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INFORMATIONAL SERVICES FOR CREW ABOUT MINIMAL CRITICAL FLIGHT VELOCITIES

For determining of approaching of critical flight modes, warning systems are installed. However, signalizing about minimal indicated speed is neglected, it is controlled by auto throttle. Therefore, it is necessary to include Informational services for crew about minimal critical flight velocities into warning system.

The analysis of flight accident statistics for the last decade shows, that considerable proportion of it, is faults of flying personnel, especially at critical flight conditions (Fig.1). Therefore, 46 % of accidents is caused by LOC (Loss of control) & CFIT (Controlled flight into terrain)

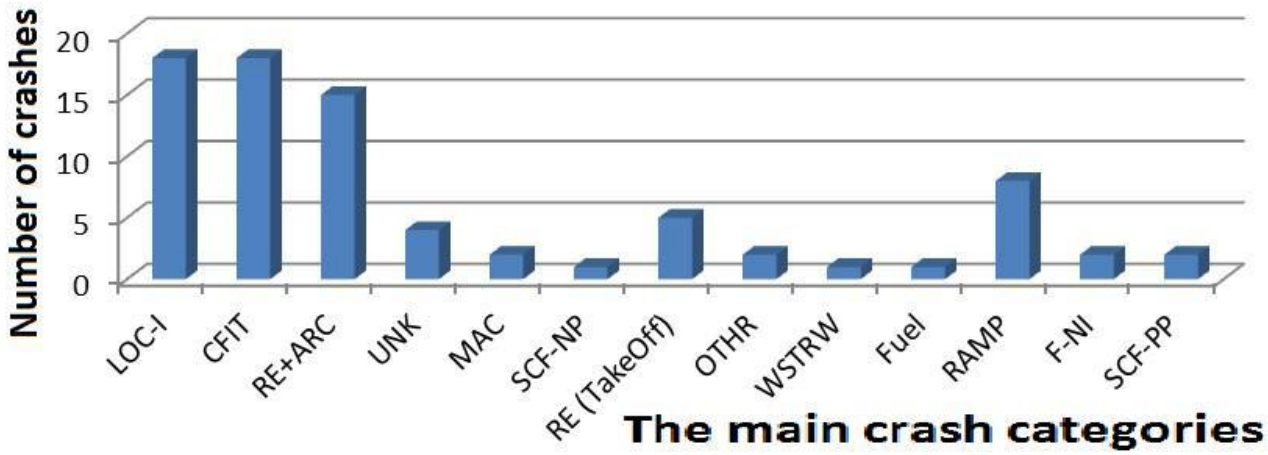

Fig. 1. Analysis of the main crash categories

For the last 35 years, increasing of crashes connected with loss of control. This is because of high automatization level for crew work simplification. Automatization is lead to losing of pilot's skills of flying in extremely conditions, such as fault of automatic control or difficult meteoconditions. Another word, during piloting in manual or direct modes.

The simplification of piloting in manual and direct modes, also prohibition of critical flight modes appearing is demand installation of Flight Warning Systems, which is warn the crew about approaching to the maximum permissible flight parameters and in some cases it corrects controlling of airplane for prohibition of critical flight modes appearing.

Appearing of maximum permissible flight parameters is leads to critical flight modes, i.e. on modes, under which occurs rather dangerous aerodynamic phenomena, such as spin stall.

It's evident, that airplane flies because of lift force (Y), whgich is appears on wing and fuselage:

$$Y = C_y \frac{\rho V^2}{2} S$$

Analysis of the Lift force expression shows, that airflow density (ρ) changes a little during flight, as well as constant aerodynamic airplane areas (wing &fuselage). However, lift force is quickly changes by parameters such as: airplane velocity relatively to airflow (*V*) (or instrument speed *Vinstr*) and lift force coefficient (*Cy*), which is, basically, the function of the wing angle of attack.

Moreover, overloading parameter (*n*) includes the set of all forces, which is acts on airplane and determines airplane controllability (fig. 2).

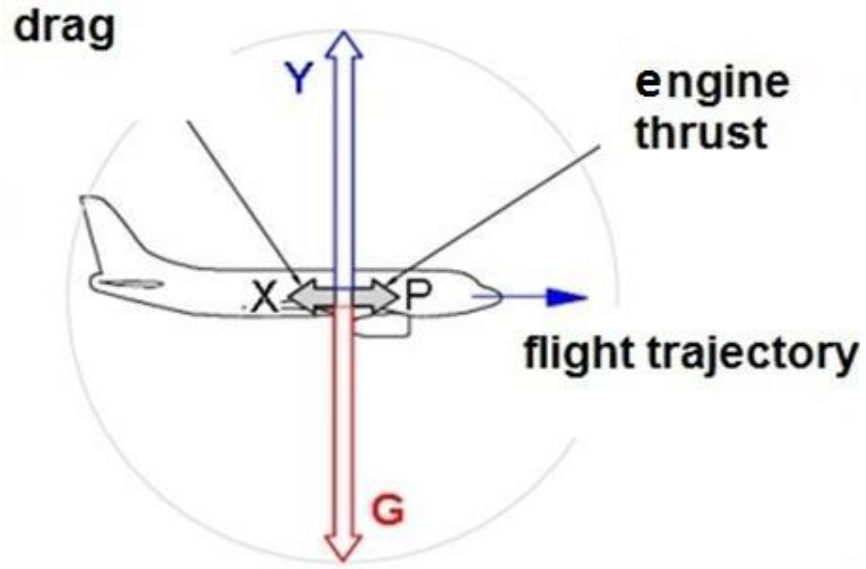

Fig. 2. Forces that act on airplane

Reducing of lift force to the level, that is lowest than gravity force is leads to loss of altitude and to stall. Therefore, one of the main danger for airplane is reducing of instrument speed (*Vinstr*) accordingly reducing of lift force and its stall because of loss of speed, or increasing of the angle of attack upper than its critical value.

In modern aircrafts installed warning systems, (fig.3), for ex., on IL-76 for alerting that the level of the angle of attack more than permissible installed.

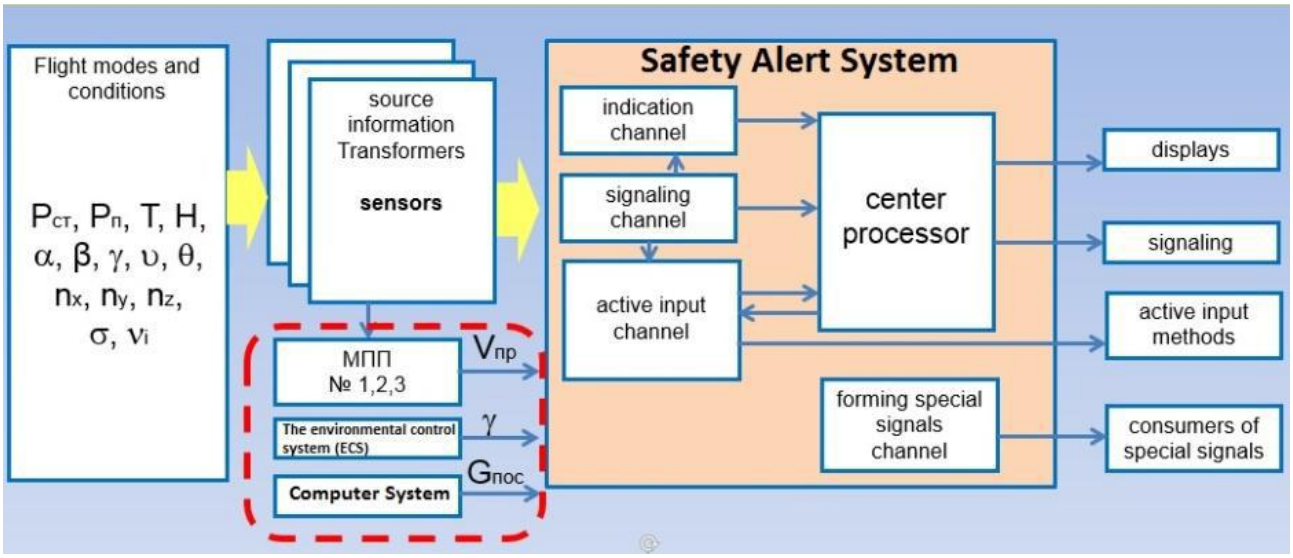

Fig. 3. The structural scheme of critical flight modes warning system

And on airplane An-148 the complex of altitude-velocity parameters is include the signal unit, which is receive information from linear accelerometer unit - about overloading and from flow angle sensor – about angle of attack.

On the base of data about speed and altitude, safety alert system forms signal of maximum permissible angles of attack and overloading and displays information in the form of red bounding sectors on the pointer of angle of attack and overloading on the command-pilot indicator.

On modern aircrafts make notice on critic angle of attack, maximum values of overloading and maximum permissible vertical and horizontal velocities, but signalizing about minimal indicated speed is neglected - it is controlled by auto throttle. Such neglecting can leads to loss of control, as well as during landing and difficult meteoconditions.

During landing pilots tries to touchdown with minimal landing speed, which is must be not lower than minimal controllable airspeed. Therefore on the phase of flareout it is possible increasing of angle of attack for reducing of vertical and longitudinal velocities.

With rising of angle of attack on low speeds – drag is rise; it leads to loss of velocity and altitude. Pilot, who is not have experience in difficult conditions, begins pull control wheel for climbs. Also increasing of angle of attack up to critical at low velocities leads to flow separation on top of wing, that rise decrease lift force coefficient. Significant influence on conditions of stall has roll angle at low velocities and exceeding of airplane weight during landing. Some types of airplanes have fuel availability nearly to weight airplane itself. In such cases weight airplane decreases about in two times and such airplanes have strict restrictions over landing weight, which influences on changing of minimum landing speed and critical angle of attack.

All defined parameters must be taken into account when calculating signalization of critical angle of attack and minimum landing speed.

Therefore, proposed to introduce for analysis of determination of critical flight parameters such as the critical angle of attack and maximum permissible overload, information about actual weight of the aircraft, which characterizes the gravity of the aircraft and aircraft roll angle to calculate its influence on reducing the vertical component of lift. In addition, for control of the minimum instrument speed proposed to introduce preventive visual, audio and tactile indication. Indeed, there are situations of loss of lift and stall in straight horizontal flight.

Thus, including of the signalizer about approaching to the minimal controllable airspeed, as a function of the angle of attack, roll angle, plane weight and flight altitude to the warning system about critical flight modes leads to increasing of pilot’s concentration to aerodynamical characteristics on low speeds and high angle of attack contribute to flying safety improving.