}	8.10^{-5}	10^{-5}	10^{-4}

(1) By extrapolation from A/C Class I/II/III to VTOL Cat 0-1/2-6/7-9

(2) For simplification it has been assumed that aircraft flying under VFR are in VMC and aircraft flying under IFR are in IMC for 50% and VMC for 50% of the flight time (so same order of magnitude between IMC and IFR)

(3) A factor 10^{-1} has been applied on the Rate of Lightning Strike to aircraft between IFR and VFR operations

Hazard related to Lightning Exposure on Aircraft:

Failure Condition / A/C Group	Catastrophic (Level A)	Hazardous (Level B)	Major (level C)
IEL Group I VFR	Likely (Safety Objectives 10^{-6})	Unlikely (Safety Objectives 10^{-5})	Unlikely (Safety Objectives 10^{-4})
IEL Group I IFR	Likely (Safety Objectives 10^{-6})	Likely (Safety Objectives 10^{-5})	Unlikely (Safety Objectives 10^{-4})
IEL Group II VFR	Likely (Safety Objectives 10^{-7})	Likely (Safety Objectives 10^{-6})	Unlikely (Safety Objectives 10^{-4})
IEL Group II IFR	Very Likely (Safety Objectives 10^{-7})	Likely (Safety Objectives 10^{-6})	Unlikely (Safety Objectives 10^{-4})
IEL Group III VFR	Very Likely (Safety Objectives 10^{-8})	Likely (Safety Objectives 10^{-6})	Unlikely (Safety Objectives 10^{-4})
IEL Group III IFR	Very Likely (Safety Objectives 10^{-8})	Likely (Safety Objectives 10^{-6})	Likely (Safety Objectives 10^{-4})

$P_{Haz} = R_{Lightning\ Strike} / S_{Safety\ Objective}$

$P_{Haz} < 1$: Hazard is Unlikely $1 \leq P_{Haz} \leq 10^2$: Hazard is Likely $P_{Haz} > 10^2$: Hazard is Very Likely

IEL - Comparisons between CS 27 and VTOL Compliance Demonstration:

Product	CS 27				Group I and II (Cat basic 0-6 Pax)			Group III (Cat basic 7-9 Pax and Enhanced)			
IEL Requirements	27.1316				VTOL.2515			VTOL.2515			
	(a)		(b)		(a)		(b)	(a)		(b)	
System LCL	Level A Control	Level A Display	Level B	Level C	Level A Control	Level A Display	Level B (except Group I VFR)	Level A Control	Level A Display	Level B	Level C (only IFR)
IEL Test Levels	Category (according ATL)	Category Level 3 or 4	Category Level 3	Category Level 2	A3J3L3 or B3K3L3		A2J2L2 or B2K2L2	Category (according ATL)	A3J3L3 or B3K3L3	A2J2L2 or B2K2L2	A1J1L1 or B1K1L1
Item Tested	System	System or Equipment	Equipment		System or Equipment		Equipment	System or Equipment		Equipment	
LCL per Channel	Prim. A Second. A	Prim. A Second. A	Prim. B Second. B	Prim. C Second. C	Prim. A Second. B		Prim. B Second. C	Prim. A Second. B	Prim. A Second. B	Prim. B Second. B	Prim. C Second. C
Comparison CS 27 vs IEL Groups I/II/III	ATL ↑/= EDTL ↑/= Item tested ↑ LCL ↑	EDTL ↑/= Item tested = LCL ↑	EDTL ↑/= Item tested = LCL =	EDTL ↑/= Item tested = LCL =	ATL ↓ EDTL ↓ Item tested ↓/= LCL ↓		EDTL ↓ Item tested ↓/= LCL =	ATL = EDTL = Item tested = LCL ↓	EDTL ↓/= Item tested = LCL ↓	EDTL = Item tested = LCL =	EDTL ↓/= Item tested = LCL =
Comparison IEL Group I/II vs Group III					ATL ↓/= EDTL ↓/= Item tested = LCL =		EDTL = Item tested = LCL =	ATL ↑ EDTL ↑/= Item tested = LCL =	EDTL = Item tested = LCL =	EDTL = Item tested = LCL ↑	EDTL ↑ Item tested ↑ LCL ↑

HIRF Requirements according HIRF Group (in Application of Proportionality Approach):

Failure Condition / A/C Group	Catastrophic (Level A)	Hazardous (Level B)	Major (level C)
HIRF Group I			
HIRF Group II			
HIRF Group III			

Rates of Exposure to Threat: $R_{HIRF}/FH \approx 1$

HIRF - Comparisons between CS 27 and VTOL Compliance Demonstration:

Product	CS 27				Group I and II (Cat basic 0-6 Pax)			Group III (Cat basic 7-9 Pax and Enhanced)			
HIRF Requirements	27.1317				VTOL.2520			VTOL.2520			
	(a)		(b)	(c)	(a)		(b)	(a)		(b)	
System HCL	Level A Control	Level A Display	Level B	Level C	Level A Control	Level A Display	Level B	Level A Control	Level A Display	Level B	Level C
HIRF Environments	III	I	II		III	I	I	III	III	I	I
Transfer Function/ Attenuation Curve	Real	Generic	Generic/ -	-	Generic		Generic/ -	Real	Generic	Generic/ -	Generic/ -
HIRF Test Levels	Cat (according to real transfer function	Cat H and Cat F or D	Cat J and Cat F or D band) OR Cat R	Cat T	Cat G and Cat L/K/J	Cat H and Cat G, F or D	Cat H and Cat G, F or D OR Cat R	Cat (according to real transfer function	Cat G and Cat L/K/J	Cat H and Cat G, F or D OR Cat R	Cat H and Cat G, F or D OR Cat T
Item Tested	System	System or Equipment	System or Equipment	Equipment	System or Equipment		Equipment	System or Equipment		Equipment	
HCL per Channel	Prim. A Second. A	Prim. A Second. A	Prim. B Second. B	Prim. C Second. C	Prim. A Second. B	Prim. A Second. B	Prim. B Second. B	Prim. A Second. B	Prim. A Second. B	Prim. B Second. B	Prim. C Second. C
Comparison CS 27 vs HIRF Groups I/II and III	HIRF Env = TF/Att ↑/= Item test. ↑ HCL ↑	HIRF Env = TF/Att = Item test. = HCL ↑	HIRF Env ↓/= TF/Att = Item test. = HCL =	HIRF Env=/≠ TF/Att = Item test. = HCL =	HIRF Env = TF/Att ↓ Item test. ↓ HCL ↓	HIRF Env = TF/Att = Item test. = HCL ↓	HIRF Env = TF/Att = Item test. = HCL =	HIRF Env = TF/Att = Item test. ↓ HCL ↓	HIRF Env ↑ TF/Att = Item test. = HCL ↓	HIRF Env =/≠ TF/Att = Item test. = HCL =	HIRF Env =/≠ TF/Att = Item test. = HCL =
Comparison HIRF Group I/II vs Group III					HIRF Env =or↓ TF/Att ↓ Item test. = HCL =	HIRF Env ↓ TF/Att = Item test. = HCL =	HIRF Env = TF/Att = Item test. = HCL =	HIRF Env = TF/Att ↑ Item test. = HCL =	HIRF Env↑ TF/Att = Item test. = HCL =	HIRF Env = TF/Att = Item test. = HCL =	HIRF Env ↑ TF/Att ↑ Item test. ↑ HCL ↑ (5)

Applicability of SC VTOL.2515/2520 according to HIRF/IEL Group:

Failure Condition A/C Group	Catastrophic (Level A)	Hazardous (Level B)	Major (level C)
IEL Group I VFR			
IEL Group I IFR			
HIRF Group I			
IEL Group II VFR			
IEL Group II IFR			
HIRF Group II			
IEL Group III VFR			
IEL Group III IFR			
HIRF Group III			

Rates of Exposure to Threat: $R_{\text{Lightning Strike IFR}}/FH \approx 10^{-4}$ $R_{\text{HIRF}}/FH \approx 1$

Similarities in HIRF/IEL Approaches (AMCs VTOL.2520/2515):

Product	Group I (Cat basic 0-1 Pax)		Group II (Cat basic 2-6 Pax)		Group III (Cat basic 7-9 Pax and Enhanced)			
IEL/HIRF Requirements	VTOL.2515/2520		VTOL.2515/2520		VTOL.2515/2520			
	(a)	(b)	(a)	(b)	(a)		(b)	
System L/HCL	Level A	Level B	Level A	Level B	Level A Control	Level A Display	Level B	Level C
IEL VFR								
IEL IFR								
HIRF								
Real/Generic Tranfer Function IEL/HIRF	Gen		Gen		Real	Gen		
Item Tested	System or Equipment	Equipment	System or Equipment	Equipment	System or Equipment		Equipment	
L/HCL per Channel	Primary A Secondary B	Primary B Secondary C	Primary A Secondary B	Primary B Secondary C	Primary A Secondary B		Primary B Secondary B	Primary C Secondary C

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Thank you
Any further question?

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