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AESA AGENCIA ESTATAL DE SEGURIDAD AÉREA

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Air Navigation Safety Assessment Methodology for ATS

Document code: **Issue A**

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1. INTRODUCTION

The Spanish Safety and Security Agency (AESA) perform its oversight duties through an Annual Inspection Plan. This Plan establishes the actions in regulatory control and aviation oversight in order to take care of the compliance with the applicable legislation of national air transportation. This Plan should consider the priorities established by the Air Transport Safety Committee, Aerial Work and General Aviation Safety Committee, Airports Safety Committee and Air Navigation Safety Committee.

The Safety Committees are high level groups leaded by the Director of the Agency, in which members of the steering board and technical experts of the different units involved in the safety and economic oversight. The committees, basing on the available information from safety assessment performed through the methodologies for each domain, analyse and make decisions to enhance safety through prevention and oversight of its domain. The Committees shall meet at least three times a year.

This document describes the Air Navigation Safety Assessment Methodology, as the result of the application of the preventive approach[1] in the field of Air Navigation. On one hand, the methodology is used to establish the prioritization of actions, including additional oversight activities as well as the necessary reallocation of resources. On the other hand, it facilitates the identification of areas susceptible to supervision, providing useful information to the oversight units for the development of their inspection tasks.

The results from this methodology will be analysed and assessed within the Air Navigation Safety Committee.

[1] The preventive approach complements the traditional approach, mainly based on the compliance with safety requirements and on inspections. This new approach is based on the performance, on risk management and on the safety assurance, and it is oriented to the processes instead of being oriented just to the consequences.

2. OBJECTIVE AND SCOPE

The objectives of the Air Navigation Safety Assessment Methodology are the following:

- Establish numeric indicators that enable the identification and measurement of parameters, values and approaches related to safety, based on the available sources.
- Obtain a regular image on the level of safety of each air navigation service provider activities.
- To monitor the evolution of safety-related parameters.
- To determine the sector's safety trend.
- Identify the scopes and providers, where an adequate focus on the oversight activity could foster safety improvements.
- Adapt the AESA Annual Inspection Plan to the results from this analysis.
- Present the results of the analysis in a graphical, straightforward and intuitive way.

This methodology shall apply to every Air Navigation Transit Service Provider (ANTSP); including all ATS units, regardless an ATC or AFIS service is provided.

3. ATS UNITS GROUPS

The ATS Units are divided in different groups according to the different parameters that define in any way its complexity (average of the number of operations in previous years, operative staff in each ATS Unit, operative schedule, number of frequencies, number of ratings and ATS service given), so as they are comparable among them.

To reach the maximum homogeneity in each group and the greatest different between groups, the Cluster Analysis and a qualitative analysis is been used.

4. INDICATORS DEFINITION

In this section, the different technical indicators are described. They have been established to, among other objectives, perform planning activities of regulatory control to the Air Navigation service providers, previously mentioned.

Some indicators could be interrelated among them to facilitate a quantitative interpretation which could serve to classify the inspections in function of the priority they have.

Hereafter, the considered hypothesis and the analysis to obtain each indicator are included.

INDICATOR	SOURCE	SUB-INDICATOR
TECHNICAL GLOBAL	Oversight	Findings
		Frequency of inspections
		Last inspection date
		Notified changes
	Safety Occurrences	Safety occurrences
		ATS incidents recommendations
	Complaints	Complaints

4.1. FINDINGS INDICATOR

FINDINGS INDICATOR (DEF)	
Acronym	**Definition**
D_j	Findings indicator represents the relationship between the number of findings that have been detected in any ATS unit during the last 6 years, weighted in function of the severity and the time between their detection and their correction. The objective of this indicator is to identify those ATS Units in which a greater number of findings has been detected, in which the most severity ones has been identified, or repeatedly and those which has not been corrected in the specified period.

Calculation

Considered hypothesis:

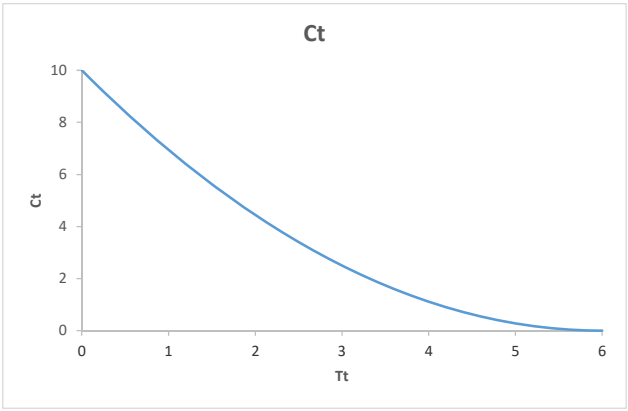
- Coefficient of time and coefficient of deficiency correction are established.
- Findings detected over the last 6 years shall be taken into account.
- Level 1 deficiency will be strongly weighted.
- The number of inspections to the ATS Unit will be considered.

Coefficient of time (C_t):

This coefficient of time to punish to a larger extent the ATS Units where more recently deficiencies have been identified. The C_t will be calculated based on the date the deficiency was detected and shall be obtained through the following formula:

$$c_t = \frac{(Tt - 6)^2}{3{,}6}$$

where T_t is the "time passed from the deficiency detection, expressed in years".



Coefficient of finding correction (C_{Subi}):

For each deficiency, the communication of corrective actions received during the applicable period will be registered and will be compared with the time passed from the existence of correction evidences compared to the proposed implementation time for the corrective actions of the detected findings in each ATS Unit.

$$C_{Subi} = \frac{1}{K_i} \sum_{n=1}^{k} \frac{te_{ki}}{tp_{ki}}$$

being:

- *i* the number of the finding,
- k_i the number of corrective actions for the ATS Unit *i*,
- n_k the number of the corrective action for the finding *i*,
- te_{ki} the time passed1 to the evidence of the implementation of the corrective action *k* for the finding *i*, and
- tp_{ki} the proposed time to the implementation of the corrective action for the finding *i.*
- For those deficiencies that have not still been corrected, te_{ki} will be the current date.

The obtained value C_{Subj} will be limited in the following way:

If C_{Subi}>1,5 →C_{Subi}=1,5
If C_{Subi}<0,5 →C_{Subi}=0,5
In any other case, $C_{Subi} = C_{Subi}$

Therefore, 0,5≤C_{Subi}≤1,5, so each ATS Unit is punished or awarded in function of this coefficient in a moderate manner.

Typology	Temporality	Domain
Cuantitative Continuous Composed	**Frequency of calculation:** The indicator is calculated three times a year (depending on the Committee calls).	Air Navigation Safety -ATS
	Data selection timeframe: The reference time frame for the selection is 6 years.	
Value range	**Formula**	
0-5	$D_j = \frac{\sum_i c_{tij} \cdot c_{Subij} \cdot DN2_{ij} + 3 \times \sum_i c_{tij} \cdot c_{Subij} \cdot DN1_{ij}}{NV_j}$ being: - $DN2_{ij}$ the level 2 finding (minor) *i* for the ATS Unit *j* in the period considered, - $DN1_{ij}$ the level 1 finding (major) *i* for the ATS Unit *j* in the period considered, - NV_j the number of inspections to the ATS Unit *j* in the period considered, - C_{tij} the coefficient of time for the finding *i* for the ATS Unit *j,* and - C_{Subij} the coeficient of finding correction *i* for the ATS Unit *j.*	

[1] The AESA entry registration date will be considered as a reference for the evidence implementation that ends correction action for this deficiency.

4.2. FREQUENCY OF INSPECTIONS PERFORMED IN PREVIOUS YEARS INDICATOR

FREQUENCY OF THE INSPECTIONS PERFORMED INDICATOR (FIP)	
Acronym	**Definition**
FIP	The frequency of inspections performed indicator represents the inspection frequency carried out in each ATS Unit during the last 6 years. For this, the inspection plans of the current and previous years will be studied. The objective of this indicator is to identify those ATS Units that a lower number of inspections has been carried out.

Calculation

Hypothesis considered:

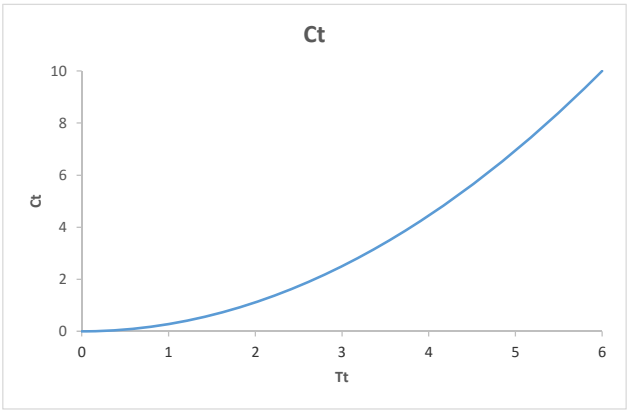
- Coefficient of time is established.
- Deficiencies detected over the last 6 years shall be taken into account.
- The minimum number of times that a ATS Unit should be inspected, regarding the maximum time between inspections applicable for each ATS Unit.

Coefficient of time (C_t):

A coefficient of time (C_t) will be considered for each performed inspection, that will be calculated based on the inspection date, with a lower value as more recent the inspection was performed and obtained through the following formula:

$$C_t = \frac{[\text{Min}(6, Tt)]^2}{3{,}6}$$

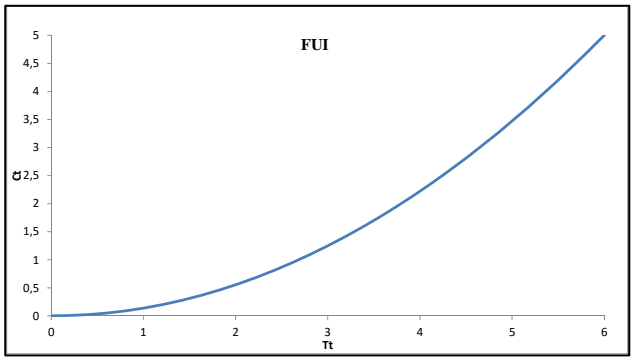
where T_t is the "time passed from the detection of the deficiency, expressed in years".



Typology	Temporality	Domain
Quantitative Continuous Composed	**Frequency of calculation:** The indicator is calculated three times a year (depending on the Committee calls). **Data selection timeframe:** The reference time frame for the selection is 6 years.	Air Navigation Safety

Value range	Formula
0-5	$$FIP = \frac{\sum_i C_{ti}}{NI^2} * (\frac{Round\left(\frac{6}{P}\right)}{NI})$$ being *i* each one of the performed inspection over the last 6 years, *NI* the number of the performed inspection over the last 6 years in this ATS Unit and *P* the maximum available time between inspections established. It is established that: - If *NI* = 0, *FIP* = 5 - If *FIP* ≥ 5, *FIP* = 5 - If *NI* ≥ $Round\left(\frac{6}{P}\right)$; *FIP* = 0 - For the rest of the cases, *FIP = FIP*

4.3. LAST INSPECTION DATE INDICATOR

LAST INSPECTION DATE INDICATOR (FUI)		
Acronym	**Definition**	
FUI	The last inspection date indicator represents the date in which the last inspection was performed. For this, the inspection plans for the current year and for the previous ones will be considered. The objective of this indicator is to identify those ATS Units for which there has passed more time from the last inspection.	
Calculation		
- Inspections over the last 6 years shall be taken into account. - In the case of having performed an inspection during the last year the minimum punctuation will be assigned, this value will be continually increased with the time passed since last inspection, to reach the maximum punctuation of 5 points in the case no inspection in performed in the maximum defined period to do it (P).		
Typology	**Temporality**	**Domain**
Quantitative Continuous	**Frequency of calculation:** The indicator is calculated three times a year (depending on the Committee calls). **Data selection timeframe:** The reference time frame for the selection is 6 years.	Air Navigation Safety
Value range	**Formula**	
0-5	$$FUI = \left(\frac{[Min(P, Tt)]}{P}\right)^2 * 5$$ where T_t is the "time passed from the last inspection, in years" and P the maximum time between inspections established. - If $T_t \geq 6$, FUI = 5 - If $T_t \leq P$, FUI = 0 - For the rest of the cases, FUI = FUI	

4.4. OCCURRENCES INDICATOR

NUMBER OF OCCURRENCES INDICATOR (ORS)	
Acronym	**Definition**
SNS_j	The occurrences indicator represents the existing relationship between the number of occurrences reported to the Occurrence Reporting System (ORS) that have happened in a ATS Unit during the last 6 years, weighing in function of their severity and the time passed since they happened. The objective of this indicator is to identify the ATS Units on which a higher number of occurrences have happened, those of higher severity, those which happened repeatedly or those which have recently happened.

Calculation

Hypothesis considered:

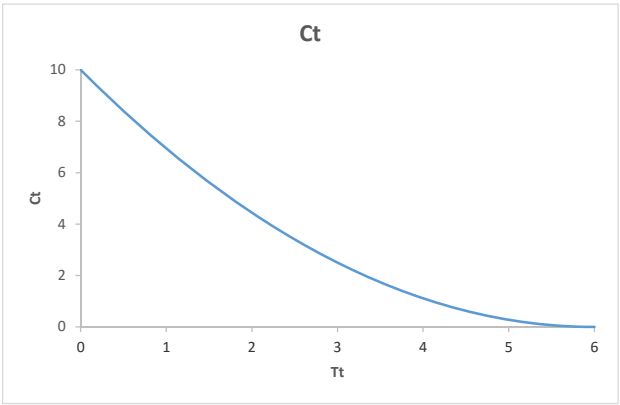
- Coefficient of time and coefficient of severity are established.
- Occurrences happened in the ATS Unit over the last 6 years shall be taken into account.

Coefficient of time (C_t):

A coefficient of time (C_t) for each occurrence shall be established, that will be calculated based on the date that it happened. The more recent the occurrence would be, the higher the coefficient. It will be obtained from the following formula:

$$c_t = \frac{(Tt - 6)^2}{3{,}6}$$

where T_t is the "time passed from the detection of the deficiency, expressed in years".



Coefficient of severity (C_{sev}):

A coefficient of severity will be assigned to each occurrence based on its severity according to the following chart:

Accident (Severity 1) with fatalities	C_{sev} = 45
Accident (Severity 1) without fatalities	C_{sev} = 20
Serious incident (Severity 2)	C_{sev} = 16
Major incident (Severity 3)	C_{sev} = 4
Significant incident (Severity 4)	C_{sev} = 0.1
Occurrence without safety effect (Severity 5)	C_{sev} = 0.00001

Typology	Temporality	Domain
Quantitative Continuous Composed	**Frequency of calculation:** The indicator is calculated three times a year (depending on the Committee calls).	Air Navitagion Safety
	Data selection timeframe: The reference time frame for the selection is 6 years.	

Value range	Formula
0-5	$$SNS_j = \sum_{suc} \frac{(C_{Sev} * C_t)}{Nº\ mov}$$ Being: - *j* is each ATS Unit; - *Nº mov* is the number of movements in the ATS Unit during the assessment period.

4.5. ATS INCIDENTS RECOMMENDATIONS INDICATOR

ATS INCIDENTS RECOMMENDATIONS INDICATOR (RCE)	
Acronym	**Definition**
$\mathbf{RCE_j}$	RCE indicator represents the ATS incidents recommendations applicable to each ATS Unit during the last 4 years. The objective of RCE indicator is to identify those ATS Units with higher number of recommendations and/or more recent recommendations, in such a way that inspection to this ATS Units is prioritize.

Calculation

Hypothesis considered:

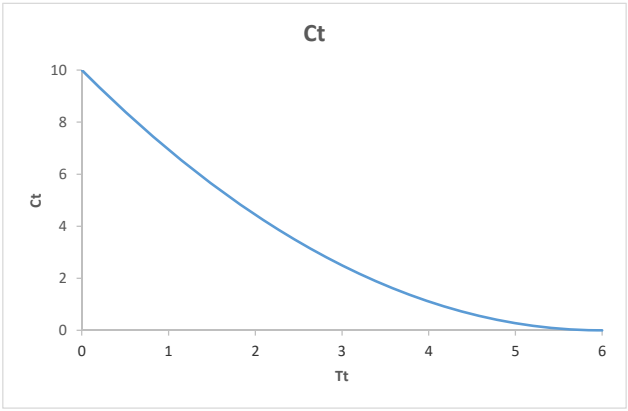
- Coefficient of time and coefficient of severity are established.
- ATS incidents recommendations addressed to each ATS Unit during the last 4 years will be taken to account.

Coefficient of time (C_t):

A coefficient of time (C_t) for each recommendation will be considered, it will be based on the date it was issued, will have a higher value as the more recent the recommendation was and will be obtained from the following formula:

$$c_t = \frac{(Tt - 6)^2}{3{,}6}$$

where T_t is the "time passed since the issuing of the recommendation, expressed in years".



Coefficient of severity (C_{sev}):

A coefficient of severity (C_{sev}) will be assigned for each recommendation based on the severity of the air traffic incident according to the following criteria:

Severity A	**C_{sev} = 16**
Severity B	C_{sev} = 4
Severity C	C_{sev} = 0,1
Severity D	C_{sev} = 0
Severity E	C_{sev} = 0

Typology	Temporality	Domain
Quantitative Continuous Composed	**Frequency of calculation:** The indicator is calculated three times a year (depending on the Committee calls).	Air Navigation Safety
	Data selection timeframe: The reference time frame for the selection is 4 years.	

Value range	Formula
0-5	$$RCE_j = \sum_{rec} C_t * Csev$$ Being: - *j* is each ATS Unit

4.6. NOTIFIED CHANGES INDICATOR

NOTIFIED CHANGES INDICATOR (CAM)	
Acronym	**Definition**
$\mathbf{CAM_j}$	CAM indicator represents the number of changes (operational or technical) reported by ATS service providers during the last 5 years. The objective of CAM indicator is to identify those ATS Units with higher number of changes, with more recent changes and/or more severe, in such a way that inspection to these ATS Units was prioritized.

Calculation

Hypothesis considered:

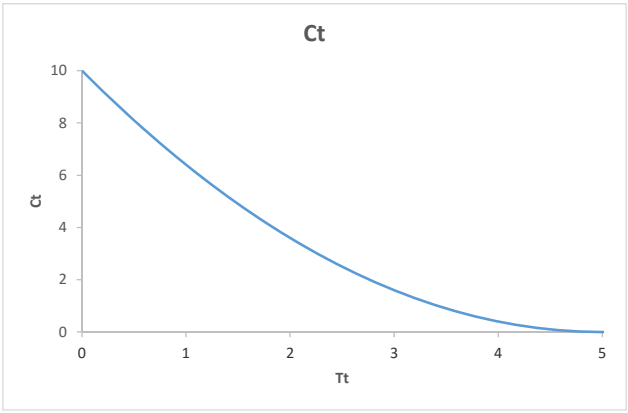
- Coefficient of time and coefficient of severity are established.
- A weight 5 times greater is agreed to be given to changes undergoing acceptance against to those only notified.

Coefficient of time (C_t):

A coefficient of time (C_t) for each change will be considered, that will be based on the date it was implemented, will be higher as more recent this date was, and will be obtained from the following formula:

$$c_t = \frac{(Tt - 5)^2}{2{,}5}$$

where T_t is the "time passed since the issue of the implementation of the change, expressed in years".



Coefficient of severity (C_{sev}):

A coefficient of severity (C_{sev}) for each change will be assigned, based on higher severity of the "worse potential credible effects" of the risk associated to the change (indicated by the own service provider in the acceptance of the change request, according to the following criteria:

Severity 1	C_{Sev}=50
Severity 2	C_{Sev}=40
Severity 3	C_{Sev}=10
Severity 4	C_{Sev}=3
Severity ALARP	C_{Sev}=1
Severity 5	C_{Sev}=0

Typology	Temporality	Domain
Quantitative Continuous Composed	**Frequency of calculation:** The indicator is calculated three times a year (depending on the Committee calls). **Data selection timeframe:** The reference timeframe for the selection is 5 years.	Air Navigation Safety

Value range	Formula

0-5	$$CAM_j = \left(\sum_{not_{CNO}} (\boldsymbol{C_{Sev}} * \boldsymbol{C_t}) + \mathbf{5} * \sum_{not_{CSA}} (\boldsymbol{C_{Sev}} * \boldsymbol{C_t}) \right)$$ being: - *j* is each ATS Unit; - not_{CNO} is the index of the summation for all notified changes, that are not subject to acceptance; - not_{CSA} is the index of the summation for all those changes subject to acceptance;

4.7. COMPLAINTS INDICATOR

<table>
<tr><th colspan="3">COMPLAINTS INDICATOR (DEN)</th></tr>
<tr><th>Acronym</th><th colspan="2">Definition</th></tr>
<tr><td>$\mathbf{DEN_j}$</td><td colspan="2">The complaints indicator represents the relationship between the number of received complaints by AESA in each ATS Unit during the last 4 years.

The objective of the DEN indicator is to identify some issue that could require an inspection.</td></tr>
<tr><th colspan="3">Calculation</th></tr>
<tr><td colspan="3">Due to the lack of a great number of complaints for each ATS Unit, it has no sense to develop an indicator similar to the previous one; therefore, a relationship between the number of complaints in any ATS Unit in the considered period and the maximum number of this ATS Unit in the considered period; after that, the result is rescaling to the interval from 0 to 5.</td></tr>
<tr><th>Typology</th><th>Temporality</th><th>Domain</th></tr>
<tr><td rowspan="2">Quantitative
Continuous
Composed</td><td>Frequency of calculation:
The indicator is calculated three times a year (depending on the Committee calls).</td><td rowspan="2">Air Navigation
Safety</td></tr>
<tr><td>Data selection timeframe:
The reference timeframe for the selection is 4 years.</td></tr>
<tr><th>Value range</th><th colspan="2">Formula</th></tr>
<tr><td>0-5</td><td colspan="2">$$DEN_j = \frac{d_j}{d_{máx}} \cdot 5$$
being:
- j is each one of the ATS Units;
- d_j is the total number of complaints received by a ATS Unit, being object of analysis by the Air Navigation Safety Committee;
- $d_{máx}$ is the maximum number of complaints in a ATS Unit during the period of study</td></tr>
</table>

4.8. TECHNICAL GLOBAL INDICATOR

TECHNICAL GLOBAL INDICATOR (ITG)	
Acronym	**Definition**
ITG	The technical global indicator combines the following indicators, weighing them in function of the weigh considered to be assigned to any of them: - *Deficiency* indicator. - *Frequency of the inspections performed* indicator - *Last inspection date* indicator - *Occurrences* indicator - *ATS incidents recommendations* indicator - *Notified changes* indicator - *Complaints* indicator

Calculation

In the following table the weighing coefficient applicable to each technical indicator are defined:

INDICATOR	DEF	FIP	FUI	SNS	RCE	CAM	DEN
C_{pi}	15	5	15	30	10	15	5

Typology	Temporality	Domain
Quantitative Continuous Composed	**Frequency of calculation:** El indicador se calcula tres veces cada año (dependiendo de la periodicidad de las reuniones del Comité). **Data selection timeframe:** The reference time for each selection is different for each sub indicator. Consult in each table.	Air Navigation Safety

Value range	Formula
0-5	$$IGT = \frac{\sum_i cp_i \, I_i}{\sum_i cp_i}$$ where I_i is each of the technical indicators from previous sections and C_{pi} is the weighting coefficient applied to each one.

5. STANDARDISATION OF VALUES OBTAINED

In order to better analyse the values obtained, the indicators have been typified and escalated so that its value is comprised between 0 and 5. The cases in which the final values are outside this interval must be analysed on a case by case basis.

With the objective of expressing the behaviour of any analysed ATS Unit against that of its group, both in the position within the group and the evolution along the time, a comparative factor is included to correct the deviation with respect to a reference period in which its average values are considered acceptable.

$$Z = \left(\left(\frac{x - \mu}{\sigma} + \left(\frac{\mu - \mu_{ref}}{\sigma} \right) \right) + 3 \right) * \frac{5}{6}$$

Where:
$x \equiv rate \rightarrow x = I_i$, being I_i each one of the technical indicators defined in 4

μ ≡ average of the group in the period to be analysed.

μ_{ref} ≡ average of the reference period

σ ≡ standard deviation according to the sample of the group

5.1. CLASSIFICATION AND KEY OF THE OBTAINED VALUES

As it has been defined in the previous section, the obtained results will be comprised, in most of the cases, between 0 and 5 in such a way that it could be assess in an analytical way.

Three priority levels are defined, with its respective codification, similar to that of a risk analysis:

- Priority 3: Corresponds to the values comprised between 0 and 2,5. No further action is required.
- Priority 2: Corresponds to the values comprised between 2,5 and 3,5. A monitoring of this indicator should be performed in case it will pass to Priority 1, controlling its evolution.
- Priority 1: Corresponds to the values greater than 3,5. The cases in which this happens should be analysed case by case in the Committee in case another corrective measure could be necessary.

6. GRAPHIC REPRESENTATION OF INDICATORS

A number of graphs have been defined to present the results from the analysis and monitoring of the level of safety in the activity of each ATS Unit:

- Global technical indicator for all ATS Units.
- Global technical indicator by ATS Unit groups.
- Comparison between an ATS Unit in relation to the group it belong to.
- Occurrence indicator
- Temporal evolution of each ATS Unit group.

These graphs enable to show standby data (fixed image of the state of the ATS Units in order to identify negative situations) and in a temporal way (evolution of the values of ATS Unit indicators along the time in order to identify negative trends).

The indicators described in the previous points, enable to make the specified graphic representations.

6.1. GLOBAL TECHNICAL INDICATOR FOR ALL ATS UNITS

A graphic representation example of the global technical indicator for all ATS Units is included. Thanks to the chart, it can be seen at a glance which ATS Units *a priori* deserve more oversight activities, as well as their more deficient aspects.

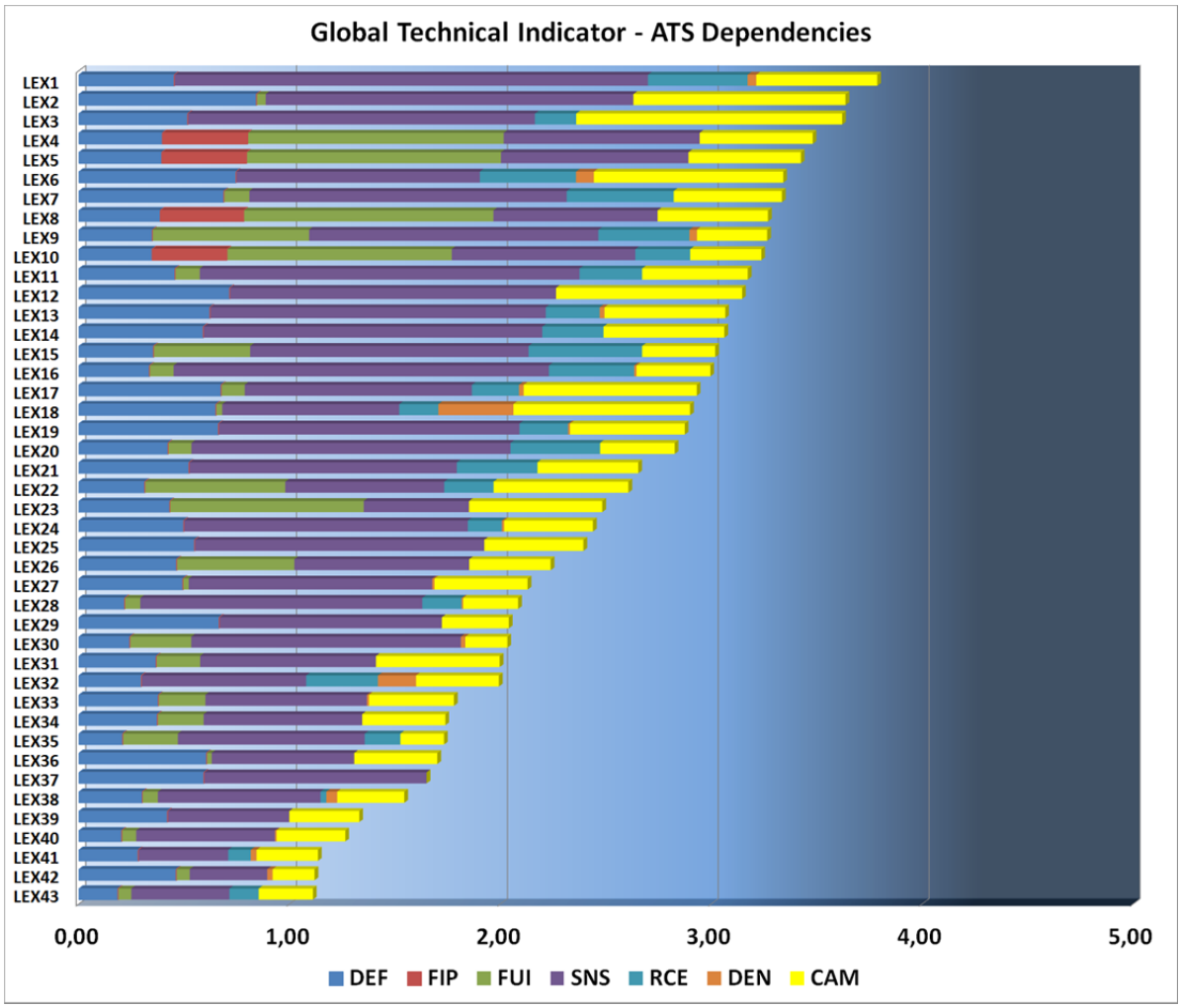


Figure 1. Global technical indicator for all ATS Units

6.2. GLOBAL TECHNICAL INDICATOR BY ATS UNIT GROUPS

Focusing on each group, the state of each ATS Unit can be compared to those ATS Units within the same group, as well as their more deficient aspects.

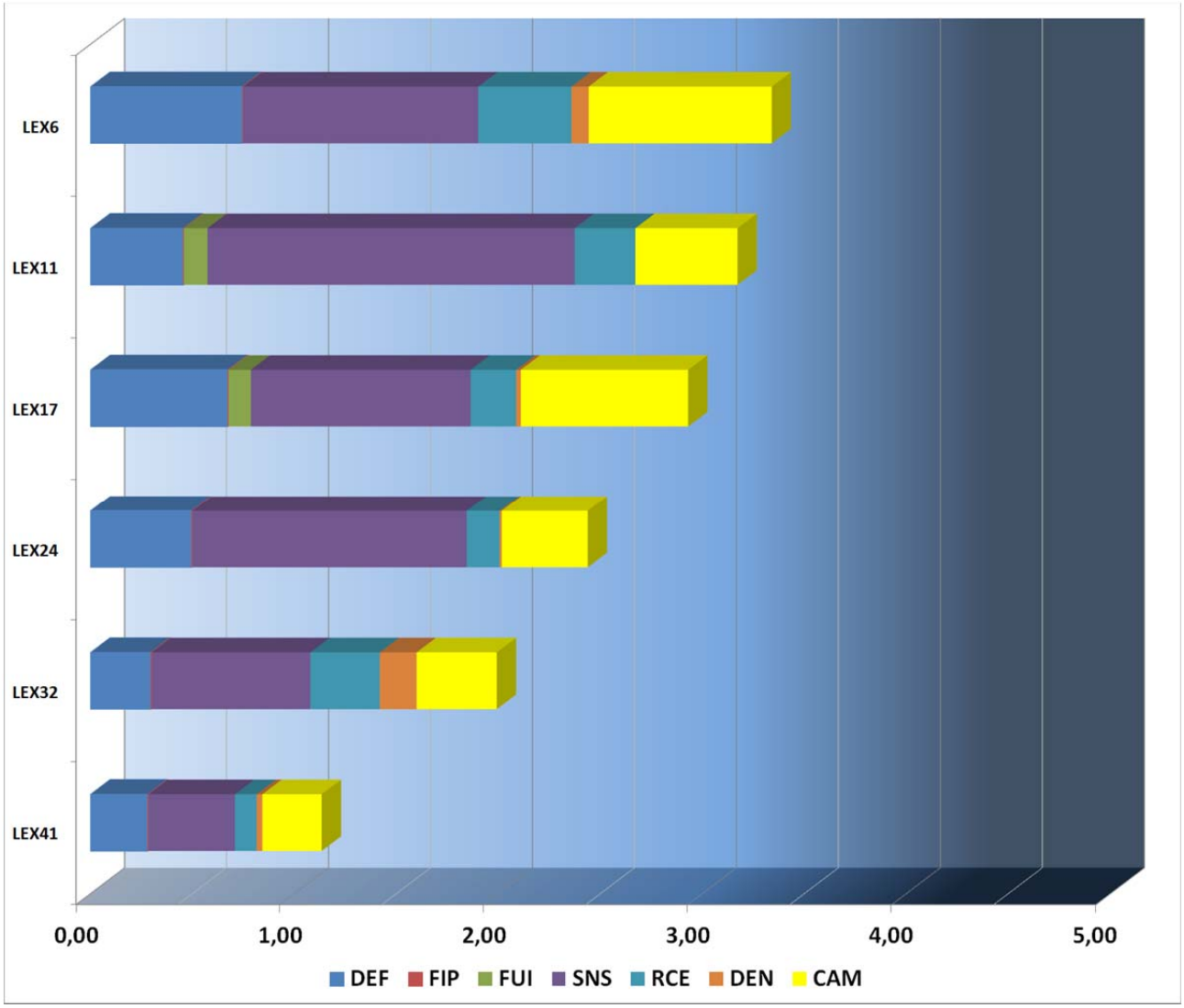


Figure 2. Technical global indicator for Group X

6.3. COMPARISON OF A ATS UNIT WITHIN ITS GROUP

In the following chart there is a graph, for a particular group of ATS ATS Units, the results from the technical indicators defined previously are included. In such a way, a comparison can be made between each ATS Unit and the group it belongs to.

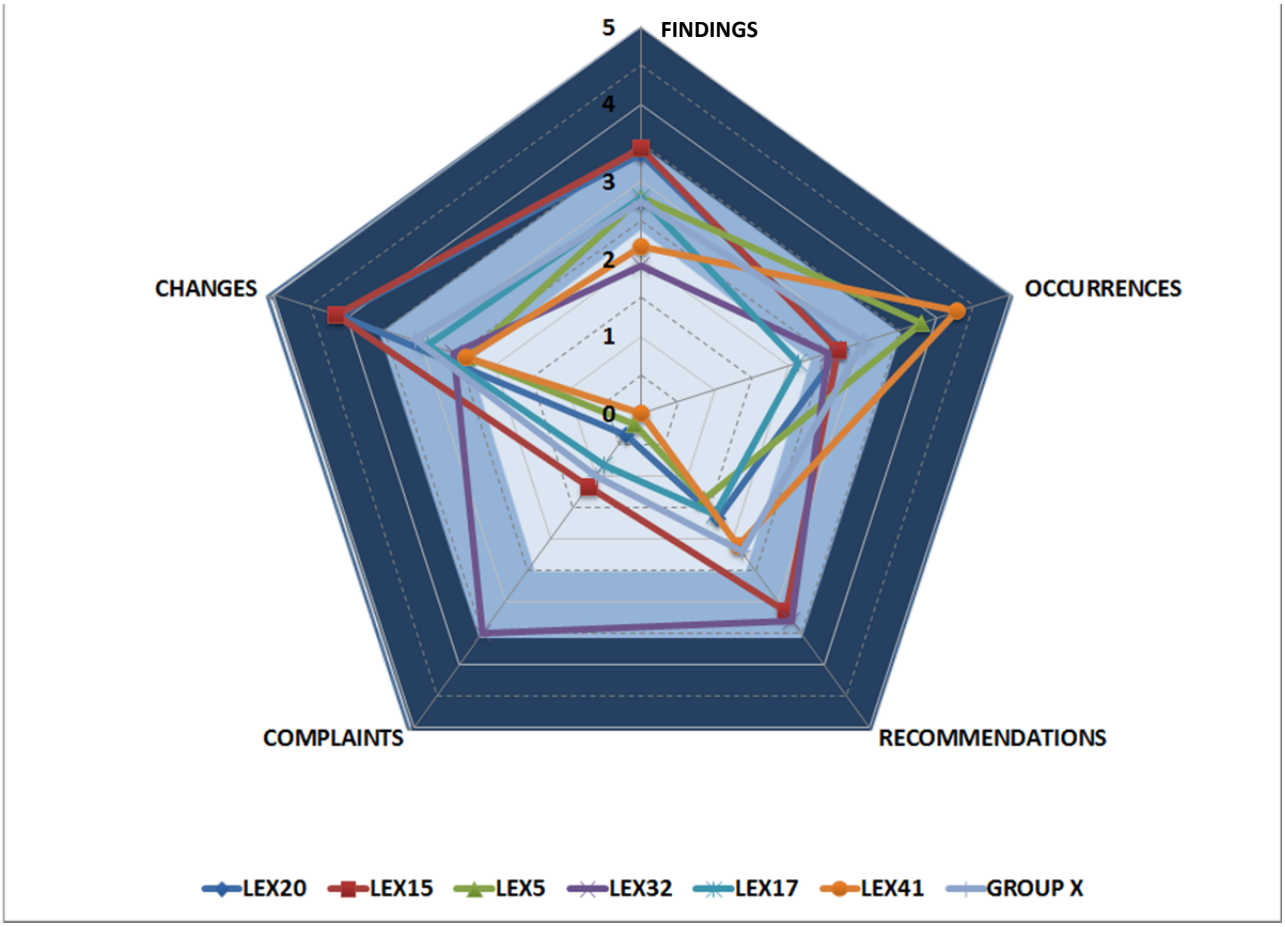


Figure 3. Technical ATS indicators for Group X

6.4. OCCURRENCE INDICATOR GRAPHIC REPRESENTATION

In the following chart a specific group of ATS Units is shown, the number of occurrences notified by tipology, considering its severity and the number of controlled flights in the last 24 months ("Interannual -1" and "Interannual -2" periods). The group data correspond to the occurrences in the only last 12 months.

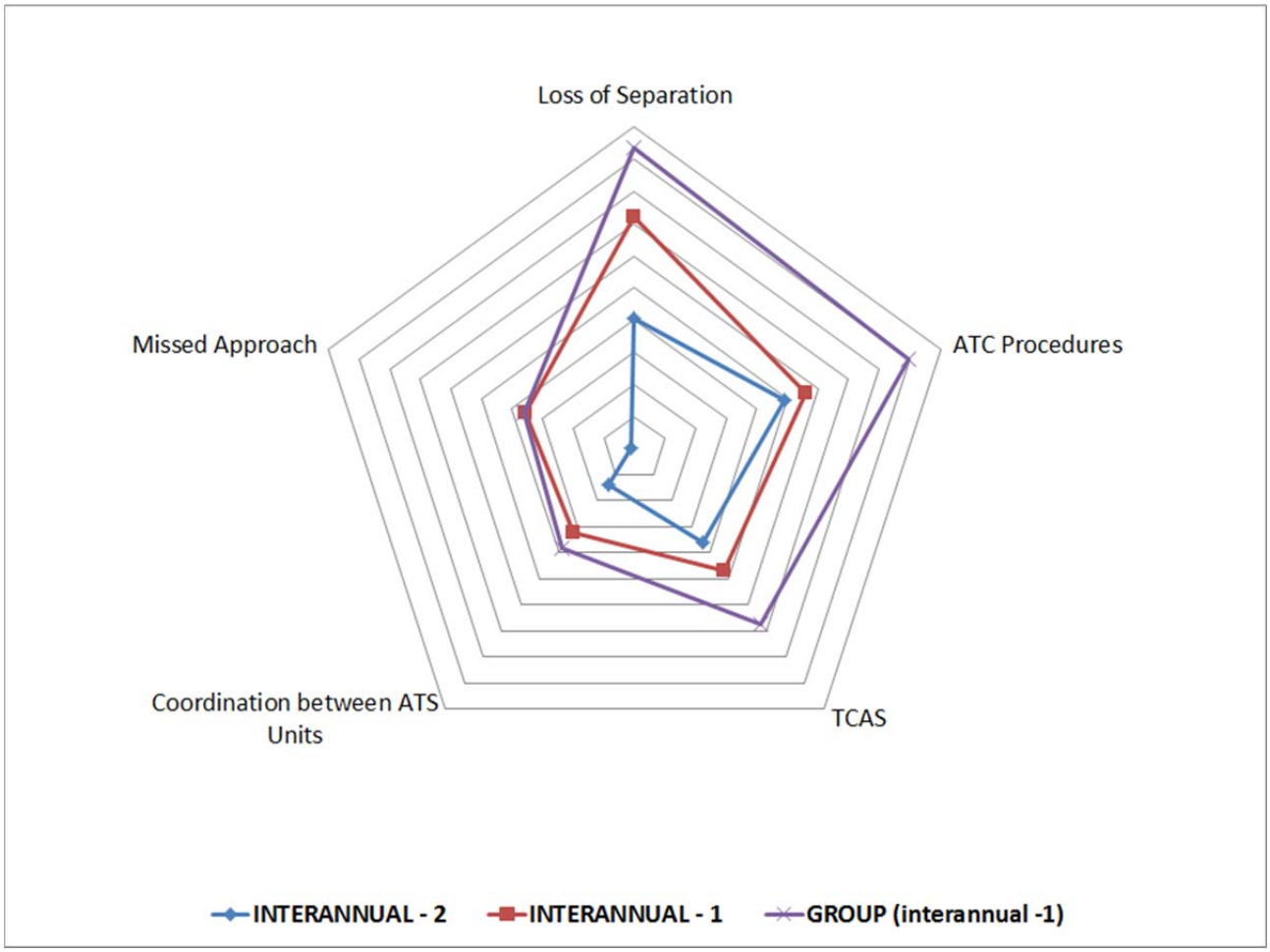


Figure 4. ORS indicator – Interannual analysis ATS Unit LEX1

6.5. TEMPORAL EVOLUTION FOR EACH ATS UNIT GROUP

The following chart represents the tendency and evolution of each ATS Unit group. The abscise axis represents the findings indicators, the last inspection date, complaints and changes. The ordinate axis represents the occurrence indicators and ATS incidents recommendations.

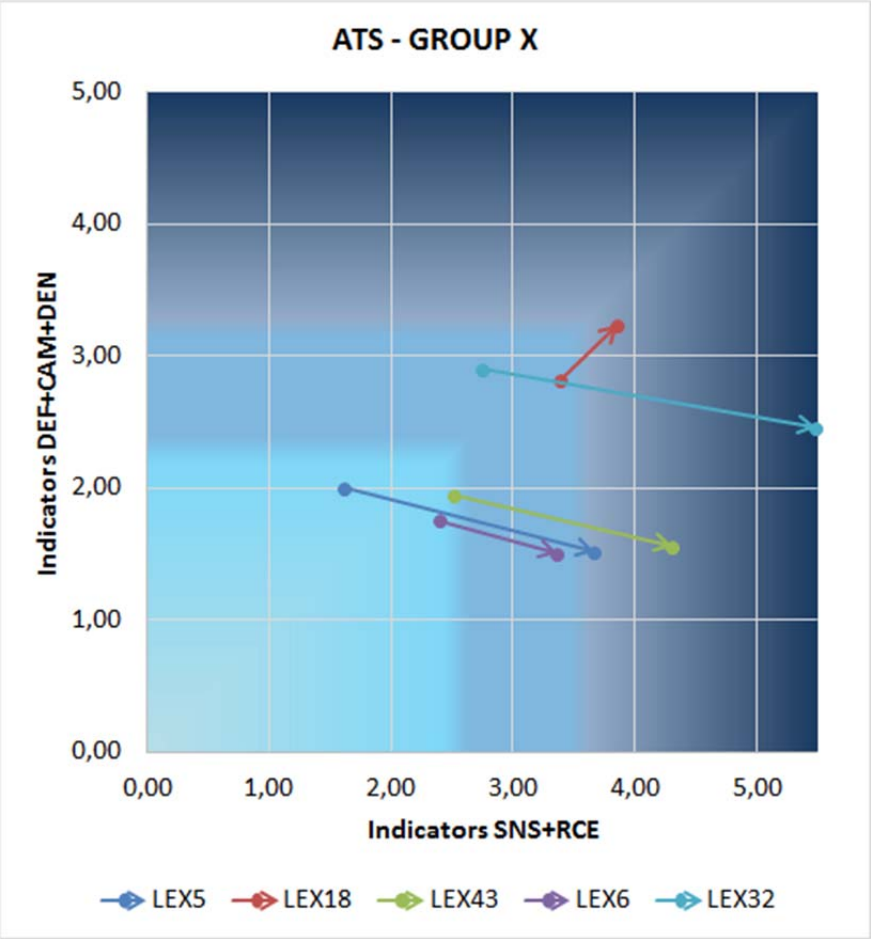


Figure 5. Temporal evolution of Group X indicators