

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

CHAPTER 19: DETAILED THEORETICAL KNOWLEDGE SYLLABUS AND LEARNING OBJECTIVES

Subject – 031 – Mass & Balance

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

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

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		ATPL	CPL	ATPL /IR	ATPL	CPL	
LO	Describe the effects if CG is behind the aft limit	x	x	x	x	x	
<b>031 01 02 02</b>	<b>Importance in regard to performance</b> <i>Remark - see also subjects 032/034 and 081/082.</i>						
LO	Describe the relationship between CG position and aircraft performance	x	x	x	x		
LO	Describe the effects of CG position on performance parameters (speeds, altitude, endurance and range)	x	x	x	x	x	
<b>031 02 00 00</b>	<b>LOADING</b>						
<b>031 02 01 00</b>	<b>Terminology</b>						
<b>031 02 01 01</b>	<b>Mass terms</b>						
LO	Define the following mass terms: <ul style="list-style-type: none"> <li>- Basic Empty Mass</li> <li>- Dry Operating Mass</li> <li>- Operating Mass</li> <li>- Take off Mass</li> <li>- Landing Mass</li> <li>- Ramp/Taxi Mass</li> <li>- In-flight Mass (Gross Mass)</li> <li>- Zero Fuel Mass</li> </ul>	x	x	x	x	x	

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<b>031 02 01 02</b>	<b>Load terms (including Fuel Terms)</b> <i>Remark - see also subject 033</i>						
LO	Define the following load 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	Explain the relationship between the various load and mass components listed above	x	x	x	x	x	
LO	Convert fuel mass, volume and density given in different units used in aviation	x	x	x	x	x	
<b>031 02 02 00</b>	<b>Mass limits</b>						
<b>031 02 02 01</b>	<b>Structural limitations</b>						
LO	Define the following structural limitations:	x	x	x	x	x	
LO	Maximum Zero Fuel Mass	x					
LO	Maximum Ramp/Taxi Mass	x					
LO	Maximum Take off Mass	x	x	x	x	x	
LO	Maximum In-flight (Gross) Mass	x	x	x	x	x	
LO	Maximum In-flight (Gross) Mass with external load			x	x	x	
LO	Maximum Landing Mass	x	x	x	x	x	
<b>031 02 02 02</b>	<b>Performance limitations</b>						

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		ATPL	CPL	ATPL /IR	ATPL	CPL	
LO	Define 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	
<b>031 02 02 03</b>	<b>Cargo compartment limitations</b>						
LO	Define the following cargo compartment limitations:	x	x	x	x	x	
LO	Maximum Floor load (maximum load per unit of area)	x	x	x	x	x	
LO	Maximum Running load (maximum load per unit of fuselage length)	x	x	x	x	x	
<b>031 02 03 00</b>	<b>Mass calculations</b>						
<b>031 02 03 01</b>	<b>Maximum masses for Take-off and Landing</b>						
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		
<b>031 02 03 02</b>	<b>Allowed traffic load</b>						
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	
<b>031 02 03 03</b>	<b>Use of standard masses for passengers, baggage and crew</b>						
LO	Extract appropriate standard masses for passengers, baggage and crew from relevant documents i.e. JAR OPS 1/3 or Operator requirements	x	x	x	x	x	

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Syllabus Reference	Syllabus and Learning Objectives	Aeroplane		Helicopter			IR
		ATPL	CPL	ATPL /IR	ATPL	CPL	
LO	Calculate traffic load by using standard masses	x	x	x	x	x	
<b>031 03 00 00</b>	<b>FUNDAMENTALS OF CG CALCULATIONS</b>						
<b>031 03 01 00</b>	<b>Definition of centre of gravity</b>						
LO	Define and explain the meaning of centre of gravity	x	x	x	x	x	
<b>031 03 02 00</b>	<b>Conditions of equilibrium (Balance of Forces and Balance of Moments)</b>						
LO	Define datum (reference point), moment arm and moment	x	x	x	x	x	
LO	Name the conditions of equilibrium	x	x	x	x	x	
<b>031 03 03 00</b>	<b>Basic calculations of CG</b>						
LO	Resolve numerical problems using the principle of equilibrium of forces and moments	x	x	x	x	x	
<b>031 04 00 00</b>	<b>MASS AND BALANCE DETAILS OF AIRCRAFT</b>						
<b>031 04 01 00</b>	<b>Contents of mass and balance documentation</b>						
<b>031 04 01 01</b>	<b>Datum, moment arm</b>						
LO	Name where the datum and moment arms for aircraft can be found	x	x	x	x	x	
LO	Extract appropriate data from given documents	x	x	x	x	x	
<b>031 04 01 02</b>	<b>CG position as distance from datum</b>						
LO	Name where the CG position for an aircraft at Basic Empty Mass can be found	x	x	x	x	x	
LO	Name where the CG limits for an aircraft 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	

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		ATPL	CPL	ATPL /IR	ATPL	CPL	
<b>031 04 01 03</b>	<b>CG position as percentage of Mean Aerodynamic Chord (% MAC)</b> <i>Remark – Knowledge of the definition of MAC is covered under reference 081 01 05</i>						
LO	Extract MAC information from aircraft documents	X	X				
LO	Explain the principle of using % MAC for the description of the CG position	X	X				
LO	Calculate the CG position as % MAC	X	X				
<b>031 04 01 04</b>	<b>Longitudinal CG limits</b>						
LO	Extract appropriate data from given sample documents	X	X	X	X	X	
<b>031 04 01 05</b>	<b>Lateral CG limits</b>						
LO	Extract appropriate data from given sample documents			X	X	X	
<b>031 04 02 00</b>	<b>Determination of aircraft empty mass and CG position by weighing</b>						
<b>031 04 02 01</b>	<b>Weighing of aircraft (general aspects)</b>						
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 an aircraft	X	X	X	X	X	
<b>031 04 02 02</b>	<b>Calculation of mass and CG position of an aircraft using weighing data</b>						
LO	Calculate the mass and CG position of an aircraft given reaction forces on jacking points.	X	X	X	X	X	
<b>031 04 03 00</b>	<b>Extraction of basic empty mass and CG data from aircraft documentation</b>						
<b>031 04 03 01</b>	<b>Basic Empty Mass (BEM) and/or Dry Operating Mass (DOM)</b>						

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Syllabus Reference	Syllabus and Learning Objectives	Aeroplane		Helicopter			IR
		ATPL	CPL	ATPL /IR	ATPL	CPL	
LO	Extract values for BEM and/or DOM from given documents	x	x	x	x	x	
<b>031 04 03 02</b>	<b>CG position and/or moment at BEM/DOM</b>						
LO	Extract values for CG position and moment at BEM and/or DOM from given documents	x	x	x	x	x	
<b>031 04 03 03</b>	<b>Deviations from standard configuration</b>						
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	
<b>031 05 00 00</b>	<b>DETERMINATION OF CG POSITION</b>						
<b>031 05 01 00</b>	<b>Methods</b>						
<b>031 05 01 01</b>	<b>Arithmetic method</b>						
LO	Calculate CG position of aircraft by use of the formula: CG position = Sum of Moments/Total Mass	x	x	x	x	x	
<b>031 05 01 02</b>	<b>Graphic method</b>						
LO	Determine CG position of aircraft by use of loading graphs given in sample documents	x	x	x	x	x	
<b>031 05 01 03</b>	<b>Index method</b>						
LO	Explain the principle of the index method	x	x	x	x	x	
LO	Define the terms index, loaded index and dry operating index	x	x	x	x	x	
LO	State the advantage(s) of the index method	x	x	x	x	x	
<b>031 05 02 00</b>	<b>Load and Trim Sheet</b>						
<b>031 05 02 01</b>	<b>General considerations</b>						
LO	Explain the principle and the purpose of load sheets	x					

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		ATPL	CPL	ATPL /IR	ATPL	CPL	
LO	Explain the principle and the purpose of trim sheets	x					
<b>031 05 02 02</b>	<b>Load sheet and CG envelope for light aeroplanes and for helicopters</b>						
LO	Add loading data 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 if applicable	x	x	x	x	x	
<b>031 05 02 03</b>	<b>Load sheet for large aeroplanes</b>						
LO	Explain the purpose of load sheet sections and the methods for establishing “Allowed Mass for Take off”, “Allowed Traffic Load” and “Under load”	x					
LO	Explain the purpose of load sheet sections and the methods for assessing load distribution	x					
LO	Explain the purpose of load sheet sections and methods for cross checking of actual and limiting mass values	x					
LO	Calculate and/or complete a sample load sheet	x					
<b>031 05 02 04</b>	<b>Trim sheet for large aeroplanes</b>						
LO	Explain the purpose of the trim sheet and the methods to determine 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 CG limits	x					



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		ATPL	CPL	ATPL /IR	ATPL	CPL	
<b>031 05 02 05</b>	<b>Last minute changes</b>						
LO	Complete Load and Trim sheet for last minute changes	X					
<b>031 05 03 00</b>	<b>Intentional re-positioning of CG</b>						
<b>031 05 03 01</b>	<b>Re-positioning of CG by shifting the load</b>						
LO	Calculate the mass to be moved over a given distance, or to/from given compartments, to establish a defined CG position.	X	X	X	X	X	
LO	Calculate the distance to move a given mass to establish a defined CG position.	X	X	X	X	X	
<b>031 05 03 02</b>	<b>Re-positioning of CG by additional load or ballast</b>						
LO	Calculate the amount of additional load or ballast to be loaded at a given position or compartment to establish a defined CG position.	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.	X	X	X	X	X	
<b>031 06 00 00</b>	<b>CARGO HANDLING</b>						
<b>031 06 01 00</b>	<b>Types of cargo (general aspects)</b>						
LO	Explain the basic idea of typical types of cargo eg Containerised cargo, Palletised cargo, Bulk cargo.	X	X	X	X	X	
<b>031 06 02 00</b>	<b>Floor area load and running load limitations in cargo compartments</b>						
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	

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		ATPL	CPL	ATPL /IR	ATPL	CPL	
<b>031 06 03 00</b>	<b>Securing of load</b>						
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	