SUMMARY OF THE PRELIMINARY RESULTS OF THE JOINT CEC PILOT PROJECT COMMUNITY REACTIONS TO AIRCRAFT NOISE

- The survey in the Netherlands -

This summary is exclusively produced for the Advisory Group of Noise Experts, as no final report is available yet.

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1. INTRODUCTION

In our modern society aircraft noise is a large scale environmental problem. Therefore all over the world many studies have been carried out, also on community reactions to aircraft noise. Thus much knowledge has been acquired in this field.

International co-operation in this field, however, has not been quite satisfactory, with the result that nowadays many different noise ratings are in use, also for legislative purposes, while also the annoyance is not defined and measured identically. This means that it is difficult to a) compare the results of different surveys, what hampers scientific progress, and b) find a common basis for an internationally agreed approach to aircraft noise abatement.

An additional drawback is that many of the occuring noise rates for aircraft noise cannot easily be transformed to the noise rate used for most other sources, the A-weighted equivalent noise level (L_{Aeq}). This means difficulties in evaluating situations with other sources than aircraft noise alone. Therefore the aims of the study have been formulated as follows:

- to see whether harmonizing the definition and measurement of aircraft noise annoyance, and relating this annoyance to some common noise rates (L_{Aeq}, $L_{\overline{Amax}}$, L_{AX} and Number of events), would yield valid and good comparable results;
- to see in what way and to what degree two noise sources influence each other in terms of annoyance.

The project is carried out in the United Kingdom, France, and the Netherlands.

2. EXECUTION OF THE PROJECT IN THE NETHERLANDS

In the Netherlands the project is carried out by the Netherlands Organization for Applied Scientific Research (TNO), around Schiphol (Amsterdam Airport).

Five common aircraft noise areas (CNA's) were identified, within which the social survey and noise measurement programme is undertaken. These are areas within which noise levels from a particular aircraft vary by no more than 3 dB, in terms of L_{Amax}.

These CNA's all were located under landing paths, to ensure that the nature of the noise is the same.

Within each CNA (except for one within which this could not be achieved) two residual noise zones (RNZ's) were identified, one experiencing high levels of residual noise and the other low levels. Differences between the high and low RNZ within one CNA were more than 10 dB(A), expressed in terms of L_{Aeq} (07-19 h). In each case the major source of the residual noise was road traffic noise.

A census was carried out of the addresses in each RNZ.

From the lists thus produced, addresses were sampled systematically. On each address, in each household, one respondent was chosen using a randomization design. This gave a total of 581 respondents. The questionnaire was drawn up and finalized in English, and translated in Dutch. To make sure that translating the questionnaire did not introduce deviant meanings and connotations, the Dutch questionnaire was translated back in English by a second expert and discrepancies were sorted out. The questionnaire was introduced as a study of the local environment and the initial section contained questions on the general environment. Respondents were given the possibility of mentioning aircraft noise - and other noises - spontaneously through questions on their likes and dislikes of the immediate environment. Subsequent questions then asked the respondents about their reactions to noise at different times of the day and week and to assess both their annoyance and the extent to which various activities were disturbed.

Finally the demografic characteristics of the respondents were ascertained.

The social survey was carried out in autumn 1984.

Aircraft noise data were gathered from:

a. short-term aircraft noise measurements in the CNA's;

b. a complete listing of the number and types of aircraft for each CNA

for each hourly period for the 28 days preceding the social survey, produced from the FANOMOS system of the Dutch Civil Aviation Authorities.

By means of an existing special computerprogramme these data were combined.

Residual noise date were gathered from:

a. spot-check measurements;

b. recent traffic counts in the area.

3. NOISE DATA

For the CNA's the original purpose was to obtain three areas with the L_{Aeq} (07-19 h) values of 55, 65, and 75 decibel to ensure a range of about 20 decibel.

In reality it appeared impossible to find living areas around Schiphol with an L_{Aeq} higher than 66 decibels. Finally five CNA's were identified, with L_{Aeq}: 50, 59, 62 (2X), and 66 dB. So the range obtained is 16 decibel. It was decided not to go below 50 dB because of measurement problems to be expected in situations like that.

With regard to the RNZ's the aim was to identify, within each CNA, one zone with a high residual noise level (L_{Aeq} (07-19 h) > 60 dB) and one zone with a low residual noise level (L_{Aeq} (07-19 h) < 50 dB) This criterion was met reasonably well, as becomes clear from the next table.

Table 1. Noise levels in L_{Aeq} (07-19 h); in the CNA for aircraft noise, in the RNZ's for residual noise.

CNA nr	1	2	3	4	5
noise level	50	59	62	62	66
RNZ high level	-	64	60	59	64	64
low level	48	46	46	53	52
Difference (high-low)	-	18	14	13	11	12

For aircraft the noise ratings are correlated with each other. $L_{\overline{Amax}}$, L_{AX}, and L_{Aeq} appear to correlate highly ($p < 0,01$) (see table 2). These measures therefore cannot be expected to differ very much in predicting annoyance.

Table 2. Correlation matrix aircraft noise, all events, 00-24 h.

	$L_{\overline{Amax}}$	L_{AX}	L_{Aeq}	N
L_{Amax}	1.00			
L_{Ax}	1.00	1.00		
L_{Aeq}	0.98	0.98	1.00	
N	-0.17	-0.17	0.03	1.00

N does not correlate significantly with L_{Aeq}, and correlates negatively ($p < 0,01$) with $L_{\overline{Amax}}$ and L_{AX}. Therefore the number of events might play a distinct role in predicting annoyance.

4. SURVEY DATA

4.1 Some spontaneous reactions

In the first section of the questionnaire people are asked about aspects of the area they particularly like or dislike.
From table 3 it becomes clear that 'quietness of the area' is more often stated as a reason for liking the area in:
a. the low residual noise zones, and
b. the CNA's with a relatively low aircraft noise level.
In nearly all research areas aircraft noise is mentioned as the most dominant disliked factor.

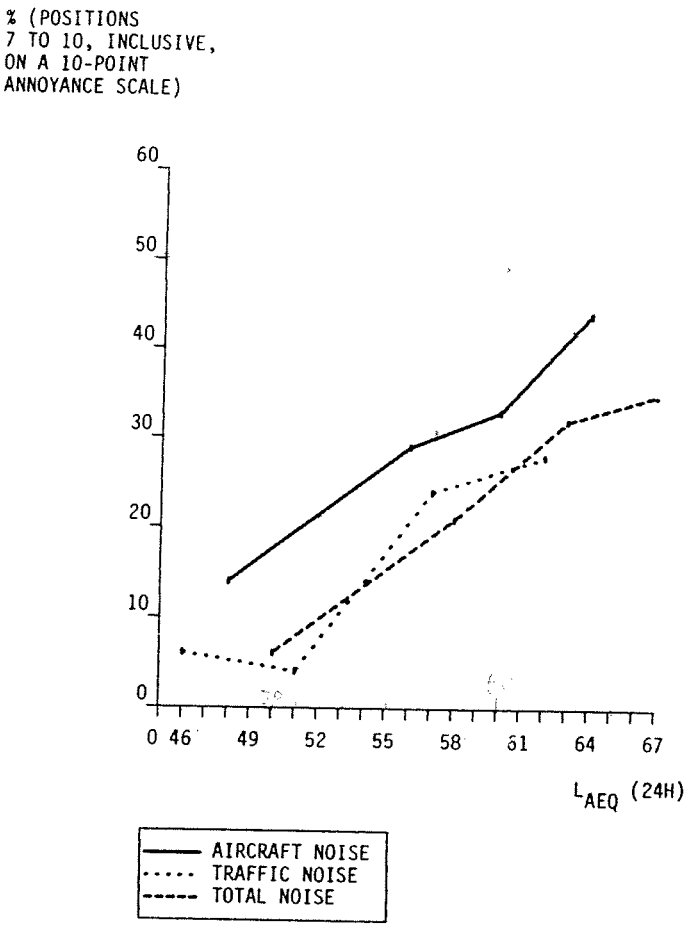
Table 3. Factors mentioned by at least twenty percent of respondents in an area as contributing to their liking or disliking that area (apart from the house itself) (Q 2 and 3).

CNA's:	1	2			3		4		5	
RNZ's:	low	high 1	high 2	low	high	low	high	low	high	low
reasons for liking an area	quietness (61) attractive neighbourhood accessability	attractive neighbourhood quietness (35) shopping facilities public services	attractive neighbourhood quietness (21) public services	attractive neighbourhood quietness (43) shopping facilities accessability	attractive neighbourhood shopping facilities quietness (20)	attractive neighbourhood quietness (35) accessability shopping facilities	accessability attractive neighbourhood	accessability quietness (27) tied to the village friendliness of neighbours	accessability attractive neighbourhood	attractive neighbourhood quietness (25) tied to the village
reasons for dis-liking an area	lack of shopping facilities poor public services bad smell	aircraft noise (35) traffic noise (35)	unfriend-liness of neighbours	aircraft noise (25) other noise (25)	aircraft noise (58) traffic noise (26)	aircraft noise (63)		aircraft noise (49)	aircraft noise (45) traffic noise (24)	aircraft noise (44)

4.2 Comparisons of aircraft, traffic, and total noise annoyance

Aircraft noise causes, noise levels being equal, more annoyance than traffic noise. How much more, depends upon the way annoyance is expressed. Equal annoyance is achieved when the aircraft noise level is approximately 2 to 7 decibel lower than the residual noise level (traffic noise is by far the main component of residual noise). See figure 1.

Figure 1. Aircraft (A 24 A), Traffic (R 24 B), and Total noise annoyance (N 24 D) x L_{Aeq} 24 H (specific).



It is surprising to find that the measure in which one reports annoyance from the total noise situation more resembled the traffic noise annoyance than the aircraft noise annoyance. The form of the slope, however, and reactions to other questions, reveal that the total noise annoyance is more driven by the aircraft noise than by the residual noise. See table 4.

Table 4. Correlation-matrix of some questions with aircraft, residual and total noise levels.

		L_{Aeq} (00-24) Aircraft Noise All events		L_{Aeq} (00-24) Residual Noise All events		L_{Aeq} (00-24) Total Noise All events	
		r	p	r	p	r	p
L7D	Quietness of the area	0,36	**	0,18	**	0,35	**
N8	Quiet or noisy : noisy	0,39	**	0,32	**	0,43	**
N9	Being bothered : frequency	0,31	**	0,12	*	0,30	**
N10	Being bothered : degree	0,30	**	0,12	*	0,28	**
N11A	Unacceptability	0,25	**	0,14	**	0,24	**
A24A	Overall feelings aircraft	0,30	**	0,06		0,27	**
R24B	Overall feelings traffic	0,19	**	0,44	**	0,30	**
N24C	Overall feelings other noise	0,04		0,04		0,04	
N24D	Overall feelings general	0,34	**	0,17	**	0,34	**

** = $p \leq 0,01$
* = $p \leq 0,05$

It is clear that this requires more in-depth analysis.

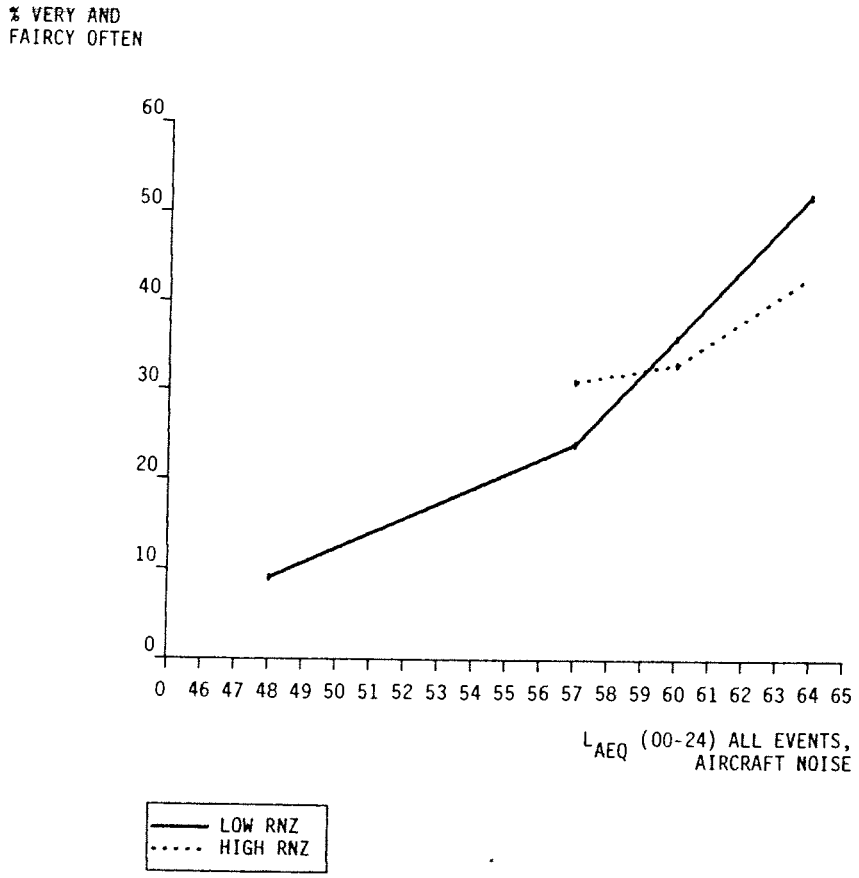
4.3 The role of residual noise

Many attempts have been made to clarify the role of residual noise in evaluating a specified 'foreground' noise. Following the rules of masking one might expect less annoyance by a specified noise with higher residual noise and vice versa (with a fixed level of the specified noise). In laboratory studies this effect has been demonstrated several times. In field studies more contradictory results are achieved. Sometimes more annoyance was found, sometimes less, and sometimes no differences could be demonstrated. In this study another attempt is made.

4.3.1 Residual noise and the evaluation of the total noise situation

In the first section of the questionnaire several questions are asked about the total noise situation (Q 8 to Q 11, inclusive). The patterns of the answers resemble each other very much. The residual noise level hardly seems to play any role. This is somewhat surprising because in the high RNZ's the residual noise level certainly influences the total noise level, while in most low RNZ's this is not the case. The expectation was, that in the high RNZ's the reactions to the total noise situation would be less favourable. Figure 2 gives one example of the findings.

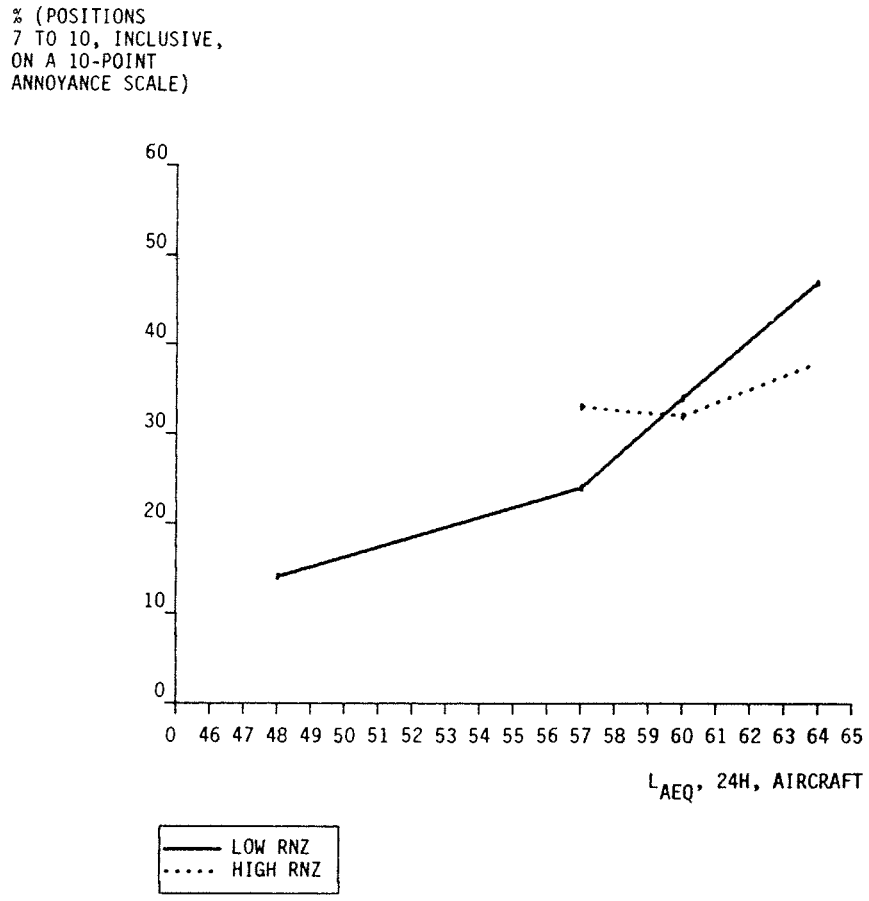
Figure 2. How often does noise bother you? (N9, not literally quoted)



4.3.2 Residual noise and the evaluation of the aircraft noise situation

From the first analysis presented here no clear influence of the residual noise levels on the aircraft noise annoyance can be demonstrated. See figure 3.

Figure 3. Aircraft noise annoyance (A 24 A) x L_{Aeq} 24 h, high RNZ and low RNZ apart



4.4 Specificity

In doing social surveys about noise annoyance one is often confronted with the problem of specificity. If you ask people about the noise annoyance they experience at home, must not you measure the noise itself inside too? Or if you ask about night time annoyance, mustn't you measure the noise at night?
As far as the exact place to measure the noise is concerned some evidence has been compiled that measuring inside hardly enhances the predictive power of the measurements (predicting annoyance) compared to measuring before the façade of the house. People obviously also react towards the outside situation (at least partly).
In this project some other topics of specificity have been investigated.

4.4.1 Specificity to the noise source

In table 4 some correlations are presented between 'overall feelings' towards aircraft, traffic, other noise and the overall noise situation. Not surprisingly specificity is demonstrated: aircraft noise annoyance (negative overall feelings) correlates best with aircraft noise level and traffic noise annoyance correlates best with traffic noise level.
'Overall feelings towards other noise' does not correlate with any of the noise levels, thus demonstrating once more that aircraft and traffic are the only important noise sources in the research areas.
Annoyance with the overall noise situation is an exception: it correlates as good with its specific noise level as with the level of aircraft noise. This is what was meant in par. 4.2 by the statement '..... total noise annoyance is more driven by the aircraft noise than by the residual noise'.
The degree of the reported total noise annoyance, however, is lower than of aircraft noise annoyance and has a level more or less similar to traffic noise annoyance (see figure 1). A tentative explanation for this phenomenon might be found in the hypothesis that people evaluate different sounds against different frames of reference. From their experience and expectations they have built up an idea about

the total collection of situations, possible with respect to aircraft noise. And they evaluate their own aircraft noise situation against this. At the same time they have formed an idea about the total collection of situations, possible with respect to total noise. Ans this can be quite another frame of reference.

4.4.2 Specificity to the period of the week

Prediction of annoyance during weekdays or weekends is not better when levels are measured and calculated for that special periods of the week instead of just for the whole week, as appears from table 5 and figures 4a and b. This holds true for both aircraft and traffic noise, with an unexplained discrepancy in the high RNZ's.

Table 5. Specificity to period of the week

		L_{Aeq} (00-24) Aircraft All events		L_{Aeq} (00-24) Aircraft Weekdays		L_{Aeq} (00-24) Aircraft Weekend	
		r	p	r	p	r	p
N14A4	Weekday aircraft annoyance	0,30	**	0,31	**		
N14B4	Weekend aircraft annoyance	0,28	**				
A17B	Weekend aircraft annoyance	0,31	**			0,25	**
A19A	Overall aircraft annoyance	0,35	**			0,28	**
		L_{Aeq} (00-24) Residual All events		L_{Aeq} (00-24) Residual Weekdays		L_{Aeq} (00-24) Residual Weekend	
		r	p	r	p	r	p
N14A1	Weekday traffic annoyance	0,42	**	0,42	**		
N14B1	Weekend traffic annoyance	0,34	**				
R17C	Weekend traffic annoyance	0,34	**			0,34	**
R19B	Overall traffic annoyance	0,34	**			0,34	**

** = $p \leq 0,01$
* = $p \leq 0,05$

4.4.3 Specificity to the time of the day

From table 6 one might be inclined to conclude that also with respect to the time of the day it would not be necessary to make any differentiation in carrying out noise measurements and calculations: The power of the relation of daytime, evening and nighttime annoyance is not improved by using the noise levels for these specific periods.
However, the power of the relation does not tell the whole story about the prediction of the annoyance out of the noise levels. Figure 5 reveales that, noise levels being equal, the annoyance at night is higher than in the evening, wherein on its turn the annoyance is higher than during the daytime.

Table 6. Specificity of the time of the day

		L_{Aeq} (00-24)	L_{Aeq} (08-18)	L_{Aeq} (07-19)	L_{Aeq} (19-23)	L_{Aeq} (00-06)	L_{Aeq} (21-07)
A19A	Overall aircraft annoyance	0,35					
A15B	Daytime aircraft annoyance	0,30	0,30	0,30			
A16B	Evening aircraft annoyance	0,29			0,28		
A18	Nighttime aircraft annoyance	0,21				0,20	0,20
R19B	Overall traffic annoyance	0,34					
R15C	Daytime traffic annoyance	0,40	0,40	0,40			
R16C	Evening traffic annoyance	0,35			0,35		

Remarks: 1. Noise levels are for all events
2. Aircraft annoyance questions X aircraft noise data
3. Traffic annoyance questions X residual noise data
4. All values $p \leqslant 0,01$

Figure 4a. Annoyance by aircraft noise

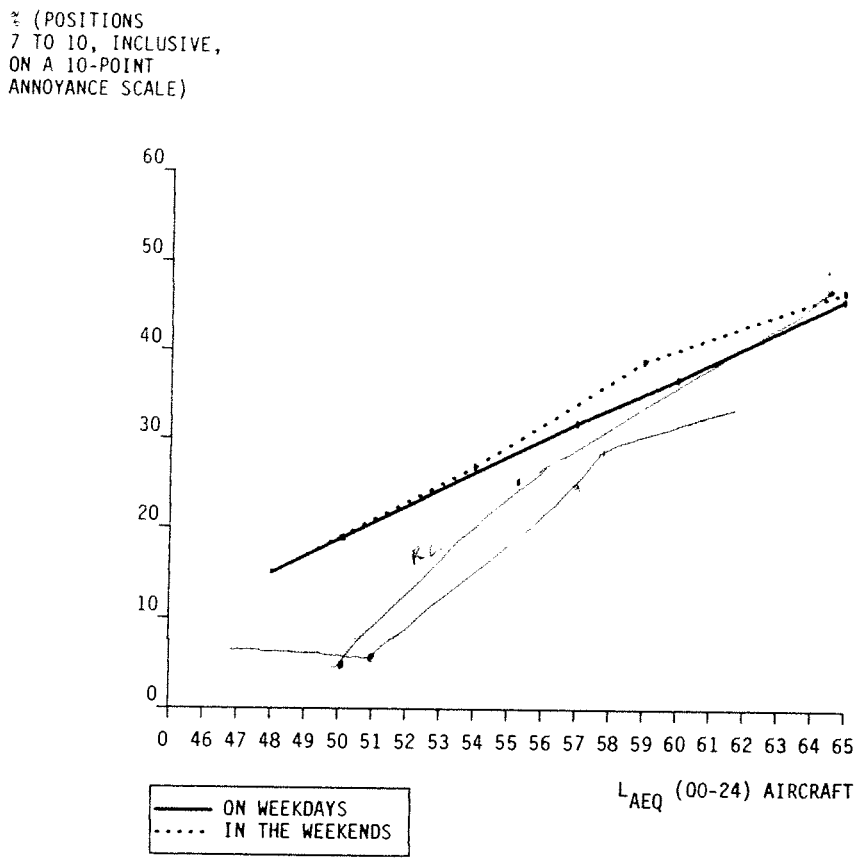


Figure 4b. Annoyance by traffic noise

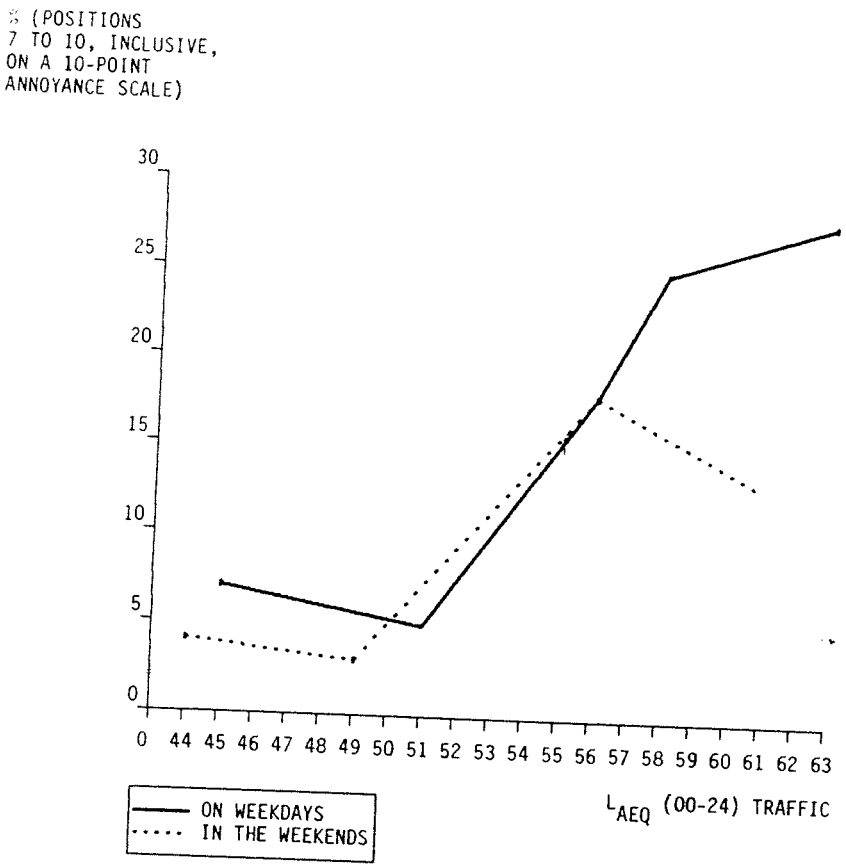
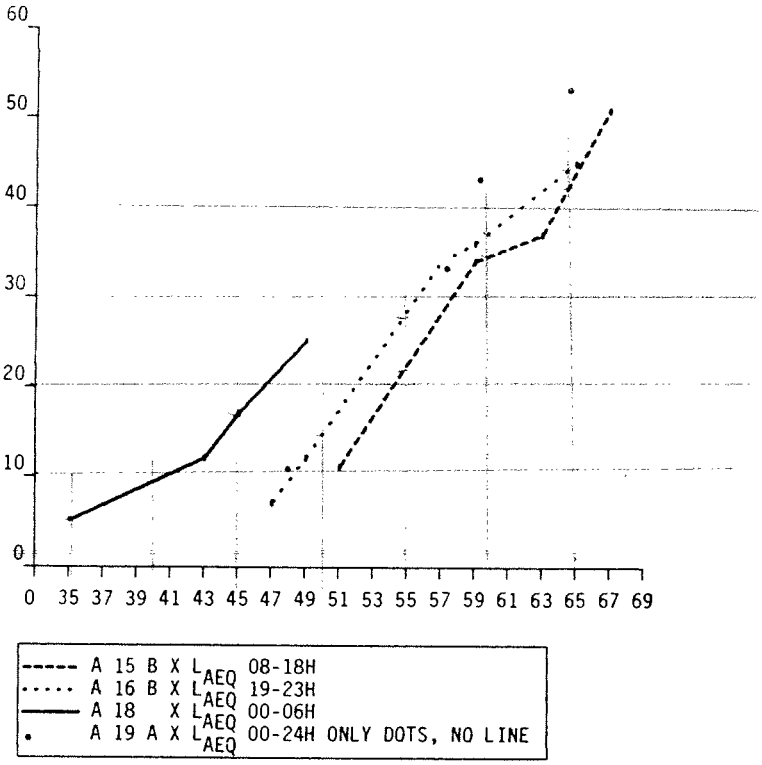


Figure 5. Daytime, evening, nighttime and overall aircraft noise annoyance, each against their own L_{Aeq}



5. CONCLUSIONS

With respect to the first aim of the study no final conclusions can be drawn from a national study. The results of the analysis of the combined, international, data must be awaited. What can be concluded from this national study is, that the power of the relations between the L_{Aeq}, $L_{\overline{Amax}}$ and L_{ax} at the one hand, and the aircraft, traffic and total noise annoyance at the other hand are, on itself, satisfactory. This means that it might be possible to use e.g. L_{Aeq} as a predictor of aircraft noise annoyance instead of other current noise ratings. Of course before drawing this conclusion definitely one has to make sure that the L_{Aeq} has about the same predictive power as the current aircraft noise ratings.

With respect to the second aim of the study the conclusion reads that the analyses carried out until now do not indicate any clear influence of the residual noise level on aircraft noise annoyance.

How the total noise situation could be evaluated from the knowledge about the annoyance caused by the separate noise sources, remains unclear at this stage.

In explaining annoyance during different periods of the day it appears to be fruitful to measure and/or calculate the noise levels during these specific periods.

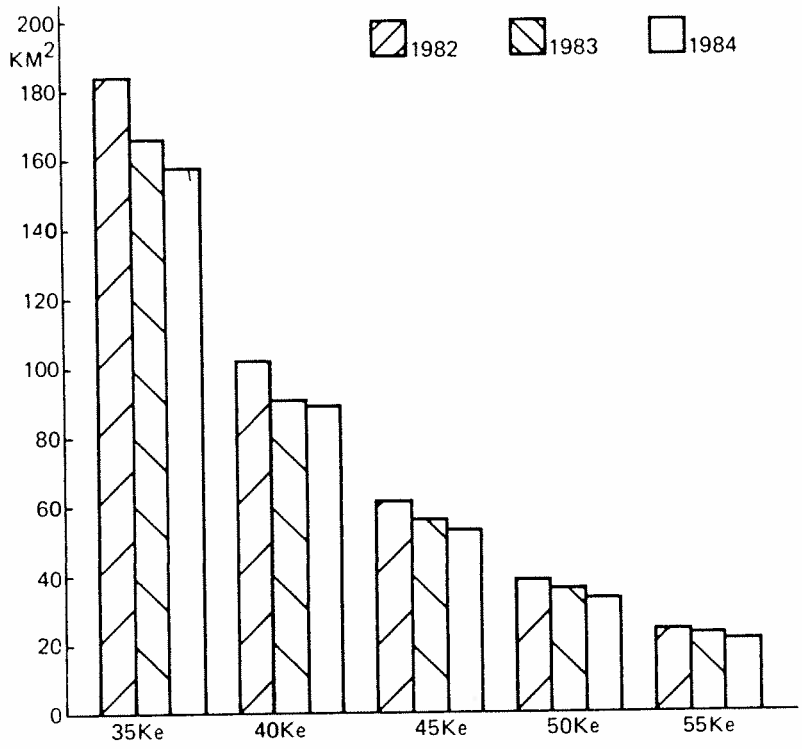


Fig. 6 Oppervlakten binnen de geluidsbelastingcontouren

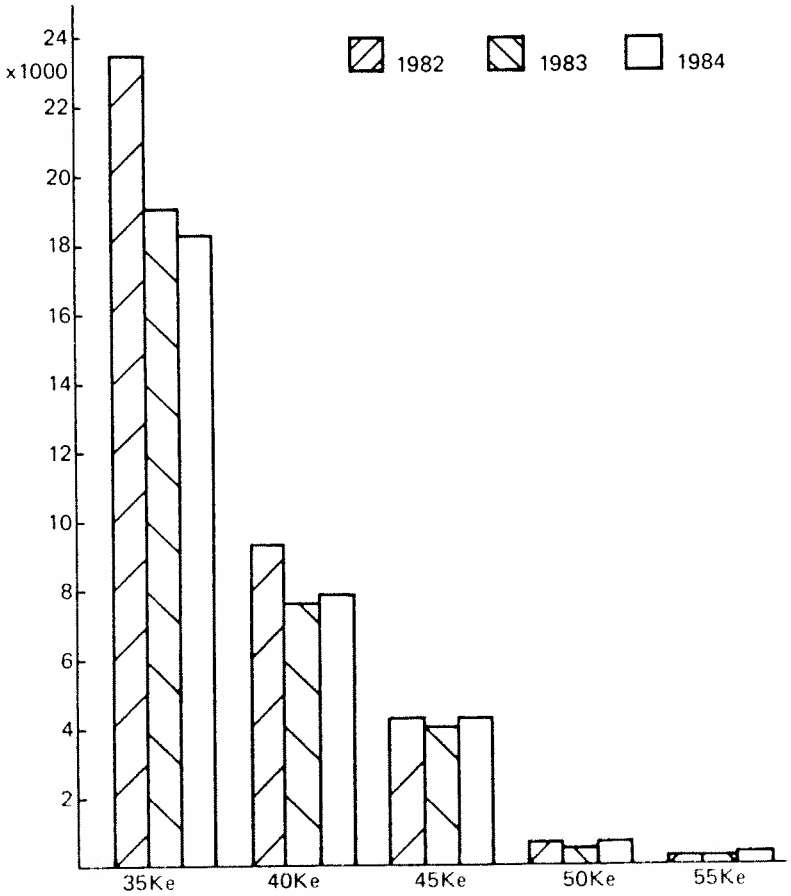


Fig. 7 Aantal woningen binnen de geluidsbelastingcontouren

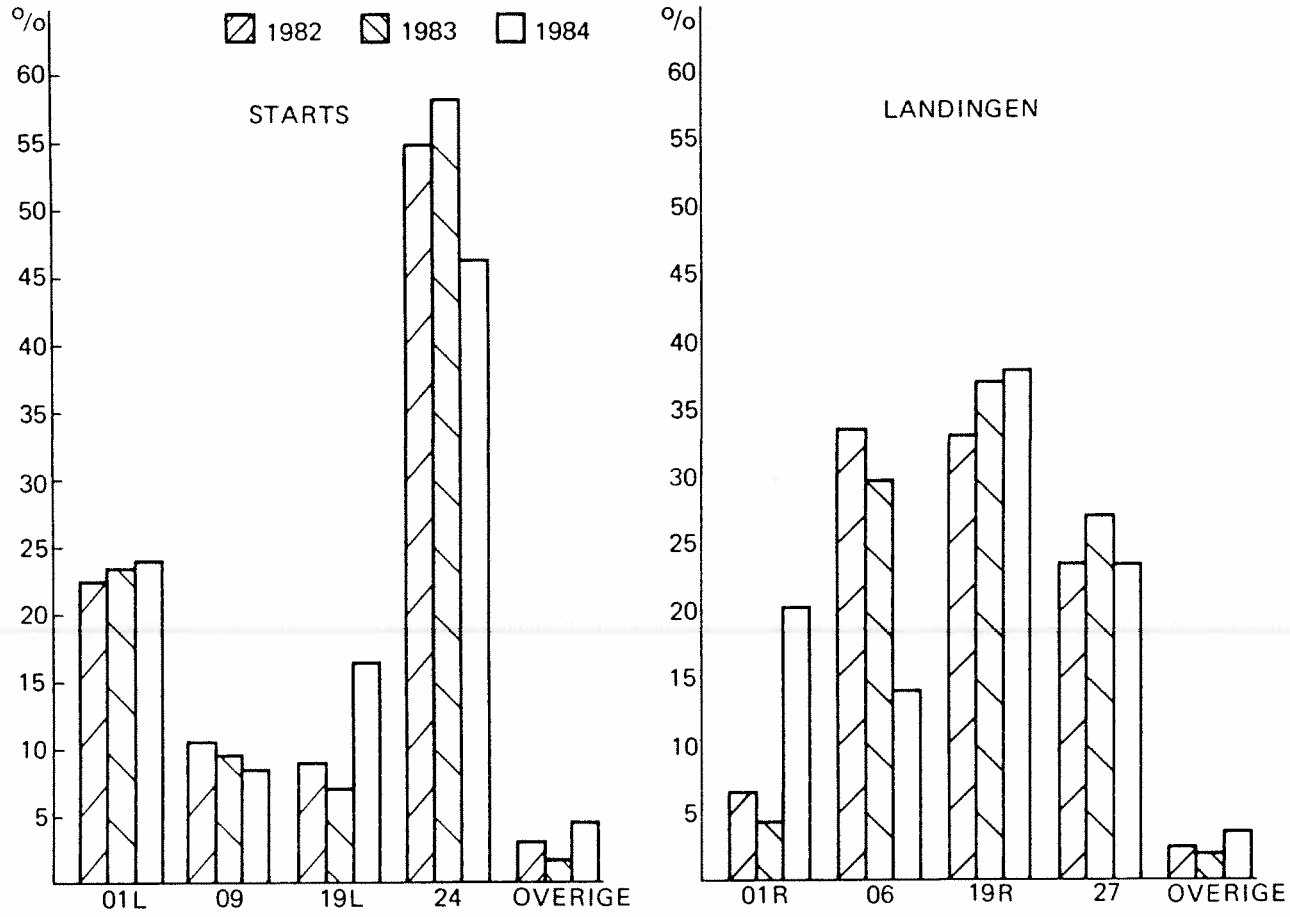


Fig. 4 Baangebruikpercentages commercieel en lesverkeer

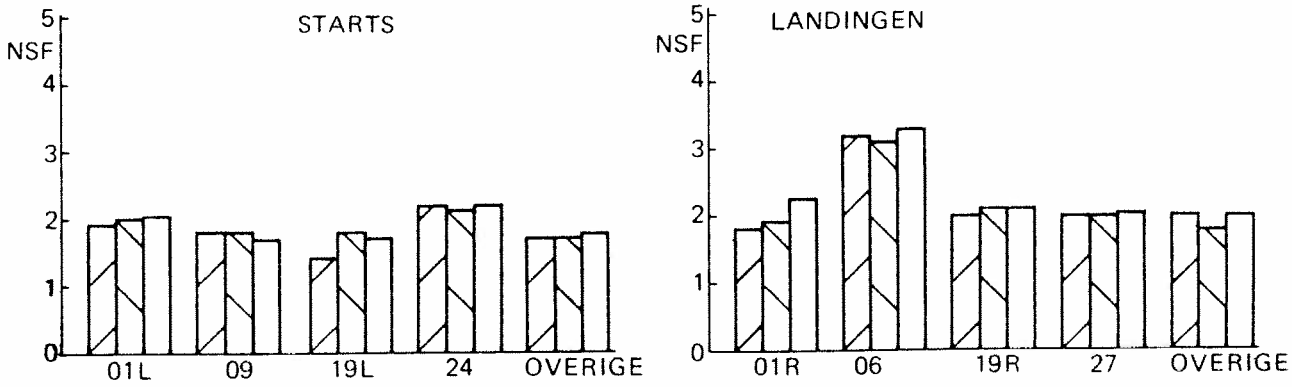


Fig. 5 Gemiddelde nachtstraffactoren commercieel en lesverkeer

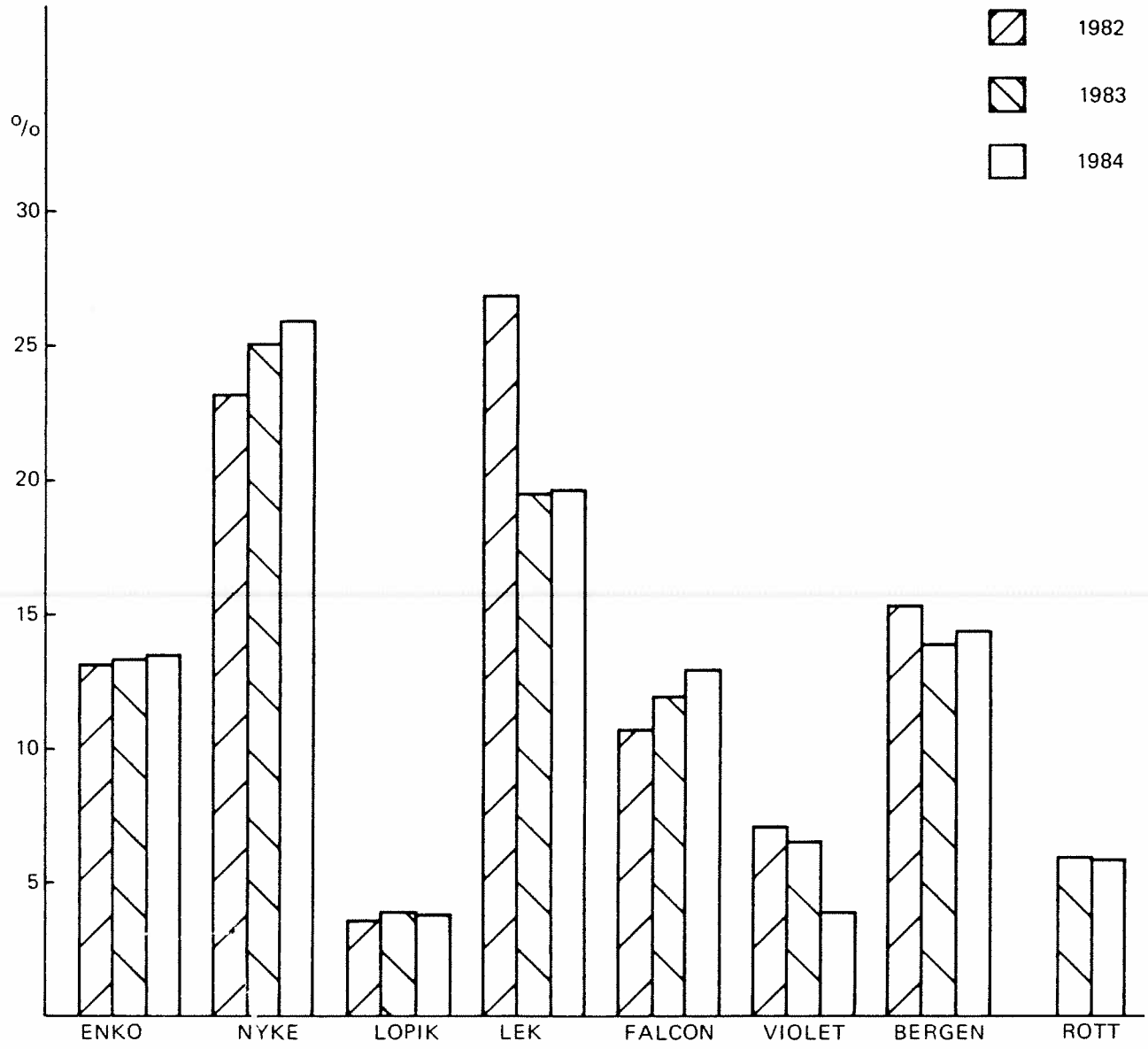


Fig. 2 Procentuele verdeling van starts over de uitvliegrichtingen (commercieel verkeer)