

**JAA Administrative & Guidance Material
Section Five: Licensing, Part Two: Procedures**

CHAPTER 17: DETAILED THEORETICAL KNOWLEDGE SYLLABUS AND LEARNING OBJECTIVES

Subject – 031 – Mass & Balance

See Appendix 1 to JAR-FCL 1.470 and JAR-FCL 2.470

Introduction

Syllabus Reference	Syllabus and Learning Objectives	Aeroplane		Helicopter		IR
		ATPL	CPL	ATPL /IR	ATPL	
030 00 00 00	FLIGHT PERFORMANCE AND PLANNING					
031 00 00 00	MASS AND BALANCE – AEROPLANES/HELICOPTERS					
031 01 00 00	PURPOSE OF MASS AND BALANCE CONSIDERATIONS					
031 01 01 00	Mass limitations					
031 01 01 01	Importance in regard to structural limitations					
LO	Explain the relationship between mass loading and structural stress <i>Remark - see also 021 01 01 00</i>	x	x	x	x	x
LO	Come to conclusion that mass must be limited to ensure adequate margins of strength	x	x	x	x	x
031 01 01 02	Importance in regard to performance limitations <i>Remark - see also subjects 032/034 and 081/082.</i>					
LO	Explain the relationship between aircraft mass and performance	x	x	x	x	x
LO	Come to conclusion that mass must be limited to ensure adequate margins of aircraft performance.	x	x	x	x	x
LO	Explain that the actual mass must be known during flight as basis for performance related decisions	x	x	x	x	x
031 01 02 00	Centre of gravity (CG) limitations					

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031 01 02 01	Importance in regard to stability and controllability <i>Remark - see also subjects 081/082</i>					
LO	Explain the relationship between CG position and stability/controllability of aircraft	X		X	X	
LO	Understand the effects if CG is outside the forward limit	X	X	X	X	X
LO	Understand the effects if CG is outside the aft limit	X	X	X	X	X
031 01 02 02	Importance in regard to performance <i>Remark - see also subjects 032/034 and 081/082.</i>					
LO	Explain the relationship between CG position and aircraft performance	X		X	X	
LO	Understand the effects of CG position on performance parameters (speeds, altitude, endurance and range)	X	X	X	X	X
031 02 00 00	LOADING					
031 02 01 00	Terminology					
031 02 01 01	Mass terms					
LO	Define and/or recognise the definition of the following mass terms: - Basic Empty Mass - Dry Operating Mass - Operating Mass - Take off Mass - Landing Mass - Ramp and Taxi Mass - In-flight Mass - Zero Fuel Mass	X	X	X	X	X
LO	Define and/or recognise the definition of Wing Zero Fuel Mass	X				

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		ATPL	CPL	ATPL /IR	ATPL		CPL
031 02 01 02	Load terms (including Fuel Terms) <i>Remark - see also subject 033</i>						
	LO Understand the following terms: - Payload/Traffic load - Useful load - Block Fuel - Taxi Fuel - Take off Fuel - Trip Fuel - Reserve Fuel (Contingency, Alternate, Final Reserve and Additional Fuel) - Extra Fuel	X	X	X	X	X	
	LO Convert fuel mass, volume and density given in different units use aviation	X	X	X	X	X	
	LO Understand the working relationship of various load and mass components	X	X	X	X	X	
031 02 02 00	Mass limits						
031 02 02 01	Structural limitations						
	LO Define and/or recognise the definition of the following structural limitations:	X	X	X	X	X	
	LO Maximum Zero Fuel Mass	X					
	LO Maximum Take off Mass	X	X	X	X	X	
	LO Maximum In-flight Mass	X	X	X	X	X	
	LO Maximum In-flight Mass with external load			X	X	X	
	LO Maximum Landing Mass	X	X	X	X	X	
031 02 02 02	Performance limitations						

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		ATPL	CPL	ATPL /IR	ATPL	
LO	Define and/or recognise the following performance limitations: - Performance Limited Take off Mass - Performance Limited Landing Mass - Regulated Take off Mass - Regulated Landing Mass	X	X	X	X	X
031 02 02 03	Cargo compartment limitations					
LO	Define and/or recognise the definition of the following cargo compartment limitations:	X	X	X	X	X
LO	Maximum Floor load (Area Load)	X	X	X	X	X
LO	Maximum Running load	X	X	X	X	X
031 02 03 00	Mass calculations					
031 02 03 01	Maximum masses for Take-off and Landing					
LO	Calculate the maximum mass for Take-off (Regulated Take-Off Mass) given mass and load components and structural/performance limits	X	X	X	X	
LO	Calculate the maximum mass for landing (Regulated Landing Mass) given mass and load components and structural /performance limits	X	X	X	X	
LO	Calculate the Allowed Mass for Take-off	X	X	X	X	
031 02 03 02	Allowed traffic load					
LO	Calculate maximum allowed traffic load given Allowed Mass for Take-off and Operating Mass	X	X	X	X	X
LO	Calculate “under load”/”over load” given Allowed Mass for Take-off, Operating Mass and actual Traffic load	X	X	X	X	X
031 02 03 03	Use of standard masses for passengers, baggage and crew					
LO	Extract appropriate standard masses from relevant documents i.e. JAR OPS 1/3 or Operator requirements	X	X	X	X	X
LO	Calculate traffic load by using standard masses	X	X	X	X	X

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		ATPL	CPL	ATPL /IR	ATPL	
031 03 00 00	FUNDAMENTALS OF CG CALCULATIONS					
031 03 01 00	Definition of centre of gravity					
	LO Define and understand centre of gravity	X	X	X	X	X
031 03 02 00	Conditions of equilibrium (Balance of Forces and Balance of Moments)					
	LO Define and understand datum (reference point), balance arm and moment	X	X	X	X	X
	LO Name the conditions of equilibrium	X	X	X	X	X
031 03 03 00	Basic calculations of CG					
	LO Resolve problems using the principle of balanced forces and balanced moments	X	X	X	X	X
031 04 00 00	MASS AND BALANCE DETAILS OF AIRCRAFT					
031 04 01 00	Contents of mass and balance documentation					
031 04 01 01	Datum, moment arm					
	LO Name where the datum and balance arms for aircraft can be found	X	X	X	X	X
	LO Extract appropriate data from given documents	X	X	X	X	X
031 04 01 02	CG position as distance from datum					
	LO Name where the CG position for aircraft at Basic Empty Mass can be found	X	X	X	X	X
	LO Explain where the CG limits can be found.	X	X	X	X	X
	LO Extract CG limits from given aircraft documents	X	X	X	X	X
	LO State the different forms in presenting CG position as distance from datum or other references	X	X	X	X	X
031 04 01 03	CG position as percentage of MAC (% MAC) <i>Remark - for definition of MAC, see reference 081 01 01 05</i>					
	LO Extract MAC information from aircraft documents	X	X			

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		ATPL	CPL	ATPL /IR	ATPL	
	LO Explain the principle of using % MAC for description CG position	X	X			
	LO Calculate the CG position as % MAC	X	X			
031 04 01 04	Logitudinal CG limits					
	LO Extract appropriate data from given sample documents	X	X	X	X	X
031 04 01 05	Lateral CG limits					
	LO Extract appropriate data from given sample documents			X	X	X
031 04 02 00	Determination of aircraft mass and balance by weighing					
031 04 02 01	Weighing of aircraft (general aspects)					
	LO Explain the general procedure and regulations for weighing of aircraft (Conditions, intervals, reasons and requirements for re-weighing). <i>Remark - see JAR-OPS 1 or 3</i>	X	X	X	X	X
	LO Extract and interpret entries from/in "Mass (weight) report" of aircraft	X	X	X	X	X
031 04 02 02	Calculation of mass and CG position using weighing data					
	LO Calculate the mass and CG position of aircraft given reaction forces on jacking points.	X	X	X	X	X
031 04 03 00	Extraction of basic mass and balance data from aircraft documentation					
031 04 03 01	Basic Empty Mass (BEM) and/or Dry Operating Mass (DOM)					
	LO Extract values for BEM and/or DOM from given documents	X	X	X	X	X
031 04 03 02	CG position and/or moment at BEM/DOM					
	LO Extract values for CG position and moment at BEM and/or DOM from given documents	X	X	X	X	X
031 04 03 03	Deviations from standard configuration					

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		ATPL	CPL	ATPL /IR	ATPL		CPL
LO	Extract values from given documents for deviation from standard configuration as a result of varying crew, optional equipment, optional fuel tanks etc.	X	X	X	X	X	
031 05 00 00	DETERMINATION OF CG POSITION						
031 05 01 00	Methods						
031 05 01 01	Arithmetic method						
LO	Calculate CG position of aircraft by use of the formula: CG position = Sum of Moments/Total Mass	X	X	X	X	X	
031 05 01 02	Graphic method						
LO	Determine CG position of aircraft by use of loading graphs given in sample documents	X	X	X	X	X	
031 05 01 03	Index method						
LO	Understand the principle of the index method	X					
LO	Define the term "Dry Operating Index"	X					
LO	State the advantage(s) of index method	X					
031 05 02 00	Load and Trim Sheet						
031 05 02 01	General considerations						
LO	Explain the purpose of load sheets	X					
LO	Explain the purpose of trim sheets	X					
031 05 02 02	Load sheet and CG envelope for light aeroplanes and for helicopters						
LO	Insert loads and calculate masses in a sample Load sheet.	X	X	X	X	X	
LO	Calculate moments and CG positions	X	X	X	X	X	
LO	Check CG position at Zero Fuel Mass and Take off Mass to be within CG envelope including last minute changes	X	X	X	X	X	

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031 05 02 03	Load sheet						
	LO Explain the purpose of load sheet sections for establishing “Allowed Mass for Take off”, “Allowed Traffic Load” and “Under load”	X					
	LO Explain the purpose of load sheet sections for assessing load distribution	X					
	LO Explain the purpose of load sheet sections for cross checking of actual and limiting mass values	X					
	LO Calculate and/or complete a sample load sheet	X					
031 05 02 04	Trim sheet						
	LO Explain and make use of the procedure for determination of the CG position	X					
	LO Check that the Zero Fuel Mass Index is within limits	X					
	LO Determine the Fuel Index using the "Fuel Index Correction Table" and determine CG position as % MAC	X					
	LO Check that the Take-off Mass Index is within limits	X					
	LO Determine "Stabiliser Trim Units" for take-off	X					
	LO Explain the difference between certified and operational limits	X					
031 05 02 05	Last minute changes						
	LO Complete Load and Trim sheet for last minute changes	X					
031 05 03 00	Intentional re-positioning of CG						
031 05 03 01	Re-positioning of CG by shifting the load						
	LO Calculate the amount of mass to be moved for a given distance, or to/from given compartments, to establish a defined CG position within limits.	X	X	X	X	X	
	LO Calculate the distance to move a given amount of mass within limits to establish a defined CG position within limits.	X	X	X	X	X	

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031 05 03 02	Re-positioning of CG by additional load or ballast					
LO	Calculate the amount of additional load or ballast to be loaded at a given position or compartment to establish a defined CG position within limits.	X	X	X	X	X
LO	Calculate the loading position or compartment for a given amount of additional load or ballast to establish a defined CG position within limits.	X	X	X	X	X
031 06 00 00	CARGO HANDLING					
031 06 01 00	Types of cargo (general aspects)					
LO	Explain the basic idea of typical types of cargo eg Containerised cargo, Palletised cargo, Bulk cargo.	X	X	X	X	X
031 06 02 00	Floor load and running load limitations in cargo compartments					
LO	Calculate the required floor contact area for a given load to avoid exceeding the maximum permissible floor load of a cargo compartment.	X	X	X	X	X
LO	Calculate the maximum mass of a container with given floor contact area to avoid exceeding the maximum permissible floor load of a cargo compartment.	X	X	X	X	X
LO	Calculate the linear load distribution of a container to avoid exceeding maximum permissible running load	X	X	X	X	X
031 06 03 00	Securing of load					
LO	Explain the reasons for having an adequate tie-down of loads	X	X	X	X	X
LO	Name the basic methods for securing loads	X	X	X	X	X