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NOISE IN GLASS CONTAINER MANUFACTURE

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INTRODUCTION

Despite intense competition from plastics and other forms of packaging, glass container manufacture in the UK is still an important industry employing over 9000 persons and having an annual turnover in excess of £400 million. The process produces high levels of noise exposing some 700 persons to levels in excess of 98 dB(A) Leq 8 hours and a great many more to levels in excess of 90 dB(A) Leq 8 hour limit recommended in the Code of Practice for reducing the exposure of employed persons to Noise: HMSO.

This paper summarises information contained in the reports of HSE Specialist Inspectors (Noise) and presents information on noise levels and noise exposure; the sources of noise and various noise reduction measures.

GLASS CONTAINER MANUFACTURE

Bottles and jars are manufactured on automatic moulding machines consisting of 5 to 10 independent sections (IS) in a linear arrangement coupled to a take off conveyor. Each section can produce from one to three containers at a time and in action gobs of molten glass are fed to a blank mould where they are preformed by either air or plunger pressure. The preform or parison is then transferred to a "blow' mould and blown to the finished shape and size before being mechanically removed and conveyed via an annealing oven (lehr) to the checking and packing area or "cold end". The mechanisms are pneumatically operated and the moulds, and other parts are, generally, air cooled. The timing of the various phases of the forming process is carried out either mechanically or, on newer machines, electronically. The process is shown in Figure 1.

NOISE LEVELS AND NOISE EXPOSURE

Noise levels vary with the type of container produced; the production rate; the mould cooling system used; machine timing; the number of machines in use; with the plant layout and with the general condition of the machines. At the forming end "Hot End" noise levels range from 95 to 1 11 dB(A) generally but levels upto 116 dB(A) have been measured. Table 1 shows the range of noise levels measured in the area around the forming (IS) machines in a selection of four factories.

Noise levels at the cold end are generally much lower - See Table 2 and Figure 2.

Noise levels of upto 105 dB(A) are often found in the burner passages but generally, levels in the furnace area range from 92 to 98 dB(A). In batching plants noise levels can reach 96 dB(A) and levels of from 88 to 105 dB(A) have been recorded in basement areas.

The range of noise spectra is shown in Figure 3 and Figure 4 shows the increase in noise levels at high frequencies that can occur as a result of inaccurate process timing and/or unsilenced compressed air exhausts.

NOISE EXPOSURE

The number of employees in a particular plant will vary with the type of product and with the size of the plant but an indication of how many might be exposed to noise in the various areas can be derived using as an example a 150 to capacity installation of 4 "IS" machines with a total of 22 sections. 220 persons run the plant operating a four shift system, 24 hours per day for 50.7 weeks a year and it is estimated that workers are, typically, exposed to noise for 6 to 7 hours a shift.

A full shift crew consists of 2 supervisors; a furnace man; seven machine floor (Hot End) men; 23 men in the lehr, inspection and packing areas and a lodge man. Estimates of employee noise exposure give values of Leq 8 hours of from 98 to 105 dB(A) for Hot End workers and of up to 92 dB(A) for workers at the "Cold End". These values are in good agreement with the results of full shift dosemeter surveys. There are some 140 "IS" machines installed in the UK and Ireland at this time and thus approximately 700 hot end workers in the UK exposed to the highest noise levels and 3000 to 4000 more who are also likely to be exposed to excessive, if somewhat lower, levels of noise.

NOISE SOURCES

At the "hot end" the sources of noise are the mould and product cooling air; the operating air; the forming air and in some cases noise generated by the machine cooling fans. Tests have shown that switching off the cooling air to the moulds, dead plates etc reduces noise levels by 2 to 3 dB(A).

Unsilenced pneumatic exhausts, air leakage from duct joints, worn seals etc and incorrect machine timing have been identified as making a significant contribution to machine noise levels. However the elimination of noise from all these sources would only reduce noise levels by 2 to 3 dB(A) - generally - because of the dominant influence of cooling system noise.

The mould cooling systems are relatively crude with a series of uncontrolled jets blowing onto the exterior of moulds etc and noise levels vary with the cooling arrangement chosen; operating pressure; mass flow and the mould design. The way in which the cooling air flow is controlled can also influence noise levels (1) (2). Noise transmitted to the "IS" machines from the cooling air fans may contribute to plant noise levels either by transmission through and radiation from the fan casing and cooling duct walls or by direct radiation from the cooling stacks.

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NOISE REDUCTION AT THE "IS" MACHINES

Noise levels at the cold end consist of some carryover from the hot end plus container conveying and handling, impact noise and pneumatic exhaust noise. Within the furnace and furnace basement areas the chief noise sources are generally the burners, the furnace fans and the machine cooling fans, where these are basement mounted. In some cases mechanical shovels (used to remove waste glass) and hopper vibrators can create problems with levels of upto 115 dB(A) being recorded.

Cooling system noise reduction has been investigated thoroughly by machine manufacturers and new air cooling systems, in which air is ducted through a carefully designed pattern of passages in the moulds, have been developed.(9) It is claimed that the new systems are not only 10 to 20 dB(A) quieter than the old but that much less air is required and therefore running costs are reduced. Improved product quality and operating speed increases of 10 to 15% are also claimed (1) (2).

Operating air noise figure 4 can be reduced by fitting suitable, non-fouling, silencers to all exhaust ports (6); by accurately timing the machines and by applying a high standard of maintenance. Fan noise can be controlled by the use of efficient fans installed in mechanically decoupled, well silenced systems with lagging used to limit noise breakout from ductwork.

Mechanical noise is being reduced by the gradual introduction of electrically driven gob distributors and the replacement of mechanical timing drums by electronic control systems (1) (3).

NOISE REDUCTION ELSEWHERE

Basement area noise levels can be reduced by silencing fans, lagging ductwork (where necessary); installing automatic waste recovery systems and by silencing and fitting quiet cabs to mechanical shovels. In furnace areas the use of low noise burners; the silencing of combustion and furnace air fans and the use of cold top electric melting furnaces should substantially reduce noise levels (1) (3) (8).

The carryover of noise from the hot to the cold end of these installations can be - and has by some container manufacturers been-done by using screens or acoustic curtains to segregate the hot and cold areas. Suspended sound absorbers may have a part to play in increasing the acoustic segregation between the two. Much could be done to reduce cold end noise levels by adopting the methods used in the bottling plants of the container manufacturers customers. The better control of the conveyor system; the use of low speed conveyors; avoidance of impact; the enclosure of accumulators and palletisers; the lining of reject ware chutes and or fitting of acoustic tunnels together with the use of non-contact inspection and checking systems are practicable measures that could be used (8).

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NOISE EXPOSURE REDUCTION

The purpose of reducing plant noise levels is to reduce worker noise exposure and this can also be done by taking various other measures such as:- using automatic doping to eliminate the periodic manual lubrication of moulds which exposes workers to very high levels of noise. Systems have been developed but they have not been generally adopted, probably because of doubts about their long term reliability. Mould precoating is an alternative to automatic doping and much work is now taking place to develop this technique. German factories are said to have almost eliminated manual swabbing by this method.

The potential benefit to hot end workers would be a 2 to 5 dB(A) reduction in noise exposure and enhanced physical safety.

Emhart UK Ltd, one of the leading manufacturers of these machines, are now marketing a "Quick change" component system which can be retrofitted to "IS" machines. The makers claim that the time required for maintenance operations can be considerably reduced by using this system, thereby increasing productivity as well as reducing worker noise exposure. Conversion costs can be recovered in a matter of months.

Many firms have installed 2 or 3 seat, air conditioned, noise refuges at the hot end which give interior noise levels 20 to 25 dB(A) lower than the exterior levels. Unfortunately full use is not generally made of these by the workers at greatest risk due to their limited, rather cramped, size and inadequate ventilation and lighting. Where space permits some rethinking of the design and role of the noise refuge seems to be necessary. The development of fully automatic control coupled with the use of close circuit TV, will enable firms to improve and extend the control room/noise refuge concept as a means of noise exposure reduction just as progressive firms in other continuous process industries have done (8).

FUTURE DEVELOPMENTS

To counter competition, an international partnership in glass research has been established with the aim of developing the means of producing strong, lightweight, low cost glass containers. The technical requirements for the consistent, high volume production of high quality containers will require closer control of machine function and of mould temperatures as well as more uniform and consistent mould lubrication. Thus the requirements of efficient production point towards a more highly automated process where human interaction with the machine is infrequent and mainly, indirect or remote, so that not only should machine noise levels be lower than they currently are but employee noise exposure should be considered reduced.

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CONCLUSION

Approximately 7½% of the workforce in this industry are likely to be exposed to noise levels in excess of 98 dB(A) Leq 8 hours and many more to noise levels which are lower but still potentially hazardous to hearing. The major sources of noise are known and practicable noise reduction measures either exist or are under development. See Table ... however, substantial reductions in noise exposure are unlikely to be achieved until all the major noise sources have been tackled.

Development work not going on in respect of plant automation; mould coating; remote container and machine inspection should, in the long term, enable the noise exposure of hot end employees to be substantially reduced and provide them with an environment which is thermally and acoustically better.

REFERENCES

(1)Engineering design to control noise around the "IS" machine, D Braithwaite, Emhart UK Ltd, Glass Technology Volume 26, Number 2, December 1985.

(2)Efficient Blow Mould Cooling, Thomas V Foster, Glass International 1983, December, page 21-22.

(3)Recent work on Measurements of Noise in the Glass Container Industry, R H Such, Glass Technology Volume 25, Number 4, August 1984.

(4)Noise problems associated with the manufacture of glass containers, Mark D Oviatt, 7th National Noise and Vibration Control Conference, Chicago, April 1979.

(5)'Noise in Milk Bottling Halls' - Diary Trades Federation.

(6)Guidance Note Number PM56 'Noise from Pneumatic Systems'. HSE.

(7)Code of Practice for Reducing the Exposure of Employer Persons to Noise - Department of Employment 1972. HMSO.

(8)Reports of HSE Specialist Inspectors (Noise).

(9)Noise in Glass Container Manufacture, A W Bednall, HM Specialist Inspector Report No. 8 1987.

The views expressed in this paper are those of the author and do not represent the views of the Health and Safety Executive or any other official body.

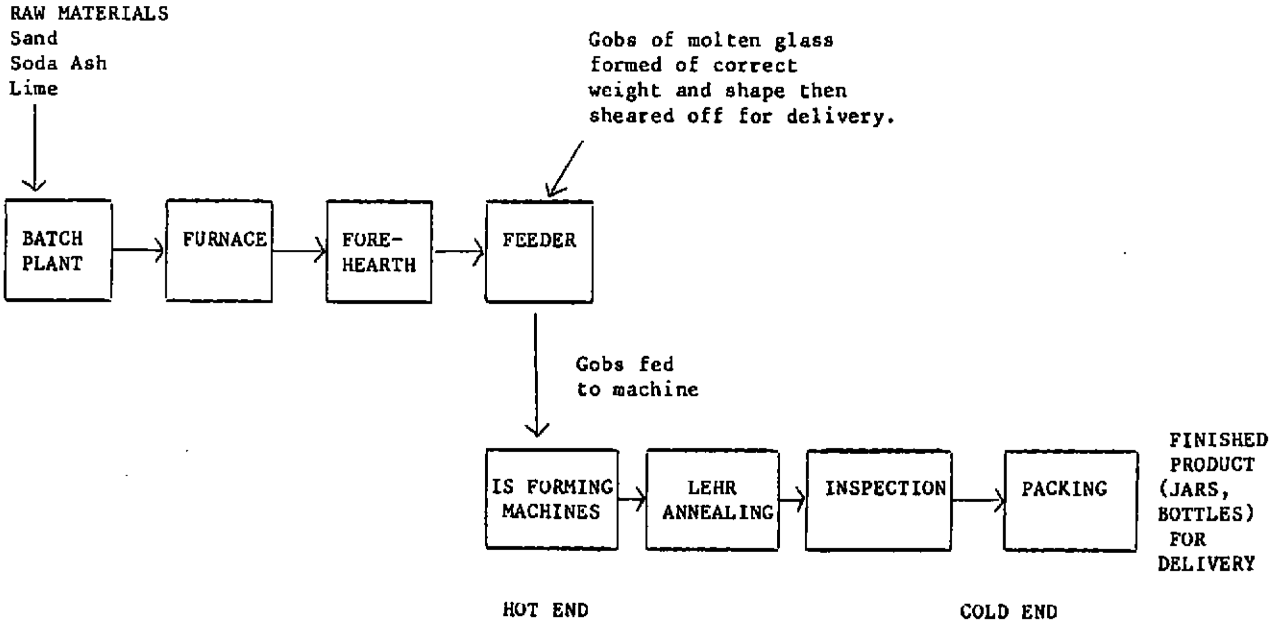
TABLE 1: NOISE LEVELS AT "IS" FORMING MACHINES

FIRM	MACHINES	PRODUCT	LOCATION	NOISE LEVELS dB(A)
A	Four IS Machines of 5 & 6 Sections	5 oz to 1.1 litre jars and bottles at 40 to 128 per min.	Around 5 and 6 Section I.S. Machines	95 to 99
B	Eleven IS Machines of 5, 8 and 10 Sections	Jars and bottles 150 gm to 2 1/4 litre at 15 to 300/min	Around 5 and 8 section I.S. machines	101 to 109 115 at closest op. position to machines
C	Three IS Machines of 6, 8 and 10	185 ml and pintie glass bottles at 80 to 2400 per/min	Around 8 and 10 Section I.S. machines	97 to 107
D	Six IS Machines 6, 8 and 10	50 cc to 1.75 l and gall containers at 12 to 207 per/min	Around 6 and 8 I.S I.S. machine	96 to 114

TABLE 2: NOISE LEVELS AT THE COLD END: PACKING AND ADJACENT AREAS

FIRM	MACHINES	PRODUCT	LOCATION	NOISE LEVELS dB(A)
A	Four IS Machines of 5 and 6 Sections	5 oz to 1.1 litre bottles at 40 to 128 per/min	Lehr Outputs Inspection and test Palletising	89 to 93 88 to 90 85 to 90
B	Eleven IS Machines of 5, 8 and 10 Sections	Jars and bottles 150 gm to 2 1/4 litre at 15 to 300 per/min	Lehr Output Gauging Machine Palletiser	86 to 90 91 95
C	Three IS Machines of 6, 8 and 10 Sections	185 ml and pintie bottles at 80 to to 240 per minute	Lehr Output Schaberger Packing machine	92 91
D	Six IS Machines of 6, 8 and 10 Sections	50 cc to 1.75 litre and gall. bottles at 12 to 207 per minute.	Lehr Output Packing Station	85 to 91 86 to 91

FIGURE 1 THE CONTINUOUS PRODUCTION OF GLASS JARS, BOTTLES AND OTHER CONTAINERS.



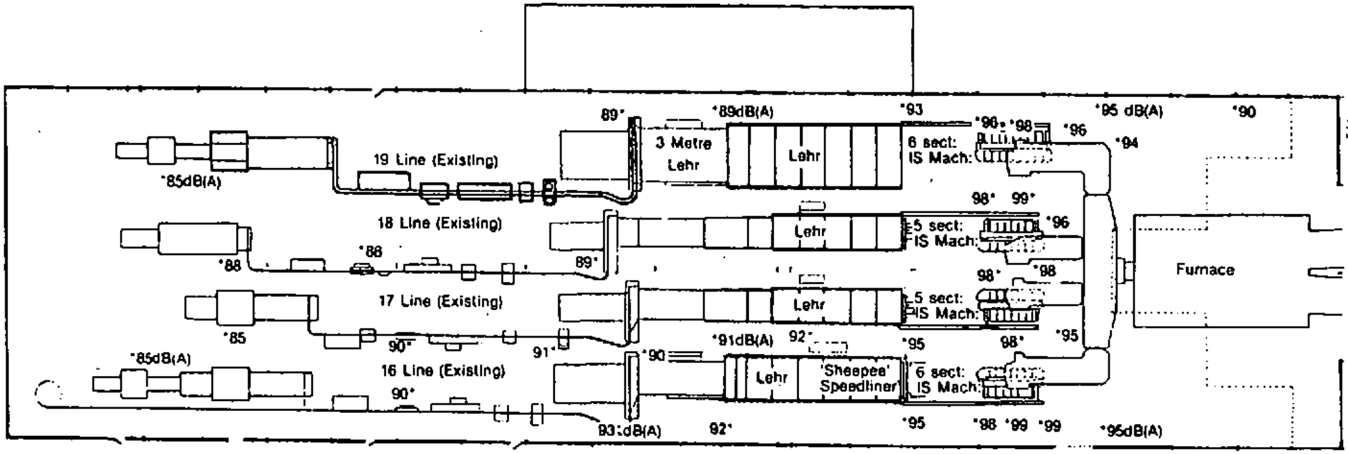


FIGURE 2 NOISE LEVELS IN GLASS CONTAINER MANUFACTURING PLANT

OPERATING CONDITIONS

Line 16	1 litre Mineral N.D.
17	1 lb Jam L/P WCTO
18	8 oz Square Sauce
19	568 ml Milk OLW

Microphone Height 1.5m

FIGURE 3

NOISE LEVELS IN GLASS CONTAINER MANUFACTURE: OVERALL ENVELOPE OF OCTAVE BAND SOUND PRESSURE LEVELS AT INDEPENDENT SECTION MACHINES IN NORMAL USE. (From Reports of H.M. Specialist Inspectors)

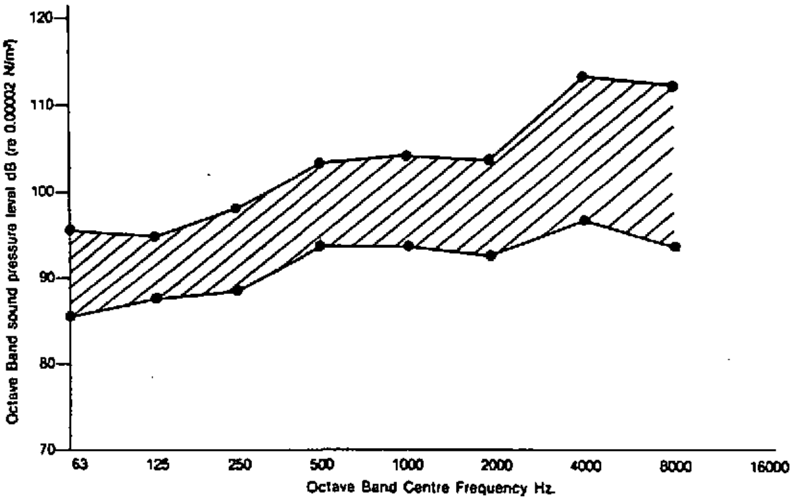
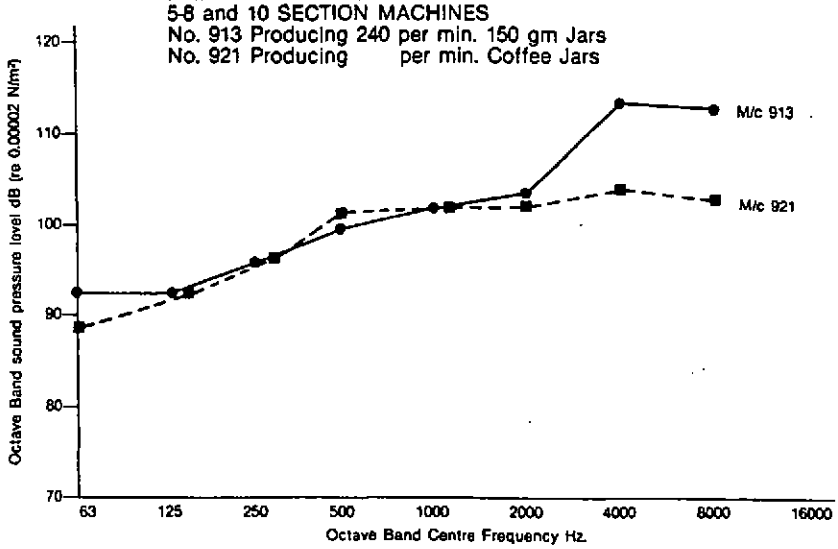


FIGURE 4 OCTAVE BAND SOUND PRESSURE LEVELS AT I.S. GLASS CONTAINER MAKING MACHINES.

5-8 and 10 SECTION MACHINES
No. 913 Producing 240 per min. 150 gm Jars
No. 921 Producing per min. Coffee Jars



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