HATRA RESEARCH REPORT 43

September 1976

Noise in the knitting industry—a factual survey

G. M. COLES

A survey of the noise levels to which operatives may be exposed in their work in the knitting industry has been designed and carried out. A total of 905 noise measurements were taken in 57 factories, covering the main aspects of both knitting and its associated processes, and are tabulated in this *Report*. Broken down by machine manufacturer and type designation, with some added comment. Straight-bar and seamless hose knitting, yarn texturing and garment pressing are the processes which produce noise levels significantly in excess of the 90 db(A) limit recommended by the Department of Employment. Differences in factory construction and layout appear to have only a small effect on noise levels, but mechanical defects in equipment may be responsible for considerable increases in noise.

1.0 Introduction

Developing awareness of the detrimental effects of noise on working environments has led to a factual survey of the noise situation in the knitting industry being carried out by Hatra, following earlier limited-scale work[1]. This *Report* presents the results obtained in the survey which covered winding, seaming, pressing, and dyeing and finishing machinery as well as a representative selection of the different types of knitting machine currently in use. The statement of the results is preceded by a brief discussion of the nature and origins of noise and the techniques used for its measurement.

2.0 The phenomenon of noise

Noise is, of course, merely a particular form of sound; indeed, it is often described as 'unwanted sound'. Sound itself is the sensation which results from small-scale fluctuations of air pressure being received and interpreted by the human ear. These fluctuations are normally generated by some kind of mechanical or aerodynamic movement and are propagated through the air as a wave motion which is superimposed on the 'normal' atmospheric pressure.

At a particular point within a noisy environment, the resulting fluctuations of air pressure with time might well be of the form shown, for example, in Fig. 1. The human ear, like most mechanical devices exposed to a varying stimulus, performs a certain amount of time-averaging of the input signal, this averaging deriving from the system's mechanical damping characteristics. In the case of the ear, the time-averaging is effectively an averaging of the input energy with a fairly short time constant, the energy being proportional to the square of the noise pressure amplitude. Thus, since the sensation of loudness is generally a function of the sound pressure amplitude, in the case of such a fluctuating signal, the loudness will be dependent on the root-mean-square (RMS) amplitude, this being shown in Fig. 1 for the example. This RMS pressure amplitude is referred to as the 'overall sound pressure level' (OASPL).

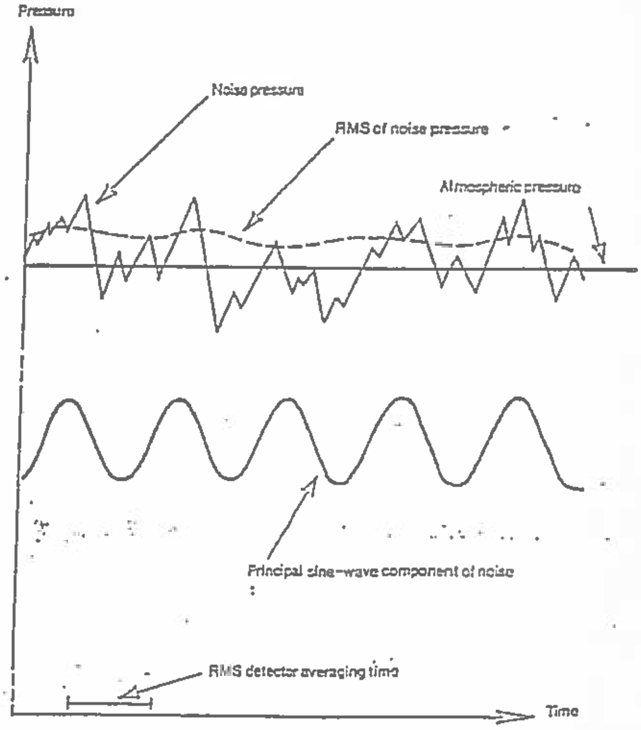


Fig. 1 Analysis of fluctuating noise signal

To obtain more detailed information on the characteristics of the noise of interest, the time-variation of pressure can be represented, according to the method developed in 1822 by Baron J. B. J. Fourier, as the sum of a number of sine-wave variations, each having a particular amplitude (and thus energy), frequency, and phase angle relative to the others (again see Fig. 1).

Hatra Research Centre for Knitting, Dyeing and Making-up
7 Gregory Boulevard Nottingham NG7 6LD Telephone 0602-623311

ne number of sine-wave components needed to present the original is a function of the original's mplexity, and in the case of such noises as are found the knitting industry, which are essentially random in eir nature, an infinite number of components may be eeded, covering frequencies throughout the whole of e human audible range, and possibly beyond. With ch a complex situation it is inconvenient to consider e energy content of the separate sine-wave components, id those within a specified frequency range may well : considered in combination.

In this present investigation it has been found lequate for the energy-distribution derived from tave-bands of frequency to be used. An octave-band defined to cover a frequency range from f Hz to $2f$ Hz, id is specified by means of its logarithmic centre equency $f\sqrt{2}$ Hz*. The ten octave-bands used, having ntre-frequencies of 31·5, 63, 125, 250 and 500 Hz, id 1, 2, 4, 8 and 16 kHz, together cover a frequency nge from 22 Hz to 22 kHz, this being slightly wider an the typical human audible range. The RMS essure amplitude of an octave-band is then referred as the 'octave-band sound pressure level', the ten tave levels considered together giving the 'noise um'.

Both the overall and octave-band sound pressure vels are conventionally expressed in the logarithmi- illy-based decibel (db) units. This scale is used both as result of the wide range of pressure amplitudes hich have to be encompassed, and because of the ear-logarithmic behaviour of the human ear. Decibels e related to a base pressure amplitude of 20 μPa by ie formula:

$$\text{Sound pressure level in db for pressure amplitude of } p\ \mu\text{Pa} = 10 \log_{10}\left(\frac{p}{20}\right)^2$$

.0 The subjective effect of noise

Whilst the subjective sensation of loudness is logarith- iically related to the square of the RMS pressure mplitude, the relation with frequency is much more omplex. As shown in Fig. 2, 'equal-loudness contours'

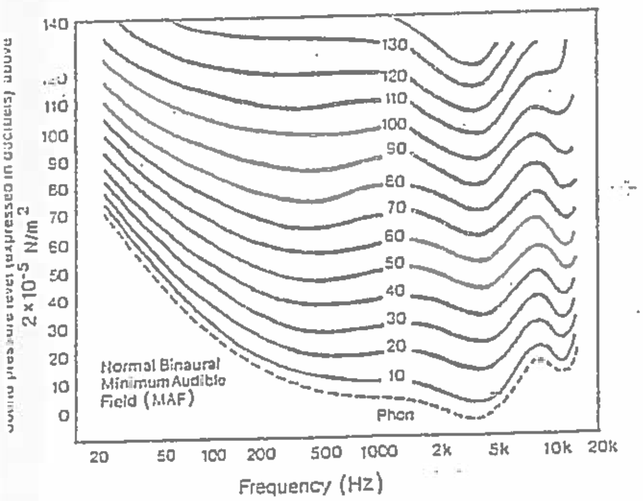


Fig. 2 Equal loudness contours

ay be drawn for a normal ear, and show that to roduce the same sensation of loudness more energy needed at low or high frequencies than in the mid- equency region, the most sensitive frequency being approximately 3 kHz. Thus, in order to compute the effective loudness of a particular noise spectrum it is necessary to 'weight' the octave levels in accordance with the equal-loudness contours. This is conventionally achieved by electrically filtering the noise signal using an International Standard 'A' filter which represents an idealized weighting. The frequency-shaping effect of this filter is shown in Fig. 3. The output from such a filter is referred to as the 'A-weighted sound pressure level' and expressed in decibels calculated as before, but annotated when written as 'db(A)' rather than 'db'.

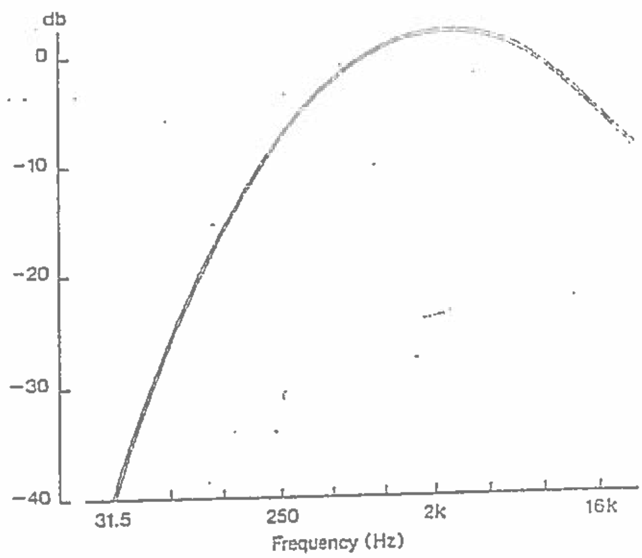


Fig. 3 'A' weighting filter shape

4.0 The scope of the present survey

The project has involved a total of 905 noise measurements taken in 57 factories. Since there are some 850 separately identifiable companies forming the UK knitting industry, the survey represents an approximately 6½% sample which should be adequate for a basic understanding of the noise situation in the industry.

A breakdown of the measurements by process type is shown in Table 1. It will be seen that 598 of the measurements (66% of the total) refer directly to knitting, with the remaining 307 (34%) spread across the associated processes of yarn preparation (4%), making-up (22%), dyeing and finishing (6%), and a small miscellaneous category (2%). Also shown in Table 1 is the number of factories participating in each class of measurement, since almost all of the factories are involved in more than one category but not necessarily in all. The lowest number of factories in any one category is four, which should be sufficient for a reasonable assessment of any inter-factory differences to be made, and the highest number is 35.

5.0 Instrumentation

The Bruel & Kjaer instrumentation system used for th survey consisted of a type 2203 Precision Sound Le Meter, equipped with type 4145 Condenser Microph Cartridge and type 1613 Octave Filter Set. For in calibration a Bruel & Kjaer type 4230 Sound

* Hertz, abbreviated to Hz, is the unit of frequency. 1 Hz=1 cycle per second.

Table 1 Summary of noise measurements

Process	Work category	No. of factories	No. of measurements	Total measurements
Knitting	Large-diameter circular	24	180	
	Flat	26	112	
	Straight-bar	19	90	
	Small-diameter circular			598
	Hose	8	111	
	Half-hose	6	66	
	Warp	4	39	
Other	Yarn preparation	11	35	
	Making-up	35	203	290
	Dyeing and finishing	11	52	
Miscellaneous		9	17	17
Total		(57)	905	905

Calibrator was used. This equipment, which meets all relevant national and international standards, and is widely used in noise control work, is shown in Fig. 4. Detailed calibration data are supplied by the manufacturer.

A schematic functional diagram of the equipment is given in Fig. 5. It will be seen that the noise field is sampled by the microphone cartridge which produces an electrical analogue output. This electrical signal is

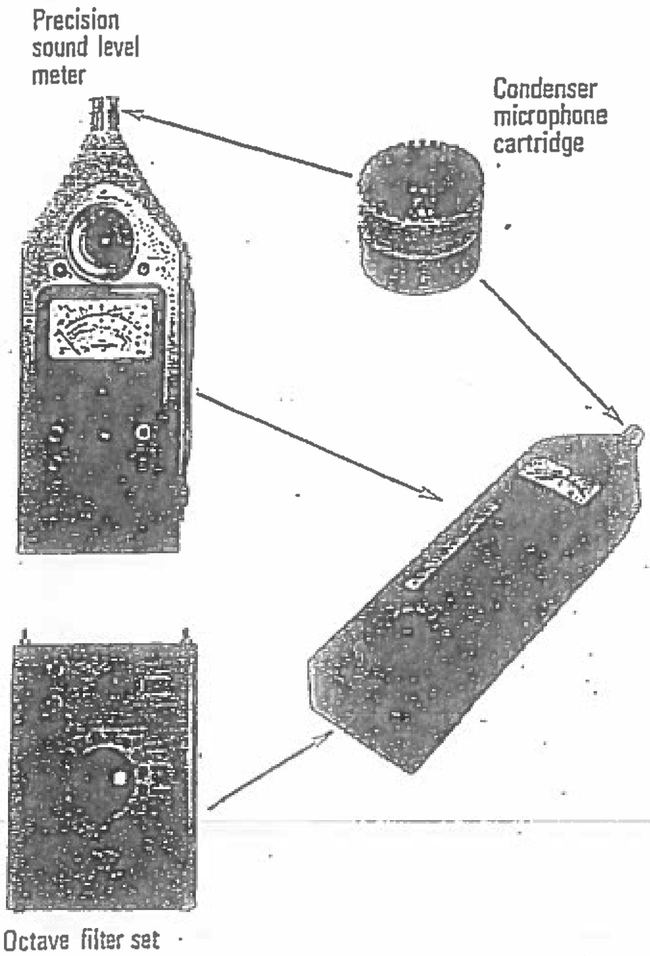


Fig. 4 Noise measurement equipment

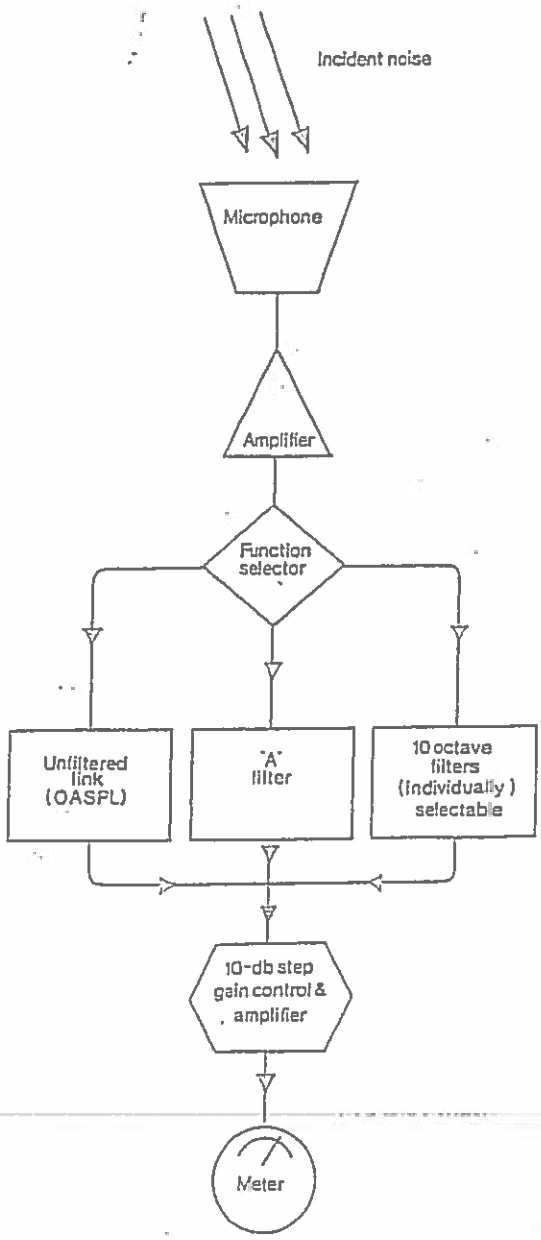


Fig. 5 Noise measuring equipment—schematic operation

input to the sound level meter, passed through a 10 db-step variable gain control, amplified, and displayed on a meter having square-law characteristics. The meter circuitry damping can produce either a 'Fast' or 'Slow' response in accordance with international standards. In the present exercise the 'Slow' response has been used throughout, as recommended in Reference 2 (Appendix 2, item 5, p. 11). Facilities for presenting filtered components of the signal to the meter are also provided, the filters either being the sound level meter's internal 'A-weighting' filter, or the external octave filters.

The accuracy of the Sound Level Meter is ±1 db at any level from 34 to 134 db within the frequency range 40 Hz to 20 kHz, and ±1·5 db from 20 Hz to 25 kHz, for ambient temperatures of 10° to 60°C. Microphone cartridges are individually calibrated by Bruel & Kjaer and the calibration curves supplied with the cartridge. The particular cartridge used in this work has an accuracy of +0·3, −0·5 db over the frequency range 8 Hz to 18 kHz for frontally-incident sound. The Sound Level Calibrator produces a 1 kHz frequency acoustic signal at a known level ±0·3 db for input to the microphone cartridge, to provide both a level-setting signal and a functional check of the complete system. A further check is provided by a 1 kHz reference signal built into the sound level meter. This can be used to check all of the system except for the microphone cartridge. With the component accuracies quoted, the overall accuracy of the system is better than ±2·0 db.

As a result of the microphone's finite size (23·8 mm diameter) it presents a significant acoustic obstacle to sound of high frequency and, consequentially, short wavelength, and sound which is not frontally-incident will be picked up at a lower level than frontally-incident sound. Fig. 6 shows the magnitude of this effect in terms of the sensitivity of the microphone to high-frequency sound, and shows that the effect involves both the frequency and the angle of incidence of the sound. This effect is considered further in Section 7.0 below.

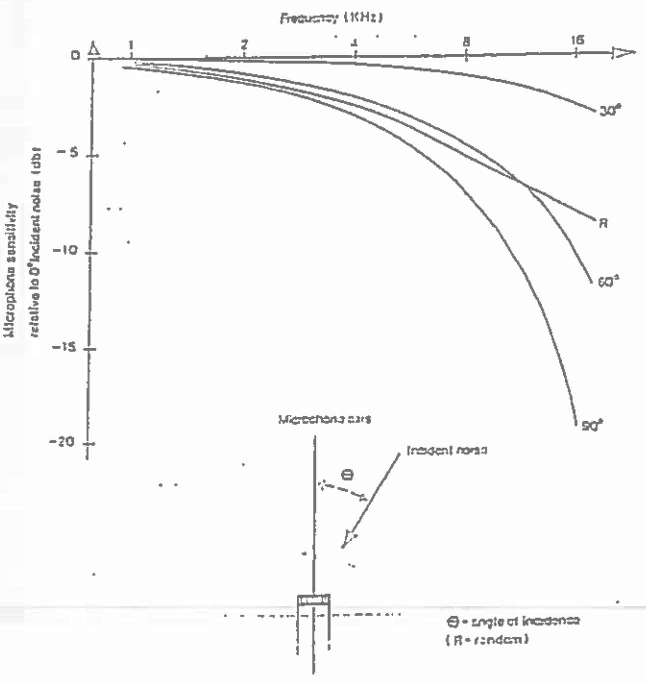


Fig. 6 Effect of microphone on system sensitivity to noise at non-axial incidence

6.0 Data reduction

To assist with the large quantity of data acquired during the survey, a program was written for the Hatra Elliott 903 computer, the data being punched on paper tape for processing. The program logic is indicated in Fig. 7 and consists of routines for checking the internal consistency of the data, for the application of calibration data where appropriate, and for re-calculations of both the unweighted and A-weighted sound pressure levels from the fully-corrected spectra. The A-weighted figures for the various measurements were then compared after being broken down by process and machine type as laid out in detail below. Where appropriate, inter-factory comparisons were made, based on the octave-band spectrum levels. These comparisons necessitated the provision of a further Elliott 903 program which permitted a statistical investigation of the differences between various comparable data sets (see Section 9.2 below).

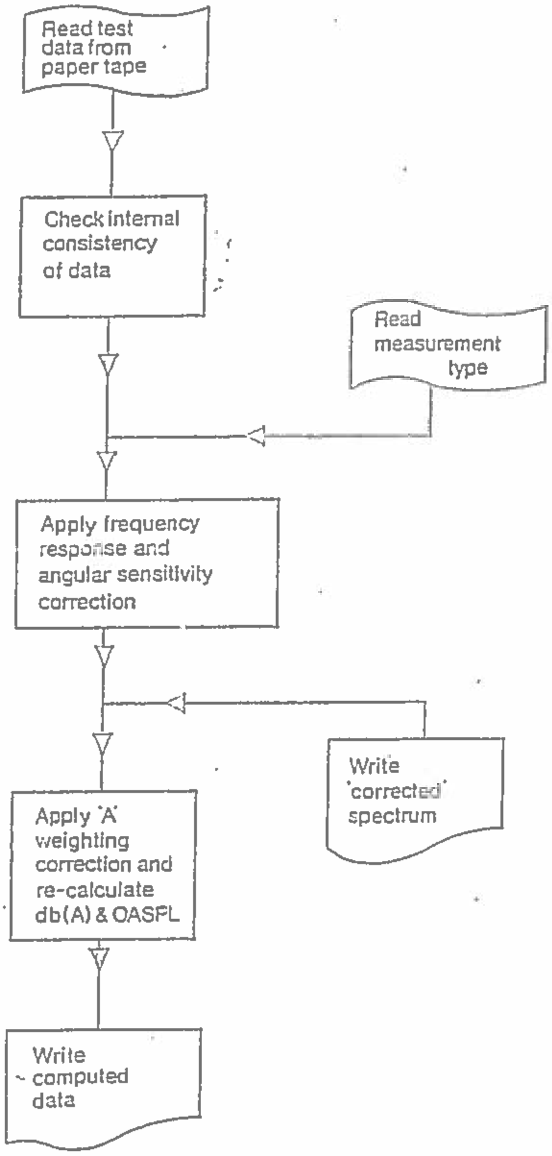


Fig. 7 Computer program for noise data analysis—functional flow chart

7.0 Measurement technique

Since the noise environment within a knitting factory is complex, being comprised of often physically indistinct areas containing many and varied noise sources and reflecting/absorbing structures, it is necessary to take extreme care in devising a noise measurement programme which will yield data both representative of the individual situation and yet comparable with others.

Three distinct types of noise environment are apparent in the knitting industry. The first, found in knitting shops and in yarn preparation, is characterized by a large number of noise sources, often showing something of a line-source characteristic, with a fairly uniform sound field throughout the whole area. Operatives normally move around in a quasi-random manner but are exposed to a fairly constant noise level. In such a case, the procedure adopted involved measurements being taken fairly close to the chosen machine (approximately 0.4—0·6 m from the knitting zone) with the microphone orientated vertically as shown in Fig. 8. The use of a microphone calibration correction for 60° or 90° sound incidence, depending on the particular type of machine involved, and especially on the height of the knitting zone which is usually the most important noise source, will then give a representative noise level for the installation. The 'background' contribution, that is, the noise from other machines in the area, which should strictly be corrected by the random calibration (see Fig. 6) is well approximated, the random calibration being close to the 60°—90° values.

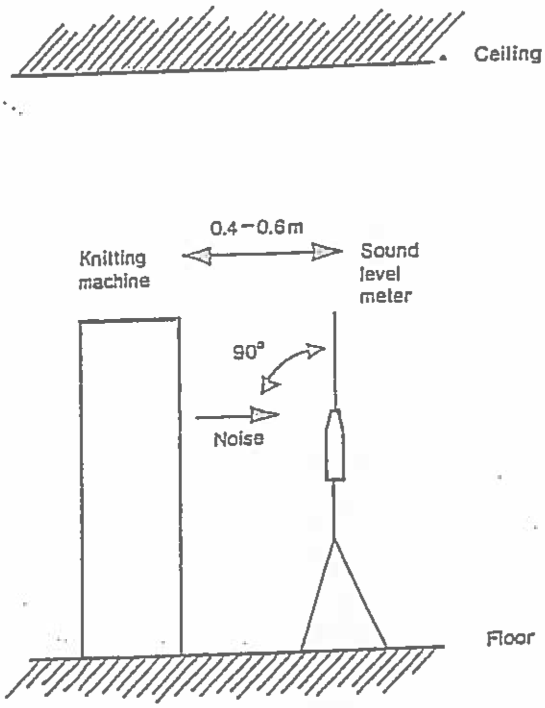


Fig. 8 Mode of operation of noise measuring equipment—knitting etc.

The second case covers making-up areas, where the apparent general noise level is relatively low because of the lower acoustic power output of the machines involved. However, in this case, the operatives are relatively statically positioned with hands, eyes, ears, workpiece and machine all necessarily close together. As a result, the operative can hear only her own machine since the distance to that is small and the distance to any other machine is relatively great. Thus the measurement required is of the individual machine and is achieved by again taking a close measurement (0·4 m) but with the microphone pointing directly at the sewing head as shown in Fig. 9. This will minimize noise pick-up from other machines which will be at less favourable angular positions, and also greater distances. The 0·4 m distance appears to be a good representation of the normal operative's ear position relative to the sewing head.

The third case arises in such areas as dyeing and finishing where there are large machines often arranged in a semi-random manner and providing a similar

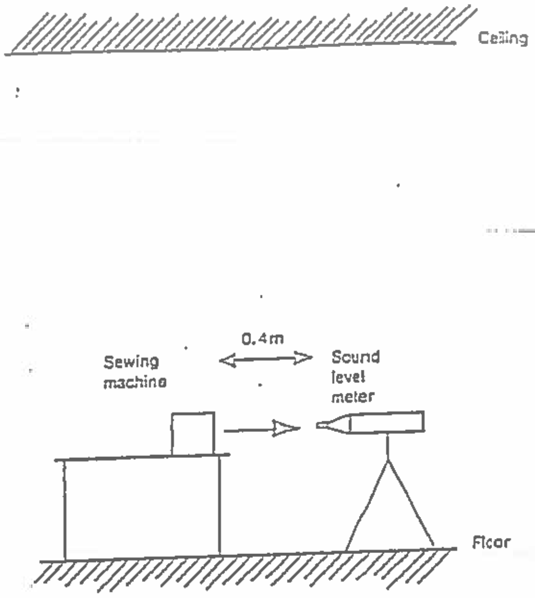


Fig. 9 Mode of operation of noise measuring equipment—making-up

sound field to that in a knitting room, but often substantially less uniform and with operatives moving in a quasi-random manner. Here the most reasonable course appears to be to take measurements with a vertically orientated microphone as in a knitting room and use a random calibration for the data. The distance from the particular machine of interest at which measurements were taken was usually 1·2 m, which corresponds to a number of standard methods and is appropriate in an environment where the spacing between machines is sufficient for its use, but would be unrealistic in most knitting shops.

One rather special case is that of garment pressing using the Paris or Hoffman types of steam press, since here the operative is tied to the machine in much the same way as a making-up operative. In this case measurements were taken close to the unit at the operative's position, and a random incidence calibration was used.

8.0 Noise measurements

8.1 Knitting

8.1.1 Large-diameter circular machines

The data are listed in Table 2.1, which gives, broken down by machine manufacturer and model, the mean A-weighted sound pressure levels measured, together with the number of measurements, the standard deviation of the measurements, and the number of factories involved. 54 machine types are shown in the Table, representing the products of 18 manufacturers. Taking all 180 measurements together, the mean A-weighted sound pressure level is 83·9 db(A) with a standard deviation of 2·4 db(A), though the mean levels for particular machines vary up to a maximum of 88·5 db(A).

One particular point arising concerns the Morat St4 M48 and Moratronik Mk 2 double-jersey machines which are fitted with heavy-gauge sliding Perspex doors around the knitting zone. The evidence obtained indicates that closing these doors can reduce the noise level by approximately 3 db(A), though it is a little difficult to be precise because of the complicating effect of the background noise from nearby machines. This effect is particularly noticeable in the measurements on the fairly quiet Moratronik which was situated somewhat unfavourably, being surrounded by relatively noisy machines, with results apparent in the poor standard deviations shown in the Table.

8.1.2 *Flat machines*

The data are shown in Table 2.2 in the same manner as before. 31 powered machines are listed, from seven manufacturers. Taking all 112 measurements the mean value is 86·6 db(A), with a standard deviation of 2·7 db(A), whilst individual machines have mean levels of up to 90·9 db(A). In addition a single measurement of a hand-flat machine was taken as listed.

8.1.3 *Straight-bar machines*

The data are shown in Table 2.3, with 14 machines from six manufacturers being listed. The mean of all 90 measurements is 93·7 db(A) with a standard deviation of 4·0 db(A), and individual machines have mean levels up to 98·5 db(A).

An exception to this is a measurement on a very old [illegible]ey-Cotton Model A machine which had been converted to half-gauge, and recorded 102·6 db(A).

One non-standard measurement is included in this group, where a Bentley-Cotton Model B machine had measurements taken at corresponding positions front and back. These two measurements gave 98·2 db(A) in front of the machine in the standard measuring position, but 99·6 db(A) behind the machine, indicating a slightly asymmetrical noise distribution pattern.

One further measurement calls for comment: with the exception of a measurement of a Bentley-Cotton Model E machine, all data refer to the machine knitting at the wide end of the fashioned piece, but one spot check was made to show the decrease involved when knitting at the narrow end. This gave 85·5 db(A) compared to a mean level of 91·7 db(A) from noise measurements taken whilst knitting at the wider end, a decrease of 6·2 db(A).

8.1.4 *Small-diameter circular machines*

8.1.4.1 *Hose machines*

[illegible] data are shown in Table 2.4 Part 1, with 11 machines from nine manufacturers being listed. The total of 111 measurements has a mean of 92·8 db(A) with a standard deviation of 2·7 db(A), and individual machine types have mean levels of up to 95·6 db(A).

8.1.4.2 *Half-hose machines*

The data are shown in Table 2.4 Part 2, with 15 machines from three manufacturers being listed. The total of 66 measurements has a mean of 89·8 db(A) with a standard deviation of 1·7 db(A), and individual machine types have mean levels of up to 91·8 db(A).

8.1.5 *Warp knitting machines*

The data are shown in Table 2.5, where 15 machine types from four manufacturers are listed. The total of 39 measurements has a mean level of 89·2 db(A) with a standard deviation of 2·0 db(A), and individual machine types have mean levels of up to 93·9 db(A).

8.2 *Yarn preparation*

8.2.1 *Texturing*

The data are shown in Table 3.1, with three machine types, all from the same manufacturer, being listed. The mean level of the 13 measurements is 104·9 db(A) with a standard deviation of 2·4 db(A), there being little difference apparent between the three types of machine.

8.2.2 *Cone winding*

The data are shown in Table 3.2. Seven machine types from five manufacturers are listed with a mean level from the 22 measurements of 89·5 db(A) and a standard deviation of 5·5 db(A). The mean levels for individual machine types vary up to a maximum of 94·6 db(A).

8.3 *Making-up*

8.3.1 *Cup seaming*

Table 4.1 shows three machine types from two manufacturers, with a total of 13 measurements. The mean level of all 13 is 85·7 db(A) with a standard deviation of 4·8 db(A), whilst individual machine types have mean levels up to 89·1 db(A). 85·7

8.3.2 *Flatlock seaming*

Two measurements of a Willcox & Gibbs flatlock machine have been taken, with a mean of 86·1 db(A) and standard deviation of 0·4 db(A), as shown in Table 4.2. 86·1

8.3.3 *Overlock seaming*

Table 4.3 lists 73 measurements of eight machine types from five manufacturers. The mean level of the 72 'normal' measurements is 90·4 db(A) with a standard deviation of 3·1 db(A). Individual machine types have mean levels up to 93·4 db(A). 90·4

One measurement was taken for a machine known to have a mechanical fault—a failed bearing. The level of 102·7 db(A) measured indicates the severe acoustic penalty caused by such a malfunction, being some 13 db(A) above the level for an equivalent mechanically-sound machine.

8.3.4 *Binding and lace attaching*

Table 4.4 lists 13 measurements of three machine types and manufacturers. The mean level of all 13 is 89·9 db(A) with a standard deviation of 2·5 db(A). Individual machine types have mean values up to 95·8 db(A).

8.3.5 *Welting*

Four machine types from three manufacturers are listed in Table 4.5. The mean level of the eight measurements is 89·5 db(A) with a standard deviation of 2·5 db(A). Individual machine types have mean levels of up to 91·7 db(A). 89·

8.3.6 *Bartacking*

Three bartackers, each from a different manufacturer, are listed in Table 4.6. The nine measurements have a mean level of 87·6 db(A) and a standard deviation of 5·1 db(A). Individual machine types have measured mean-levels up to 92·6 db(A).

8.3.7 *Buttonholing*

Twelve measurements of six machine types from four manufacturers are listed in Table 4.7. The mean level of all 12 is 87·4 db(A) with a standard deviation of 3·0 db(A), and individual machine types have mean levels of up to 91·3 db(A). 87·4

8.3.8 *Button sewing*

Ten measurements of three machine types, each from a different manufacturer, are listed in Table 4.8. The mean level of all 10 is 84·0 db(A) with a standard deviation of 2·6 db(A), and individual machine types have mean levels of up to 85·3 db(A). 84·0

.3.9 Tabbing

Three measurements of the Reece tabbing machine were taken, with a mean level of 88·6 db(A) and a standard deviation of 9·2 db(A), as listed in Table 4.9. This very wide scatter arises from one measurement (at 78·7 db(A)) being widely different from the other two (90·3 and 96·8 db(A)), and these figures must thus be treated with caution.

8.3.10 Rouleau

One measurement of the noise from a Singer rouleau machine was taken, giving a level of 84·8 db(A), as shown in Table 4.10.

8:3.11 Linking

Table 4.11 lists the 12 measurements taken covering noise from linking machines. Eight types of linker, each from a different manufacturer, have been sampled, and a mean level of 81·1 db(A) found, with a standard deviation of 4·9 db(A). Individual machine types have mean levels of up to 86·5 db(A).

8.3.12 Toe-closing etc.

Ten measurements of the noise from Rossô toe-closing and Takatori tights-seaming machines are listed in Table 4.12, and have a mean level of 85·7 db(A) with a standard deviation of 3·0 db(A).

8.3.13 Garment pressing

Table 4.13 lists measurements of the noise of the main types of steam garment press. The 37 measurements have a mean level of 96·5 db(A) with a standard deviation of 5·3 db(A). Individual machine types have mean levels of up to 101·5 db(A).

8.4 Dyeing and finishing

8.4.1 Sample dyeing

Two measurements of the noise from Pegg sample dyeing machines were taken, with a mean level of 91·1 db(A) and a standard deviation of 2·5 db(A). The noisier of the two machines gave a level of 92·9 db(A) as shown in Table 5.1.

8.4.2 Beam dyeing

Two measurements of the noise from beam dyeing machines were taken with a mean of 94·4 db(A), and a standard deviation of 5·4 db(A). The noisier of the two machines gave a level of 98·2 db(A) as shown in Table 5.2 and was measured during steam raising, whilst the quieter measurement of 90·5 db(A) was taken during the normal operating cycle.

8.4.3 Paddle dyeing

Two measurements of the noise from paddle dyeing machines are listed in Table 5.3. The mean level is 90·0 db(A) with a standard deviation of 8·1 db(A). This arises from the different conditions of operation during measurement, the noisier (96·6 db(A)) being taken during steam raising, and the quieter (85·2 db(A)) during the normal operating cycle.

8.4.4 Winch dyeing

Six measurements of the noise from Leemetals winch dyeing machines are listed in Table 5.4. Two measurements taken during steam raising have a mean of 96·0 db(A), and four measurements taken during the normal operating cycle have a mean of 81·3 db(A). Taking all six together the mean is 86·3 db(A) with a standard deviation of 8·3 db(A).

8.4.5 Package dyeing

One measurement of the noise of a Pegg package dyeing machine was taken and is shown in Table 5.5 at 91·9 db(A).

8.4.6 Package hydro-extraction

One measurement of the noise of a yarn package hydro-extractor of unknown manufacture was taken and is shown in Table 5.6 at 93·1 db(A).

8.4.7 Beam spin drying

Three measurements of the noise of beam spin drying machines have been made as shown in Table 5·7. The mean of the three is 87·3 db(A) with a standard deviation of 7·5 db(A). This high scatter is caused by a very low measurement (78·7 db(A)) being combined with two other much higher ones (91·2 and 92·0 db(A)) which were in good agreement with each other, and this necessitates caution in further use of these figures.

8.4.8 Tumble drying

Three measurements of the noise of the Ibis Kamsin tumble dryer have been taken as shown in Table 5.8, and have a mean of 82·4 db(A) with a standard deviation of 2·1 db(A).

8.4.9 Stentering

A total of 12 measurements of the noise of stenters has been made. Since stenters are of considerable size, three general classes of measurement have been adopted: (i) at the operator's position at the fabric input end of the machine; (ii) at approximately mid-length (that is, in the region of the burners) at 1·2 m to the side of the machine; and (iii) at the operator's position at the fabric take-off end. These measurements are noted separately in Table 5.9 where data for five makes of stenter are listed. It appears, however, that the variation of noise level with position is not great and in consequence it is convenient to ignore this effect.

The mean of all 12 measured levels is 84·4 db(A), with a standard deviation of 3·3 db(A), but individual measured levels vary up to 88·4 db(A).

8.4.10 Half-hose steaming

Eleven measurements of the noise of the Girland half-hose steaming unit are shown in Table 5.10, with a mean value of 86·6 db(A), and a standard deviation of 1·0 db(A).

8.4.11 Decatizing

Four measurements on three makes of decatizing machine are shown in Table 5.11. The mean level is 80·1 db(A) and the standard deviation is 4·2 db(A), whilst the highest individual machine level is 84·7 db(A).

8.4.12 Brushing

Two measurements of the noise of the Tomlinson brushing machine have been taken giving a mean level of 88·4 db(A), and a standard deviation of 1·0 db(A) as shown in Table 5.12.

8.4.13 Roll printing

Three measurements of the noise of roll printing machines of unknown manufacture have been taken with a mean level of 88·7 db(A) and a standard deviation of 4·5 db(A), as given in Table 5.13.

8.5 Miscellaneous

All of these data are listed in Table 6.

8.5.1 Stitch bonding

A single measurement of the noise produced by the Arachne nonwoven fabric production machine was taken in the area of the stitch bonding unit, giving a level of 92·6 db(A).

8.5.2 Embroidery

A single measurement of the noise of a Zangs embroidery machine gave a level of 77·2 db(A).

8.5.3 Half-hose separating

Three measurements of the noise from the Merrow cutting machine used for separating half-hose knitted in continuous form gave a mean level of 86·7 db(A) with a standard deviation of 4·4 db(A).

8.5.4 Half-hose and hose turning

Five measurements of the noise of the compressed-air powered units used for turning half-hose or hose were [illegible]. The mean level was 93·0 db(A) with a standard deviation of 3·2 db(A).

8.5.5 Warping

A single measurement of the noise produced during the preparation of a warp beam gave a level of 84·0 db(A).

8.5.6 Die cutting

Measurements of the operation of two presses used for the die cutting of fabric were made. In one case, a small Samco press, three measurements showed noise levels of 85·8 to 89·9 db(A) during the operational cycle, and a 'background' motor idling level of 76·8 db(A). In the other case, a much larger press, the general motor noise, at 73·5 db(A), was not exceeded during the operational cycle.

8.5.7 Steam generation

A measurement of the noise level of a group of three Ruston Thermax boilers used for steam production gave a general boiler room noise level of 89·5 db(A).

8.5.8 Spot cleaning

A single measurement of the noise produced by a spot cleaning gun resulted in a noise level of 89·5 db(A).

Table 2.1 Noise measurements of large-diameter circular knitting machines

Manufacturer	Model	No. of factories	No. of measurements	Mean db(A)	Standard deviation db(A)
Alber & Bitzer	ROA 3	1	1	82·0	—
Berridge (including	89	1	2	82·2	0·6
Stibbe-Berridge)	89/57	1	1	82·2	—
Blackburn	—	1	1	71·0	—
Camber	Cheminit	1	1	85·6	—
Dubied	Wevenit	1	3	88·5	0·8
Fouquet	—	1	3	84·0	1·2
Kirkland	FMK	1	1	81·8	—
	PFMK	1	2	82·6	0·4
	DJK 36 R	1	1	84·9	—
Lebocey	EMP 122	1	1	80·0	—
M[illegible]	OVJA 24	1	3	84·4	0·4
	OVJA 36	4	11	84·6	1·8
Monarch	PFL	2	3	83·1	0·5
	PFW	1	3	83·9	0·7
	PFW-2	1	1	87·1	—
	XL-FW	1	1	84·0	—
	XL51	1	1	86·6	—
Morat	St 4 M 48(1)	4	11	84·2	0·7
	St 4 M 48(2)	2	4	81·6	0·9
	St 4 Moratronik Mk 2(1)	2	4	81·6	3·0
	St 4 Moratronik Mk 2(2)	1	3	78·1	3·6
inger	Supreme ROFN	2	2	84·2	3·2
	Supreme TIFN	1	1	81·0	—
	Supreme MLVPN	1	3	79·0	0·5
tibbe	FBWP	1	1	83·1	—
	GS2	1	3	81·6	1·0
	Octet	2	3	85·4	0·3
	PBDR M	1	1	86·7	—
	PBDR SM	3	6	84·1	1·0
	PBDR SMO	2	7	83·1	1·7
ibbe-Monk	Mini-jac	2	5	84·2	0·9
errot	(old type)	1	1	86·1	—
	(more recent type)	1	1	79·7	—
	13P4F	2	2	83·6	1·3
	RMA	4	6	82·4	0·9

Perspex doors around knitting zone open
Doors closed

Table 2.1—*continued*

Manufacturer	Model	No. of factories	No. of measurements	Mean db(A)	Standard deviation db(A)
Textima	18E	1	1	85·2	—
Tompkins	—	1	1	79·0	—
Wildt Mellor Bromley	5/RJ	2	3	85·5	0·2
	8/RJ	3	8	85·3	1·6
	9/RJ	6	13	85·4	1·4
	14/RJ	1	3	86·2	0·5
	9/MSJ	2	3	85·5	0·8
	SPJ	3	7	84·7	0·9
	6/LM	2	4	87·2	0·6
	9/LM	1	3	82·1	0·6
	10/LM	1	3	85·6	0·9
	3/RLM	4	6	84·1	1·4
	4/RD	1	3	85·2	1·6
	8/RD	1	3	83·3	1·0
	4/RLS/4	1	2	84·2	1·3
	RTR	2	4	82·0	1·3
	RTR 2	1	1	81·3	—
	RTR 4	1	1	83·2	—
	RTR 8	1	3	84·4	0·2
	RTR A	3	4	83·1	2·0

Table 2.2 Noise measurements of flat knitting machines

Manufacturer	Model	No. of factories	No. of measurements	Mean db(A)	Standard deviation db(A)
Alemania	—	1	1	83·8	—
Dubied	BAN	1	1	85·9	—
	CAL	2	2	90·9	1·3
	DBA	1	1	85·7	—
	DC	5	5	84·6	2·0
	DC2	1	1	88·6	—
	DDD	1	1	85·1	—
	DL	2	4	88·0	1·1
	DRB	4	7	89·6	1·8
	DRB2	4	8	89·0	2·5
	DRL	3	5	87·5	1·6
	DRL2	3	7	88·0	2·0
	JDR	4	6	85·1	1·2
	RAL	1	1	81·4	—
	Strapping machine	3	4	85·4	5·6
Protti	PRT	1	1	87·1	—
Schaffhouse	DJFU	2	3	85·6	0·3
	DOFU	1	2	84·8	0·6
	MDA2	1	2	88·2	0·6
Scomer	Strapping machine	3	3	87·2	0·6
Stoll	AJUM	9	11	86·1	2·5
	AJUM 1	2	5	84·7	1·2
	JBOM/b	3	3	85·2	1·1
	UFD	2	4	88·4	0·5
	220	3	5	86·0	1·3
	Strapping machine	3	3	85·2	3·7
	Hand flat machine	1	1	74·0 ✓	—
Universal	MC1-T	1	3	87·2	0·0
	UST/USH 8	1	1	88·7	—
	UST/USH 10 Supramat	3	6	84·0	4·4
	UST/USH 12 Supramat A	2	4	84·5	0·9
	Suprafix 5G	1	1	85·5	—

Table 2.3 Noise measurements of straight-bar knitting machines

Manufacturer	Model	No. of factories	No. of measurements	Mean db(A)	Standard deviation db(A)
Bentley-Cotton	A	1	3	94·1	1·4
	A(1)	1	1	102·6	—
	AEF	4	5	93·1	2·1
	B(2)	8	13	98·5	3·0
	B(3)	1	1	99·6	—
	E(4)	6	14	91·7	1·3
	E(5)	1	1	85·5	—
	EF	1	3	92·5	1·2
	FT	1	2	91·0	0·8
Cotton	Patent	2	3	97·6	3·1
Monk	UM Mk 1	3	5	91·2	0·7
	Superspeed	5	16	91·0	2·0
Scheller	07/21	1	3	87·7	0·4
Textile Machine Works	Reading	2	9	96·2	2·0
	Reading 100	2	5	94·5	2·2
	Reading 200	1	2	94·0	0·5
W[illegible]ndcock	—	2	4	97·0	1·3

(1) Machine half-gauged—see text
(2) Measurements taken in the normal position at the front of the machine
(3) Measurements taken at the back of the machine
(4) Measurements taken during the knitting of the wide end of the piece
(5) Measurements taken during the knitting of the narrow end of the piece

Table 2.4 Noise measurements of small-diameter circular knitting machines.
Part 1—Hose machines. Part 2—Half-hose machines.

Manufacturer	Model	No. of factories	No. of measurements	Mean db(A)	Standard deviation db(A)
Bentley	KL	2	10	92·6	2·3
	KL2FH	1	4	93·2	0·5
Bertolini	Olimpic	1	4	90·0	0·6
Billi	Zodiac	1	3	92·6	0·3
	Zodiac 8	5	32	94·9	1·5
	Zodiac 8F Fantasia	1	5	92·9	1·4
Booton	8	2	17	93·5	0·6
Lonati	—	2	7	88·2	0·3
	L8KO	1	3	95·6	1·8
Samo	6C	2	12	92·1	1·1
	8C Elite	1	3	92·9	0·4
Santoni	8F-S	1	2	95·0	0·2
Scott & Williams	K	1	4	86·9	1·1
Stibbe	Maxim 48	1	4	86·1	0·8
	Maxim 50	1	4	90·2	0·9
Bentley	Komet BC	1	2	89·9	0·3
	Komet BR	5	19	90·6	1·6
	Komet BR II	2	8	91·5	1·1
	Komet CP	1	1	91·8	—
	Komet HC	1	1	87·5	—
	Komet JL	1	1	90·1	—
	Komet LT	3	6	89·8	1·5
	Komet OW	1	1	87·8	—
	Komet SCS	1	1	87·5	—
	Komet TC	2	7	90·1	0·7
	Komet TJ	1	2	89·6	0·4
	Komet TJ II	1	4	89·0	1·0
Cesare Colisio	CPN	1	3	86·8	0·7
Wildt	Autoswift B	1	1	89·1	—
	Autoswift E	3	9	88·1	0·8

20.7/15

15.9/30

90.5

Table 2.5 Noise measurements of warp knitting machines

Manufacturer	Model	No. of factories	No. of measurements	Mean db(A)	Standard deviation db(A)
FNF	VE	1	1	91·7	—
Liba	4-W	1	1	93·9	—
Mayer	K2	2	4	87·1	0·7
	K3	1	3	89·5	0·5
	K4	1	3	88·7	0·2
	K13	1	3	87·8	0·7
	KC4	2	4	89·1	1·9
	KE2	3	7	89·1	1·4
	KE3	2	4	90·1	1·0
	KE4	1	3	91·2	0·8
	R4N	1	2	87·2	0·4
Platt	COP2	1	1	95·5	—
	COP3	1	1	86·0	—
	EX3LT	1	1	88·7	—
	KFCA3	1	1	86·8	—

Table 3.1 Noise measurements of texturing machines

Manufacturer	Model	No. of factories	No. of measurements	Mean db(A)	Standard deviation db(A)
Scragg	CS 12-400	1	1	104·8	—
	CS 12-600	1	9	104·7	2·9
	Superset	1	3	105·6	1·0

Table 3.2 Noise measurements of cone winding machines

Manufacturer	Model	No. of factories	No. of measurements	Mean db(A)	Standard deviation db(A)
Hirschberger	—	2	4	87·0	3·6
Holt	M86	5	6	89·9	5·2
Leesona	—	2	2	94·6	0·3
	Universal Rota-Coner	2	3	81·1	1·6
Savio	RSM	1	1	84·4	—
Schlafhorst	Autoconer	1	1	89·5	—
Schweiter	—	1	5	94·6	0·9

Table 4.1 Noise measurements of cup seaming machines

Manufacturer	Model	No. of factories	No. of measurements	Mean db(A)	Standard deviation db(A)
Rimoldi	—	6	8	84·2	5·1
Singer	242-1	1	1	81·7	—
	242-2	1	4	89·1	3·0

Table 4.2 Noise measurements of flatlock seaming machines

Manufacturer	Model	No. of factories	No. of measurements	Mean db(A)	Standard deviation db(A)
Willcox & Gibbs	—	2	2	86·1	0·4

Table 4.3 Noise measurements of overlock seaming machines

Manufacturer	Model	No. of factories	No. of measurements	Mean db(A)	Standard deviation db(A)
Merrow	M-3W, M-3DW	3	5	93·4	1·7
	M-4-45, M-4D-45	5	16	92·4	1·5
Rimoldi	—	2	2	85·3	2·1
Singer	175	6	8	90·6	2·2
	246 K43	1	6	87·9	1·7
Union Special	39500	5	21	89·1	2·4
Willcox & Gibbs	514/1-11	4	10	89·7	2·4
	514/1-11[1]	1	1	102·7	—
	Older model	4	4	88·3	3·2

[1] This measurement refers to a machine known to be mechanically faulty

Table 4.4 Noise measurements of binding and lace attaching machines

Manufacturer	Model	No. of factories	No. of measurements	Mean db(A)	Standard deviation db(A)
Rimoldi	—	3	7	89·3	1·8
Union Special	52800	3	5	89·6	1·9
Willcox & Gibbs	—	1	1	95·8	—

Table 4.5 Noise measurements of welting machines

Manufacturer	Model	No. of factories	No. of measurements	Mean db(A)	Standard deviation db(A)
Merrow	MM33	1	1	91·7	—
Rimoldi	—	1	3	91·3	2·6
Union Special	33700	2	2	87·5	0·4
	56700	1	2	87·7	0·7

Table 4.6 Noise measurements of bartacking machines

Manufacturer	Model	No. of factories	No. of measurements	Mean db(A)	Standard deviation db(A)
faff	—	1	1	82·7	—
eece	—	4	4	92·6	3·1
otan	123A-4	3	4	83·8	1·2

Table 4.7 Noise measurements of buttonholing machines

Manufacturer	Model	No. of factories	No. of measurements	Mean db(A)	Standard deviation db(A)
urkopp	—	2	2	84·2	2·8
aff	—	1	1	86·0	—
eece	S2	1	1	91·3	—
	101	1	1	89·2	—
nger	71/48	1	1	88·8	—
	71/112	6	6	87·4	3·0

Table 4.8 Noise measurements of button sewing machines

Manufacturer	Model	No. of factories	No. of measurements	Mean db(A)	Standard deviation db(A)
Adamson	—	2	4	83·8	3·6
Pfaff	—	2	2	81·4	1·1
Singer	—	4	4	85·3	0·6

Table 4.9 Noise measurements of tabbing machines

Manufacturer	Model	No. of factories	No. of measurements	Mean db(A)	Standard deviation db(A)
Reece	—	3	3	88·6	9·2

Table 4.10 Noise measurements of rouleau machines

Manufacturer	Model	No. of factories	No. of measurements	Mean db(A)	Standard deviation db(A)
Singer	—	1	1	84·8	—

Table 4.11 Noise measurements of linking machines

Manufacturer	Model	No. of factories	No. of measurements	Mean db(A)	Standard deviation db(A)
Beck	—	4	4	81·2	4·4
Hague	—	1	1	73·0	—
Imperial	—	1	1	83·5	—
Julian	JD1	1	1	84·8	—
Kettma	—	1	1	74·5	—
KMF	—	1	1	77·4	—
Mathbirk	—	2	2	86·5	1·4
Underwood & Perry	—	1	1	81·0	—

Table 4.12 Noise measurements of toe-closing machines, etc.

Manufacturer	Model	No. of factories	No. of measurements	Mean db(A)	Standard deviation db(A)
Rosso	—	3	7	85·4	3·5
Takatori	—	1	3	86·0	1·7

Table 4.13 Noise measurements of garment pressing machines

Manufacturer	Model	No. of factories	No. of measurements	Mean db(A)	Standard deviation db(A)
—	'Paris' type	6	13	99·2	2·2
—	Hoffman type (open-top)	3	3	101·5	2·5
—	Hoffman type (closed-top)	6	8	89·9	3·5
—	Conveyor type	3	8	95·1	5·3
Ibis	Tunnelmatic	1	5	98·6	5·4

Table 5.1 Noise measurements of sample dyeing machines

Manufacturer	Model	No. of factories	No. of measurements	Mean db(A)	Standard deviation db(A)
Pegg	FJ3250	1	1	92·9	—
	PD3989	1	1	89·3	—

Table 5.2 Noise measurements of beam dyeing machines

Manufacturer	Model	No. of factories	No. of measurements	Mean db(A)	Standard deviation db(A)
Leemetals	—	1	1[1]	90·5	—
Pegg	PD 2815	1	1[2]	98·2	—

[1] Normal operation
[2] During steam raising

Table 5.3 Noise measurements of paddle dyeing machines

Manufacturer	Model	No. of factories	No. of measurements	Mean db(A)	Standard deviation db(A)
Freeman-Taylor	Gridflow	1	1[1]	96·6	—
FTM	—	1	1[2]	85·2	—

[1] Normal operation
[2] During steam raising

Table 5.4 Noise measurements of winch dyeing machines

Manufacturer	Model	No. of factories	No. of measurements	Mean db(A)	Standard deviation db(A)
Leemetals	—	4	4[1]	81·3	3·1
	—	2	2[2]	96·0	4·9

[1] Normal operation
[2] During steam raising

Table 5.5 Noise measurements of package dyeing machines

Manufacturer	Model	No. of factories	No. of measurements	Mean db(A)	Standard deviation db(A)
Pegg	—	1	1	91·9	—

Table 5.6 Noise measurements of package hydro-extraction machines

Manufacturer	Model	No. of factories	No. of measurements	Mean db(A)	Standard deviation db(A)
—	—	1	1	93·1	—

Table 5.7 Noise measurements of beam spin drying machines

Manufacturer	Model	No. of factories	No. of measurements	Mean db(A)	Standard deviation db(A)
Pegg	—	1	1	92·0	—
Smith-Drum	—	1	1	91·2	—
—	—	1	1	78·7	—

Table 5.8 Noise measurements of tumble drying machines

Manufacturer	Model	No. of factories	No. of measurements	Mean db(A)	Standard deviation db(A)
Ibis	Kamsin	2	3	82·4	2·1

Table 5.9 Noise measurements of stenters

Manufacturer	Model	No. of factories	No. of measurements	Mean db(A)	Standard deviation db(A)
Bruckner	—	3	1(1)	84·8	—
			1(2)	79·8	—
			2(3)	81·4	2·7
Famatex	—	1	1(1)	88·2	—
			1(3)	88·2	—
Krantz	—	1	1(3)	87·0	—
Lawson & Sutcliffe	—	1	1(1)	80·1	—
			1(2)	83·4	—
Whiteley	—	1	1(1)	84·4	—
			1(2)	88·4	—
			1(3)	86·2	—

(1) Measurements taken at operator's position at fabric input
(2) Measurements taken at 1·2 m to side at mid-length
(3) Measurements taken at operator's position at fabric take-off

Table 5.10 Noise measurements of half-hose steaming machines

Manufacturer	Model	No. of factories	No. of measurements	Mean db(A)	Standard deviation db(A)
Girland	—	1	11	86·6	1·0

Table 5.11 Noise measurements of decatizing machines

Manufacturer	Model	No. of factories	No. of measurements	Mean db(A)	Standard deviation db(A)
Ateliers Raxhon	—	1	2	80·6	0·9
Bates	—	1	1	84·7	—
—	—	1	1	74·5	—

Table 5.12 Noise measurements of brushing machines

Manufacturer	Model	No. of factories	No. of measurements	Mean db(A)	Standard deviation db(A)
omlinson	—	2	2	88·4	1·0

Table 5.13 Noise measurements of roll printing machines

Manufacturer	Model	No. of factories	No. of measurements	Mean db(A)	Standard deviation db(A)
	—	2	3	88·7	4·5

Table 6 Noise measurements of miscellaneous operations

Manufacturer	Model	No. of factories	No. of measurements	Mean db(A)	Standard deviation db(A)
'ch bonding of woven fabric					
nvesta	Arachne	1	1	92·6	—
broidery					
'angs	—	1	1	77·2	—
f-hose separating					
1errow	—	2	3	86·7	4·4
f-hose and hose turning					
–	—	2	5	93·0	3·2
:ping					
-	—	1	1	84·0	—
cutting					
ımco	—	1	4	(see text)	—
m generation					
uston	Thermax	1	1	89·5	—
cleaning					
	—	1	1	89·5	—

Discussion of results

Overall assessment

ıe deduction which may be made from the data ɛd in Section 8 above is that of the comparative ıtabilities of the working environments resulting the noise levels of the processes considered.

ɜ Department of Employment[2] points out that, in ion to simply causing annoyance, noise may ere with working efficiency by inducing stress isturbing concentration, especially where the work ficult or highly skilled, and that by hindering ıųnications and masking working signals noise ıe a cause of accidents. Particularly, however, noise lamage the hearing of exposed persons, and the 'tment recommends that, unless effective ear tion is used, operatives should not be exposed to ving environment having an 'equivalent continuous evel' (L_{eq}) exceeding 90 db(A), this recommenda- ɜing based on an 8-hour working day. Where the ıg day is other than eight hours, the decibel lent of the hourly ratio may be applied as a modification to the recommended L_{eq}; thus for a 7½-hour working day, L_{eq} = 90·3 db(A), and for a 9-hour working day, L_{eq} = 89·5 db(A).

In an environment in which the operative is relatively stationary, and the noise field is unvarying in time with level L db(A), or in an environment in which the noise field is uniform, L_{eq} will equal L, but where a time-variation is present as a result of either operative movement or variation in the overall noise field, L_{eq} will equal the appropriate time-average of L. Consequently, in this latter case, it is necessary to compute a value of L_{eq} from a knowledge of the time spent in the various noise levels; that is to compute a personal time-average of L for the individual.

So far as the present work is concerned, it appears reasonable to consider knitting, yarn preparation, and dyeing and finishing processes as producing reasonably uniform noise fields, but to make a moderate allowance for the fact that employees spend some proportion of their time in quieter environments as a result of their necessary movements around the plant. If this time-allowance is arbitrarily taken as 20% of the total, the

Table 7 Assessment of process noise relative to D.o.E. recommendations

Process	Work area	Mean noise level db(A)	Standard deviation db(A)	Time correction db(A)	Corrected mean level db(A)	Percentage of distribution exceeding 90 db(A)
Knitting	Large-diameter circular machines	83·9	2·4	−1	82·9	0·2
	Flat machines	86·6	2·7		85·6	5·2
	Straight-bar machines	93·7	4·0		92·7	75·0
	Small-diameter circular machines					
	Hose	92·8	2·7		91·8	74·8
	Half-hose	89·8	1·7		88·8	24·0
	Warp machines	89·2	2·0		88·2	18·4
Yarn preparation	Texturing	104·9	2·4	−1	103·9	100·0
	Cone winding	89·5	5·5		88·5	39·2
Making-up	Cup seaming	85·7	4·8	−5	80·7	2·6
	Flatlock seaming	86·1	0·4		81·1	0·0
	Overlock seaming	90·4	3·1		85·4	6·9
	Binding and lace attaching	89·9	2·5		84·9	2·1
	Welting	89·5	2·5		84·5	1·4
	Bartacking	87·6	5·1		82·6	7·4
	Buttonholing	87·4	3·0		82·4	0·6
	Button sewing	84·0	2·6		79·0	0·0
	Tabbing	88·6	9·2		83·6	— (1)
	Rouleau	84·8	—		79·3	— (2)
	Linking	81·1	4·9		76·1	0·2
	Toe-closing, etc.	85·7	3·0		80·7	0·1
	Garment pressing	96·5	5·3		91·5	61·2

(1) No figure quoted in view of the excessively high scatter in the data
(2) No figure possible on the present data

effect is that $L_{eq} = L - 1$. In fact, as a result of the logarithmic nature of the decibel scale, the calculated correction is fairly insensitive to the time-allowance assumed, so that a quite rough approximation is probably adequate.

In the case of making-up processes, the noise-time history for individual employees is likely to vary widely. Probably the most reasonable assumption is to take the quoted decibel levels as applying for 20-50% of the operative's total work time which would give $L_{eq} = L - 7$ or $L_{eq} = L - 3$ respectively. For simplicity it will be arbitrarily assumed that $L_{eq} = L - 5$, which corresponds to a 32% operative exposure time.

If it is now assumed that the data for the various industrial processes can be generalized adequately by a Gaussian distribution, this being reasonable since no deliberate bias has been imposed on the choice of factories or of types of machinery involved in the exercise, it is possible to calculate the degree of excessive noise involved in the processes in terms of the proportion of the Gaussian curve cut off by the 90 db(A) limit. The resultant figures are shown in Table 7, which covers the knitting, yarn preparation, and making-up processes. No figures are shown for dyeing and finishing or miscellaneous processes as a result of the relatively few data acquired in the present survey, and the wider degree of uncertainty this implies.

The data of Table 7 are also shown diagrammatically in Fig. 10, which covers knitting and yarn preparation, and in Fig. 11, which covers the other processes.

It will be seen that four processes stand out as being particularly noisy, even after taking account of the time-reduction referred to above. These processes, all giving in excess of the 90 db(A) L_{eq}-recommendation for more than 60% of their distribution are: (i) straight-bar knitting; (ii) seamless hose knitting; (iii) yarn texturing; and (iv) garment pressing.

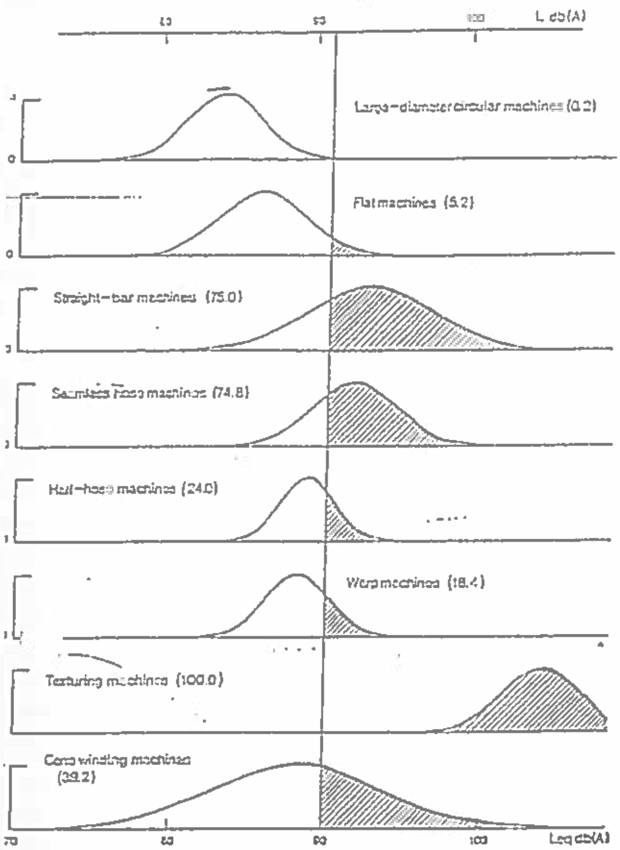
9.2 Installation effects

9.2.1 Methodology

To assess the magnitude of the effects on the noise environment which result from variations in details of factory layout and construction, an examination was made of the data for ten knitting machine types for which multiple measurements in each of two or more factory locations were available.

For each machine type a mean octave-band noise spectrum was calculated from the appropriate group of measurements in each factory, together with the standard deviation in each octave.

Examination of the db(A) levels computed from these mean spectra showed that the scatter for a particular machine type was of the same magnitude as is implied by the basic system accuracy of ±2·0 db quoted in Section 5. In the most extensive set of data, where eight measurement groups were available, this scatter was found to be −2·4 to +1·5 db(A), whilst considering the relevant data for all machine types together, the maximum range was found to be −2·6 to +2·0 db(A). Since this scatter is accountable, the several mean spectra for each machine type were then adjusted to agree with the overall mean db(A) level for that machine (except in one atypical case as noted in Section 9.2.2.4.1 below).



ig. 10 *Probability distribution of noise levels and per-ntage above $L_{eq} = 90$—knitting and yarn preparation equipment*

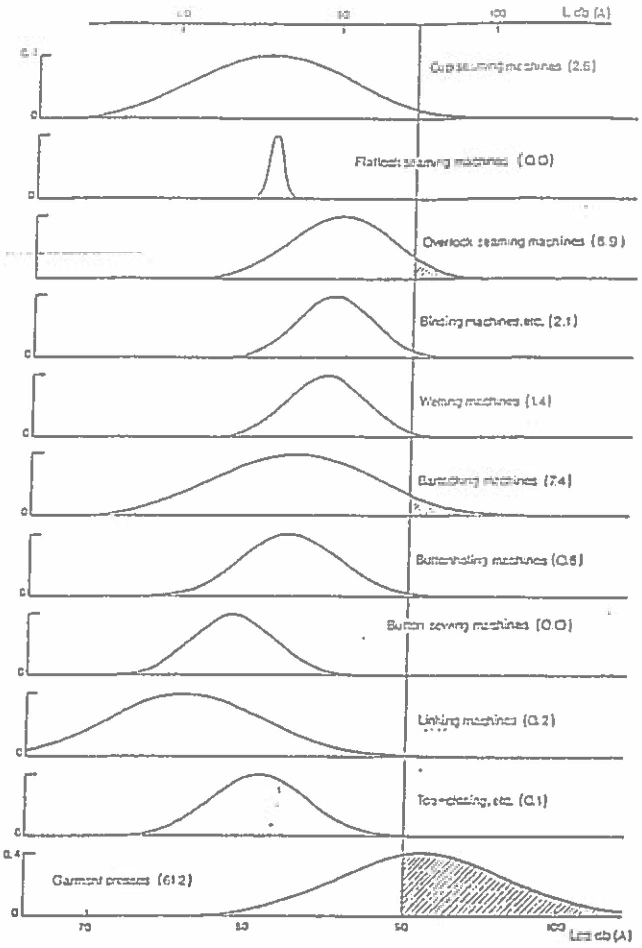


Fig. 11 Probability distribution of noise levels and percentage above $L_{eq} = 90$—making-up equipment

A further program was then written for the Hatra liott 903 computer and used to compare these mean ectra in pairs, using a *t*-test technique to establish e percentage level at which the difference would be atistically significant.

The results are given in the Tables following this ction.

2.2 Comparison data

2.2.1 Large-diameter circular machines

Fig. 12 includes mean spectra for two machine types; e Stibbe PBDR SMO machine as measured in two parate factory locations, and the Wildt Mellor Bromley RJ machine as measured in four locations. Computer sessments of these spectra are given in Tables 8 and 9 spectively.

In the case of the Stibbe machine, the two mean ectra are in good agreement and not significantly fferent except in the two lowest frequency octaves. ysically, the two locations were generally similar in ms of ceiling height and floor and ceiling construction; wever, the shop in which measurement group 1 was ken had a much larger floor area than that for asurement group 2 (at least 10×) and it is likely at this is one of the reasons for the difference in the v-frequency region.

This difference is, however, of little consequence in w of the heavy weighting given to the upper mid-quencies by the 'A' filter, and it can be safely ignored.

In the case of the Wildt Mellor Bromley machine mparisons, a generally similar pattern is evident with iability apparent in the three lowest octaves and, a certain extent, also in the two highest octaves. The r knitting shops varied widely in size, construction, and age, and it is likely that the rather low level of measurement group 2 in the higher octaves is a result of the small and cramped nature of the shop with an attendant high acoustic absorption coefficient, the other three groups being generally of more modern and spacious type. There is no obvious explanation of the greater low-frequency levels found in group 1.

9.2.2.2 Flat machines

Two groups of measurements of the Dubied DRL 2 machine are compared in Table 10 and the mean spectra shown in Fig. 12. No significant difference is apparent at any frequency, though the two knitting shops concerned were of somewhat different character and size, but not to the degree noted above in the cases of the large-diameter circular machines.

9.2.2.3 Straight-bar machines

Two groups of measurements of the Textile Machine Works Reading machine are compared in Table 11 and the mean spectra shown in Fig. 12. Significant differences again occur only in the lower-frequency region, with the smaller knitting shop of measurement group 2 again tending to show the higher level. In respects other than size the physical properties of the shops were similar.

9.2.2.4 Small-diameter circular machines

9.2.2.4.1 Hose machines

Data for three machine types are given. Table 12 covers eight groups of measurements of the Billi Zodiac 8 machine; Table 13 covers four groups of measurements of the Booton 8 machine; and Table 14 deals with three groups of measurements of the Samo 6C machine. In each case the mean spectra are also shown in Fig. 12.

For the Billi machine, the data fall into two distinct classes; measurement groups 1, 2, 3, 5 and 6 being of one generic type, and noticeably different from groups. 4, 7 and 8 which show good agreement with each other. In consequence in this particular comparison the spectra's db(A) levels have been adjusted to the separate class means and are thus shown in Fig. 12. For groups 1, 2, 3, 5 and 6 the comparison is similar to those made above; there is good mid-frequency-agreement, with a noticeable scatter at the lowest frequencies, and a rather smaller scatter at the highest. In the case of groups 4, 7 and 8 there is little significant difference in the six mid- and high-frequency octaves, but a considerable difference in the lower octaves, probably as a result of the high noise level resulting from the plant air. systems in the factories in which measurement groups 7 and 8 were taken.

The only apparent explanation for the differences seen between the two classes is that groups 4, 7 and 8 represent machine layouts with a machine density which is only about a half of that of the other groups. This would be expected to affect the low frequencies leaving the higher ones unaltered.

In the case of the Booton machines a similar situation is found with fair agreement between the four measurement groups at higher frequencies and a deterioration at lower frequencies. Again the higher level of groups 3 and 4 at low frequencies results from the high noise level of the plant air systems.

The three groups of measurements of the Samo 6C machine show characteristics similar to those of the other hose machines.

9.2.2.4.2 Half-hose machines

Three groups of measurements of the Bentley Komet Model BR machine are compared in Table 15, and two groups of measurements of the Wildt Autoswift Model E machine are compared in Table 16. The spectra are shown in Fig. 12.

In both cases there is again good agreement at high frequencies with some deterioration at the lower frequencies.

9.2.2.5 Warp machines

Three groups of measurements of the Mayer KE2 warp machine are compared in Table 17, and the mean spectrum is shown in Fig. 12. The measurements of groups 1 and 3 are in generally very good agreement but group 2 is different. Groups 1 and 3 were measured in large, high, reverberant shops, but group 2 was in a much smaller shop containing only a few machines. The results thus tend to be similar to those quoted above in Sections 9.2.2.1 and 9.2.2.3.

9.2.3 Appraisal

The data, as described, show that the effect on noise of installation and factory differences is, in general, small compared with the effect of differences between machine types. The main effect of the factory layout occurs in the lower frequencies, say, up to about 300-400 Hz, and is not significant in affecting the db(A) rating of the noise because of the low importance assigned to these frequencies by the 'A-weighting' filter. Some slight differences between factory locations can be seen at high frequencies, over 6 kHz, in certain sets of data, and these could indicate that increasing the acoustic absorption in a particular knitting shop could

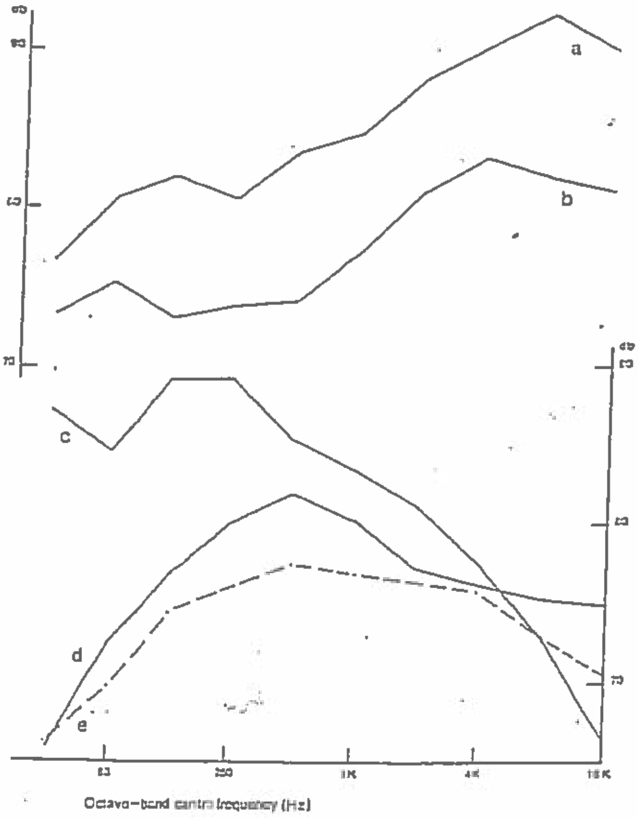


Fig. 12a Mean spectra of typical knitting machines. (a—Textile Machine Works Reading straight-bar machine, b—Dubied DRL 2 flat machine, c—Mayer KE 2 warp knitting machine; d—Wildt Mellor Bromley 9RJ large-diameter circular machine, e—Stibbe PBDR SMO large-diameter circular knitting machine.)

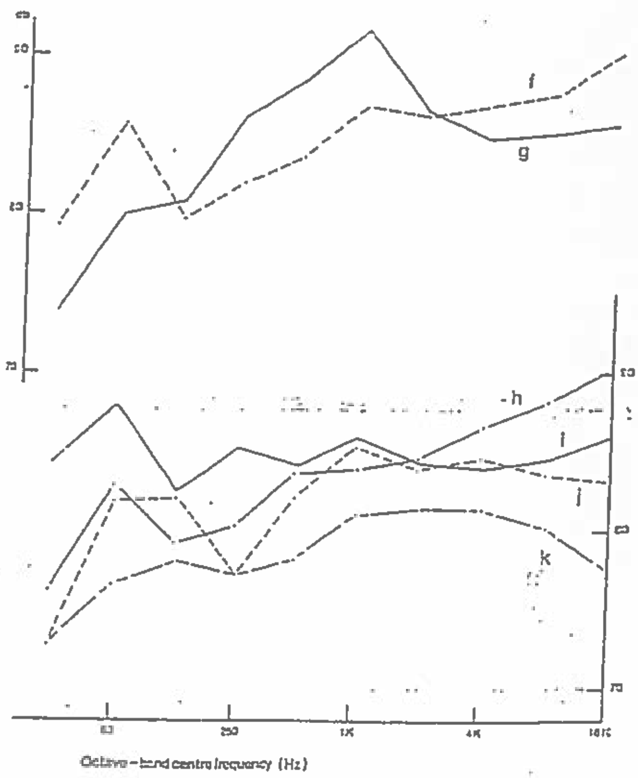


Fig. 12b Mean spectra of typical knitting machines. (f—Test groups 4, 7 and 8 for Billi Zodiac 8 seamless hose machine, g—Test groups 1, 2, 3, 5 and 6 for Billi Zodiac 8 seamless hose machine, h—Booton 8 seamless hose machine, i—Samo 6C seamless hose machine, j—Bentley Komet BR half-hose machine, k—Wildt Autoswift E half-hose machine.)

e slightly beneficial for machine types with principally igh-frequency noise energy characteristics. The potential enefits from this approach are, however, small since the ypical noise rating, at least as identified by the techniques adopted herein, is governed in the main by directly transmitted noise and has only a low reflected noise content. In the case of making-up equipment this relation is even stronger.

TABLES OF COMPARATIVE NOISE MEASUREMENTS

Table 8 Stibbe PBDR SMO large-diameter circular machines

FREQUENCY HZ

GROUP NO.	NO OF MEAS.	31.5	63	125	250	500	1K	2K	4K	8K	16K	DBA
MEAN SPECTRA AND STANDARD DEVIATIONS												
1	3	63.1	68.3	74.0	75.1	77.5	76.5	76.4	76.0	73.5	71.0	83.1
		1.0	1.0	1.3	0.3	0.6	0.8	0.8	0.6	1.3	1.0	0.4
2	4	70.2	71.6	74.6	77.2	77.3	77.3	76.1	75.2	72.1	69.8	83.1
		0.2	1.0	2.9	1.9	0.9	0.5	1.1	1.0	1.1	1.7	0.5

COMPARISON OF MEASUREMENT GROUP 1 WITH HIGHER-NUMBERED GROUPS

00 INDICATES NO SIGNIFICANT DIFFERENCE
5 OR 10 INDICATES THAT THE DIFFERENCE IS SIGNIFICANT AT THAT PERCENT.

2	5	5	00	00	00	00	00	00	00	00	00

Table 9 Wildt Mellor Bromley 9RJ large-diameter circular machines

FREQUENCY HZ

GROUP NO.	NO OF MEAS.	31.5	63	125	250	500	1K	2K	4K	8K	16K	DBA
MEAN SPECTRA AND STANDARD DEVIATIONS												
1	2	74.5	81.7	80.0	80.2	81.0	79.9	77.1	76.8	76.7	78.1	85.4
		2.7	3.3	0.6	1.2	1.6	1.6	1.9	1.2	0.8	1.2	1.5
2	3	64.1	73.6	78.1	80.1	82.6	80.5	76.6	75.3	74.1	72.5	85.4
		2.4	1.4	2.5	0.8	1.8	0.4	0.6	0.8	0.5	0.5	0.5
3	3	64.0	70.7	76.3	80.0	81.5	80.1	77.1	76.5	75.7	75.6	85.4
		0.9	1.7	0.5	0.4	1.3	1.5	1.3	0.7	0.7	1.5	1.0
4	3	64.0	67.9	73.5	79.7	81.7	79.9	77.7	76.4	74.9	73.8	85.4
		2.1	1.6	1.7	1.2	1.9	1.2	0.4	0.4	0.3	0.2	0.9

COMPARISON OF MEASUREMENT GROUP 1 WITH HIGHER-NUMBERED GROUPS

00 INDICATES NO SIGNIFICANT DIFFERENCE
5 OR 10 INDICATES THAT THE DIFFERENCE IS SIGNIFICANT AT THAT PERCENT.

2	5	5	00	00	00	00	00	00	5	5	00
3	5	5	5	00	00	00	00	00	00	00	00
4	5	5	5	00	00	00	00	00	5	5	00

COMPARISON OF MEASUREMENT GROUP 2 WITH HIGHER-NUMBERED GROUPS

3	00	10	00	00	00	00	00	00	5	5	00
4	00	5	10	00	00	00	10	10	10	5	00

COMPARISON OF MEASUREMENT GROUP 3 WITH HIGHER-NUMBERED GROUPS

4	00	00	5	00	00	00	00	00	00	00	00

Table 10 Dubied DRL 2 flat machines

FREQUENCY HZ

GROUP NO.	NO OF MEAS.	31.5	63	125	250	500	1K	2K	4K	8K	16K	DBA
MEAN SPECTRA AND STANDARD DEVIATIONS												
1	2	72.9	75.4	71.4	73.1	75.1	77.7	80.8	83.1	81.6	80.9	88.0
		1.8	1.8	3.9	2.1	2.1	1.4	1.8	1.1	1.8	2.5	1.6
2	4	73.3	75.2	73.7	74.1	73.7	77.0	80.9	83.1	81.9	81.0	88.0
		1.0	0.9	0.9	1.0	0.9	1.1	0.9	0.6	1.0	0.8	0.8

COMPARISON OF MEASUREMENT GROUP 1 WITH HIGHER-NUMBERED GROUPS

00 INDICATES NO SIGNIFICANT DIFFERENCE
5 OR 10 INDICATES THAT THE DIFFERENCE IS SIGNIFICANT AT THAT PERCENT.

GROUP	31.5	63	125	250	500	1K	2K	4K	8K	16K	DBA
2	00	00	00	00	00	00	00	00	00	00	00

Table 11 Textile Machine Works Reading straight-bar machines

FREQUENCY HZ

GROUP NO.	NO OF MEAS.	31.5	63	125	250	500	1K	2K	4K	8K	16K	DBA
MEAN SPECTRA AND STANDARD DEVIATIONS												
1	4	76.1	78.4	79.6	79.6	84.4	85.2	88.2	90.2	92.2	89.7	96.2
		1.3	1.7	0.5	0.8	1.6	1.7	1.8	1.6	1.4	1.4	1.4
2	5	77.5	83.3	84.8	81.7	82.6	84.4	88.2	90.3	92.1	90.2	96.2
		2.8	0.9	1.5	0.7	1.0	1.4	1.3	1.1	1.7	2.8	1.4

COMPARISON OF MEASUREMENT GROUP 1 WITH HIGHER-NUMBERED GROUPS

00 INDICATES NO SIGNIFICANT DIFFERENCE
5 OR 10 INDICATES THAT THE DIFFERENCE IS SIGNIFICANT AT THAT PERCENT.

GROUP	31.5	63	125	250	500	1K	2K	4K	8K	16K	DBA
2	00	5	5	5	10	00	00	00	00	00	00

Table 12 Billi Zodiac 8 seamless hose machines

FREQUENCY HZ

GROUP NO.	NO OF MEAS.	31.5	63	125	250	500	1K	2K	4K	8K	16K	DBA
MEAN SPECTRA AND STANDARD DEVIATIONS												
1	4	74.5	79.4	83.6	88.0	89.0	90.8	86.0	86.3	87.2	87.2	95.2
		1.3	1.3	1.5	1.7	0.9	1.4	1.0	0.3	0.3	0.4	0.8
2	4	70.3	77.0	77.6	85.1	88.1	91.2	87.2	85.1	86.5	88.5	95.2
		1.6	1.2	1.1	1.3	1.0	0.5	1.6	1.0	0.5	1.8	0.7
3	4	71.2	75.7	78.4	86.3	89.0	91.5	87.2	85.3	85.2	85.8	95.2
		0.8	0.5	1.3	0.8	1.2	0.9	0.9	0.6	0.3	0.5	0.6
4	2	74.9	76.2	74.7	79.2	83.7	86.8	86.1	87.7	88.1	89.3	94.2
		1.5	0.3	0.4	1.7	1.0	1.0	1.1	0.8	0.8	1.1	0.4
5	4	78.3	83.1	82.3	86.1	87.8	92.2	86.3	84.3	85.2	84.9	95.2
		1.6	0.9	1.0	1.1	1.5	1.8	0.6	0.6	0.9	1.4	1.1

continued overleaf

Table 12—Billi Zodiac 8, continued

6	4	74.3	83.2	82.2	85.3	88.8	92.8	86.4	83.1	81.7	82.4	95.2
		1.9	0.6	1.5	0.9	0.6	1.1	1.0	0.9	1.4	1.1	0.9
7	6	80.6	90.6	81.6	83.0	84.3	86.8	87.1	87.3	87.1	88.6	94.2
		1.9	2.4	2.9	1.7	1.4	0.9	1.7	0.6	1.0	1.1	0.7
8	4	79.6	83.0	79.4	81.5	82.7	86.3	85.0	85.9	88.4	93.2	94.2
		0.9	2.2	0.9	0.3	1.1	0.7	2.9	1.3	1.7	3.0	0.7

COMPARISON OF MEASUREMENT GROUP 1 WITH HIGHER-NUMBERED GROUPS

00 INDICATES NO SIGNIFICANT DIFFERENCE
5 OR 10 INDICATES THAT THE DIFFERENCE IS SIGNIFICANT AT THAT PERCENT.

2	5	5	5	5	00	00	00	10	5	00	00
3	5	5	5	00	00	00	00	5	5	5	00
4	00	5	5	5	5	5	00	5	10	5	00
5	5	5	00	00	00	00	00	5	5	5	00
6	00	5	00	5	00	10	00	5	5	5	00
7	5	5	00	5	5	5	00	5	00	10	10
8	5	5	5	5	5	5	00	00	00	5	00

COMPARISON OF MEASUREMENT GROUP 2 WITH HIGHER-NUMBERED GROUPS

3	00	10	00	00	00	00	00	00	5	5	00
4	5	00	5	5	5	5	00	5	5	00	00
5	5	5	5	00	00	00	00	00	5	5	00
6	5	5	5	00	00	5	00	5	5	5	00
7	5	5	5	10	5	5	00	5	00	00	5
8	5	5	10	5	5	5	00	00	10	5	10

COMPARISON OF MEASUREMENT GROUP 3 WITH HIGHER-NUMBERED GROUPS

4	5	00	5	5	5	5	00	5	5	5	10
5	5	5	5	00	00	00	00	10	00	00	00
6	5	5	5	00	00	00	00	5	5	5	00
7	5	5	10	5	5	5	00	5	5	5	5
8	5	5	00	5	5	5	00	00	5	5	10

COMPARISON OF MEASUREMENT GROUP 4 WITH HIGHER-NUMBERED GROUPS

5	10	5	5	5	5	5	00	5	5	5	00
6	00	5	5	5	5	5	00	5	5	5	00
7	5	5	5	5	00	00	00	00	00	00	00
8	5	5	5	10	00	00	00	00	00	00	00

COMPARISON OF MEASUREMENT GROUP 5 WITH HIGHER-NUMBERED GROUPS

6	5	00	00	00	00	00	00	10	5	5	00
7	10	5	00	5	5	5	00	5	5	5	00
8	00	00	5	5	5	5	00	10	5	5	00

COMPARISON OF MEASUREMENT GROUP 6 WITH HIGHER-NUMBERED GROUPS

7	5	5	00	5	5	5	00	5	5	5	10
8	5	00	5	5	5	5	00	5	5	5	00

COMPARISON OF MEASUREMENT GROUP 7 WITH HIGHER-NUMBERED GROUPS

8	00	5	00	00	10	00	00	5	00	5	00

Table 13 Booton 8 seamless hose machines

FREQUENCY HZ

MEAN SPECTRA AND STANDARD DEVIATIONS

GROUP NO.	NO OF MEAS.	31.5	63	125	250	500	1K	2K	4K	8K	16K	DBA
1	4	75.1	77.6	78.6	82.1	82.6	82.6	84.1	86.8	89.8	90.6	93.5
		1.0	1.1	1.8	1.8	0.7	0.3	0.7	0.7	1.1	2.5	0.7
2	5	73.1	77.6	73.4	77.9	85.6	82.5	84.3	87.3	88.8	89.7	93.5
		1.0	2.7	0.9	1.6	2.7	0.6	0.7	0.9	0.9	1.5	0.5
3	4	78.3	92.8	79.8	80.8	82.7	85.4	85.4	87.0	88.3	89.2	93.5
		3.6	4.8	2.3	1.8	1.3	1.2	0.1	0.5	0.5	0.5	0.3
4	3	79.6	85.2	78.4	81.1	83.1	86.2	84.6	85.0	88.3	92.5	93.5
		0.3	1.1	0.6	1.0	0.7	0.7	0.6	1.0	0.7	0.8	0.5

COMPARISON OF MEASUREMENT GROUP 1 WITH HIGHER-NUMBERED GROUPS

00 INDICATES NO SIGNIFICANT DIFFERENCE
5 OR 10 INDICATES THAT THE DIFFERENCE IS SIGNIFICANT AT THAT PERCENT.

2	5	00	5	5	10	00	00	00	00	00	00
3	00	5	00	00	00	5	5	00	5	00	00
4	5	5	00	00	00	5	00	5	10	00	00

COMPARISON OF MEASUREMENT GROUP 2 WITH HIGHER-NUMBERED GROUPS

3	5	5	5	5	10	5	5	00	00	00	00
4	5	5	5	5	00	5	00	5	00	5	00

COMPARISON OF MEASUREMENT GROUP 3 WITH HIGHER-NUMBERED GROUPS

4	00	5	00	00	00	00	10	5	00	5	00

Table 14 Samo 6C seamless hose machines

FREQUENCY HZ

MEAN SPECTRA AND STANDARD DEVIATIONS

GROUP NO.	NO OF MEAS.	31.5	63	125	250	500	1K	2K	4K	8K	16K	DBA
1	4	80.5	84.9	80.5	85.6	83.8	85.9	83.8	84.2	85.9	86.5	92.1
		1.2	1.0	1.1	1.5	1.1	1.8	0.7	0.3	0.7	0.6	0.7
2	4	89.4	91.4	85.3	86.1	85.2	86.2	84.6	84.5	83.7	83.3	92.1
		2.8	2.0	2.2	1.3	2.8	0.9	0.8	0.9	0.7	0.7	1.0
3	4	82.3	84.4	81.7	83.9	83.3	85.7	84.4	83.2	84.2	88.3	92.1
		1.3	2.4	0.9	1.9	1.2	1.3	1.1	0.8	2.7	5.9	1.3

COMPARISON OF MEASUREMENT GROUP 1 WITH HIGHER-NUMBERED GROUPS

00 INDICATES NO SIGNIFICANT DIFFERENCE
5 OR 10 INDICATES THAT THE DIFFERENCE IS SIGNIFICANT AT THAT PERCENT.

2	5	5	5	00	00	00	00	00	5	5	00
3	10	00	00	00	00	00	00	10	00	00	00

COMPARISON OF MEASUREMENT GROUP 2 WITH HIGHER-NUMBERED GROUPS

3	5	5	5	00	00	00	00	10	00	00	00

Table 15 Bentley Komet BR half-hose machines

GROUP NO.	NO OF MEAS.	31.5	63	125	250	500	1K	2K	4K	8K	16K	DBA
		FREQUENCY HZ										

MEAN SPECTRA AND STANDARD DEVIATIONS

GROUP NO.	NO OF MEAS.	31.5	63	125	250	500	1K	2K	4K	8K	16K	DBA
1	6	76.0	77.0	83.4	80.0	83.3	84.3	83.6	83.8	87.1	80.1	90.6
		1.5	1.8	1.9	0.4	1.3	0.8	1.1	1.1	1.4	1.9	0.8
2	4	70.4	77.8	79.8	76.0	81.0	84.9	83.1	83.9	82.7	82.0	90.6
		1.1	0.6	0.8	0.6	1.3	1.6	1.4	0.9	1.2	1.6	1.1
3	5	71.3	84.0	82.4	78.0	81.2	83.4	83.0	83.8	84.0	85.5	90.6
		0.6	3.3	1.0	1.3	1.1	0.4	0.7	0.3	0.5	1.5	0.3

COMPARISON OF MEASUREMENT GROUP 1 WITH HIGHER-NUMBERED GROUPS

00 INDICATES NO SIGNIFICANT DIFFERENCE
5 OR 10 INDICATES THAT THE DIFFERENCE IS SIGNIFICANT AT THAT PERCENT.

	31.5	63	125	250	500	1K	2K	4K	8K	16K	DBA
2	5	00	5	5	5	00	00	00	00	00	00
3	5	5	00	5	5	10	00	00	5	5	00

COMPARISON OF MEASUREMENT GROUP 2 WITH HIGHER-NUMBERED GROUPS

	31.5	63	125	250	500	1K	2K	4K	8K	16K	DBA
3	00	5	5	5	00	10	00	00	10	5	00

Table 16 Wildt Autoswift E half-hose machines

GROUP NO.	NO OF MEAS.	31.5	63	125	250	500	1K	2K	4K	8K	16K	DBA
		FREQUENCY HZ										

MEAN SPECTRA AND STANDARD DEVIATIONS

GROUP NO.	NO OF MEAS.	31.5	63	125	250	500	1K	2K	4K	8K	16K	DBA
1	4	76.9	76.2	77.2	78.7	76.9	79.6	81.8	81.9	80.6	76.9	88.0
		0.8	0.6	0.3	0.6	1.0	1.1	1.1	1.2	0.9	0.6	0.9
2	4	69.7	76.8	78.8	75.6	79.4	82.3	80.9	80.8	79.8	78.1	88.0
		0.9	0.9	1.2	1.3	1.1	1.3	1.1	0.9	1.5	2.7	0.9

COMPARISON OF MEASUREMENT GROUP 1 WITH HIGHER-NUMBERED GROUPS

00 INDICATES NO SIGNIFICANT DIFFERENCE
5 OR 10 INDICATES THAT THE DIFFERENCE IS SIGNIFICANT AT THAT PERCENT.

	31.5	63	125	250	500	1K	2K	4K	8K	16K	DBA
2	5	00	5	5	5	5	00	00	00	00	00

Table 17 Mayer KE2 warp knitting machines

GROUP NO.	NO OF MEAS.	31.5	63	125	250	500	1K	2K	4K	8K	16K	DBA
		FREQUENCY HZ										

MEAN SPECTRA AND STANDARD DEVIATIONS

GROUP NO.	NO OF MEAS.	31.5	63	125	250	500	1K	2K	4K	8K	16K	DBA
1	2	86.5	82.7	87.0	87.5	85.2	84.2	81.6	78.4	71.8	63.4	89.1
		1.7	2.1	1.7	1.0	0.6	1.3	1.7	2.1	1.3	1.3	1.4
2	2	90.7	90.2	94.2	92.4	85.9	82.2	79.3	74.9	70.2	63.9	89.2
		1.0	2.4	1.0	0.6	0.1	1.0	1.7	2.4	5.2	1.7	0.8
3	3	85.4	82.3	87.1	88.3	84.8	83.6	82.2	78.6	75.3	69.6	89.1
		1.8	2.0	1.1	1.1	2.0	1.2	1.3	1.1	1.1	0.9	1.3

continued overleaf

COMPARISON OF MEASUREMENT GROUP 1 WITH HIGHER-NUMBERED GROUPS

Table 17—*Mayer KE2 continued*

00 INDICATES NO SIGNIFICANT DIFFERENCE
5 OR 10 INDICATES THAT THE DIFFERENCE IS SIGNIFICANT AT THAT PERCENT.

2	10	10	5	5	00	00	00	00	00	00	00
3	00	00	00	00	00	00	00	00	5	5	00

COMPARISON OF MEASUREMENT GROUP 2 WITH HIGHER-NUMBERED GROUPS

3	5	5	5	5	00	00	00	10	00	5	00

9.3 Mechanical effects

In Section 8.3.3 above it was commented that a measurement on a known mechanically defective overlock seaming machine produced a noise level of 102·7 db(A) compared with a mean of 89·7 db(A) from measurements of identical but mechanically normal machines. Thus, in this case, the noise penalty of operating this mechanically defective machine was some 13 db(A). A comparison of the spectrum of the normal and faulty machines is given in Fig. 13.

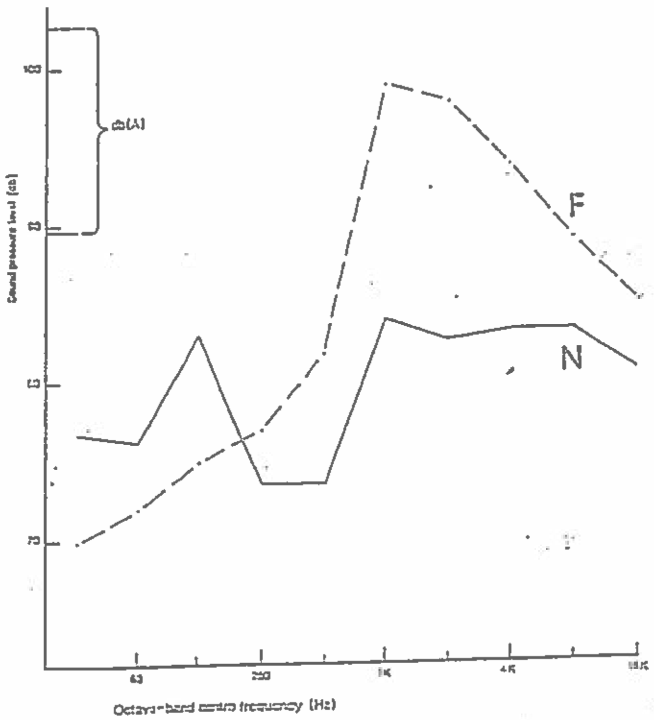


Fig. 13 Comparative noise measurements of normal (N) and faulty (F) Willcox & Gibbs 514/1–11 overlock seaming machines

Another example of the penalty of mechanical troubles occurred in the measurement of large-diameter circular knitting machines. A measurement on a Wildt Mellor Bromley 14/RJ machine having an audibly obvious mechanical defect, probably gear or drive mechanism failure, gave a noise level of 89·1 db(A) compared with a mean of 86·2 db(A) from three measurements of identical but mechanically normal machines. In this case the noise penalty of the mechanical problem was only 3 db(A), but this would be likely to increase fairly rapidly with usage. A spectrum comparison is given in Fig. 14.

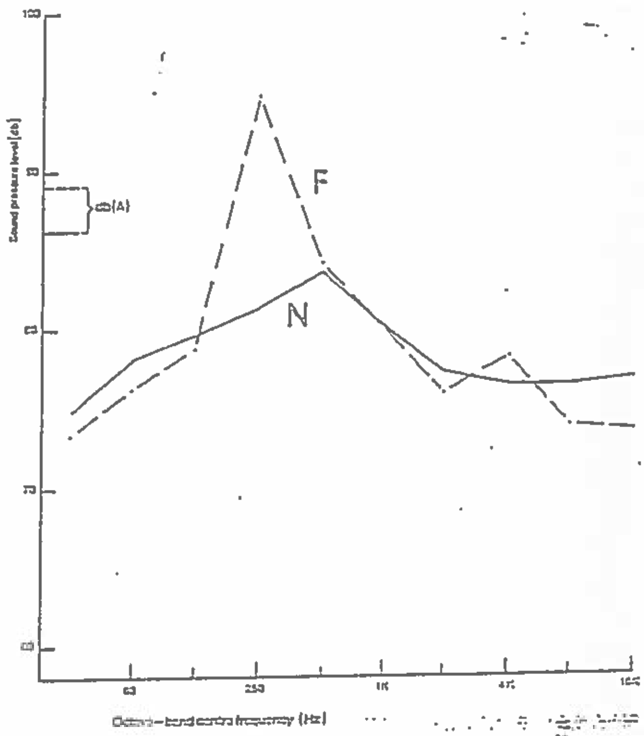


Fig. 14 Comparative noise measurements of normal (N) and faulty (F) Wildt Mellor Bromley 14/RJ large-diameter circular knitting machines

A final example occurs in the measurements taken on flat knitting machines. Because of the reciprocating motion of this type of machine, an impulsive blow is applied to the machine structure repetitively at the ends of the traverse motion. It is common to see these machines, even when provided with mounting feet for bolting to the floor, merely placed on the floor without attachment. In extreme cases the whole machine can be seen to 'jump' up to half a centimetre alternately left-to-right and right-to-left to accompany the knitting action. This is an obvious source of low-frequency noise but in its less extreme forms it is so common that it has not been possible to isolate the magnitude of the effect in this present exercise.

10.0 Conclusions

Working noise levels in the knitting industry have been established as tabulated herein.

The processes of straight-bar knitting, seamless hose knitting, yarn texturing, and garment pressing produce noise levels significantly in excess of the 90 db(A) recommended by the Department of Employment.

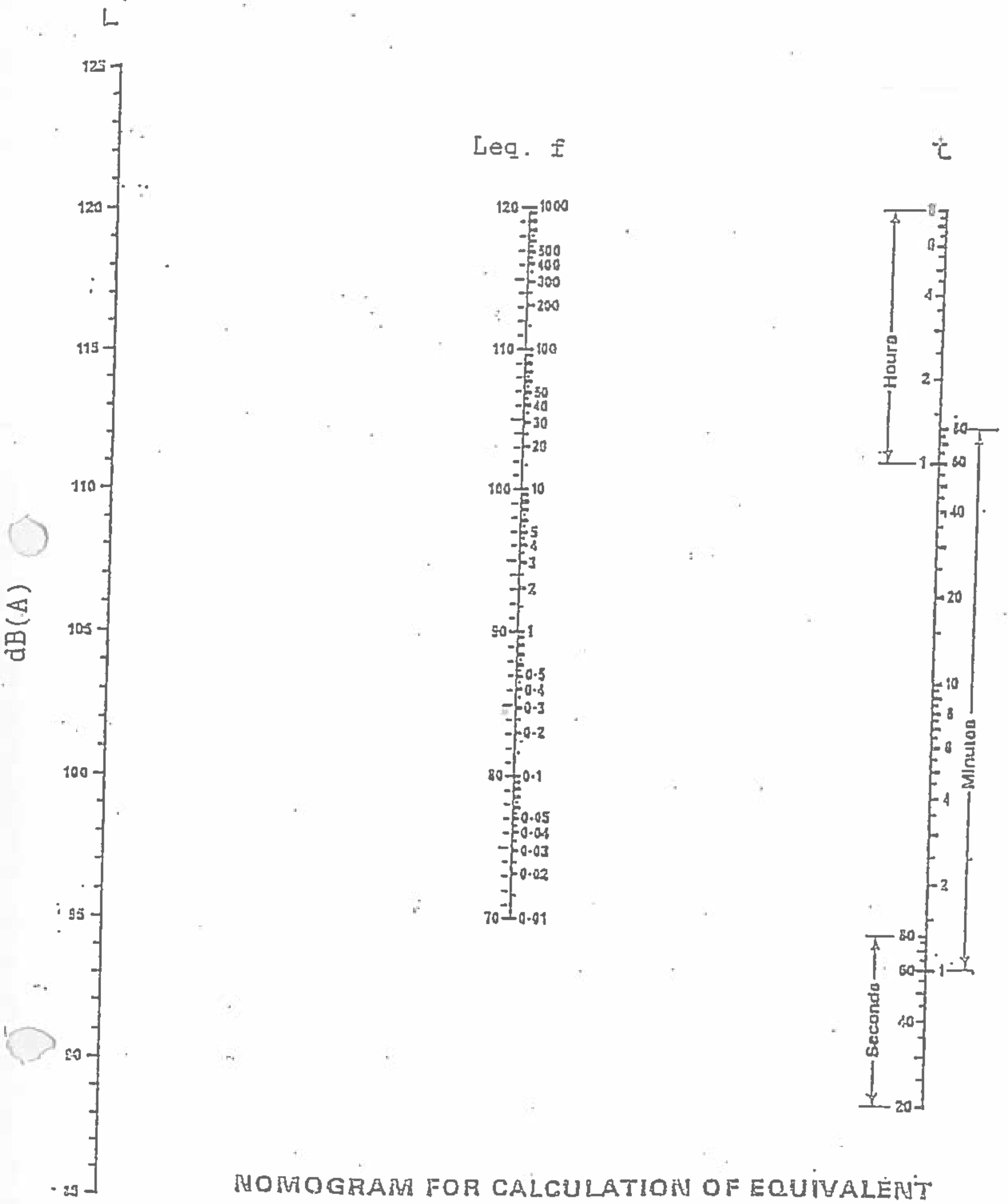
The effects on noise levels of installation differences and factory construction and layout appear to be small.

Mechanical defects within equipment in use can produce very considerable increases in noise levels.

References

1 J. Stone. *Noise and the hosiery worker: an investigation into the effects of industrial noise on the hearing of employees in the hosiery industry.* Leicester, National Union of Hosiery and Knitwear Workers, 1971

2 Department of Employment. *Code of practice for reducing the exposure of employed persons to noise.* London, HMSO, 1972



NOMOGRAM FOR CALCULATION OF EQUIVALENT CONTINUOUS SOUND LEVEL

1. Using a straight edge connect the sound level in dB(A) on scale L with the duration of exposure on scale t and read off the fractional exposure f where the line intersects scale f

2. Add all the fractional exposure values of f received in one day together to give a total value of f

3. Locate total value of f on the f scale to obtain the Equivalent Continuous Sound Level from the adjoining L Eq Scale (eg. A total f value of 2.0 corresponds to an L Eq value of 93dB(A)