SYNTHETIC INDICATORS OF AIR FORCES RESOURCES UTILIZATION IN INTERNATIONAL MISSIONS

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Abstract

To protect and promote the security interests of the Romanian state, its air force is called to perform tasks effectively both within the national borders, within and outside NATINADS in NATO and non-NATO multinational operations under or without UN mandate.

1. Quantitative synthetic indicators used in preparing and conducting war missions

Any combat unit's operational cots, as well as its success in war missions and guarantee of mission accomplishment is rendered by the interaction between human resources' quantity and quality, military equipment and logistics supplies.

In this respect, special focus on behalf of the air forces is on quantitative quantifications of its combat units' potential, as well as on the estimation of likely combat situations through synthetic indicators aimed at ensuring and maintaining fire power, combat disposition and maneuverability.

Standard estimation and assurance[1] of combat units' potential through **synthetic indicators** consists of calculations of the capabilities needed to conduct and accomplish war missions. Therefore, the focus of this article will be

[1] Any tactical or operational structure that can accomplish war missions independently or in a centralized manner

on the indicators directly impacting upon air force resources management in international missions.

2. Synthetic indicators of the radiolocation resource usage

Radiolocation usage in air space recce is a defining indicator of any radio technical unit's combat capabilities and it consists of the parameters of the area under recce which are established by the radio technical unit. Therefore, I will present the manner of calculating two parameters of the investigated area that can be viewed as synthetic indicators to be employed in calculating the radiolocation resource.

One of the most important parameters of the investigated area is ***the investigated area's inferior limit height*** and it can be defined as the minimum height ensuring safe detection of own aircraft and uninterrupted pursuit of the enemy's.

In order to calculate the ***investigated area's inferior limit height*** through radiolocation $H_{0,}$ the numerical value pertaining to the detection range for the main radiolocation station in the case of a specific combat device is first established for the area's inferior limit height (D_0) by the formula:

$$D_0 = \sqrt{\frac{S_{Z.D.}}{2.6 N_{sub.}}}, \qquad (1)$$

Where:

$S_{Z..D}$ – Surface of display area;

$N_{sub.}$ – Number of subunits.

Once the numerical value of D_0 established, where the vertical direction of the radiolocation unit D_d = f (H), we then calculate the height value of D_0 which equals the area's inferior limit height.

The probability of air targets detection represents the radio technique system's capacity to positively identify air targets that have similar effective surface reflection and fly at the same height.

For the radio technical unit the ***probability of air targets detection*** is an important matter especially in terms of the recce area's inferior limit height.

The probability of air targets detection can be calculated for one entity in the case of alignment, direction, or for the whole higher echelon by using the formula: (2):

$$P = 1 - (1 - P_1)(1 - P_2)(1 - P_3).....(1 - P_n) \qquad (2)$$

where:

$P_1, P_2, P_3 ... P_n$ refer to the probability of air target detection by any radiolocation unit and ***P*** is the probability of air target detection at a lower combat echelon for the radio technical unit.

3. Synthetic indicators used to calculate air force resource

I will now present some objective **synthetic indicators** used to calculate the air force resource, namely the most significant capabilities of the combat units within the air force group (that is the joint multinational air force component) represnted by aviation and ground- air missiles.

Aviation resource calculations

If the irretrievable losses in air force capabilities are taken into account, the following formula is to be applied:

$$N_{i.av.} = N_0 \frac{1-\beta^n}{\alpha} \qquad (5)$$ [2]

where:

$N_{i.av.}$- the aviation resource expressed as sorties/ time length taking into account the losses

[2] Fl. Răpan, *Tendințe de întrebuințare a aviației militare în cadrul strategic actual*, Editura Academiei de Înalte Studii Militare, 1998, pag.100

N_0 - the initial number of sorties

α -average coefficient of global losses calculated as

$\alpha = K_{n.r.}+K_{r.c.}+K_{r.m.}+K_{r.crt.}$

$K_{n.r.}$ – irretrievable losses coefficient;

$K_{r.c.}$ – coefficient of losses resulting from general overhaul

$K_{r.m.}$ – coefficient of losses resulting from average repairings

$K_{r.crt.}$ – – coefficient of losses resulting from current repairings

The losses coefficient „K" is the ratio between the average number of lost or under repair planes and the number of planes:

$$K = \frac{Np}{Nav} \quad (6)$$

$$\beta = 1 - \alpha$$

n – the total number of sorties for the given period calculated in terms of fight intensity „I":

$n = N_z \cdot I$

N_z – the number of days for which the resource calculations are made;

I - the fight intensity (number of sorties per day for a plane)

Based on the initial formula we can also calculate:

a. The average number of lost planes– N_p:

$$N_p = N_0\left(1 - \beta^n\right) \quad (7)$$

b. After how many sorties „n_n" the losses reach a given level „N_p" that actually results from the agreed upon level of losses when the operation is halted or when the efficiency level no longer matches the efforts (costs).

$$n_n = \frac{\ln\left(1 - \frac{N_p}{N_0}\right)}{\ln\beta} \text{ or } n_n = \frac{\ln\left(1 - \frac{N_p[\%]}{100}\right)}{\ln\beta} \quad (8)$$

c. The number of planes N_n that can participate in the „n"- sortie.

$$N_n = N_0(1-\alpha)^n \quad (9)$$

d. The number of operational planes on ground after an „n” sortie.

$$N_r = N_0(1-\alpha)^{n-1} \qquad (10)$$

Mathematical determinations of the expected number targets downed/ annihilited

A more complex and thorough manner of calculating air force combat capabilities is provided by the *theory of mass servicing* by viewing combat units as service systems with losses or with limited abeyance (mono- channel or multi-channel).

I will exemplify how the aviation annihilation expectancies can be calculated based on the results of the analysis of the service systems with losses, multichannel:

α = service factor, $\alpha = \lambda t_d$;

λ = entry flux parameter; average cost of the planes arrived in the time unit

t_d = service time

t_c = shooting/ control cycle

t_d = tc,

n = the number of channels of the service system

k = the number of units within the system; K position

$P_k = \frac{\lambda^k}{k!\mu^k} P_0$, the probability for the system to be in the position „k” (13)

$P_0 = \frac{1}{\sum_{K=0}^{n} \frac{\alpha^k}{k!}}$, the probability for the system to be clear

(14)

(no channel engaged)

$P_n = \frac{\frac{\alpha^n}{n!}}{\sum_{K=0}^{n} \frac{\alpha^k}{k!}}$, the losses probability

(15)

(the probability for all channels to be engaged)

$$P_d = 1 - P_p = 1 - \frac{\frac{\alpha^n}{n!}}{\sum_{K=0}^{n} \frac{\alpha^k}{k!}}$$, service probability (16)

$$W_* = 1 - e^{\frac{-N_v \cdot I_v}{N_i} \cdot Pd \cdot Wn},$$ (17)

where:

W_* = probability of annihiliation of an enemy plane by at least one of the combat planes;

N_v = number of fighter palnes participating in annihilating enemy in the air;

I_v = own number of fighter sorties during the enemy's attack;

N_i = number of enemy planes participating in attack;

P_d = probability of service;

W_n = probability of annihilating an isolated enemy plane by one of the fighters.;

M_c = mathematical determination of the number serviced/ countered targets

M_n = mathematical determination of the number of annihilated targets

4. Synthetic indicators used to calculate the ground-air missile resource

As far as the ground- air missile resource is concerned, a highly used method to calculate the fire power (that is *the combat and annihilation expectancies*) employs the ratio between *the number of anti-aircraft channels* within fire power system and the *density of the air attack*.

Calculating the combat (employment) expectancy

$$M_c = N \cdot (Ta / Tc) + 1$$
$$N = n \cdot k$$ (18)

where: N = total number of anti aircraft channels;

n = number of antiaircraft systems of a certain type;

k = number of channels of that antiaircraft system.

In order to thoroughly evaluate fire expectancy it is necessary to analyse a few possible tactical situations emerging from the analysis of the likely air ballistic attack against the target: *the number of ballistic missiles* that will attack the target estimated by compartment A_2 and the *attack duration*.

An example in this respect will clarify the above observations. Thus, should there be a ballistic attack (that is 30 ballistic missiles) attack against the target as indicated by compartment A_2 for 1 min.

$$d = \frac{30}{1} = 30$$

The result of previous calculations had pointed out that out of the 30 missiles attacking target „M", M_n = 24 ballistic missiles would be destroyed, whereas 6 missiles would hit and destroy the target.

The effectiveness of antiballistic defense of target is 24/30 %, that is 80 %, with an attack density d = 30 ballistic missiles/min.

Tactically speaking, attack density *„d"* is of high importance since by resorting to it one can determine the number of antiaircraft systems (channels) that are necessary in the antiballistic defence of an objective (N). Thus, mathematical expectancy is met as follows: $n = d \cdot T_c$, (21)

Where, according to the example above, n = 30 · 0,25 = 7,5 ≈ 8 cantiballistic/ antiaircraft shooting channels.

As for the mathematical expectancy in terms of the ballistic missiles fought back:

M_c = 8 · (60/15) + 1 = 32 + 1 = 33 ballistic missiles fought back (system's capacity) ≥ 30, which means that all 30 ballistic missiles are fought back.

M_n = 30 · 0,96 = 28,8 ≈ 29 ballistic missiles downed.

Thus, system's efficiency is 29/30 = 0,96 (96%), increasing by 16%.

In conclusion, I have identified some of the objective synthetic indicators used to calculate combat operational capabilities of the air force (that is the air force resources from joint multinational force). Moreover, I wish to emphasize the role of these indicators in employing the air force resource at its best in accordance with the features of international operations where the air force resources are employed.

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