SECTION 2. AVIATION, ROCKET AND SPACE EQUIPMENT

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CALCULATION OF THE AIRCRAFT AN-148 MAXIMUM PAYLOAD FOR PERFORMANCE FLIGHTS ACCORDING TO ETOPS-180 RULES

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Extended-range Twin-engine Operational Performance Standards (ETOPS) [1] are flights that allow increased distance between the flight route and adequate alternate aerodromes more than 60 minutes of flight in case of failure of one power plant on a twin-engine plane. Obviously, this allows you to significantly shorten routes (and in some cases, make them possible at all) in underdeveloped areas where there are few adequate alternate aerodromes. Naturally, having under unconditional economic benefits, ETOPS imposes additional the strictest safety requirements and, as a basis for this, reliability of aviation equipment and professional level of personnel. Flying under the ETOPS rules is becoming generally accepted, they proved their safety and unconditional global success [2, 3].

«UIA» Airlines has long and successfully performed ETOPS flights on Boeing 767 aircraft and on today has a tolerance of 138 minutes, which allows it to fly on the most profitable routes across the Atlantic and Asia.

So, there is a justified interest in the use of ETOPS when flying on modern domestically made aircrafts for example An-148 [4].

When choosing the type of aircraft for operation according to the desire route must take into account the following requirements for aircraft technical requirements [5, 6]: non-stop flight, the maximum commercial load must be at least 80%, economic, i.e.

$$\frac{G_{commercial}^{max}}{G_{commercial}^{economical}} \cdot 100\% \geq 80\% \tag{1}$$

Calculation of the maximum payload

Maximum commercial payload (MPL) of the aircraft, operated on a given airline, calculated by formula:

$$MPL = MTOW - BOW - Wt_{FUEL} - Wt_{CRUE}, \tag{2}$$

Where MTOW – maximum take-off weight

BOW – basic operating weight

Wt_{FUEL} – fuel weight

Wt_{CRUE} – crew weight

The weight of the fuel required for the flight is determined depending on the duration and rates of fuel consumption per hour flight. The air navigation fuel reserve (FR) is assumed to be hourly fuel consumption [7].

Crew weight is determined based on the numbers of the crew and flight attendants. When calculating P_{comm}^{max} the following values should be taken:

– weight of one crew member – 80 kg

– weight of flight attendants – 70 kg

The flight time is determined as follows. First, we define the block speed TAS_{block}. According to the formula

$$TAS_{block} = \frac{DIST_{route}}{\frac{DIST_{route}}{TAS_{cruising}} + t} \tag{3}$$

Where $DIST_{route}$ – distance of route, km

$TAS_{cruising}$ – course speed

Δt – time for takeoff, landing and aircraft maneuvering in the airport area, hour, (take equal to Δt = 0.3-0.5 hours)

$$\text{Flight time} = \frac{DIST_{route}}{TAS_{block}} \tag{4}$$

Planning the work of the aircraft fleet along a planning route

The planning of the aircraft fleet includes the calculation of the “Plan of movement and transportation” and “Plan of movement and use of the aircraft”.

When calculating the planned payload, the following condition must be met:

$$PL_{comm}^{plan} \leq MPL$$

$$PL_{comm}^{plan} = SOP \cdot PL_{comm}^{econom} \tag{5}$$

The planned payload of one flight includes the weight of passengers, cargo and paid baggage.

The weight of the scheduled passenger load of one flight is determined by the formula

$$PL_{comm}^{plan} = SOP \cdot n_{chairs} \cdot 0.09 \tag{6}$$

Number of single flights per year:

$$N_{flights}^{year} = \frac{\text{Npas}}{SOP \cdot n_{chairs}} \tag{7}$$

where: $N_{flights}^{year}$ – planned year passenger flow;

SOP – Seats Occupied Percentage;

n_{chairs} – quantity armchairs.

Annual flying rate

$$W_{hour}^{year} = Flight\,time \times N_{flights}^{year} \tag{8}$$

$$W_{km}^{hour} = DIST_{route} \times N_{flights}^{year} \tag{9}$$

Hourly flight performance:

$$P_{hour} = \frac{GS_{km}^{hour}}{GS_{hour}^{year}} \tag{10}$$

The calculation plan of movement and use of the aircraft is carried out taking into account indicators of the traffic plan and air transportation [8].

The average number of aircraft ($N_{aircraft}$) is determined based on average annual flight hours per aircraft and annual flight hours on a given airway.

$$N_{aircraft} = \frac{GS_{hour}^{year}}{T_{hour}} \tag{11}$$

Where: GS_{hour}^{year} – annual flight hours for a given airway, hours;

T_{hour} – average annual flight hours per aircraft (take equal 2000 ... 2500 h) [7].

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