Noise assessment in the neighbourhood of Italian military airports

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ABSTRACT

This paper reports the most recent application of the MILNOISE PROCEDURE for the assessment of noise pollution due to training flight operations at Italian military airports. The experimental acoustic characterization of different military aircraft, like C27J, NH500, MB339, AM-X, F-16, EFA, HARRIER, TORNADO, operating in various military airfield, was carried out in the last 10 years. The results of airport acoustic impact on the surrounding environment, with reference to the actual traffic, have been reported in terms of L_{VA} contour plots on 1:25000 scaled maps. In order to minimize the noise impact on inhabited areas surrounding the airfield, both dedicated noise impact evaluation for each aircraft (and for every its single noise event such as: take-off, approach, touch & go and flyover) and a specific airport noise assessment with different air traffic scenarios have been carried out. Moreover, a numerical study aimed at evaluating the noise impact of F35 new military aircraft and at comparing its noise characteristic with actually and future military airfield scenarios have been effectuated. All the reported activities have been made in cooperation with the Italian Air Force.

I-INCE Classification of Subjects Numbers: 52.2.2

1. INTRODUCTION

Italian regulations on noise pollution (Act n. 447 of 1995 and the respective enactments) concern, at present, only with the civil airports. For the prevention and limitation of noise areas affected by military installations and activities of the Armed Forces exclusively, the above Act provides for the establishment of specific agreements, through the Regional agencies “COmitati MIsti PARitetici (CO.MI.PAR.)”, that plan in a harmonized way the regional development. Since some Italian military airports are also open to civil air traffic, in these cases, to properly plan the development of the surrounding area, it is necessary to quantify the contribution of noise pollution of military activities. This allows local authorities to be fully informed about the environmental impact produced by all airport activities, and therefore to identify the procedures and mitigation measures prescribed by the regulations for the civil part. While for civil aviation, the international law requires aircraft noise certification, this is not true for military aircraft. Therefore, in order to comply with environmental civil regulations and allow airlines to better manage the fleet, the aviation industry is committed to develop less and less noisy aircraft. In the military sphere, however, the aviation industry promotes the development of increasingly higher performance aircraft and therefore often more "noisy". Italian Air Force (AMI) however, within the framework of politics to protect the outdoor environment from high levels of noise around military airfields, more than ten years ago, started a complex applied research activity named “MILNOISE Project” in conjunction with Italian Aerospace Research Centre (CIRA). Such a project is aimed at identifying the strategies and operative procedures to control and reduce the noise pollution due to the aircraft training flight operations of Italian Air Force.

2. MILNOISE PROCEDURE

The tools and procedures necessary to perform risk assessment of the noise impact of military airports were implemented. In particular, through a series of measurement campaigns aimed at the acoustic characterization of military aircraft (with the use of at least 15 microphone positions for each campaign) a database (named MILNOISE Database) has been realised. Dedicated flight test for a total of over 1500 noise test measurements for each aircraft were performed and the corresponding time-histories were analysed and processed.

During the various noise testing campaign each aircraft performed, for at least three power settings, several flight operations: flyovers at 11 altitudes (from 122 m [400 ft] to 2413 m [8000 ft] executed several times in order to confirm the accuracy of the individual test performance) in order to develop/process the aircraft Noise Power Distance (NPD) curves; furthermore a series of take-off, landing and touch & go operations were carried out in order to provide comparison data for verification of the forecasting model.

Starting from a noise emission evaluation of the Italian Air Force aircraft and using predictive models for aircraft noise propagation (INM – Integrated Noise Model), a procedure for the assessment of the environmental impact, described in terms of airport noise assessment levels (L_{VA}) in the vicinity of military airbases, has been developed.

A critical information required by such forecast software is a set of curves named “Noise Power Distance” (NPD - see figure 1 as example). These curves characterize the aircraft noise source and have been used to estimate the noise level due to a specific aircraft operation.

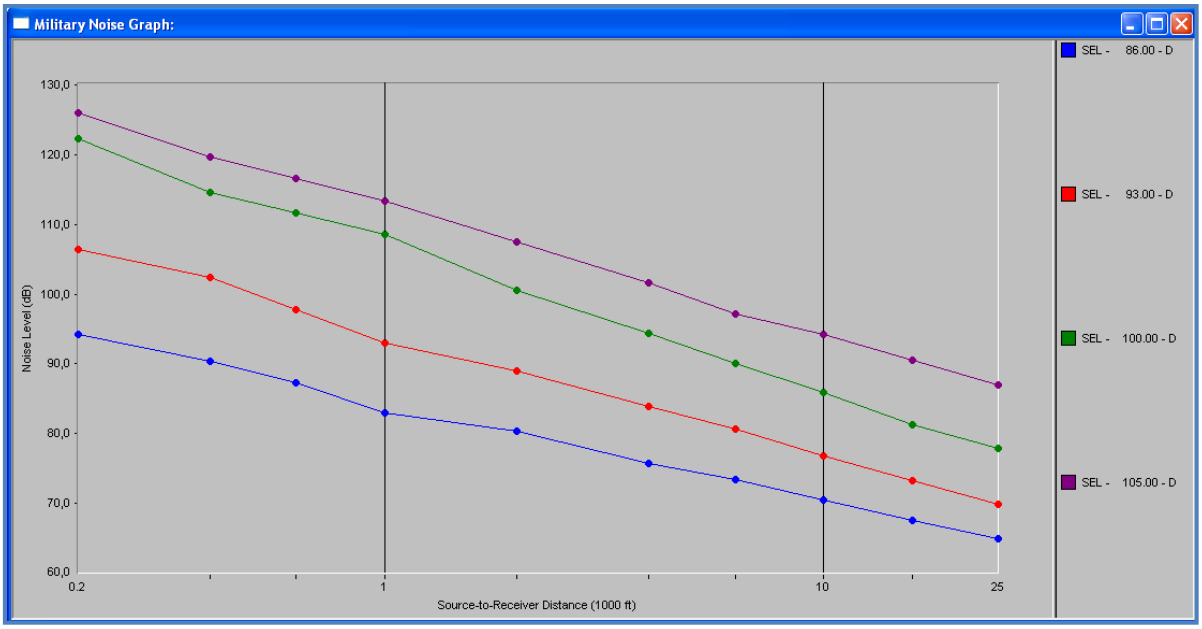

Figure 1: *Example of experimentally noise data for military aircraft NPD*

Therefore in the MILNOISE project several test campaigns were planned and carried out in order to experimentally acquire all data necessary for the acoustic characterization of the aircraft included in Italian Air Force fleet: F-104, AM-X, MB339, HH3F, NH500, C130, TORNADO, EFA, etc..

Therefore an analysis and elaboration of the noise measurement and a comparison between results obtained by using the Milnoise Database and corresponding ones obtained by using the INM software have been carried out in order to validate the MILNOISE procedure. After such numerical-experimental validation, this procedure has been used to predict received noise levels in areas close to the military airports for current and future operative traffic scenario. Noise laws, issued in Italy for civil aviation, require that aircraft noise pollution to be described in terms of a descriptor named L_{VA} (**A**irport e**V**aluation noise **L**evel).

The main acoustic descriptors used in the present study are those required by the reference regulations, namely: L_{Amax}, SEL, and L_{Vad} L_{Vaj}

The index of evaluation of airport noise in the determination of the noise contours in Italy is the

"Level of Evaluation of Airport Noise" (L_{VA}) described by the following expression:

$$L_{VA} = 10 \log \left[\frac{1}{N} \sum_{j=1}^{N} 10^{L_{VAj}/10} \right] dB(A) \quad (1)$$

where N is the number of days in the observation period[1] and L_{VAj} is the daily value of airport noise assessment level as defined below:

$$L_{VAj} = 10 \log \left[\frac{17}{24} 10^{L_{VAd}/10} + \frac{7}{24} 10^{L_{VAn}/10} \right] dB(A) \quad (2)$$

where:

$$L_{VAd} = 10 \log \left[\frac{1}{61200} \sum_{i=1}^{N_d} 10^{SEL_i/10} \right] dB(A) \quad (3)$$

$$L_{VAn} = 10 \log \left[\left(\frac{1}{25200} \sum_{i=1}^{N_n} 10^{SEL_i/10} \right) + 10 \right] dB(A) \quad (4)$$

in which N_d and N_n are, respectively, the number of aircraft movements during the daytime (06:00–23:00) and during the night (23:00-06:00).

The Level of Evaluation of Airport Noise (L_{VA}) takes into account, by means of a single number, of the air traffic trend during the interest periods that are those prescribed by the regulations for civil airports, in particular: high traffic week - first quarter; high traffic week - second quarter; high traffic week - third quarter.

The values of the above-mentioned descriptor used in quantifying noise exposure coming from air traffic in residential neighbourhoods have been used to obtain L_{VA} contour plots drawn on a map that allow to subdivide the area, surrounding the airport, according the three zones shown in the Table 1.

Respect Areas	L_{VA} (dBA)	TERRITORY USE DESTINATION
A	**60 - 65**	No expected restriction
B	**65 - 75**	Agricultural activities, trading activities, industrial activities, offices
C	**> 75**	Exclusively activity and office for airport working

Table 1: Noise limits for respect areas of Italian airports and restrictions for territory use destination

As seen above, the Italian Law about airport noise defines a L_{VA} noise pollution level for each respected area; therefore the A, B and C areas extension is the basic information to perform assessments of the environmental acoustic impact due to the airport activities.

[1] The number of days should be twenty-one that are equal to three weeks, each of which must be chosen in the following periods:
October 1 - January 31; February 1 - May 31; June 1- September 30
Under the civil context the week within the observation period must be the one in which there are greater number of movements.

Figure 2: Italian military airports involved in the Milnoise Project

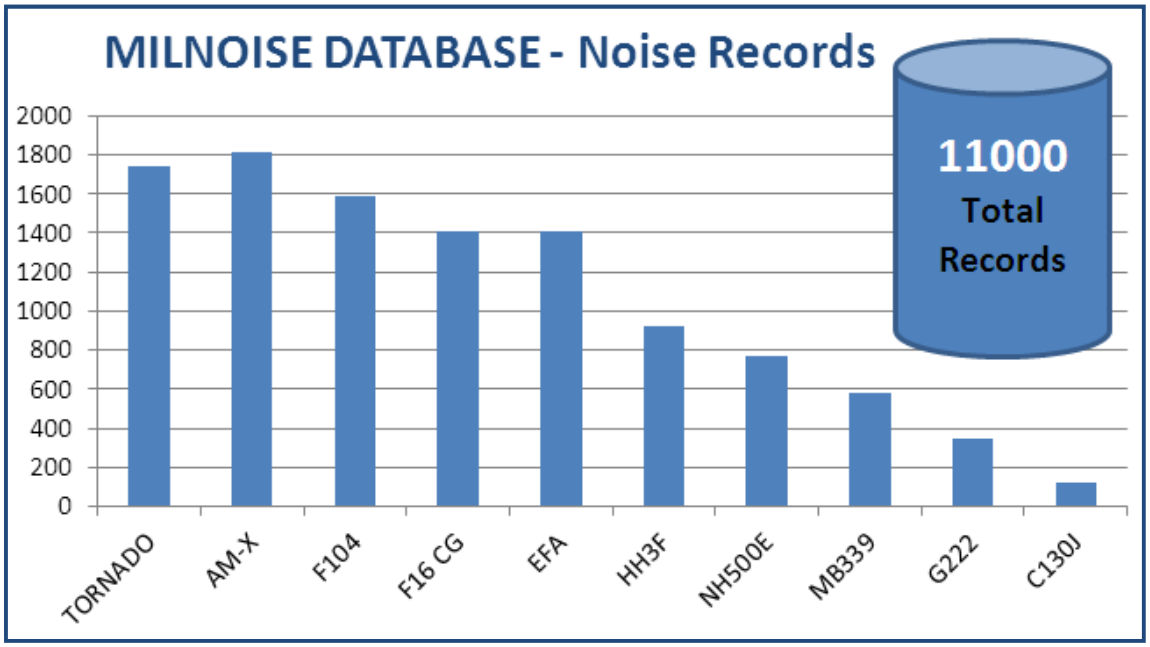

Figure 3: Aircraft's noise records in the MILNOISE Database

To carry out a forecast acoustic impact study about the airport surrounding territory due to the flight activities, a series of qualitative and quantitative data and information (regarding the type of flight activities, the aircraft configuration and performance etc.) were analysed to better represent the operative and real conditions. A detailed acquisition and elaboration of flight profiles in terms of paths and performances, with particular reference to those relative to take-offs and landings, allowed to better simulate the operative and real situations; the computational results are very close to the experimental data.

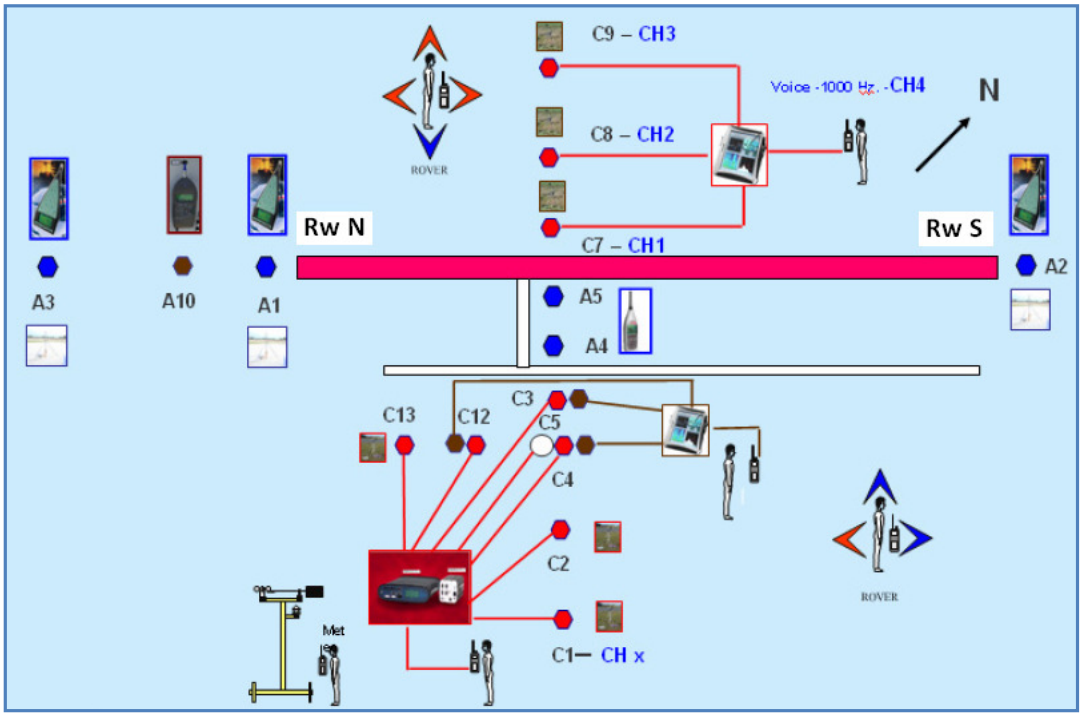

Figure 4: A typical resources layout for a Milnoise test campaign

3. RESULTS OVERVIEW

In the following figures various examples of representation of the results obtained are shown. In particular: in Figure 5 is shown the time history for an aircraft flyover and the noise spectrum corresponding to the L_{Amax} value;

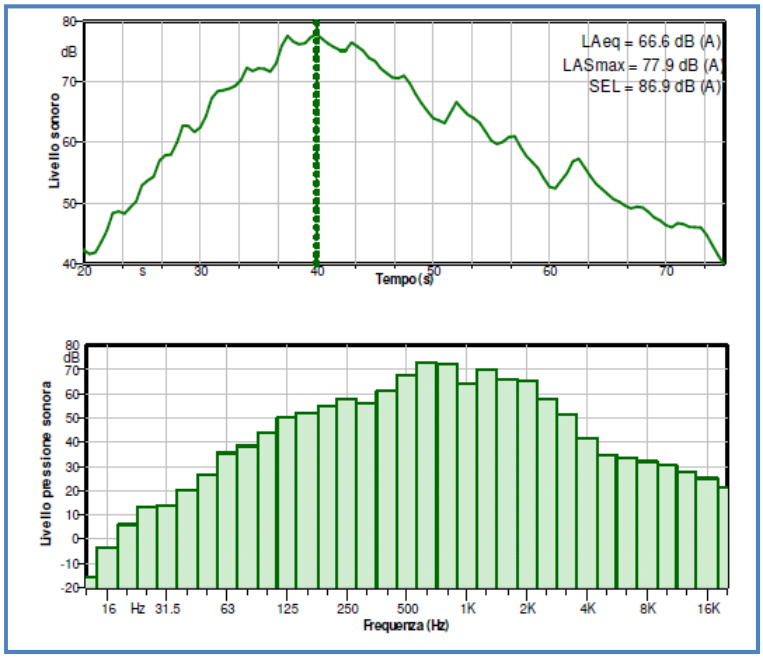

Figure 5: Example of a Noise time history with the spectrum at L_{Amax} value (Aircraft flyover)

In Figure 6 a comparison between calculated and experimental measure noise levels, corresponding to those microphones located in a normal position respect to the aircraft ground flight projection during a flyover operation, is illustrated;

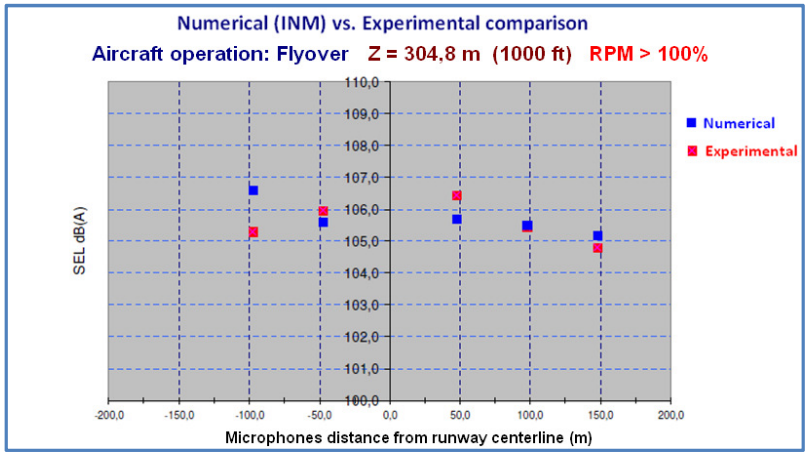

Figure 6: Numerical versus experimental noise data comparison

In Figure 6 experimental measure noise levels, corresponding to those microphones located in a normal position respect to the aircraft ground flight projection during a flyover operation, for various altitudes and for a given engine power set, are reported;

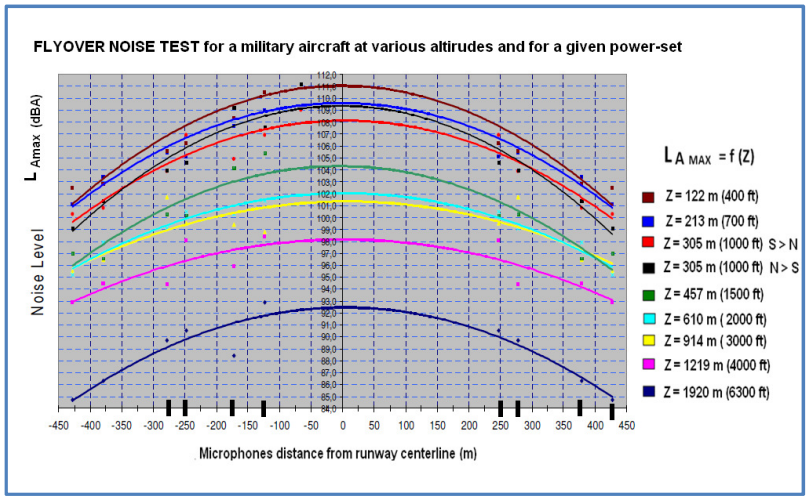

Figure 7: Aircraft noise data for various altitudes and given power-setting

In Figure 8 experimental measured noise levels, corresponding to those microphones located in a normal position respect to the aircraft ground flight projection during a flyover operation, for different airspeeds and for a given altitude, is reported;

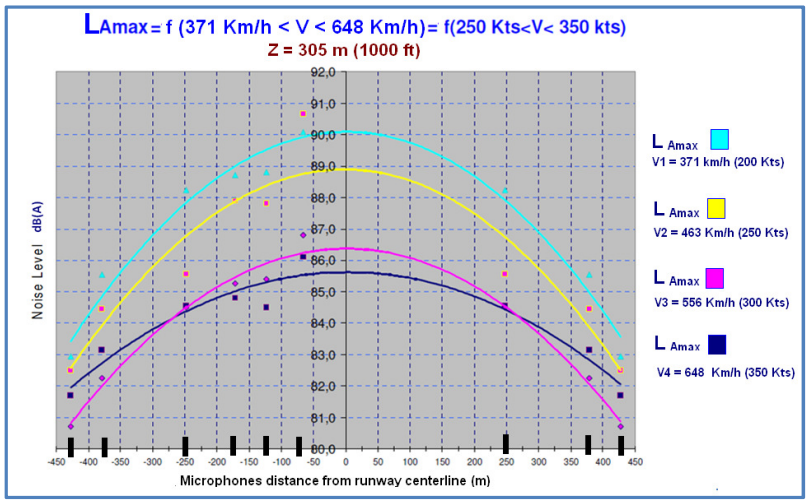

Figure 8: Aircraft flyover noise data for various airspeeds and a given altitude

in Figure 9 and Figure 10 two examples relatives to low and high traffic scenarios of noise impact evaluation in terms of LVA loudness contours, around a military airport, are reported;

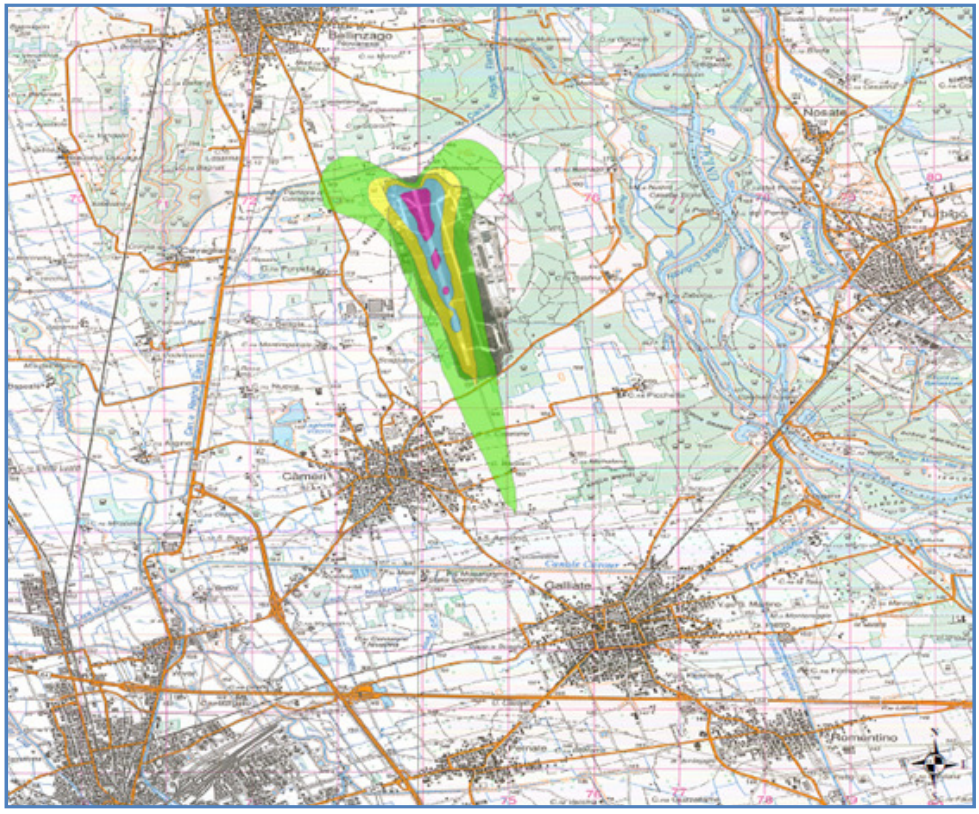

Figure 9: Graphical representation of equal loudness contours in terms of L_{VA}(low traffic)

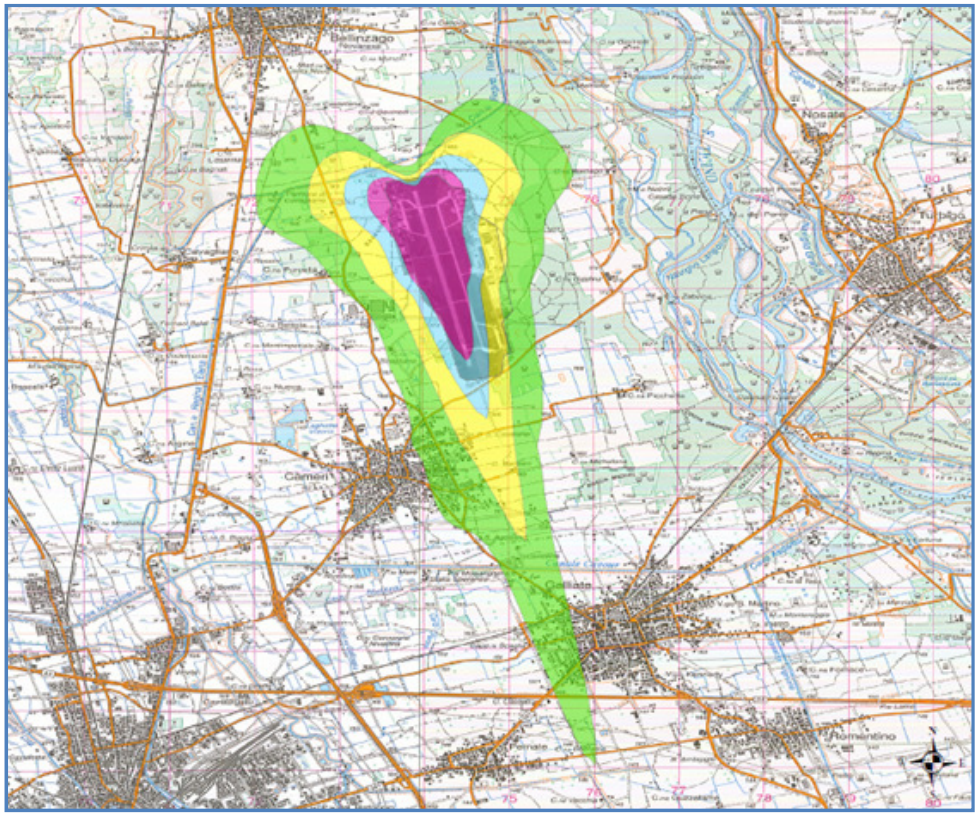

Figure 10: Graphical representation of equal loudness contours in terms of L_{VA} (high traffic)

In the Figure 11 an example of comparison of noise evaluation impact relative to four different military airports is showed;

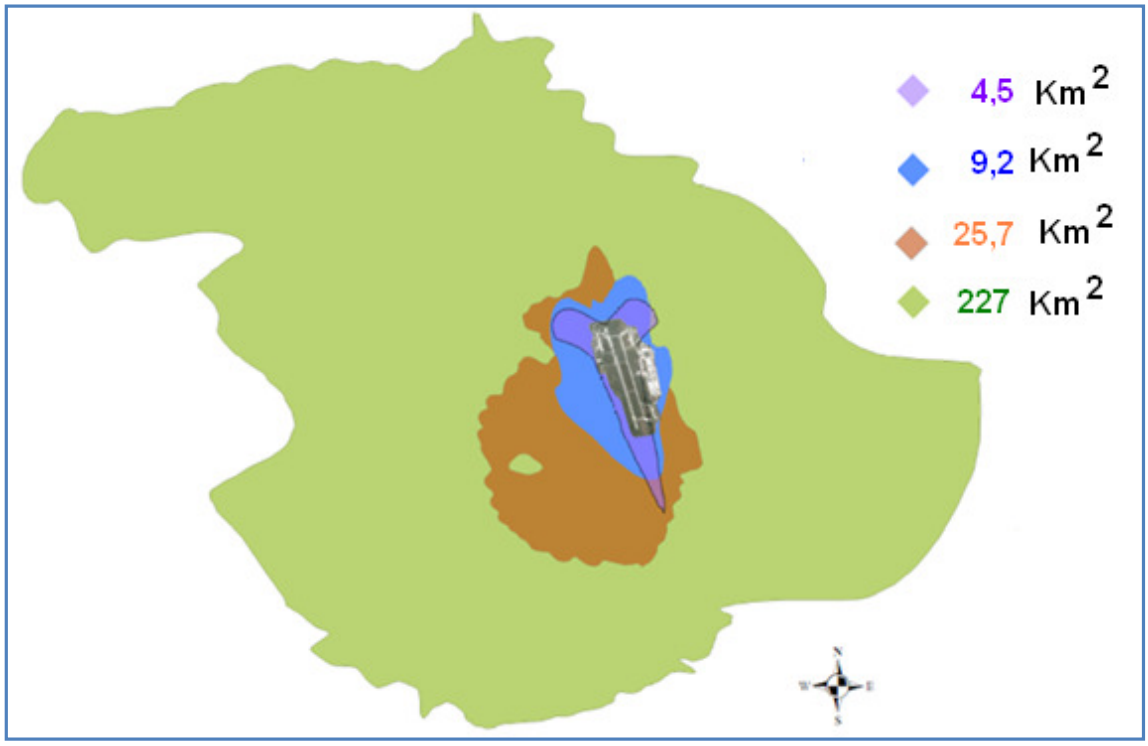

Figure 11: Noise footprint comparison (L_{VAJ} = 60 dBA) for various military airport surroundings

Finally in Figure 12 an example of numerical analysis activity about the definition of minimum noise impact take-off profile is represented

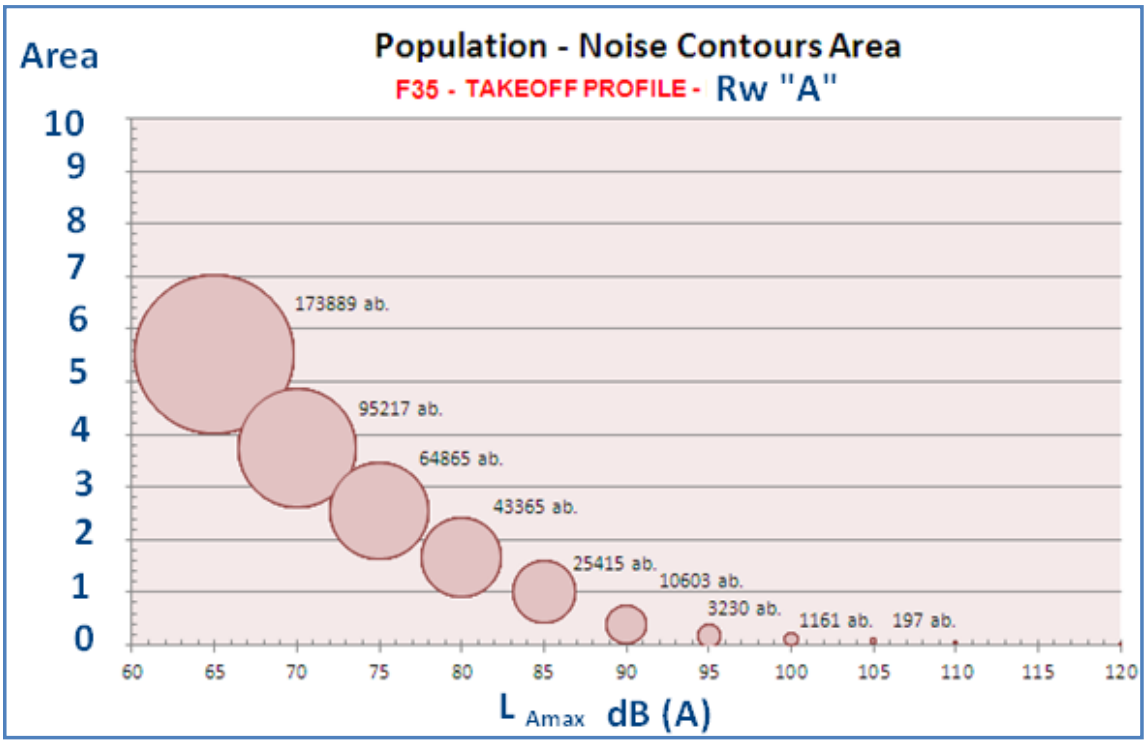

Figure 12: Example of acoustic impact analysis for a defined take-off trajectory

In the following Table 2 is reported as an example the impact of noise contour "L_{Amax}=85 dbA" for different F35 flight operations. The noise impact is reported as the ratio between the noise area footprint vs. the minimal noise area footprint (the minimal noise area footprint is gotten as reference value) and the residential population within the noise area footprint.

JSF PROJECT F-35  Impact of noise contours curve L_{Amax} = 85 dBA			
AIRCRAFT OPERATION	**Runway (North/South)**	$\frac{A}{A_{min}}$	**Residential Population**
Aligned Landing	Rw South	1,41	18744
Landing in Circuit - 1	Rw South	1,28	19573
	Rw North	2,07	39359
Landing in Circuit - 2	Rw South	1,60	21495
	Rw North	1,46	25844
Landing in Circuit - 3	Rw South	3,16	27952
	Rw North	1,33	35760
TAKE-OFF – Track 1	Rw South	2,51	10913
	Rw North	2,63	13191
TAKE-OFF – Track 2	Rw South	2,74	10993
	Rw North	2,63	13180
TAKE-OFF – Track 3	Rw South	1,19	13185
	Rw North	1,60	25374
TAKE-OFF – Track 4	Rw South	**1,00**	10783
	Rw North	1,02	14983
TAKE-OFF - Track 5	Rw South	1,97	25415
	Rw North	1,40	24432
TAKE-OFF - Track 6	Rw South	1,57	17795
	Rw North	1,62	18007
TAKE-OFF – Track 7	Rw South	2,16	18027
	Rw North	2,18	20768

Table 2: Example F-35 Single Event – LAmax = 85 dBA – involved population Estimation

4. CONCLUSIONS

The good results of the study for the assessment of noise pollution due to training flight operations, throughout MILNOISE PROCEDURE, carried out for different Italian military airports, demonstrates both the reliability of the procedure itself and their helpfulness to reduce and prevent the acoustic pollution caused by aircraft traffic in communities close to both military and civil airfields. Such procedure is used to evaluate the noise impact associated to actual and new operative scenarios. Milnoise database and procedure allows accurate prediction of the Italian military airport assessment level L_{VA} and allows defining and optimizing take-off and landing trajectories at low noise impact both in terms of isophone extension areas and population.

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