

# Proceedings of the Institute of Acoustics

## MILITARY AIRCRAFT NOISE IN DENMARK - ENVIRONMENTAL ASPECTS AND PLANNING

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### 1. INTRODUCTION

All aircraft noise problems can be solved at the planning stage!

But as town planning with respect to traffic noise is often many years behind development of traffic systems (roads, railways, and airports) and traffic volume development, we have a lot of unsolved problems.

Aircraft noise problems not solved at the planning stage often necessitate emergency measures when the political noise exceeds the "safe constituency"-limit.

Emergency measures are: extra sound insulation of dwellings which is good when people are inside with closed windows, but not very efficient when people are in the garden or are sleeping with open windows.

Emergency measures are also: inconvenient air traffic restrictions as night ban, preferential runways, flight track limitations, maximum noise levels, noise abatement procedures, prohibition of full thrust reversal during landing, etc.

The problem is two-sided. But it is not too late that both sides, the aeronautical side and the public side, demand proper noise-sensitive planning from now on.

In Denmark all new airfields - civil and military - must have an environmental approval before they can be put into service. If an airfield was in use at the time when our environmental law came into force (1974), a voluntary approval may be applied for. An environmental approval has to be renewed every 8 years unless the noise exposure exceeds the approval limits before 8 years after approval. On the other hand the approval is an insurance against new restrictions during the 8-year period.

Almost all civil airfields/airports in Denmark are approved or are in the (lengthy) process of being so.

The number of military air bases with an environmental approval is low (a decreasing number of operations and new less noisy aircraft types will normally not provoke a demand for approval), but an increasing awareness of noise problems in the population and the Air Force seems to accelerate the process.

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The aim of this paper is to demonstrate the progress towards a better environment near military aviation areas in Denmark made possible by the willingness of cooperation between the environmental authorities and the Danish Air Force.

The Danish Acoustical Institute has the privilege of catalyzing this process.

### 2. ENVIRONMENTAL ADJUSTMENT

Not all aircraft noise problems have been solved at the planning stage!

When both the aircraft noise, the dwellings, and the complaints are present, the community has a problem.

The solution is no longer planning. Maybe alleviation by "environmental adjustment" is possible.

Sound insulation of many dwellings is expensive and not the best solution. Thus the environmental authorities often impose on the Air Force to investigate possibilities of noise exposure reduction in noise-sensitive areas.

The procedure is typically the following:

- a) Based on all necessary traffic information, operation information and noise, and performance data, the DANSIM-program [1] is used to make a noise exposure calculation.
- b) Planners, environmental authorities, representatives from the Air Force and from the Danish Acoustical Institute meet and identify existing and future trouble areas.
- c) A small working group (chief of operations for the air base under consideration and the acoustician in charge) carefully lists all possibilities of alleviation in the trouble areas.
- d) Every possibility is evaluated with respect to noise reduction capabilities, operational and tactical feasibility and economy.
- e) If it is possible to reduce the noise problem, decisions on one or more measures that will reduce or eliminate the problem are taken.
- f) The nature of the measures, the time of realization, and the implication on noise exposure are communicated back to the environmental authorities and to the planners.

In the following a few recent examples from the fruitful cooperation between the Danish Air Force and the Danish Acoustical Institute during more than two decades are mentioned.

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### 3. AIRCRAFT NOISE AT A MILITARY SHOOTING RANGE

The following is an example of an environmental adjustment which has been introduced to reduce the noise impact in an attractive beach area and in some towns and villages near a military shooting range in Denmark. The range is used by Danish fighters and fighters from other NATO-countries.

Figure 1 shows the shooting range by the coast and the two approach tracks from southwest and northeast (flight track and dispersion area). On the figure areas with existing holiday cottages and areas of interest for development are hatched.

To base the calculations on a realistic track pattern, unannounced radar recordings of all operations were made for a period of 14 days covering different aircraft types and operation types.

Figure 2 shows the principle pattern for an F35 weapon delivery, and Figure 3 shows the actual radar tracks for 12 circuits flown by 4 F35-fighters. On Figure 4 the flight track dispersion sectors for right- and left-hand patterns collected during the radar recording period are shown for F35 strafing.

Based on these dispersion sectors, distribution of tracks inside the sectors, number of circuits per aircraft type, noise, and performance data, the DANSIM-program was used to calculate the resulting noise exposure shown in Figure 5.

As seen in Figure 5, there will be restrictions on cottage building ( $L_{DEN}$  above 50 dB) and on all-year dwelling areas ( $L_{DEN} = 55$  dB) inside an extensive area.

As environmental adjustment it has been investigated if it would be possible to use right-hand patterns only. The investigation concluded that it is feasible. Figure 6 shows the result of the first step of environmental adjustment.

Recently the Danish Acoustical Institute has taken steps to illustrate the consequence of new approach tracks over the sea area instead of passing a number of towns and villages, which has given rise to a number of complaints. If this adjustment is also feasible, it will mean a great relief for many families in the area.

### 4. BETTER ENVIRONMENT AROUND VAERLOESE AIR BASE

The second example illustrates some possible environmental adjustments for an air base. As the investigation is going on for the moment, the final results are not yet available.

This particular air base is situated in the Copenhagen area near to extended dwelling areas, a large part of which have been built during the last two de-

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acades. The air base has been operating for the last 40 years, but the town planners seem to have ignored the noise exposure until two years ago when the Danish National Agency of Environmental Protection declared that all further establishment of dwellings, etc. should be stopped until the noise exposure had been mapped.

In Denmark noise from an airport is considered being of two types: "flight noise" and "ground noise", which are subject to two different sets of environmental rules. The guiding maximum noise exposure levels in new dwelling areas (garden city) are:

Flight noise: $L_{DEN}$	= 55 dB
Ground noise: $L_{Aeq,8h}$	= 45 dB day
$L_{Aeq,1h}$	= 40 dB evening
$L_{Aeq,0.5h}$	= 35 dB night

### 4.1 Flight Noise

When we calculate the noise from flying aircraft, the fighter traffic is divided on categories of procedure as shown in Figure 7.

For each category we calculate separately the  $L_{DEN}$ -contours according to a traffic forecast (normally 10-15 years ahead) and store the result. This calculation procedure which is a part of the DANSIM-program facilitates the manipulation with separate traffic categories during the environmental adjustment phase. By adding all categories we get the total noise exposure as shown in Figure 8.

To be in accordance with the maximum level of  $L_{DEN} = 55$  dB, a number of rather new dwelling areas should never have been approved. An attempt to repair the missing planning is now expected to be a duty of the air base.

According to the environmental adjustment procedure mentioned in Section 2 almost 10 different measures which reduce the noise exposure in existing dwelling areas have been carefully evaluated. Among the noise-reducing strategies are:

- Minimum noise routing for VFR-departures
- Reduction of VFR-approaches via IP-west (all non-Danish aircraft approach on centre line)
- Landing circuits for helicopters are moved west to the farming area between "Stenløse" and "Måløv".

By being willing to put such new flight rules into force, the air base contributes to a better environment in considerable dwelling areas.

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Calculations executed later this year are expected to show noise reductions in the dwelling areas framed with dashed lines in Figure 8 down below the environmental limits.

It might be considered to use dwelling density information [2] and the built-in options of DANSIM to show to the environmental authorities and planners how many dwellings will get a noise reduction, how large it will be, and where the dwellings in question are situated.

### 4.2 Ground Noise

Ground noise (or terminal noise) originates in a number of different sources distributed over the air base:

- Ground run-up of aircraft
- Engine test in test cells
- Hover test of helicopters
- Taxiing of fixed-wing aircraft and helicopters
- Internal car and lorry traffic at the air base

Measurements of directivity patterns and spectra for all noise sources (except cars and lorries) including ground run-up and taxiing for representative aircraft types as Gulfstream III, F16, C130, and S61 were made.

By means of the Nordic Calculation Model for Industrial Noise [3], the noise immission was calculated in 23 positions in the dwelling areas of the neighbouring communities.

For some activities, especially unshielded ground run-ups of GIII and C130, violation of the guiding noise limits is flagrant (for GIII 16-33 dB in day-time!).

Noise from engine test cells and from taxiing (except for C130) is a minor problem at Vaerloese (but not at all air bases!). Finally noise from heavy vehicles on the perimeter road violates the noise limits in the dwellings adjacent to the south fence of the air base.

The following measures are now under consideration:

- Establishment of shielded ground run-up facilities combined with aircraft orientation (maxima in directivity pattern pointing away from nearest dwelling area)
- Increase of the efficiency in the test procedures in order to cut test duration
- Construction of a new perimeter road which will move the heavy traffic away from the dwelling areas.

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It is believed that these measures for environmental adjustment will not only alleviate the noise problems among the neighbours of the air base, but will also give credit to the Danish Air Force for efforts to repair what was not solved at the planning stage.

### 5. REFERENCES

- [1] B. Plovsing and C. Svane, "Aircraft Noise Exposure Prediction Model. Report No. 101, Danish Acoustical Institute, 1983. Or a short description: DANSIM. Danish Airport Noise Simulation Model. Basic Principles, Experience, and Improvements. Inter-Noise Proceedings 1990.
- [2] Christian Svane and Birger Plovsing, "DANSIM Applications - Development of Airport Noise Reduction Strategies and Environmental Policy". Inter-Noise Proceedings 1990.
- [3] Jørgen Kragh et al., "Environmental Noise from Industrial Plants. General Prediction Method". Report No. 32, Danish Acoustical Institute, 1982.



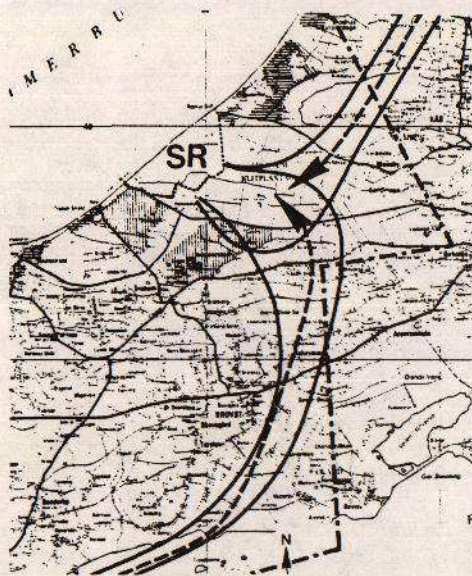


Figure 1 Shooting Range (SR) with approach tracks.  
 [Shaded box] Holiday cottages  
 [Hatched box] Development areas

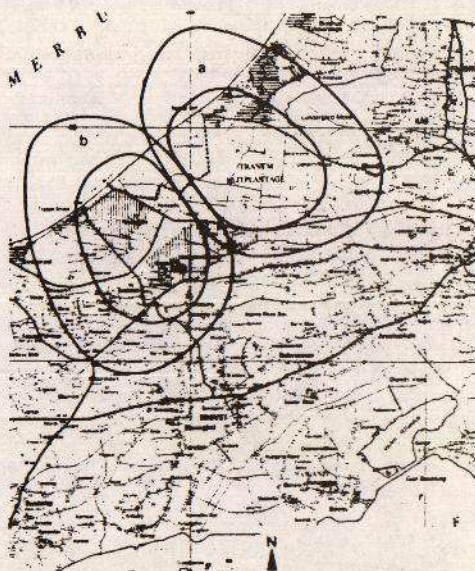


Figure 4 Flight sectors for F35 strafing. Right-hand (a) and left-hand (b) patterns.

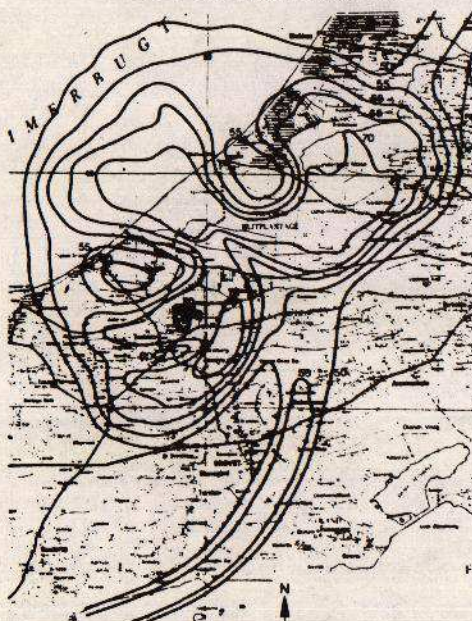


Figure 5 Total noise exposure. All aircraft types. Right- and left-hand patterns.

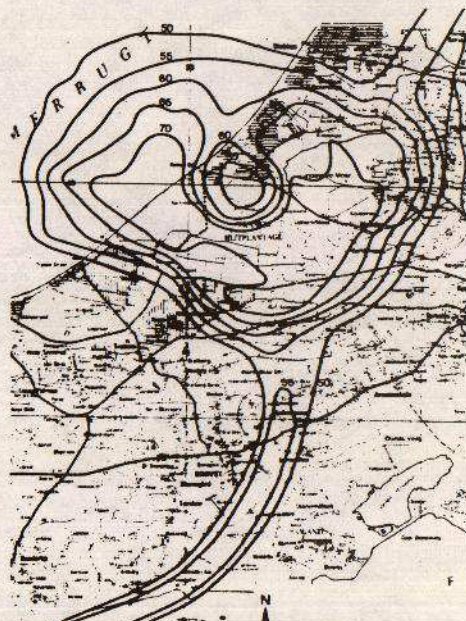


Figure 6 Total noise exposure. All aircraft types. Right-hand patterns only.



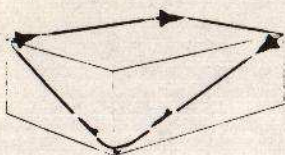


Figure 2 Weapon delivery pattern for F35. Speed, altitude, and power setting are variables.

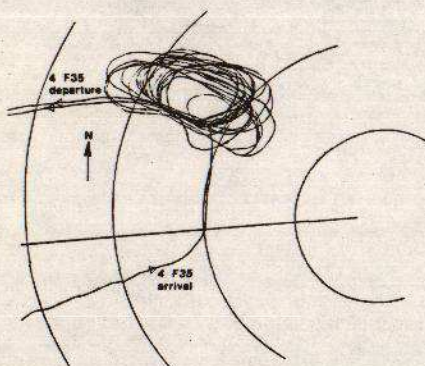


Figure 3 Radar recordings of 12 patterns.

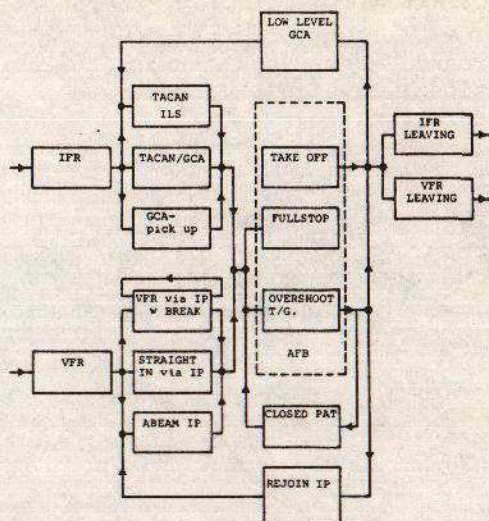


Figure 7 Flow chart for the fighter traffic at an air base.



Figure 8 Noise exposure map for Vaerloese Air Base  
 $L_{DEN} = 50, 55, 60, 65, \text{ and } 70 \text{ dB}$   
 --- Areas of environmental adjustment