

# TRACTOR NOISE

## Field measurements of noise at ear level

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### INTRODUCTION

This survey has been done in co-operation with the Safety Department of the Ministry of Social Affairs in the Netherlands. The objective was to gather information about the noise at ear level for tractor drivers under normal field work conditions. This is important from the point of view of the validity of the OECD measurements in practice. Furthermore, one likes to know something about the influence of the working conditions on the operational noise.

The measurements were taken in the field with Bruël & Kjaer no. 2206 sound level meters. The man with the meter was standing to one side, behind or inside the cab, holding the microphone at the operator's ear level. A screen was fitted on the meter; the setting was: dB(A)-slow response.

The operator was told to proceed as usual, so that the measurements were taken with doors and windows closed or open, with or without playing the radio, just as the driver had been driving before the test.

In an appendix some data are given of a survey with a Bruël & Kjaer Noise Dose Meter 4424. The instructions to the tractor drivers were the same.

### RESULTS

The results are shown in Tables I-V and Figs. 1-4.

$L_{t,n}$  is the noise level exceeded in n% of cases.

The  $L_{t,10}$  values are high, about 98 dB(A) - an indication that there are field conditions which are extremely hazardous to the hearing of the tractor driver. (In the Netherlands 20% of the tractor drivers suffer some hearing loss.).

The  $L_{t,50}$  values in the field are on average about 4 dB(A) lower than the OECD values. The working conditions have little effect on the noise reaching the operator. Only drilling and harrowing without pto-drive are a favourable exception. The introduction of the quiet cab in 1976 represents a turning point to better conditions, as shown in Table 1. This applies particularly to fairly new tractors with high powered engines. Fig. 1 shows that the oldest tractors with a working time of 6000 h and more are used mostly in easy working conditions.

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Furthermore, the max. engine speeds are often lower than those of the more powerful tractors of the last ten years.

Table 1 Reduction in noise level brought about by the quiet cab

Group	% 90 dB(A)	$L_{t90}$	$L_{t50}$	$L_{t10}$
All tractors 1975-1977	65%	85 dB(A)	93 dB(A)	98 dB(A)
All tractors 1977*	48%	82 dB(A)	90 dB(A)	97 dB(A)

\* first half only

## CONCLUSIONS

- In the past, 60% of tractor drivers have been exposed to hazardous noise levels under normal working conditions in the field.
- The results of the mean OECD measurements for the tractors with frames are about 3-4 dB(A) higher than the mean field values.
- In the case of tractors with quiet cabs the difference between field and OECD tests are insignificant.
- So far the good results obtained with the "silent tractors" are due to the "quiet cabs". There are no indications of fundamental changes in engine design to achieve significant reductions of noise emission.

## REFERENCES

- 1 Arbeidsinspectie: Gehoorbescherming P blad no. 138, 1975.
- 2 Arbeidsinspectie: Vierwielige trekkers in de landbouw P blad no. 29, 1977.
- 3 Crucq, J.: Trekkerbehendigheidswedstrijden, Landbouwmechanisatie (1977) 28 (11) 1191-1192.
- 4 Dekker, J.C.; Hielema, Zr. Tj.; Sieswerda, D.: Schijnzekerheid in de akkerbouw: een onderzoek naar lawaaidoofheid bij trekkerbestuurders. Tijdschrift voor Sociale Geneeskunde (1978) 56 (9) 288-292.
- 5 EEG richtlijn no. 77/311 d.d. 29 maart 1977.
- 6 ISO 1999: Assessment of occupational noise exposure for hearing conservation purposes. 1st edition, Aug. 1975.
- 7 Maring, J.: Lawaaidoofheid bij trekkerbestuurders. Rapport, ILR 170 (1972) 1-23.
- 8 OECD: Summary of tests on safety frames and cabs Agr/TS (78) no. 20.

Table II Noise at ear level during various field operations

	Year	≥90 dB (A) %	L <sub>t</sub> 90 dB (A)	L <sub>t</sub> 50 dB (A)	L <sub>t</sub> 10 dB (A)	N number
All tractors	1975	73	85	93	99	225
All activities	1976	66	84	92	98	218
	1977*	47	81	89	97	79
	1975-1977	64	84	92	98	522
With cab	1975	72	84	94	99	159
	1976	62	84	92	98	174
	1977*	40	81	89	96	54
	1975-1977	63	83	92	98	387
Without cab	1975	80	87	92	96	66
	1976	84	88	93	97	44
	1977*	65	85	93	97	25
	1975-1977	75	86	92	97	135

All tractors,  
specified activities

Tillage, ploughing,	1975	73	84	94	98	132
harrowing (power)	1976	68	85	93	98	145
	1977*	56	82	92	97	45
	1975-1977	68	84	93	98	322
Harvest, beets, potatoes	1975-1977	80	85	94	97	21
Transport, mat. handling	1975-1977	66	85	91	97	42
Drilling, harrowing	1975-1977	49	80	88	94	61
Ditch, trench digging	1975-1977	66	85	92	99	15
Forage harvesting	1975-1977	79	86	93	98	33
Manure, fertilizer distribution	1975-1977	83	89	93	98	29

\* first half only

Table III Noise at ear level with tractors of different ages

Tractor age in working hours	Year	$\geq 90$ dB (A) %	$L_t 90$ dB (A)	$L_t 50$ dB (A)	$L_t 10$ dB (A)	N number
<500	1975	50	82	90	98	60
	1976	44	83	89	96	70
	1977*	21	80	86	92	19
	1975-1977	43	82	89	96	149
500-1000	1975	82	86	94	97	39
	1976	65	83	92	97	37
	1977*	33	80	87	93	12
	1975-1977	68	83	92	97	88
1000-1500	1975	81	87	95	99	22
	1976	86	88	93	98	23
	1977*	50	82	90	97	12
	1975-1977	78	86	93	98	57
1500-3000	1975	85	88	95	100	53
	1976	83	88	94	99	46
	1977*	67	85	93	97	12
	1975-1977	82	88	94	99	111
3000-6000	1975	84	89	94	97	37
	1976	82	87	94	98	33
	1977*	67	87	94	98	18
	1975-1977	79	87	94	98	88
> 6000	1975	53	85	90	96	15
	1976	67	87	93	101	9
	1977*	37	79	87	96	6
	1975-1977	53	84	90	98	30

\* first half only

Table IV Noise at ear level with tractors of different power classes

Power class of tractor (at the p.t.o.)	Year	$\geq 90$ dB (A) %	$L_t 90$ dB (A)	$L_t 50$ dB (A)	$L_t 10$ dB (A)	N number
<40 hp	1975	25	84	88	92	18
	1976	60	85	91	95	17
	1977*	50	80	90	95	14
	1975-1977	44	83	89	94	49
51-50 hp	1975	78	88	94	99	32
	1976	65	85	92	98	22
	1977*	79	87	94	98	12
	1975-1977	73	87	93	98	66
51-60 hp	1975	83	88	93	97	30
	1976	77	87	93	98	46
	1977*	69	85	92	97	16
	1975-1977	79	87	93	98	92
61-70 hp	1975	86	88	95	99	68
	1976	77	84	94	99	73
	1977*	35	80	88	99	17
	1975-1977	77	84	94	98	158
71-80 hp	1975	61	82	92	99	44
	1976	56	83	91	96	36
	1977*	37	81	87	95	6
	1975-1977	61	82	91	98	86
81-100 hp	1975	67	83	93	98	24
	1976	41	85	89	94	19
	1977*	36	82	87	95	11
	1975-1977	50	83	90	97	54
$\geq 100$ hp	1975	--	--	--	--	--
	1976	--	--	--	--	--
	1977*	--	--	--	--	--
	1975-1977	56	84	91	97	18

\* first half only

Table V Noise at ear level  
OECD-measurements (test reports 1975-1977)

Tractor tested	Year	≥90 dB(A) %	L <sub>t</sub> 90 dB(A)	L <sub>t</sub> 50 dB(A)	L <sub>t</sub> 10 dB(A)	N number
With cab	1975	72	85	98	103	74
	1976	15	82	85	100	170
	1977*	19	80	85	97	47
With frame	1975	98	93	98	100	95
	1976	100	95	97	100	101
	1977*	98	94	98	101	33
All reports	1975	89	89	97	102	169
	1976	47	82	89	100	271
	1977*	52	82	93	100	80

\* first half only

## APPENDIX

Some figures are given of a survey with a Bruël & Kjaer Noise Dose Meter 4424. The instructions to the tractor drivers were: "Drive just as you were driving all day". The worker wore the noise dose meter also during his lunch-hour, tea time etc.

Table VI shows the noise dose percentages (according ISO 1999) and the calculated L equivalent (8 h exposure) of different agricultural field activities. Fig. 4 gives some information about different working conditions. Ploughing and cultivating produced high noise levels.

If known, the OECD or USA (Nebraska) test data are indicated (N = 75% refers to load condition).

### Conclusions

- The OECD (Nebraska) measurements are in agreement with the field values.
- The quiet cabs are effective in the fight against high noise levels at ear level produced by agricultural tractors and associated equipment.

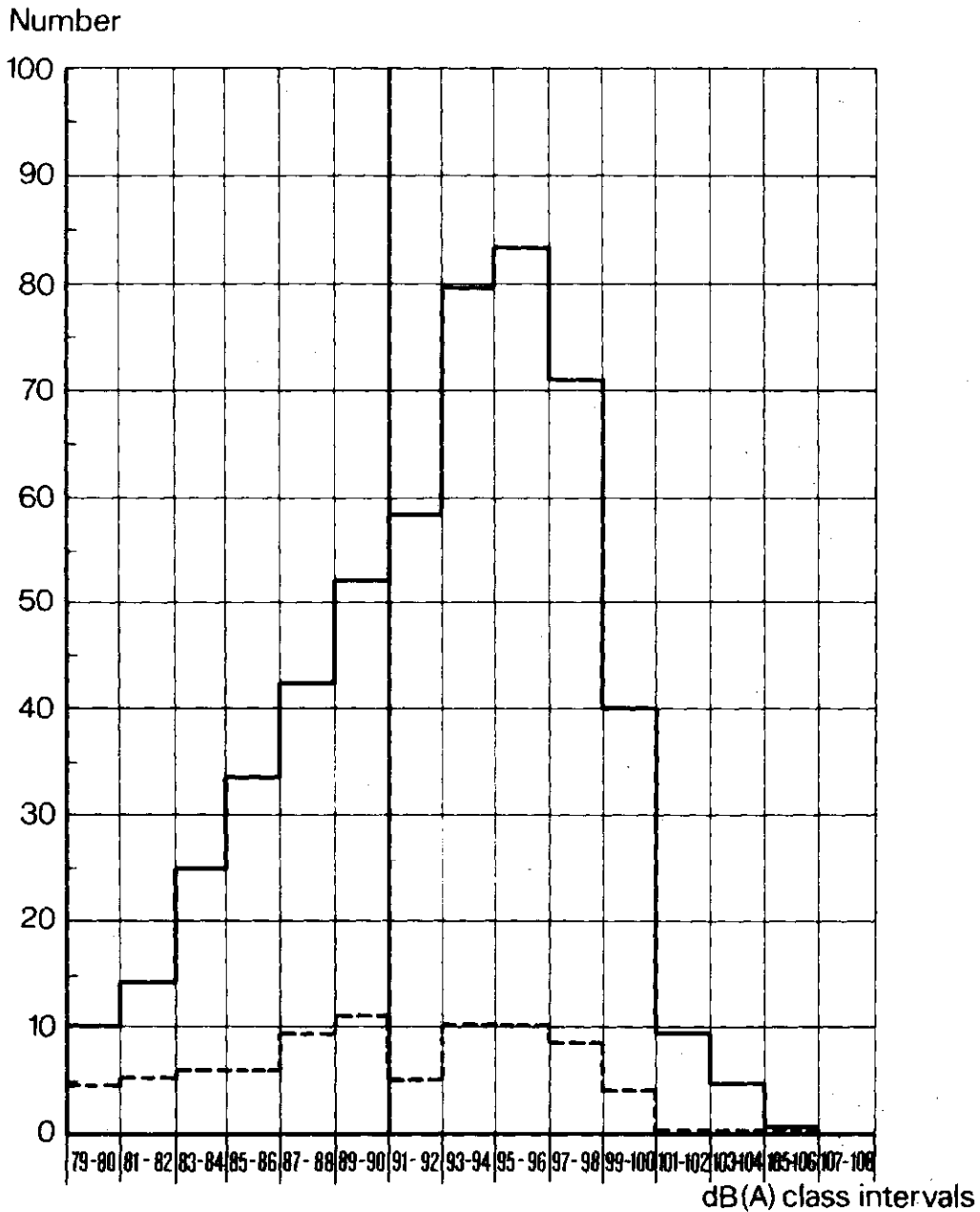


Fig. 1a Probability distribution plot: class intervals of noise levels at ear  
 — All tractors, all activities 1975, 1976 and first half of 1977 N = 522  
 - - - All tractors, all activities first half of 1977 N = 79



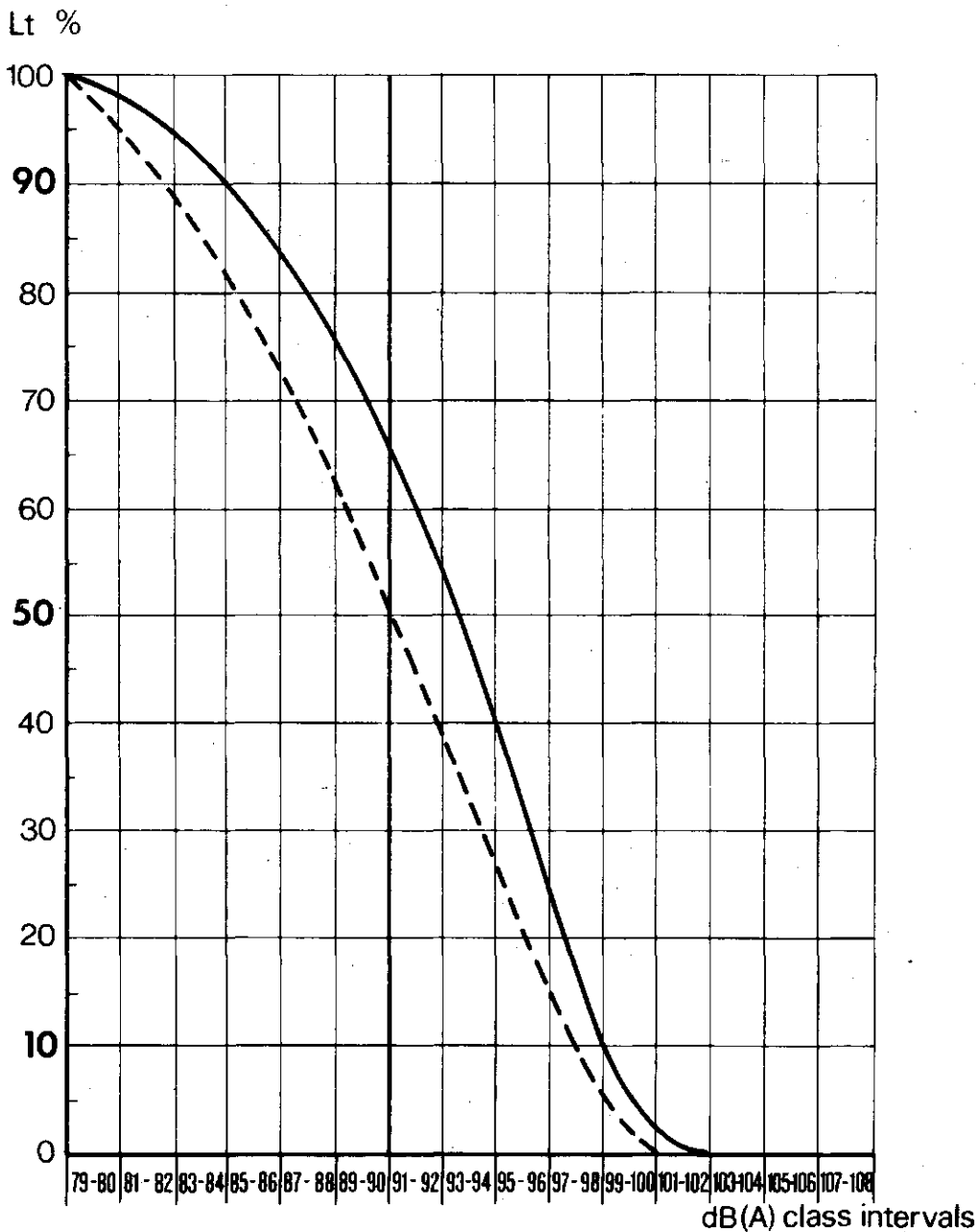


Fig. 1b Cumulative distribution curves: class intervals of noise levels at ear

— All tractors, all activities 1975, 1976 and first half of 1977 N = 522

----- All tractors, all activities first half of 1977 N = 79

Number

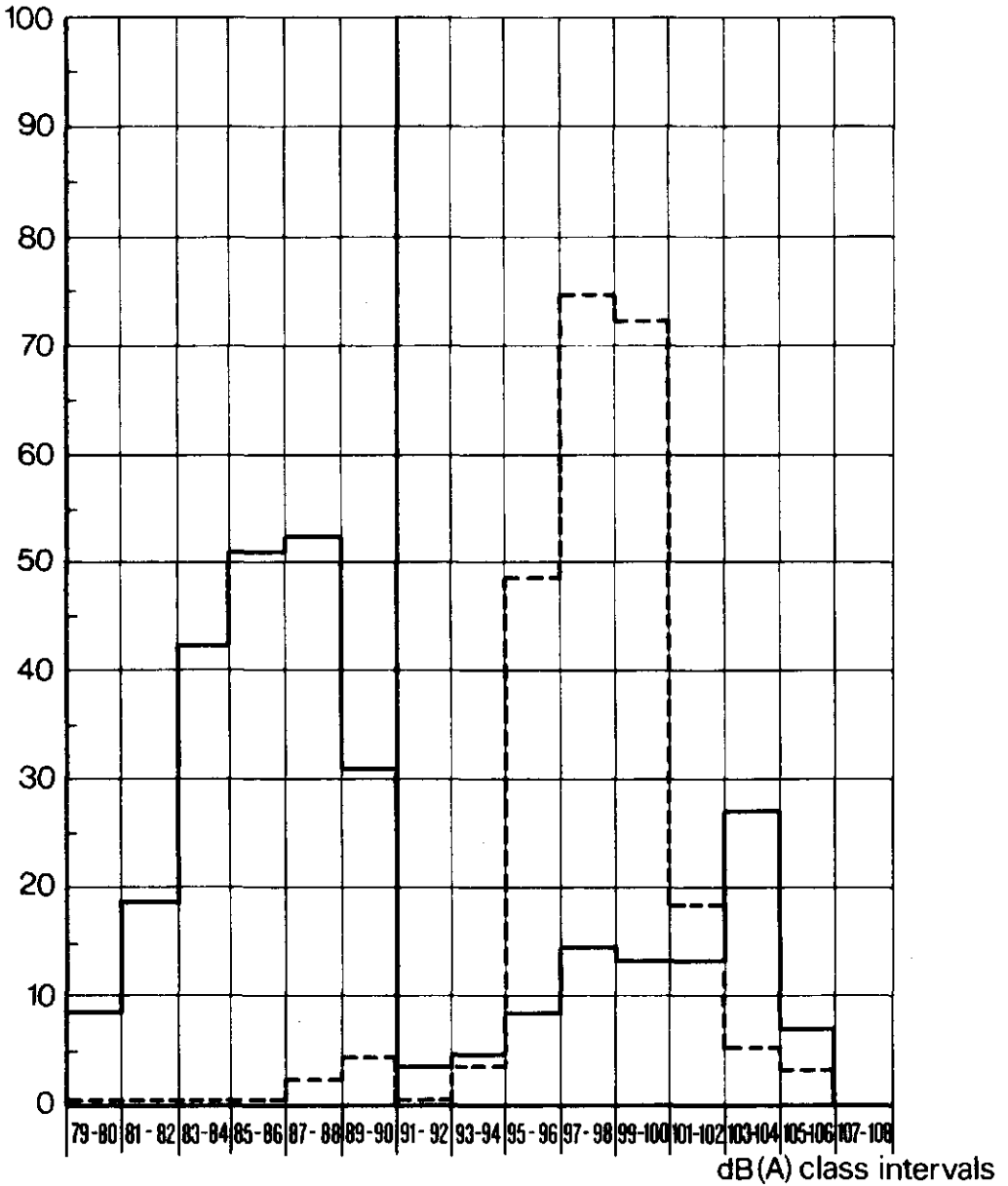


Fig. 2a Probability distribution plot: class intervals of noise levels at ear

— OECD reports, 1975, 1976 and first half of 1977, with cab  
N = 295

----- OECD reports, 1975, 1976 and first half of 1977, with frame  
N = 229

Lt %

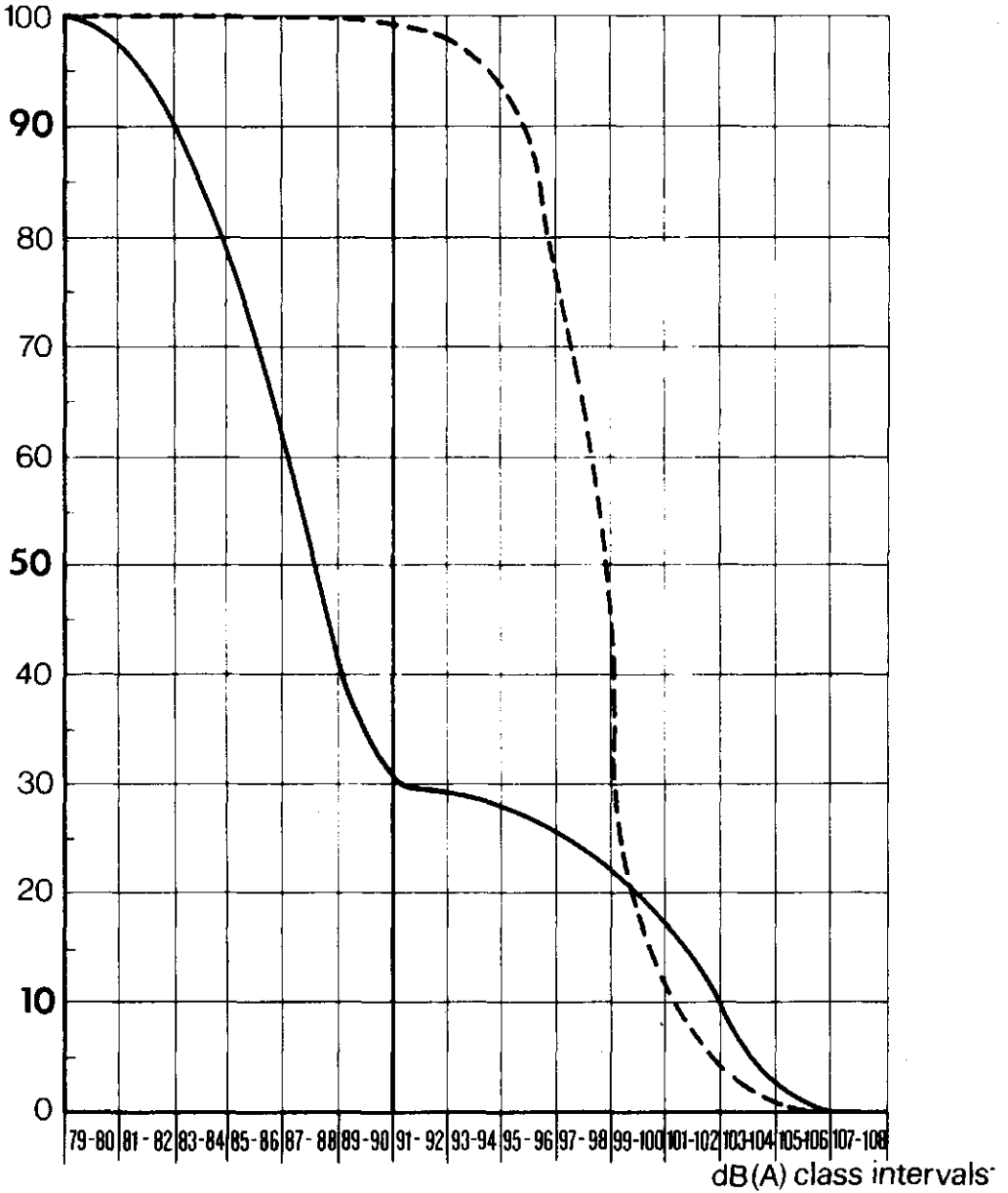


Fig. 2b Cumulative distribution curves: class intervals of noise levels at ear

— OECD reports, 1975, 1976 and first half of 1977, with cab  
N = 295

- - - - OECD reports, 1975, 1976 and first half of 1977, with frame  
N = 229

Number

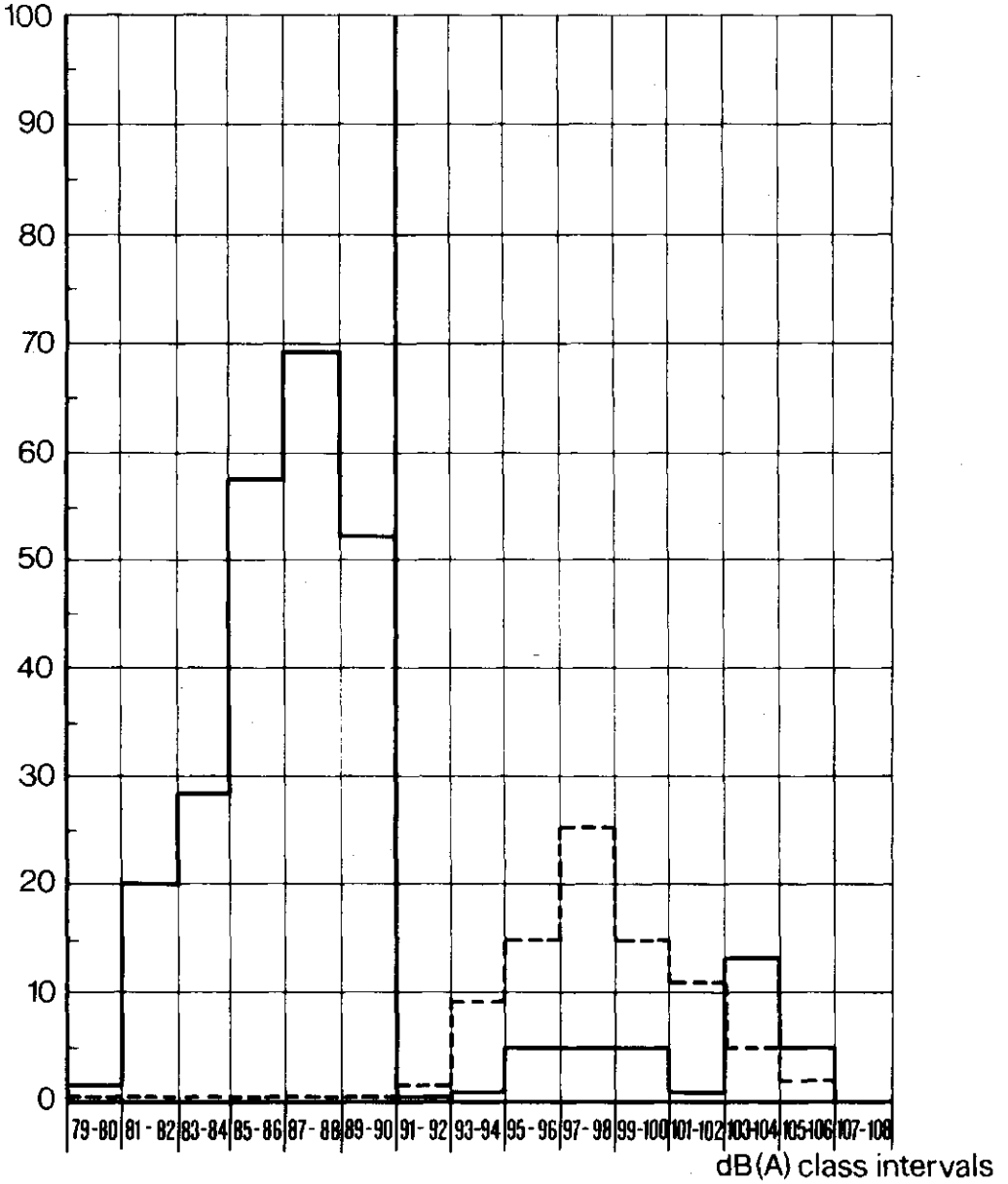


Fig. 3a Probability distribution plot: class intervals of noise levels at ear

— OECD reports, May 1977-May 1978, with cab,  
N = 262

- - - - - OECD reports, MAY 1977-May 1978, with frame,  
N = 83

Lt %

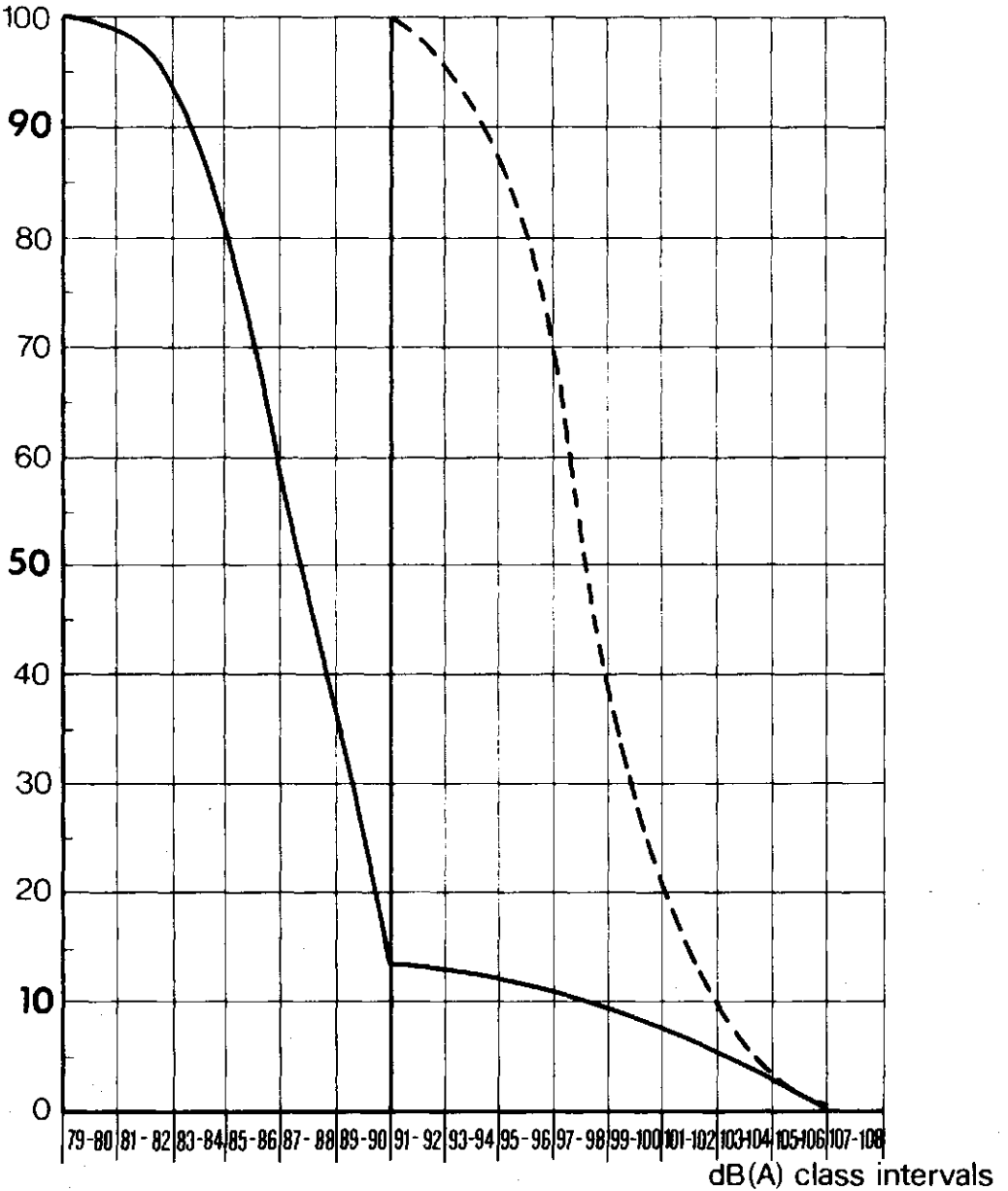


Fig. 3b Cumulative distribution curves: class intervals of noise levels at ear

— OECD reports, May 1977-May 1978, with cab,  
N = 262

- - - - OECD reports, May 1977-May 1978, with frame,  
N = 83

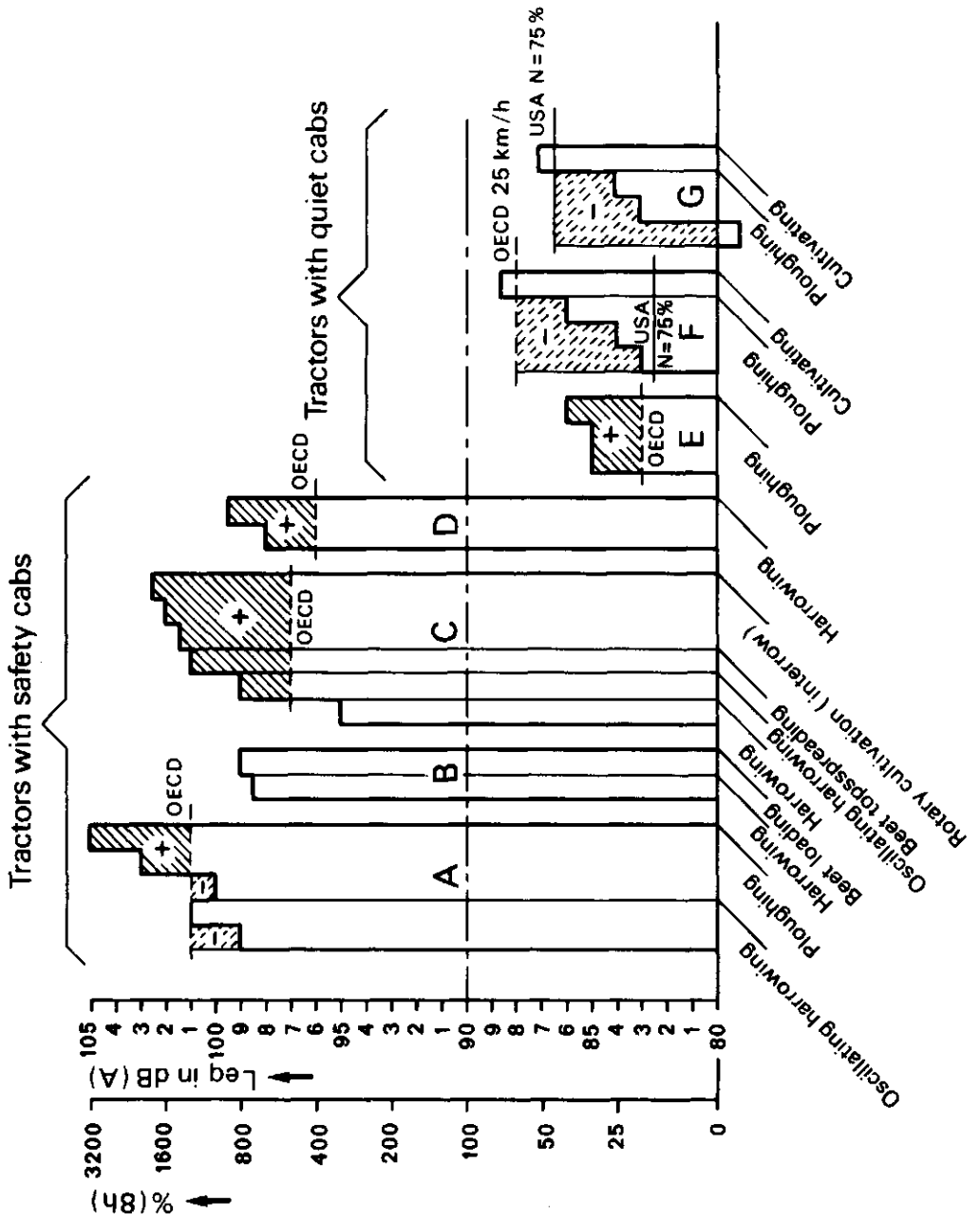


Fig. 4 Equivalent noise levels calculated as noise dose percentages, based on personal noise dose measurements obtained from agricultural activities in the field  
 A-G = different tractor types.

Table VI Personal noise dose measurements obtained from agricultural activities in the field under normal operating conditions.

Activities	Exposure duration, h	Noise doses %	L eq dB(A) 8 h	Remarks
Ploughing	6.5	1590	103	
"	5.5	819	101	
"	3.5	1285	105	
"	1.5	74	96	
"	5.5	23	85	Quiet cab
"	5.5	28	86	Quiet cab
"	8.5	42	86	Quiet cab (back window open)
"	9.-	28	84	Quiet cab
"	3.-	7	83	Quiet cab
"	1.-	1	79	Quiet cab
Rotary cultivation (inter row)	2.-	73	95	
Rotary cultivation	8.-	1353	101.5	
" "	7.5	1209	102	
Cultivation	2.-	18	88.5	Quiet cab
"	8.-	20	83	Quiet cab
"	1.5	9	87	Quiet cab
Beet loading	6.5	634	99	
" "	5.5	1037	102.5	Self propelled machine
" "	9.25	1168	100	Self propelled machine
Beet tops spreading	8.-	1239	101	
Fertilizer distribution	6.5	559	98.5	Without cab
Potato lifting	9.-	41	86	Frame with roof
" "	5.-	24	86	" " "
Mowing, side raking	8.75	131	90.5	