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VERSION	EFFECTIVE DATE	DESCRIPTION OF REVISION(S)
001	2016.01	Module creation and release.
002	2017.02	Format updates and minor type corrections.
003	2019.11	Submodule 3 revisions. Typo corrections in Submodules 3, 4 and 8.
004	2020.02	Enhanced or modified content within the following Submodules: 13.3: Added Autopilot Modes of Operation 13.4: Reorganized based on Part-66 2018 changes; added content: ADS-B and Datalink; Corrected Figures 4-78 and 4-79. 13.7: Added Fly-By-Wire Failsafe and Fly-By-Wire operation.
004.1	2021.04	Enhanced or modified content within the following Submodules: 13.4: Corrected 150 Mhz to 150 Hz. 13.8: Corrected Figure 8-12; Engine Pressure Ratio (EPR) 14.7 psi to 14.5 psi.
004.2	2022.10	Inclusion of Measurement Standards for clarification, page iv. Minor appearance and format updates.
004.3	2023.04	Minor appearance and format updates.
005	2024.12	Regulatory update for EASA 2023-989 compliance.
005.1	2026.06	Replaced practice questions and answers in Submodule 11.
005.2	2026.09	Minor typographical updates and topic clarification. Rewrite of Fuel Systems - Section E, Longitudinal Balance Fuel Systems.

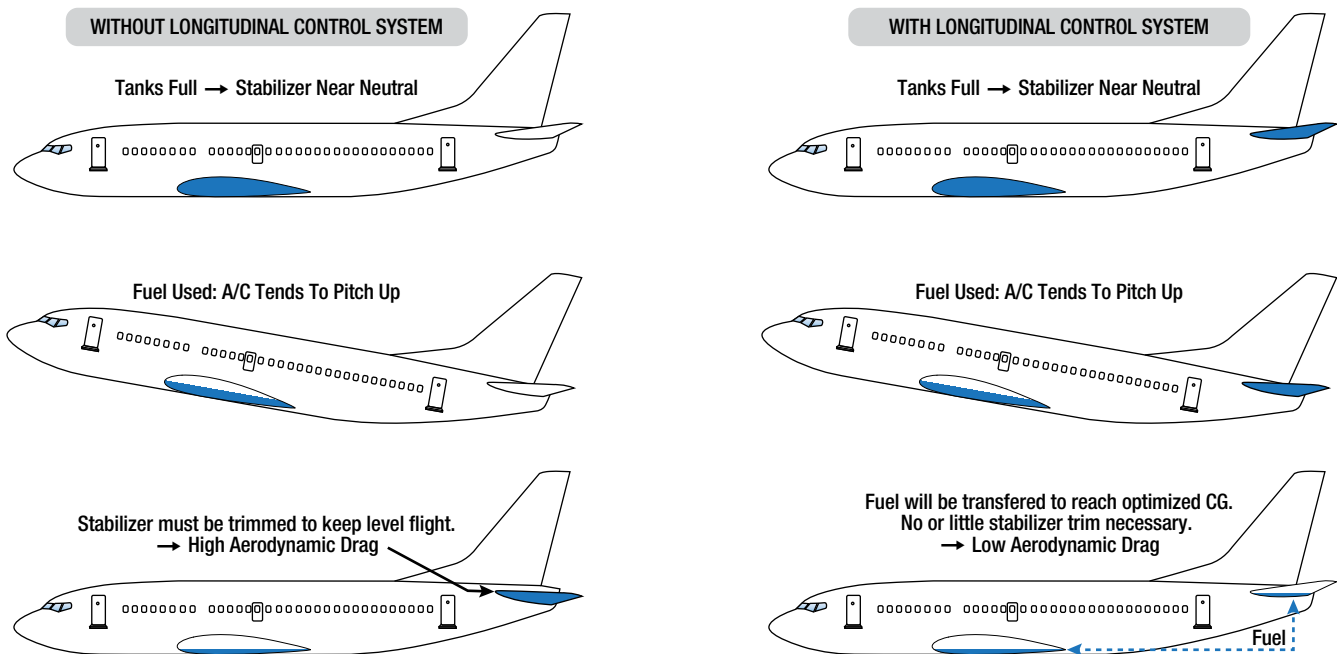


Figure 13-48. Benefits of longitudinal balance fuel system.

SECTION E

LONGITUDINAL BALANCE FUEL SYSTEMS

The center of gravity (CG) of an aircraft is the point where all of the weight of the aircraft is considered to be located. Where the weight is placed in the airplane is a major factor that has a tremendous effect on how well the airplane will fly. Because of this, the CG of the airplane must be maintained within the limits prescribed by the manufacturer in order for the aircraft to be flown safely. If the CG gets too far forward or too far back the aircraft will be out of balance and difficult, if not impossible to control. CG control is especially important during flight phase. To operate an aircraft as economical as possible, the center of gravity should be held in a range where the horizontal stabilizer is as streamlined as possible. This means that the stabilizer trim settings should be close to 0° (Zero) in cruise. In flight, these adjustments are done by transferring fuel. [Figure 13-48] Fuel tanks designated as trim tanks are used to carry the fuel that is transferred to maintain longitudinal balance. [Figure 13-49]

To relieve the flight crew of the task of continually monitoring and transferring fuel to maintain a trim free center of gravity, center of gravity control computers (CGCC) are used. Fuel flow, fuel usage and tank volumes are monitored by the fuel system computer so that valves and pumps are automatically operated to transfer fuel to proper tank locations to maintain the desired CG. Pitch attitude and stabilizer position are also monitored by the CGCC. The CG location is referred as a percentage of the mean aerodynamic chord (MAC). [Figure 13-50]

The target center of gravity must always be forward of the certified aft limit of the aircraft. The flight crew initiates system operation by entering variables such as passenger and cargo loads before flight. Once airborne as the fuel is consumed, fuel management systems and tank volume inputs are used by the CGCC to calculate and perform transfers that keep the CG within desired range.

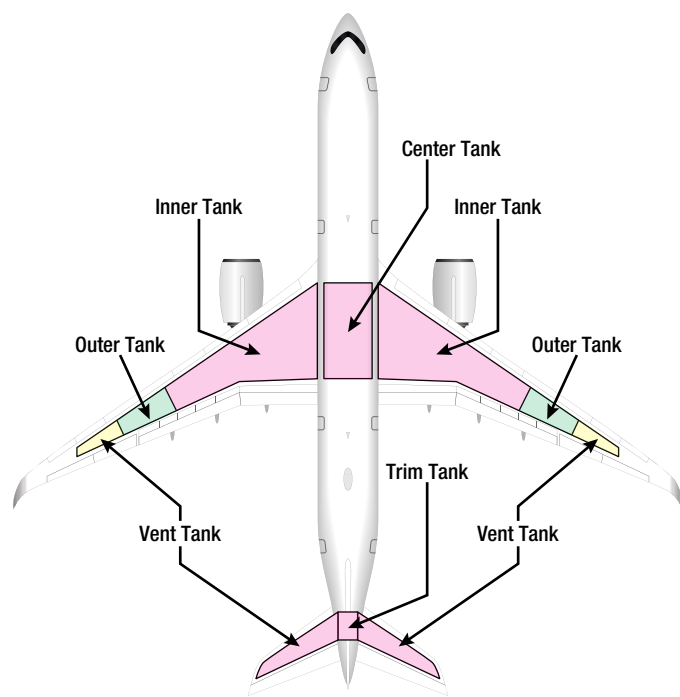


Figure 13-49. Airbus A330 Fuel system tank and trim tank arrangement.

Flight deck display of the aircraft weight and CG location allow crew surveillance of the automated transfers. Should the CGCC system fail, the system automatically switches to an alternate mode. It may also switch to a fault mode which automatically empties the trim tank.

In Figure 13-51 you can find an example of an Airbus A300 CG longitudinal control system. The A300 CGCC has three main functions:

1. The CGCC computes the aircraft CG and gross weight which are displayed on the ECAM.

The CG and gross weight calculation is based on:

- Zero fuel CG and zero fuel weight entered by the crew on the FMS.
- Fuel quantity in each tank provided by the fuel quantity indicator.
- Aircraft pitch provided by the inertial reference system.

- Monitoring the aircraft CG and maintaining the CG target.
- Controlling fuel transfer to and from the trim tank in order to maintain the CG target. This function is only active if at least one trim pump pushbutton switch is selected ON, and the MODE selector is in the AUTO position.

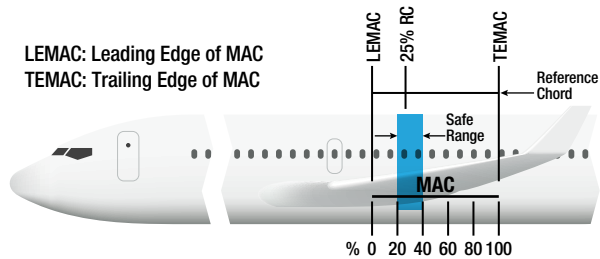


Figure 13-50. Center of gravity (CG) location as a percentage of the mean aerodynamic chord (MAC).

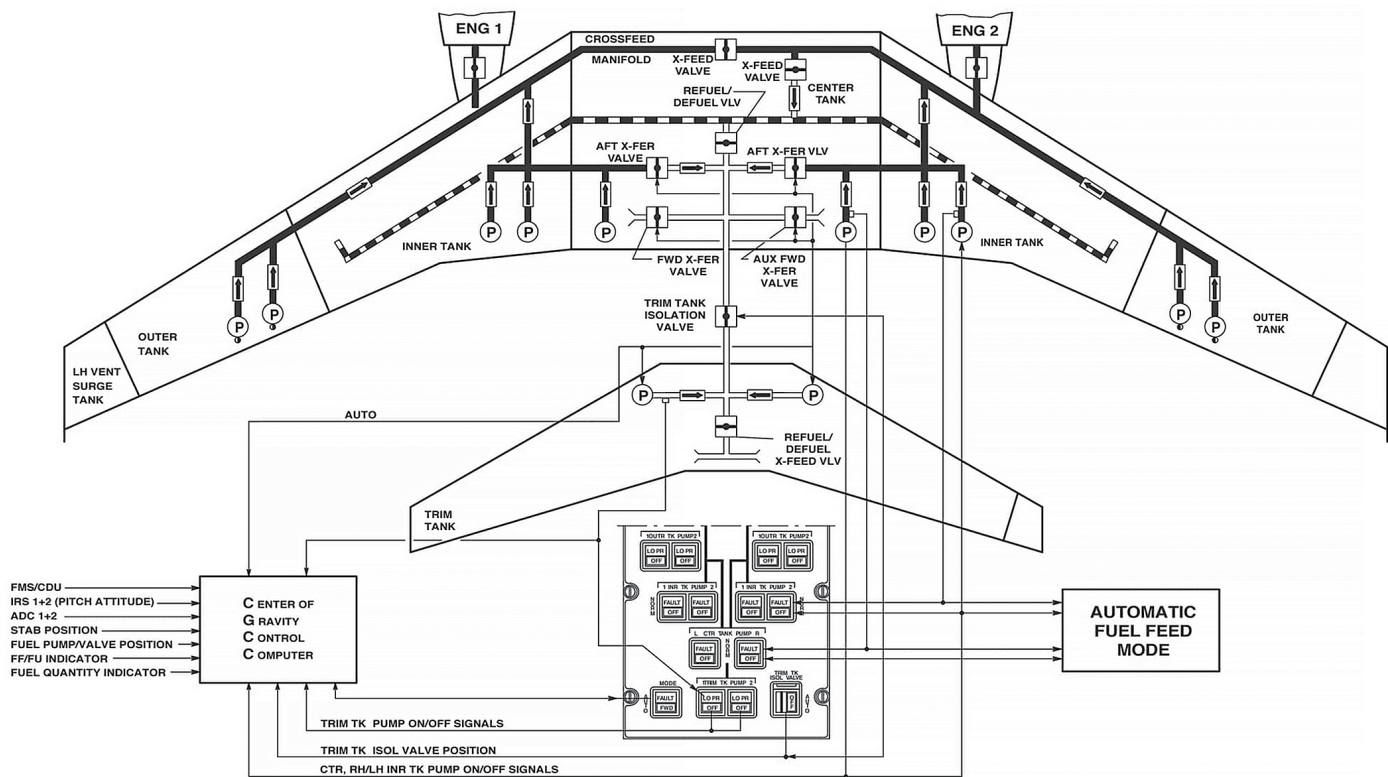


Figure 13-51. Airbus A300 CG longitudinal control system.