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RESULTS AND METHODOLOGIES OF AIRPORT NOISE STUDIES

Authors:
Max Glisser Donoso
Christian Gerard Büchi

CONTROL ACUSTICO
GERARD INGENIERIA ACUSTICA SPA

www.controlacustico.cl

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Certificado: 01 100 072559

ABSTRACT

For more than 5 years *Control Acústico* has been working on different projects for evaluating the noise generated by operations related to different Chilean airports and also to some foreign cases.

This work presents the obtained results when using the Integrated Noise Model (INM) of the Federal Aviation Administration (FAA) applied to some studies carried out by the company.
Also are discussed the methodologies for obtaining the noise exposure contours based on the Yearly Day-Night Level YL_{DN}.

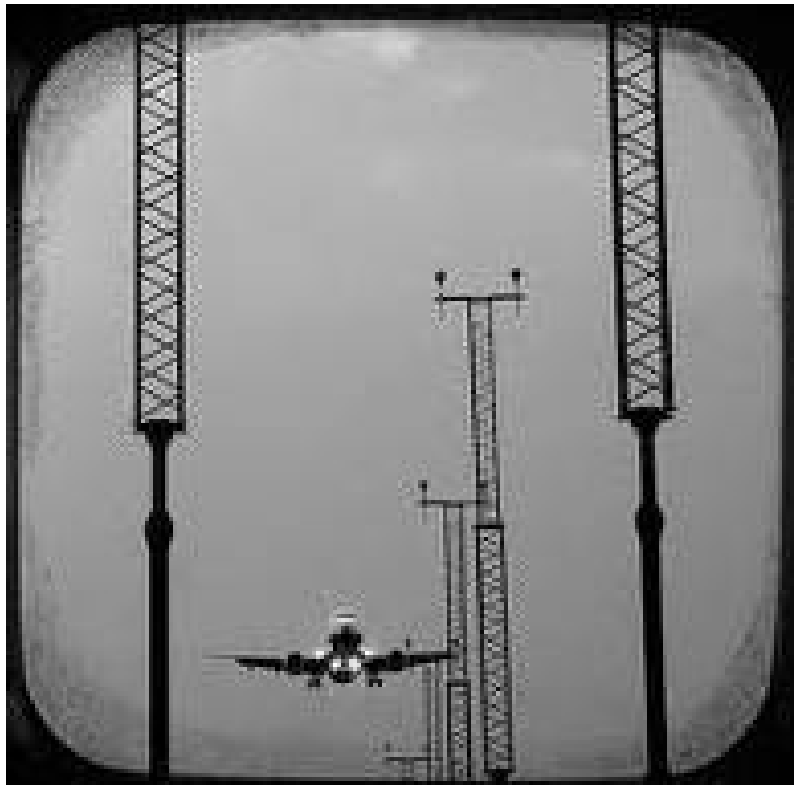
INTRODUCTION

In this work is discussed the applicable standards and the methodologies adopted by *Control Acústico* to perform studies for evaluating the noise generated by the operation of public airports.

Some of the factors that were taken into account for analyzing the methodologies are:

- **Sound Pressure Level (24 hours or more);**
- **The composition of the Aircraft Fleet;**
- **Taking off and landing routes;**
- **ETC.**

THEORETICAL BACKGROUND



THEORETICAL BACKGROUND

Policy and Noise Regulations – FAA (U.S. Federal Aviation Administration)

The FAA publishes the policy, guides and other general information by means of the so-called Advisory Circulars (AC).

The objective of the F.A.A is to develop regulations, including the problem of the noise generated by the inherent activities of an airport.

These regulations, FAR (Federal Aviation Regulations), are presented in the Code 14 CFR (Code of Federal Regulations) for the United States of America.

THEORETICAL BACKGROUND

About noise, the FAR establishes:

<u>FAR Part 150:</u> This regulation was developed for answering the necessity to establish a national standard for identifying the incompatibilities between "land use" and noise level. At the same time, it establishes programs to eliminate these type of conflicts. The FAR 150 was published in the act of 1979 of the "Aviation Safety and Noise Abatement".

THEORETICAL BACKGROUND

FAR Part 150:

Defines specific standards and systems for:

- **Noise measurements**
- **Estimation of the cumulative sound exposures using computational modeling**
- **Acoustical descriptors for sound exposure, considering instantaneous noise levels, noise levels for single events and cumulative exposure.**
- **It is defined the Day-Night Level L_{DN}:**

$$L_{DN} = 10\log\left\{\left(\frac{1}{24}\right)\left[\left(15\times10^{0.1L_D}\right)+\left(9\times10^{0.1(L_N+10)}\right)\right]\right\}$$

Where:

L_D: Equivalent Continuous Sound Pressure Level for the day period (07:00 – 22:00 hrs)

L_N: Equivalent Continuous Sound Pressure Level for the night period (00:00 – 07:00 hrs and 22:00 – 00:00 hrs)

THEORETICAL BACKGROUND

- **Defines the Yearly Day-Night Level (YL_{DN}) as the mean of the 365 Day-Night Levels L_{DN} (or *DNL*):**

$$YL_{DN} = 10Log\left[\frac{1}{365}\sum_{J=1}^{365}10^{\frac{L_{DNJ}}{10}}\right]$$

- **Coordinates the development of compatible noise programs considering the land uses defined by local authorities and other interested parts.**
- **Details the documentation and the analytic processes for the implementation of programs compatible with the land uses and noise, which will be remitted to the FAA.**
- **Defines the FAA processes for the public revision of the study.**
- **Defines the FAA processes to approve the study**

Noise Levels limits [in dB(A)] , compatibles with different land uses

Uso de Terreno	Nivel de Ruido Día-Noche por año (YLDN) en dB					
	< 65	65 -70	70 -75	75 - 80	80 - 85	Sobre 85
Residencial						
Residencial, casas rodantes y alojamientos transitorios	SI	NO	NO	NO	NO	NO
Estacionamientos de Casas Rodantes	SI	NO	NO	NO	NO	NO
Estadías Transitorias	SI	NO	NO	NO	NO	NO
Uso Público						
Escuelas	SI	NO	NO	NO	NO	NO
Hospitales y Casas de Reposo	SI	25	30	NO	NO	NO
Iglesias, Auditorios, Salas de Concierto	SI	25	30	NO	NO	NO
Servicios gubernamentales	SI	SI	25	30	NO	NO
Transporte	SI	SI	SI	SI	SI	SI
Estacionamientos	SI	SI	SI	SI	SI	NO
Uso Comercial						
Oficinas, negocios y profesionales	SI	SI	25	30	NO	NO
Supermercados y comercio en general, ferretería y equipamiento de granja	SI	SI	SI	SI	SI	NO
Servicios	SI	SI	25	30	NO	NO
Comunicaciones	SI	SI	SI	SI	NO	NO
Manufactura y Producción						
Manufactura en General	SI	SI	SI	SI	SI	NO
Fotografía y óptica	SI	SI	25	30	NO	NO
Agricultura excepto animales y forestación	SI	SI	SI	SI	SI	SI
Semilleros, otros	SI	SI	SI	NO	NO	NO
Minería, pesca, producción y extracción	SI	SI	SI	SI	SI	SI
Recreacional						
Deportes en exterior	SI	SI	SI	NO	NO	NO
Conchas Acústicas, Anfiteatros	SI	NO	NO	NO	NO	NO
Exposiciones naturales y zoológicos	SI	SI	NO	NO	NO	NO

THEORETICAL BACKGROUND

FAR Part 161:

Establishes a program to revise the noise levels at airports, considering the restrictions related to the use of aircrafts stage 2 and stage 3. This FAR requires that the airport's administrator examines the Acoustic Impacts within a determined observation area, produced by propositions in the access and variations of the noise level,

The area must include all the points located within the *YLDN* 65 dB(A) contour, then the procedure in accordance with the FAR 150 must be applied.

NOISE MEASUREMENTS

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NOISE MEASUREMENTS

•Measurement procedure: Continuous monitoring and punctual measurements

Background noise:

For minimizing the effect of the background noise, i.e., the noise not being emitted by the operation of the airport, at each evaluation point it was measured the background noise, checking that the L_{max} would be at least 10 dB(A) below the L_{max} related to an aircraft passing by.

These measurements were in charge of an Acoustic Engineer, writing down the time in which an aircraft noise event had occurred.

Also, were installed 24- and 48-hours continuous noise monitoring, with a 10-seconds resolution, storing the Sound Exposure Level SEL and the descriptors L_{max} and L_{eq}.

NOISE MEASUREMENTS

Considering the stored descriptors, a Noise Event was identified when exceeding a determined threshold level (for the SEL), taking into account the duration of the event and a constant difference between the maximum level and the SEL (*SEL* – L_{max} = 10 dB(A)).

In addition, the detected events are associated with the itinerary of flight operations, validating the methodology adopted.

NOISE MEASUREMENTS

Criteria for the selection of the evaluating points

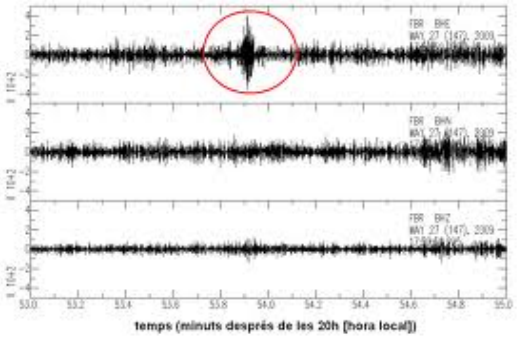
- **The points must be far away from steady-state noise sources and traffic noise.**
- **That represents regions with dense population and with a high perception of the aircraft noise.**
- **To be localized in the marginal region of the contour of 65 dB(A), defned by the FAA screening method (conjunction of the models AEM and INM).**
- **To describe the regions of the expected noise contours, being lateral regions of the noise contours or the threshold of the contour.**
- **To represent future regions of potential impact, characterizing the possibles scenarios.**

NOISE MEASUREMENTS

The selection of the moving points provides important information about the spread of the waves with the distance, and the noise exposure doses by event, allowing the noise contour maps, inside the area of influence.

The stored descriptors were:

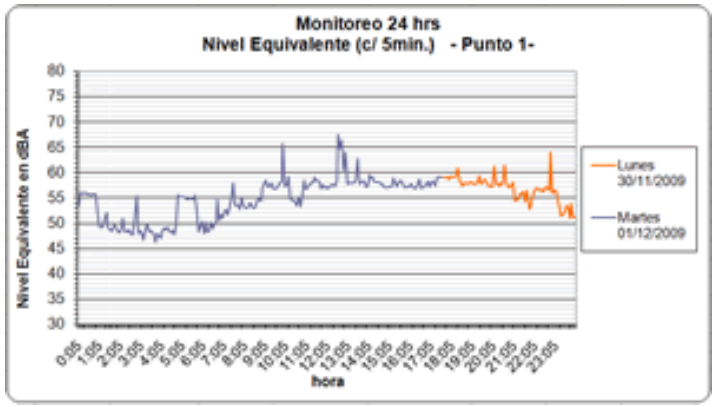
- ✓ **Equivalent Continuous Sound Pressure Level (L_{eq})**
- ✓ **Maximum Sound Pressure Level (L_{max})**
- ✓ **Minimum Sound Pressure Level (L_{min})**
- ✓ **Sound Exposure Level (*SEL*)**

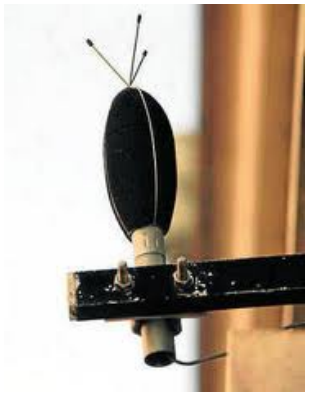


NOISE MEASUREMENTS

- **Locations of the points for installing a continuous noise monitoring system**

Bellow it is shown the location for some of the selected points for the 48- and 24-hours continuous monitoring :





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NOISE MEASUREMENTS

Airport "Mataveri", Eastern Island, Chile.

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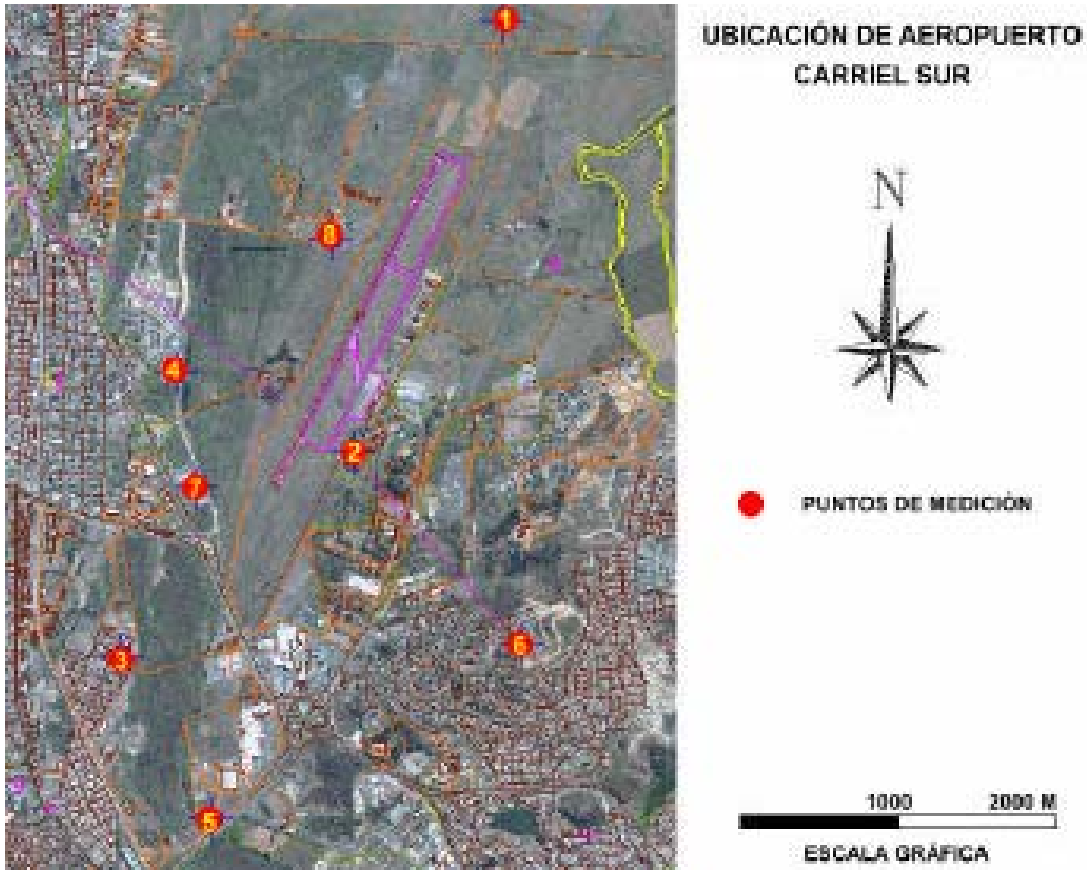
NOISE MEASUREMENTS

Aerodrome Carriel Sur, Concepción, Chile.



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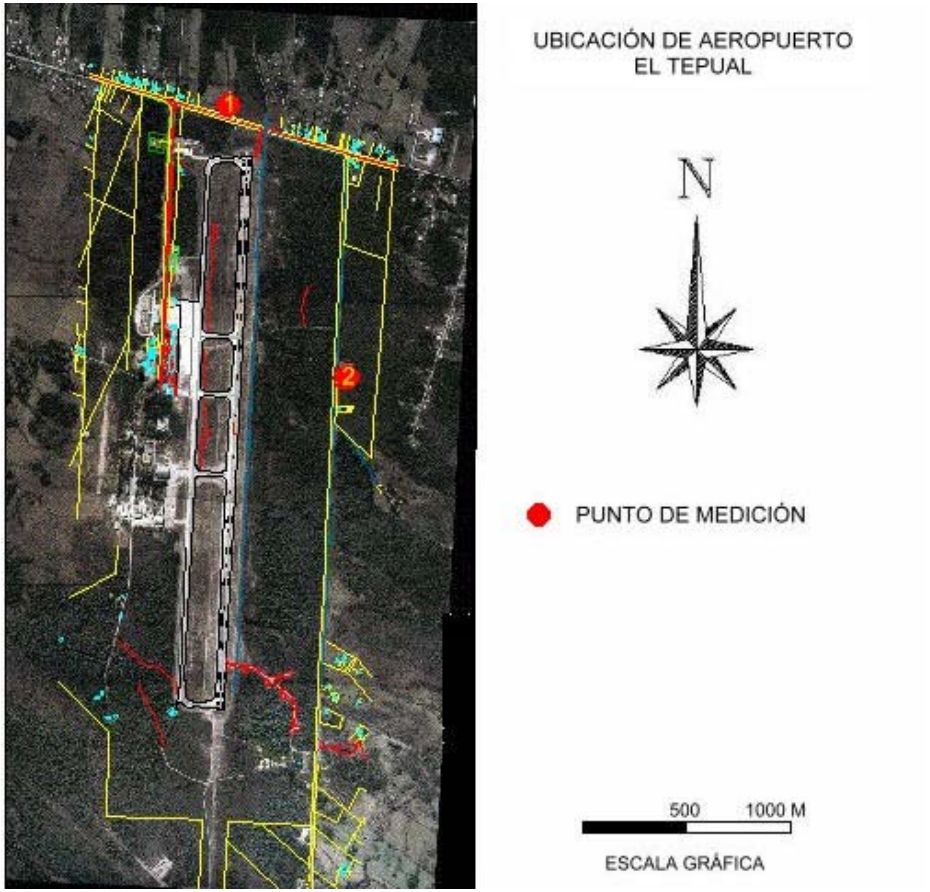
NOISE MEASUREMENTS

Airport "El Tepual", Puerto Montt, Chile.



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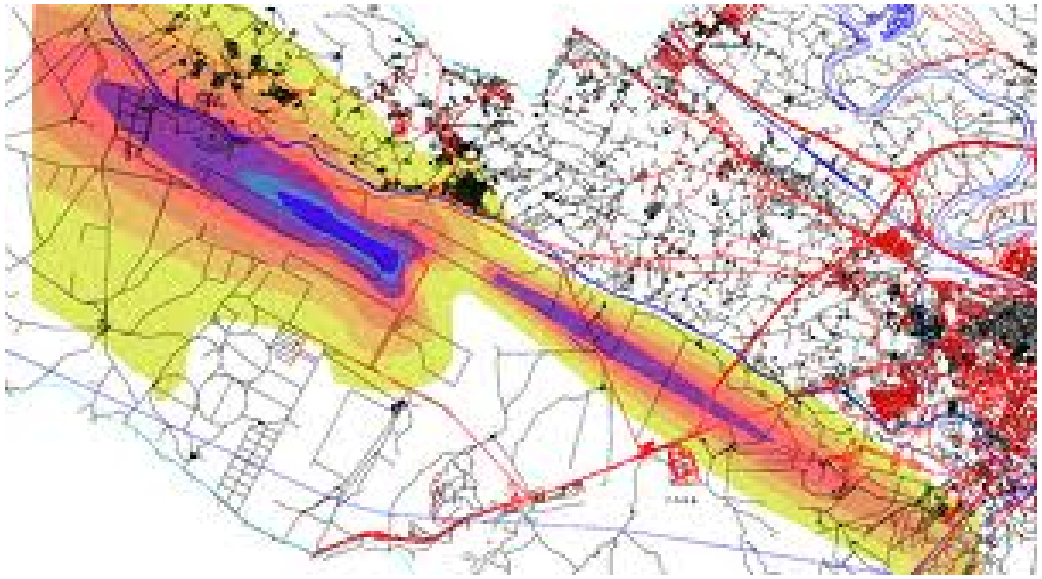
MODELLING OF NOISE EXPOSURE MAPS



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MODELLING

It is difficult to obtain with an accepable presicion the acoustic impact produced by an airport, due to the big dimension of the area of influence and other factors as:

- **The use of different landing and take-off tracks.**
- **Sound propagation because of the wether parameters.**
- **Charge of the aircraft and the operation modes of the aircraft.**
- **Areas in which could exist the presence of external focuses of noise.**

A methodology for allowing to cover these considerations, it is the use of advanced calculation methods for getting a representative acoustic impact in long-term periods (Yeary media).

MODELLING

• Methodology to Analize and to model aircraft noise according the FAR 150, appendix A

The procedure for the elaboration of the model for determining the noise exposure contours, it was estalished according to the recommendation FAR 150, appendix A, that is to say:

- **It includes an unique method to make the measurements and relate them with the degree of noisiness.**

- **Allow the use of the INM model or other authorized by the FAA for generating the current noise contours and the predictives, normilized.**

- **The measurements and monitoring are used for the improvement (checking) of the model.**

MODELLING

• Methodology to Analize and to model aircraft noise according the FAR 150, appendix A

The appendix A defines the descriptors and procedures for doing the measurements:

- **The measurements are done using a Sound Level Meter Class 2, using the A-Weighting curve, slow.**

- **The measurements for validating the model must include Lmax and the SEL, in dB(A).**

- **Describes the method for calculating the LDN (day-night level) and the YL_{DN} (yearly day-night level)for a known number of events,**

MODELLING

• Methodology to Analize and to model aircraft noise according the FAR 150, appendix A

The reports for determinig Sound Exposures must to fulfil the following minimum requirements:

- **It must include (at least) the 65, 70 y 75 dB(A) YL_{DN} contours.**
- **Must be identified the flight routes and the airport tracks used.**
- **To evaluate sensible areas (schools, churches, hospitals).**
- **To estimate the amount of people within the 65, 70 y 75 dB(A) YL_{DN} contours.**
- **The map must present a scale in which could allow to identify the streets.**
- **Must be included descriptors for the routes for the day and nicht periods.**

MODELLING

- **Methodology to Analize and to model aircraft noise according the FAR 150, appendix A**

<u>Simulation Software INM 6.1</u>

Include complex variables as:

- Elevation of the airport, configuration of the tracks, flight routes, flight profile, index of mixture by route, aircraft charge, number of operations by aircraft model and meteorological variables.

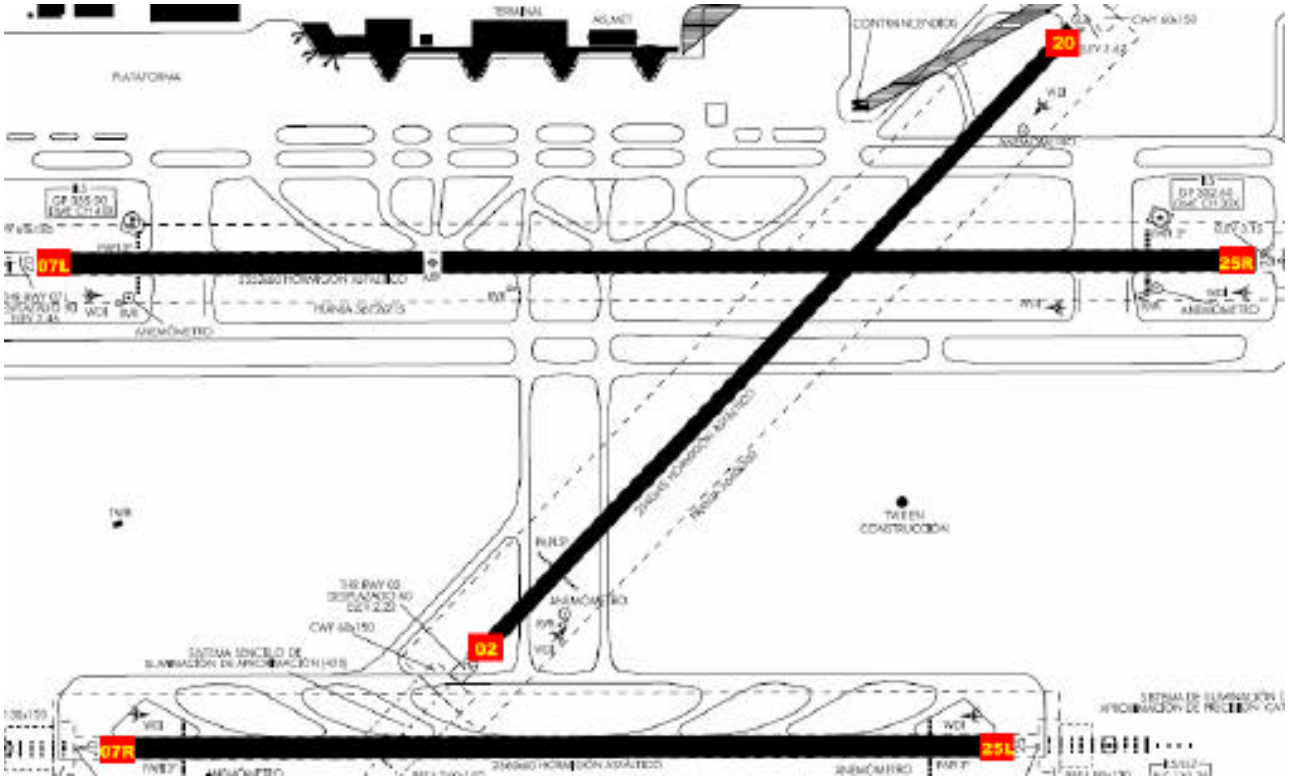
The software provides a database for elaborating the flight profiles, allowing the determination of the engine power (Corrected Net Thrust per Engine), for any designed operation.

The software is able to calculate descriptor values within a grid providing precise values in those points defined as receivers, and also determines the noise map contours.

MODELLING PERFORMED BY CONTROL ACÚSTICO

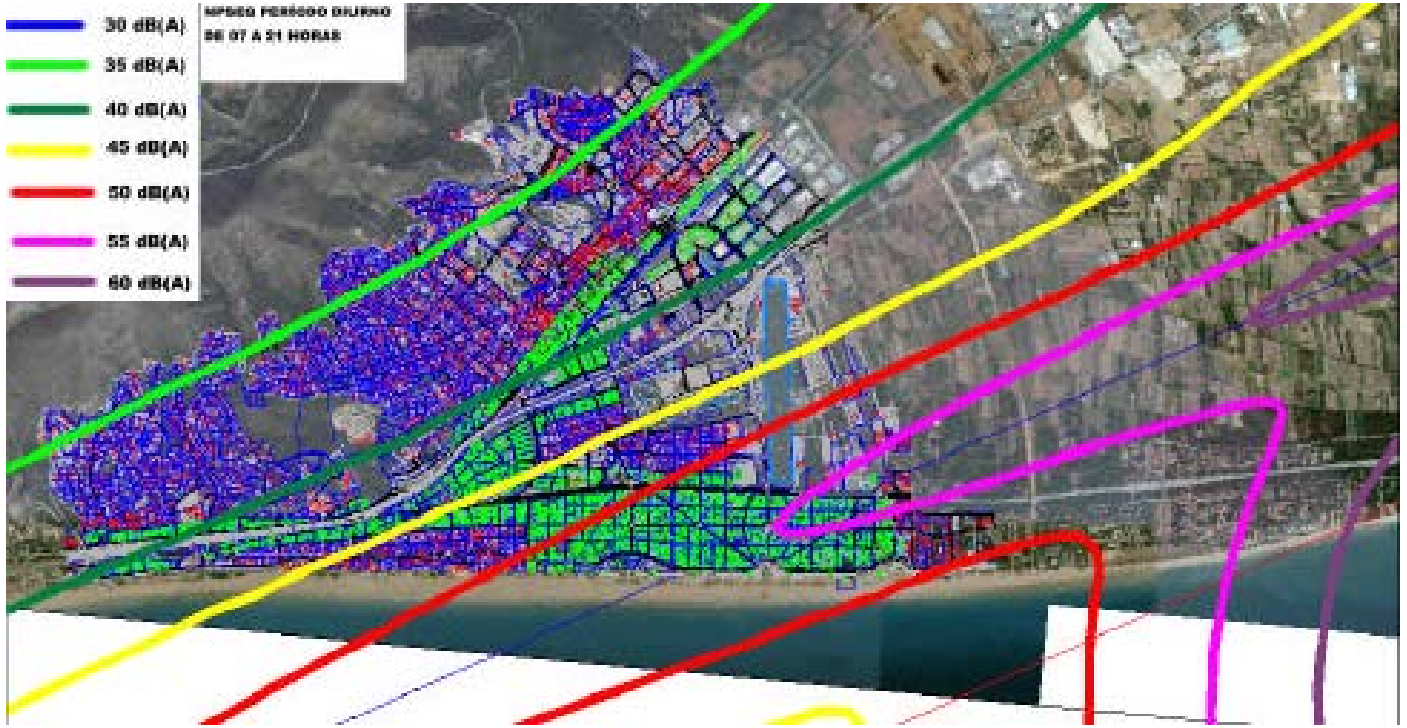
MODELLING

Example for a modeled scenario – Tracks and Routes



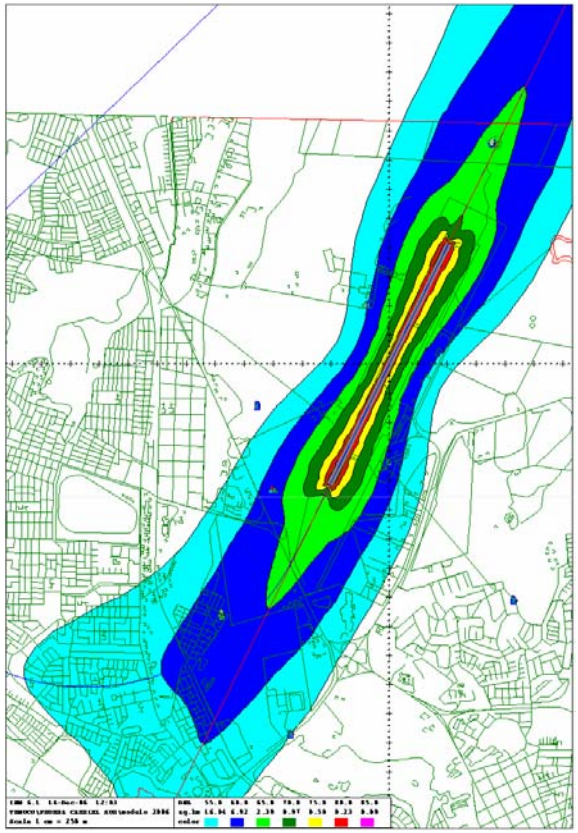
Description of routes and thresholds in the Barcelonas's airport

MODELLING



Noise map scenary for the day period L_{Day}. For Castelldefels neighborhood, Barcelona.

MODELLING



Noise mapping YLDN scenary in 2006. Carriel Sur, Concepción, Chile.

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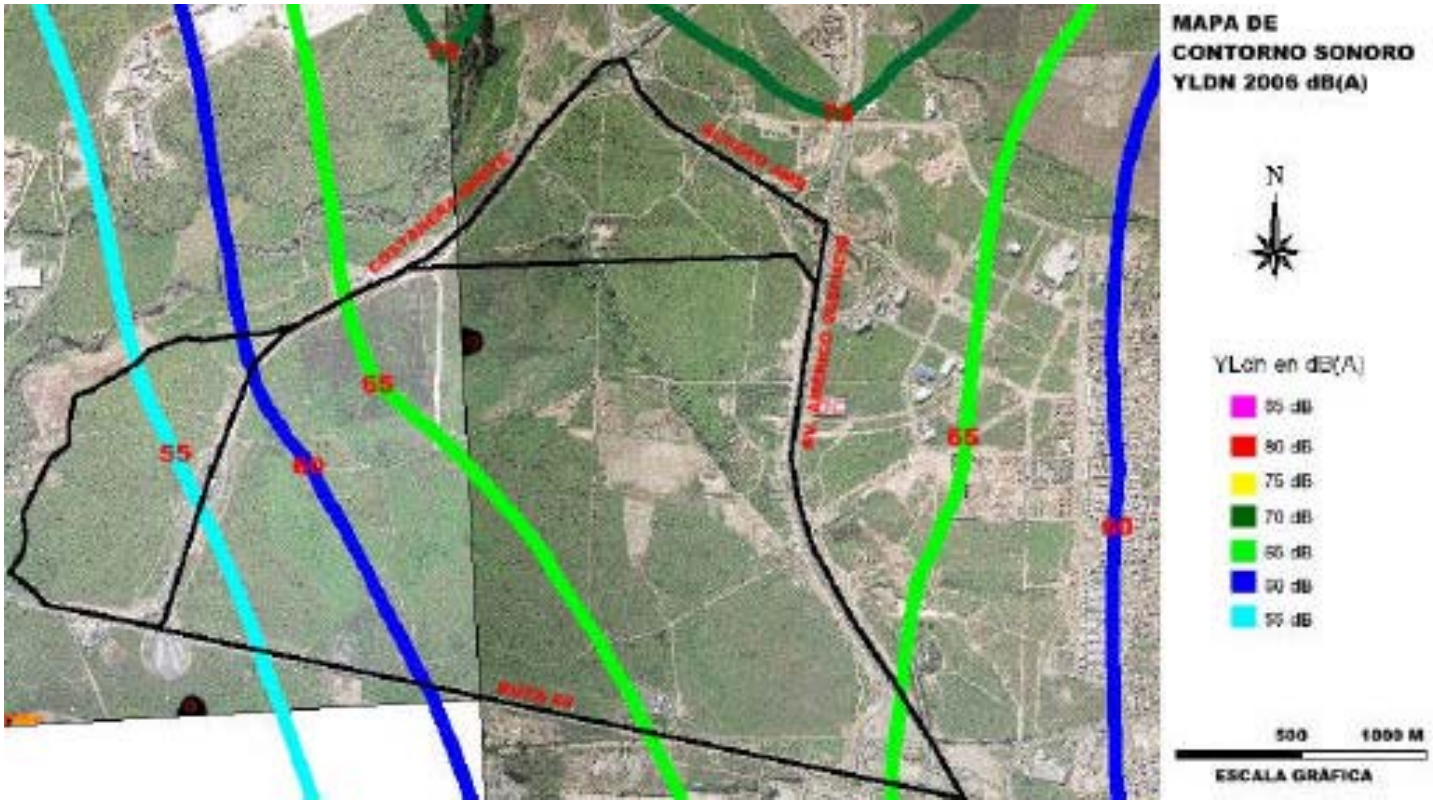
MODELLING



YL_{DN} in 2006. To the south of the Ap. AMB, Santiago, Chile.

CONCLUSIONS

✓ **The recommended measurement procedure in FAR 150 Is an efficient tool for evaluating noise generated by aircrafts.**

✓ **When modelling the YLDN descriptor is possible to evaluate the land use compatibility in the selected points (and areas).**

✓ **When using the Integrated Noise Model (INM) model, other acoustic descriptors could be determined, which could be added as SIG formats or as vectors for determining current or future regions with respect to the land use compatibility.**

THANKS

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