CONTROL OF TECHNICAL EQUIPMENT IN THE FIELD OF AVIATION

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Annotation: The article devoted to open the theme control of technical equipment in the field of aviation. Furthermore, information about main control channels and the primary method of controlling the immediate airport environment were given.

Key words: *aviation aircraft, tiltrotors, powered-lift aircraft, civil airplane, flight operations, budgetary requirements, Air traffic control, longitudinal separation.*

Even to a layperson, it is evident that many different types of aircraft are flying about, including general aviation aircraft, helicopters, commercial airliners, military aircraft, etc., as shown in the exemplary photos below. Besides airplanes, there are lighter-than-air concepts such as airships (i.e., dirigibles and blimps) and balloons, unpowered aircraft such as sailplanes and hang gliders, as well as rotorcraft in the form of helicopters, gyroplanes (autogiros), and tiltrotors. Today, more unoccupied air vehicles or UAVs (drones), often classified as powered-lift aircraft, are flying in the airspace and have to safely intermingle with existing aircraft operations. A tiltrotor may also be categorized as a form of powered-lift aircraft[1]. Aerospace engineers need to become familiar with how types of aircraft are classified, certified, and used, e.g., whether it is a civilian or civil airplane designed to transport passengers (i.e., an airliner) or a general aviation airplane intended for training and recreational use or a military aircraft developed for a combat role, or some other type of aviation asset. This distinction is fundamental because the rules and regulations that apply to an aircraft's engineering design, manufacturing, testing, and flight operations (including piloting) depend on the classification of that aircraft.

Furthermore, aerospace engineers need to understand the specific regulatory requirements that apply to the aircraft they are designing and to stay current with any changes to regulations because they are often periodically updated. Therefore, engineers must have a good understanding of the regulations and guidelines. It is also essential for engineers to consider the impact of regulations on their design choices and to balance the safety, performance, and cost requirements. Ultimately, the goal is to produce safe and reliable aircraft that meet a customer's operational and budgetary requirements while adhering to the regulatory framework. Air traffic control (ATC) is a service provided by ground-based controllers who direct aircraft on the ground and in the air. The primary purpose of ATC systems worldwide is to separate aircraft to prevent collisions, to organize and expedite the flow of traffic, and to provide information and other support for pilots when able. In some countries, ATC may also play a security or defense role (as in the United States), or be run entirely by the military (as in Brazil).

Preventing collisions is referred to as separation, which is a term used to prevent aircraft from coming too close to each other by use of lateral, vertical and longitudinal separation minima; many aircraft now have collision avoidance systems installed to act as a backup to ATC observation and instructions[2]. In addition to its primary function, the ATC can provide additional services such as providing information to pilots, weather and navigation information and NOTAMs (Notices to Airmen). In many countries, ATC services are provided throughout the majority of airspace, and its services are available to all users (private, military, and commercial). When controllers are responsible for separating some or all aircraft, such airspace is called "controlled airspace" in contrast to "uncontrolled airspace" where aircraft may fly without the use of the air traffic control system. Depending on the type of flight and the class of airspace, ATC may issue instructions that pilots are required to follow, or merely flight information (in some countries known as advisories) to assist pilots operating in the airspace. In all cases, however, the pilot in command has final responsibility for the safety of the flight, and may deviate from ATC instructions in an emergency.

Aerodynamic forces and moments occur during the control of the movement of unmanned aerial vehicles (UAVs). As the regulating factors for the control of the aircraft, the angles of inclination (roll), torsion, danger (risk) and traction (thrust) of the engine are used, which allow to influence its movement. UAVs as a control object involves a complex dynamic system due to the large number of interrelated parameters and the complex interactions between them. Complex movements are often divided into the simplest types:

- angular movements and center of gravity movements;
- longitudinal and lateral movement.

The governing bodies that make up management actions can be divided into two groups:

- longitudinal control body, which provides movement in the longitudinal plane;
- lateral motion control, which provides the necessary characteristic of changes in the angles of rotation, displacement and rotation in the lateral plane.

Such a division of controls is conditional, which can be attributed to flight modes in which controls interact with other actions[3]. At the same time, such an approach allows to highlight the main functions of certain bodies and management channels and to independently solve tasks of relatively simple and practical importance. Four control channels are needed to ensure full automation of flight control:

• engine control channel (thrust);
• channel (pitch) control channel along the transverse axis;
• control channel for longitudinal rotation (roll);
• channel to control the rotation along the vertical axis (risk).

The engine control channel regulates the movement according to the set flight program. The following three control channels provide the desired angular position of the apparatus in space. Information about the movement of the unmanned aerial vehicle, i.e. the commands generated in the steering wheel, aeronautics and engine control support that provide the specified flight control, comes to the appropriate channels. Sustainable flight management is not possible without creating an acceptable quality automatic control system. The aircraft control system serves to ensure flight along a given trajectory by generating the required aerodynamic forces and moments on the wing and aerodynamic surfaces.

The primary method of controlling the immediate airport environment is visual observation from the airport traffic control tower (ATCT). The ATCT is a tall, windowed structure located on the airport grounds. Aerodrome or Tower controllers are responsible for the separation and efficient movement of aircraft and vehicles operating on the taxiways and runways of the airport itself, and aircraft in the air near the airport, generally 2 to 5 nautical miles (3.7 to 9.2 km) depending on the airport procedures. Radar displays are also available to controllers at some airports. Controllers may use a radar system called Secondary Surveillance Radar for airborne traffic approaching and departing. These displays include a map of the area, the position of various aircraft, and data tags that include aircraft identification, speed, heading, and other information described in local procedures[4]. The areas of responsibility for ATCT controllers fall into three general operational disciplines; Local Control or Air Control, Ground Control, and Flight Data/Clearance Delivery -- other categories, such as Apron Control or Ground Movement Planner, may exist at extremely busy airports. While each ATCT may have unique airport-specific procedures, such as multiple teams of controllers ('crews') at major or complex airports with multiple runways, the following provides a general concept of the delegation of responsibilities within the ATCT environment.

In conclusion it should be noted that the design, operation, and regulations for aircraft vary greatly depending on the aircraft type and its intended use. For example, military aircraft must meet different requirements than commercial airliners, and small general aviation aircraft have different regulations than larger commercial aircraft. Each aircraft type has unique characteristics and operational requirements that must be considered in its design and regulation, so a one-size-fits-all approach is not practical or effective. Different aircraft types have different operational requirements and must be designed to meet those requirements, which will determine the set of rules and regulations that apply. The aircraft's size, weight, complexity, intended use, and human factors all play a role in determining the specific regulations and standards that must be met. The regulatory authorities must ensure that the safety of the aircraft and its passengers is guaranteed, which is why the regulations for each type of aircraft can vary widely. More stringent rules will govern larger, heavier, and more complex passenger-carrying aircraft and comprise more complicated requirements. Again, different rules and regulations will necessarily apply to crewed versus uncrewed aircraft design and operation.

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