Noise control in the wood processing industry.

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Executive summary.

This survey of noise in sawmilling and the wood processing industries was commissioned by ACC and carried out by the University of Otago with the aim of assessing noise within the industry and identifying simple solutions to reducing the noise.

In general, noise levels were in the 90-100 dB range, **very noisy**.

Although the problem might seem insoluble, simple solutions at each stage could be identified. At the source of the noise, new designs of both band and circular saws can reduce the noise by up to 6 dB (a quarter of the noise). During sawmilling operations, a significant amount of noise came from timber handling, where damping of panels and reduction of "ringing" noise by filling rollers with sand could once again reduce the levels by 3 dB (half the noise).

Enclosures were quite often provided, particularly with planers and "four siders", but periodic inspection and maintenance of these is necessary: door seals deteriorate, as does insulation around infeed and outfeed openings.

Similarly, noise refuges were noisier than they should have been because of door seals and uninsulated floors.

Lastly, Hearing Protection is not "fit and forget". Individuals require to be trained in their use, **particularly plugs** which can be very effective if fitted properly.

Introduction.

Noise exposure is a well known hazard in the wood processing industry, with one of the highest proportions of employees exposed to noise: in at least one study 50% of individuals were exposed to noise levels greater than 90 dB(A). {Tak, 2009 #46}

A main-stay of noise control is the provision of hearing protective devices, but the theoretical protection provided is often much less than that found in practice, and a large survey in Alberta sawmills showed such high noise levels that noise induced hearing loss remained a significant risk. {Koehncke, 2003 #338}

Because of the high levels of noise output of many wood working processes, noise abatement at source or during transmission might be considered unattainable goals, but simple solutions such as properly positioned barriers, machinery isolation, double-wall enclosures, acoustically treated infeed and outfeed tunnels, employee rotation, and machinery enclosures have been recognised for some time now {Fairfax, 1989 #337}

The aims of this study were therefore to identify the significant sources of noise exposure, investigate "simple" control measures and assess the prevalence of noise induced hearing loss.

Methods

All the sawmills who were part of an industry safety group in two New Zealand wood processing regions, South Canterbury and Hawkes Bay, were invited to participate. All the companies agreed to participate, total of 11 companies, including 6 carrying out milling only, 2 milling and further processing and 3 further processing only.

An employer information sheet was sent to the appropriate manager at each location, who sought volunteers and distributed study information sheets to individuals at each location. On the day of the study visit, participants carrying out jobs in each main process area were selected for personal dosimetry using Cirrhus Research doseBadge devices, a small unit worn by an individual which measures the sound levels and saves them using data logging software.

Appointments were made for those volunteering for audiometric (hearing) assessment. Audiograms were performed using Amplivox CA 850 and Interacoustics instruments using audiometric booths inside sound-proofed vehicles. A standard audiometric questionnaire was completed at this visit.

Area and operator position monitoring was carried out using a Brüel and Kjær (B&K) type 2260 precision sound level meter, with the microphone vertical, as close as possible to operators ears where appropriate. Calibration was carried out by B&K piston-phone. Each monitoring position was video-taped for later assessment.

Hazard management.

The Health and Safety in Employment Act Places obligations on employers to identify, assess and control occupational hazards in the workplace.

Noise identification.

Identification that noise is a hazard in the wood processing industry is not a particular problem, it is well recognised as such and tends to be accepted as inevitable and irreducible. It should however be assessed in the general scheme of things as part of a regular review of hazards. Processes (and personnel) change, and noise is a good example where maintenance plays a significant part in the process. Other hazards such as vibration and dust often co-exist with noise exposures, so regular reviews, or "walk through surveys" of all hazards are a necessary part of a health and safety management plan.

An adequate hazard ID requires a job process review, looking at the workers' job routine, procedures and methods. Their location in relation to and time spent in close proximity to noise sources, methods of handling materials, and use of control equipment will all affect exposure to noise and other hazards.

It should always be remembered that while management may know how a job *should* be done, the worker knows *how* it is done. They are also invariably aware of the sources of noise (and other exposures) and the tasks which involve the highest exposures.

Exact hours and patterns of work should also be determined so that the contribution of overtime and the related prolonged exposure duration can be evaluated. Work hours in the sector often extend to 12 hours.

Worker complaints should always be taken seriously. The workers involved should always be consulted and involved in the evaluation of their work environment. They should be asked about complaints or symptoms that may be attributable to significant exposure. Their advice should even be sought on how best to proceed with an investigation as they have the most intimate knowledge of their job.

The final aspect of the qualitative "identification" exercise is the type of controls applied - both collective and personal. The misuse or absence of personal protective equipment is both common and usually self evident: a well known example is the wearing of "beanies" with hearing protection applied over them. The effectiveness of engineering controls such as enclosures can be assessed by looking at the seals on doors, the state of repair of enclosures and noise from inadequately maintained equipment.

Noise assessment.

Noise assessment is a more formal process, which may involve (as in the present project) monitoring the occupational environment to characterise and assess the magnitude of noise hazards. This is the next step in making a 'diagnosis' of an 'unhealthy' work environment. It complements or confirms the information gained from the assessment made during the preliminary investigation, and provides a means of quantifying the extent of risk. The information gained provides a baseline from which to design and assess the effectiveness of control strategies.

The primary elements of the noise sampling strategy can be summarised as being those which relate to *location*, *number*, and *time* of samples.

The location of samples must be considered in terms of where samples are taken in relation to:

0

1. The individual worker.
2. The work area (including selection of which workers to sample).

There are essentially two choices of location of sampling on an individual worker, *personal* sampling in the worker's hearing zone (with a dosimeter as here), and *area* or *static* sampling in a fixed location in the work area.

As a general rule *personal sampling is the only valid method of estimating personal exposure*, and area or static sampling is the best method for obtaining information on the sources of noise emissions to direct control efforts. Also as a general rule neither method will give valid or useful information for the other purpose.

Area sampling was also carried out for this project, the focus being on the sources of noise emissions, and samples were taken at fixed locations, usually where employees were normally present.

In this survey, the sampling was usually "worst case" a subjective determination based on careful observation during the walk through survey. Some caution is required with this approach: differences in work habits of individual workers may also have a significant effect on levels of exposure experienced, even when performing essentially the same process (the noisy and quiet worker).

The obvious advantage of worst-case sampling is the degree of certainty with which group exposures can be said to be 'safe' when maximum risk employees have been shown to have exposures within recognised standards.

Lastly, a number of samples are required but there are no set rules for doing this. There may be variations within the day, form day to day and within the season. A minimum number of samples must be taken to characterise the exposure in space and in time, and to provide the level of confidence required.

The test of whether the hazard is significant or not is, in the case of noise, whether the exposure exceeds 85 db(A) the Workplace Exposure Standard (WES) for noise. For this exposure to cause hearing loss, exposure must be for 8 hours a day, 40 hours a week for a working life-time of 45 or so years.

Control of Significant hazards.

Given that a Hazard Assessment has been performed, then, for significant hazards, the following three control measures have to be considered in order:

- elimination
- isolation
- minimisation and monitoring.

Note that *it is not acceptable for Minimisation and Monitoring to be adopted as the first option.* Elimination and Isolation must be considered first.

Therefore, firstly, can the hazard be eliminated, could the task be done in some different way, for example the use of new saw technology. If the noise can't be eliminated, then the reasons why not must be stated.

If the hazard can't be eliminated, can it be isolated? Isolation means that although the hazard still exists, workers cannot come into contact with it, for example the well known solution of enclosing multi-head planers.

However, for many noisy processes, neither elimination nor isolation are possible. Consequently, the aim is to minimise and monitor exposure to the hazard.

The most common ways to minimise exposure are the wearing of Personal Protective Equipment, Hearing Protective Devices (HPDs) and occasionally job rotation when working from within cabins can be combined with a period on the chain, thus reducing the exposure for two workers instead of just one.

Any process of recognition and evaluation of potential hazards should be regarded as preparation for their control, and should never be performed for its own sake. Having made these assessments, there are three major areas where measures to eliminate or control hazards posed by harmful exposures can be implemented. The first, and most effective, control alternative is to concentrate on the *source*. Effort should then be directed toward control of the *path* of the hazard, and the last alternative is to provide protection at the *receiver*.

As mentioned above there is a well-recognised hierarchy, or order of priority, of control alternatives which can also be summarised as:

Control at the source
Elimination of the hazardous process or operation.
Substitution of a toxic material or hazardous process with less toxic or hazardous alternatives.

Control of the path
Isolation of the process or substance to eliminate or minimise exposure of workers.
Enclosure of the process to achieve isolation from employees, or to assist other means of control such as extraction ventilation.

Control at the receiver
Personal protective equipment to provide a barrier at the worker.
Training and education in methods of reducing their own exposure.

This is how noise sources were looked at in this present survey.

Glossary.

SPL	Sound Pressure Level. Measured in dB, with .00002 Pa as the reference level.
dB	"A" weighted sound Pressure level in dB: weighting takes into account frequency sensitivity of the human ear at "normal" sound levels.
dB(C)	"C" weighted sound pressure level, used for measuring impulse noise.
LAeq,8h	The 8 hour equivalent SPL ("averaged" over 8 hours).
LAeq,t	The equivalent SPL over a period t.
L peak	The peak level of the noise.
LAFmax	The maximum "instantaneous" SPL during a period.
LAFmin	The minimum "instantaneous" SPL during a period measures what the "background" noise is, i.e. a saw running without load and no timber handling.

Explanation.

There are a number of tables which represent individual noise levels measured generally at the operators position. As most sawmill operations are cyclical, 5 minutes is usually all that is required to capture what the equivalent noise will be over 8 hours. If the operation was not observed to be cyclical, longer measurement periods were used to capture a full cycle of operation.

The tables in the report give, in general, four figures: the elapsed time, the LAeq (which will be the LAeq for the elapsed time, usually around 5 minutes i.e. LAeq 5 minute); the LAFmax, which is the maximum during the period captured by a "fast" averaging in the meter and the LAFmin, which is the minimum level. In most cases the LAFmax is the noisiest thing that occurs during the 5 minutes, the LAFmin representing "no load and no handling" conditions.

In the figures, the "peak" levels of impulse ("ringing" or "explosive") noise are captured using an even shorter average than the "fast" one (milliseconds) to capture the height of the peak. Impulse noise is generally very loud, and measured in dB(C).

The graphs show the same information. With dosimetry, the noise is measured every minute, with the blue line indicating the average during that period and the impulse levels by points above. With the area monitoring, all the levels are shown. Some spectra are shown, these represent the individual frequencies making up the overall noise.

Noise sources in the wood processing industry.

In performing a hazard ID, the most logical way to ensure that all the hazards have been identified is to look at the process from raw product in to finished product out.

Sawmills.

The first step in the green chain is debarking.

Debarking noise exposure

Noise levels were 85-90 dB measured outside cabins, but operators had lower exposure, in the order of 80 dB or so. If combined with other jobs (as below) such as loading, the noise exposure was around 75 dB on the loader (with cab) but 80 dB in the cabin.

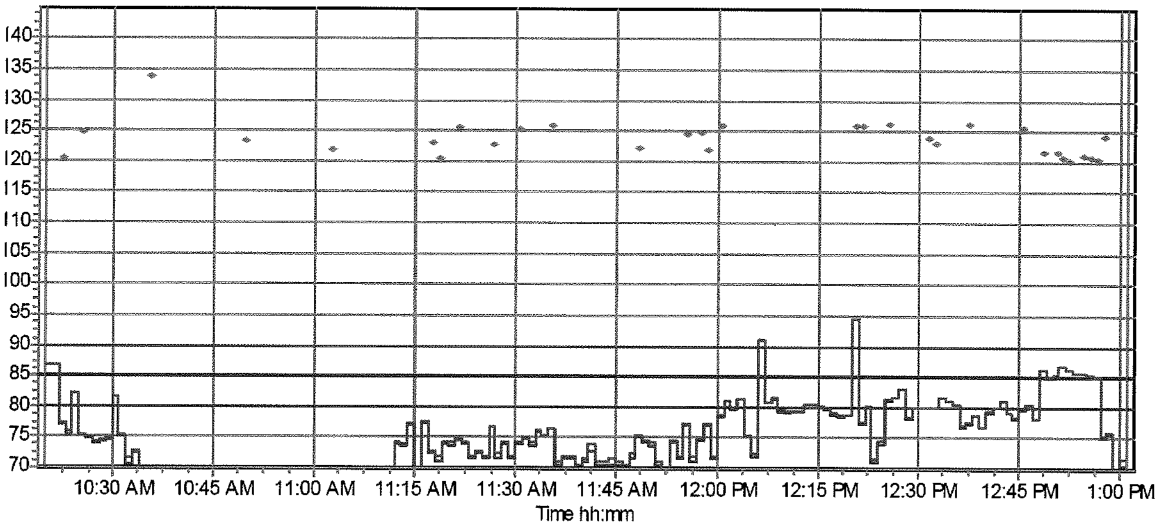


Figure 1, Debarker operator dosimetry

Source.

Noise comes from the handling chain, the debarking rotor and the associated drive and transmission systems. Logs are generally carried by chain conveyors. One or two of these were poorly designed, with inadequate diameter of sprockets, resulting in snatching of the chains. Some maintenance problems with "squealing" were also observed. Where logs were and passing through transfer points there was significant reverberation of panels, transmitted through the structure of the debarker and to noise refuge cabins. Many debarker operators also carried out loading operations, but loaders have enclosed cabs.

Path.

Debarker operators were, without exception, outdoors and provided with cabins. In some cases these were poorly maintained. Proper design an attention to door seals (and door closure) is essential. Most doors were actually left open, reducing their effectiveness. Anti vaibration mounting of cabins, and insulating the floors, can make a difference.

Receiver
None of the operators used hearing protection inside cabins, some wore them outside, but not consistently.

Headrig/resaw noise exposure.

The noise around headrig operations varies widely, from 94 dB to well over 100 dB. The 94 dB levels were idling, cutting obviously increases the noise but a major contribution comes from the timber handling chain.

Headrig

	Start time	**Elapsed** time	**Overload** [%]	**LAeq** [dB]	**LAFmax** [dB]	**LAFmin** [dB]
Value			0	99	118	94
Time	2:16:20 PM	5.00				
Date	6/4/2009					

Resaw

	Start time	**Elapsed time**	**Overload [%]**	**LAeq [dB]**	**LAFmax [dB]**	**LAFmin [dB]**
Value			0	98.1	106.5	93.6
Time	8:50:46 AM	0:05:00				
Date	6/3/2009					

Source.
The Bandsaw noise is from the machine (bearings etc) and the cutting teeth. Adequate maintenance is essential. There have been some developments in saw design

"A band saw blade having relatively extended pitch patterns of eight of more teeth exhibits relatively low noise and vibration during cutting operations, and substantially uniform tooth loading characteristics. The band saw blade defines set patterns within each pitch pattern, and each set pattern is defined by an unset leading tooth followed by a plurality of offset trailing teeth. Each tooth within each set pattern defines a pitch between the respective tooth and the preceding tooth in the cutting direction of the saw blade, and an accumulated pitch between the respective tooth and the preceding tooth of like set direction in the cutting direction of the saw blade. The ratio of pitch to accumulated pitch for each tooth within each set pattern increases from one tooth to the next in the direction opposite the cutting direction of the saw blade for substantially uniformly distributing the chip load over the teeth of the saw blade. In addition, during cutting operations, each tooth entering or exiting the workpiece defines a different pitch or forcing frequency than does every other tooth simultaneously entering or exiting the workpiece, or successively entering or exiting the workpiece, to thereby minimize noise and vibration during cutting operations

The following is from an attached UK Health and Safety executive document.

When a band re-saw is idling, vibration of the blade is usually the main source of noise. When cutting, high vibration levels in the blade caused by sawdust trapped between the pulleys and blade, and vibration of the timber being sawn are the main noise sources. How much the blade vibrates is affected by the:

- gauge of the blade;
- condition of the saw pulley surfaces;
- effectiveness of the sawdust deflection and extraction systems;
- effectiveness of the pulley and blade scrapers/cleaners;
- effectiveness of the sawblade lubrication system;
- adjustment of the saw guides; and
- blade tension.

The condition of the sawblade and the smoothness of the pulley faces have been found to affect idling noise levels by as much as 10 dB. How efficient the sawdust extraction and wheel scraping/cleaning systems are can have a similar effect. Poorly adjusted saw guides can push noise levels up by 3 dB and using an unnecessarily heavy-gauge sawblade produces a wider kerf (cut) and can also produce more noise. A new 19 gauge 100 mm blade running on 900 mm diameter pulleys has been found to produce levels 5 dB higher than a new 20 gauge blade on the same machine.

In terms of handling, if the timber strikes a hard surface such as a roller or a panel, impact noise will be produced. The effect is that impact noise raises the overall levels can be considerably increased, observed to be up to 118 dB(A). The noise from panels on the conveyor chutes could be reduced by either stiffening or absorptive materials. Rollers, which "ring" on impact, can be filled with damping material, for example sand. The bearings are robust, and because of inertia, not much more energy will be required.

Path

The solution is, as applied with debarkers, to provide an operators cabin. The effect on noise exposure can be seen in the figure: average level of 98-100dB while on the mill floor, 80 dB or so in the cabin, but with peaks while outside: on leaving noise refuges in the Mill, hearing protection should always be worn. One headrig operator in the survey was not provided with a cabin.

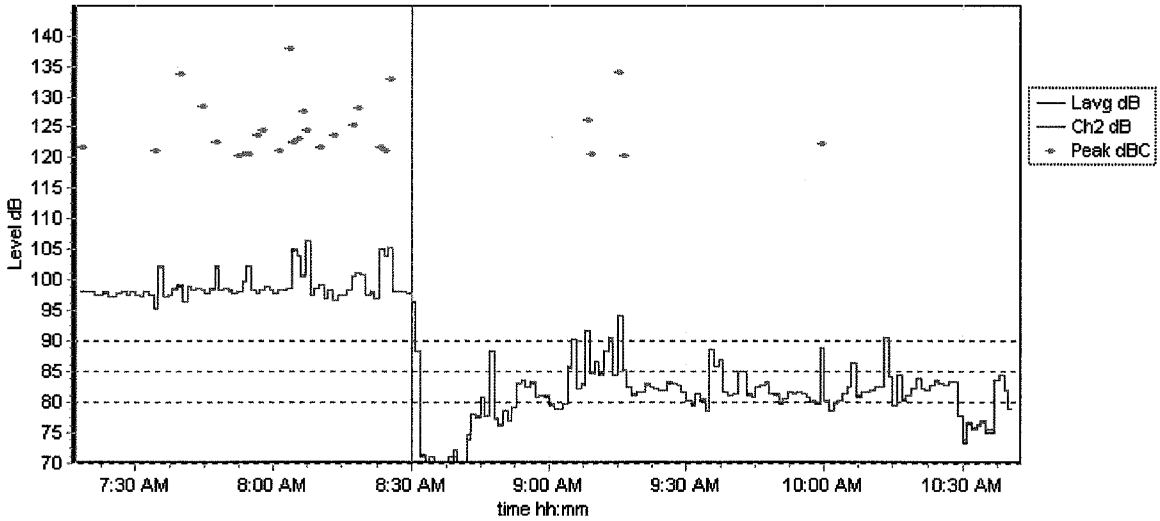


Figure 2, Headrig operator noise.

Receiver

Protection of the receiver is mainly through the use of hearing protection. If this is the control method of choice there needs to be a hearing conservation programme (qv). *If hearing loss continues to be a problem, then some aspect of the hearing conservation programme is likely to be at fault.* Not wearing the protection has obvious implications, see the section "reduction of effectiveness". Poor fitting and maintenance may also be to blame.

A significant point here is that one should not "over-protect". Although class 5 might be seen as "best" in all situations, higher classes of protection *may* be bulkier and also might increase the sense of isolation if used in lower noise levels through attenuating too much "signal" noise. The Leq's suggest that class 4 ear-muffs would be satisfactory in this area. If other personal protective equipment (PPE) is used, then **plugs may be the only option**. This includes wearing earmuffs over beanies: they will let the noise through.

Plugs, *if well fitted* can be very effective, but they are difficult to fit properly. **Each individual should therefore have their technique checked.** The plugs should be held in the ear for **one minute** to allow them to expand. Class 4 or 5 hearing protection will be effective, and there are a number of choices available in the DoL guideline.

Re-saw and edger noise exposures.

	Start time	Elapsed Time	Overload [%]	LAeq [dB]	LASmax [dB]	LASmin [dB]
Value			0	98.3	101	95.8
Time	2:02:52 p.m.	0:04:44				
Date	14/05/2009					

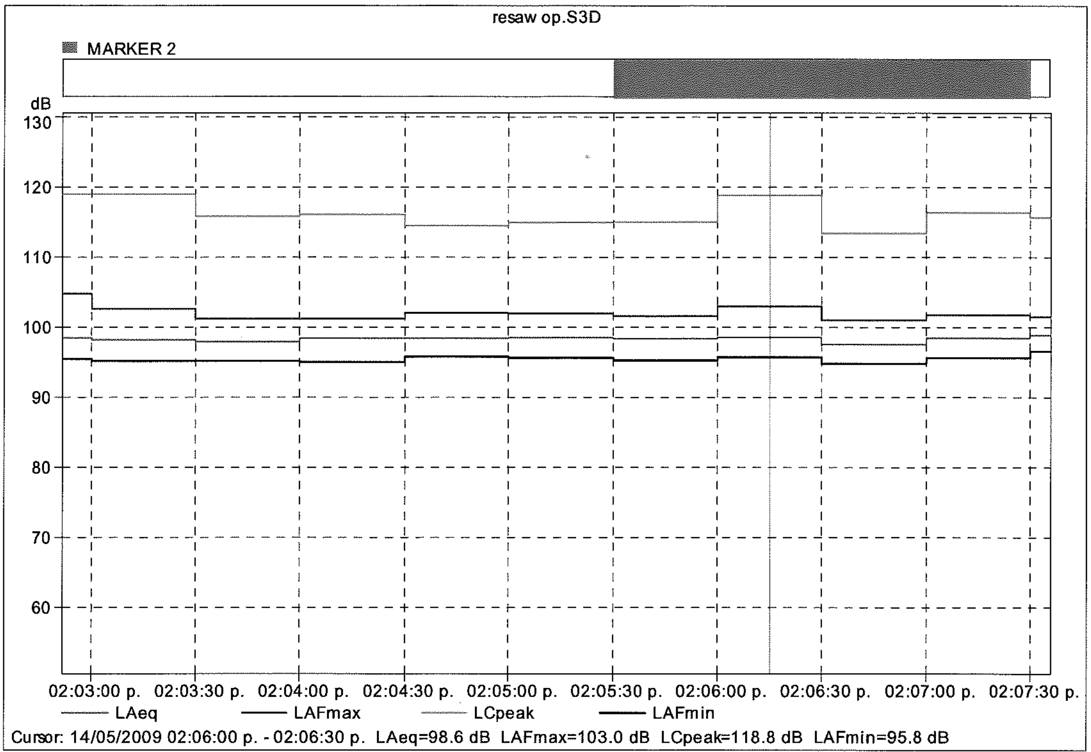


Figure 3, re-saw.

Resaw and edging operations are similar to headrig operations. Noise here is around 98 dB (blue line), but the peaks in the noise (red line) are mostly due to timber handling.

Source
While most re-saws and edgers are band saws, several circular re-saw operations were observed.

The following is from the IFA (Institut fuer Arbeitsschutz der Deutschen Gesetzlichen Unfallversicherung) web site:

http://www.dguv.de/ifa/en/pra/saegeblaetter/index.jsp

In the case of the circular saw, the blade's excitation of vibration is particularly strong because the blade is of thick steel, which has practically no damping effect. With damped, noise-reduced saw blades, it is possible to effectively reduce the excitation and hence the propagation of sound. Other factors that have an effect on the saw blade's excitation of vibration (e.g. hardness of the material or saw tooth geometry) can only be modified to a limited extent. The feed rate and saw blade projection, i.e. the distance the saw blade projects from the table, have a major effect on the sound level. It is advisable to always keep the saw blade projection as low as possible. Significant noise reductions, 6-10 dB, are thought to be possible.

There are two types of noise-reduced saw blades.

Saw blades that have a "sandwich design", i.e. consisting of two sheets of metal and a damping film in between.

Saw blades incorporating laser incisions that inhibit the generation of natural vibration and, thanks to the friction in the incisions, achieve better damping.

Either is suitable for sawmill application. An additional advantage of these saw blades is that their higher quality and the low-vibration operation result in an increased capacity and precision and hence better results. These two points compensate for the on average 30% higher cost of purchasing these products. Low-noise saw blades are thus a highly cost-effective way of reducing noise from the use of circular saws

Path and receiver.
As previously.

Handing chain noise exposure.

The noise exposure on the handling chain in all the mills were between 95-97 dB, depending on whether there are other significant noise sources such as docking saws, or on the proximity to the main mill operations. Stacker operations tended to be similar. Some examples are shown

Docking

	Start time	Elapsed time	Overload [%]	LAeq [dB]	LAFmax [dB]	LAFmin [dB]
Value			0	**94.9**	109.6	89.4
Time	2:04:26 p.m.	0:03:20				
Date	18/05/2009					

Sticking

	Start time	Elapsed time	Overload [%]	LAeq [dB]	LASmax [dB]	LASmin [dB]
Value			0	87.3	92.8	81.9
Time	1:02:17 p.m.	0:03:32				
Date	14/05/2009					

Stacker

	Start time	Elapsed time	Overload [%]	LAeq [dB]	LASmax [dB]	LASmin [dB]
Value			0	93.7	102.2	87
Time	1:32:52 p.m.	0:04:40				
Date	14/05/2009					

Sorter

	Start time	Elapsed time	Overload [%]	LAeq [dB]	LASmax [dB]	LASmin [dB]
Value			0	95.3	102.4	90.7
Time	1:42:45 p.m.	0:04:52				
Date	14/05/2009					

Sorter out-feed

	Start time	Elapsed time	Overload [%]	LAeq [dB]	LASmax [dB]	LASmin [dB]
Value			0	95.1	99.1	90.8
Time	1:51:48 p.m.	0:02:44				
Date	14/05/2009					

Source.

The sources have been briefly described. Any point at which logs or timber strikes a part of the conveyor system, such as at transfer points between conveyors, and also at "drop outs" has the capacity to produce impact noise. The amount of noise produced depends on the weight of the timber, tending to be worse at the headrig, and on the surface being struck. The length of the drop will also influence the amount of energy released.

When the object struck is a roller, there is a tendency for "ring" which may be prolonged. Striking a panel also causes this effect. The solution for rollers may be to fill them with an absorptive material such as sand. The bearings are robust enough to withstand this, and due to inertia not much more energy will be needed.

Panels can either be faced with sound absorptive material, or have stiffening or supporting members retrofitted.

Path and receiver.
Sound absorption, especially at transfer points, would provide benefits in terms of sound transmission to other areas.

Further processing operations.

The further processing operations were involved with general timber processing for the furniture and building trade and also various manufactured timber products (laminated building products, also pallets, cable drums and bins).

All of the standard wood process operations were included: conversion (band saws, docking saws etc); component making (machining operations, moulding, finger jointing) assembly (lamination) and final finishing and packing.

Conversion operations.

Band saws
Band Saws used in further processing conversion are on a scale of magnitude smaller than those in the mills. They do tend to be slightly less noisy at the operators position, but not much more so. Average levels are still in the order of 95 dB, with quieter minimum, around 90 dB.

Source
The same criteria apply to reduction of noise at source from conversion saws.

Path.
In further processing, the work area tends to be open plan, as this facilitates the work flow. As a result, noisy items of machinery plant and equipment tend to affect bystanders, those working “quieter” machines nearby, for example. Sound barriers will absorb some of this noise and can reduce reverberation, thus lowering the noise by up to 3 dB, which is half the sound energy.

Receiver
As previously

Docking saws
Source
Docking saws are circular saws with guards. Care must be taken with these, which because of the enclosures become, in effect, miniature sirens. This can be seen in the figure below where there are peaks in the noise spectrum at 2 and 3 kHz, audible as a high pitched whine- a bit like an irish pom. Re-design of the enclosure will reduce this noise signature, which is audible right through the production area.

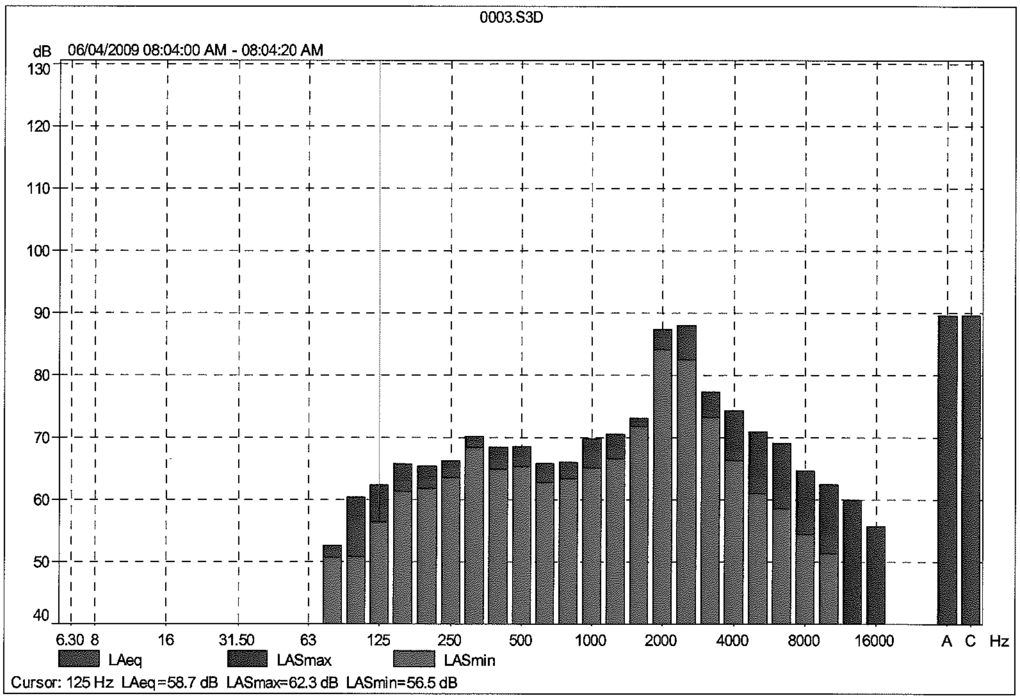


Figure 4, Noise spectrum, docking saw.

Path.
As in all areas from which high noise levels originate, it helps if the sound can be contained or absorbed by baffles or barriers. This will stop sound transmission.

Component making.

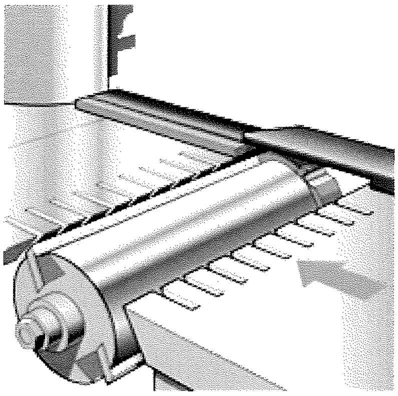
Source
The noise from multi-head machines comes from a number of sources:

1. Idling noise generated aerodynamically by the rotating cutter heads.
2. Cutting noise generated by the impact of the knives on the timber.
3. Noise created by the transmission of vibration along the timber length.
4. Poorly designed and sited chip extraction systems.

The following is from the UK Health and Safety Executive web site:

http://www.hse.gov.uk/noise/goodpractice/planingmoulding.htm

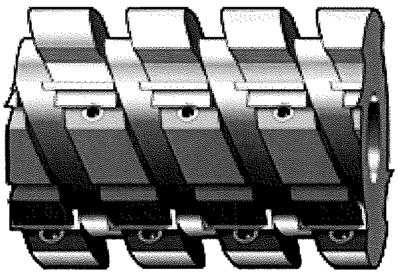
[extracted from L108 "Controlling noise at work" p 57]



Slotted table lips on a planer reduce air turbulence and noise.

When any rotating part such as a fan blade or a woodworking cutter block passes close to a stationary part of the machine, noise is produced. If the distance between the rotating part and the stationary part is increased, the noise level will be reduced. Also if cutter blocks are fitted which have helical blades, the smooth transition of the curved cutting edge next to the stationary table instead of the abrupt impact of a normal blade will reduce the noise considerably.

CAUTION: Gaps between stationary and rotating parts of machinery are dangerous. You should not alter gaps without ensuring that the machinery can be used without risks to safety.



Reduced-noise cutter block.

When air flows past an object or over sharp edges, turbulence is caused which produces noise. Also when air flows over cavities or voids a noise tone can be produced (similar to blowing over a milk bottle). Making edges as smooth as possible and removing voids or rounding the edges can reduce the level of noise created. Similarly, air flowing smoothly through ducts and pipes will produce less noise.

Methods of noise reduction at source

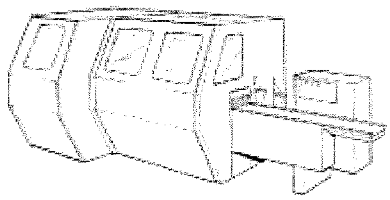


Figure 1: Integral enclosure – close fitting round feed area with controls outside and overlapping strips across opening.

Planing and straightening heads often produce most of the idling noise. This can be reduced by up to 10 dB by using smoother profile blocks with low blade projection. Slotted or perforated table lips can reduce idling noise levels by more than 5 dB at the bottom first head (straightening cutter).

Helically bladed cutter blocks can significantly reduce cutting noise when planing. However, this type of cutter is not readily available for moulding machines. Segmented blocks (which are more widely available) can reduce in-feed noise levels by 5 dB if used at the bottom first head.

Reductions in cutting noise can also be made by reducing the cutter's rotational speed, and increasing the number of knives on the cutter – without detriment to the finish.

Correct design of chip extraction systems can reduce idling noise levels significantly, where the system is not part of a noise enclosure.

Design of high speed drive motors should embody up-to-date noise reduction techniques.

Path.
Interruption of the path can be achieved by enclosure: The attached DoL guide gives guidance on this. The points outlined should be addressed if possible, although this is likely to cause some access problems in feeding and outfeeding.

In two instances, a four sider was not provided with an acoustic enclosure at all because of access requirements and the need for manual feeding of smaller off cuts of timber and was by far the noisiest single item of machinery on site. Some form of acoustic barrier (or isolation) would provide benefit in terms of sound transmission to the rest of the plant.

If an enclosure is provided, maintenance is still important, for example the seals around doors. These should obviously be kept closed for maximum effect (which was not always the case).

Receiver
As previously

Assembly

Laminating

	Start Time	Elapsed time	Overload [%]	LAeq [dB]	LASmax [dB]	LASmin [dB]
Value			0	94	105.2	72.5
Time	11:02:50 a.m.	0:10:00				
Date	20/05/2009					

An average noise of 94 dB(A). The major sources are "donging" down the laminates with a wooden sledge or donger and the rattle gun used to compress the laminates during the cure. The peak noise levels can reach 133 dB(C).

Source.
The noise of the impact wrench comes from the turbine vanes on the air motor, the impact of the hammer on the anvil when it strikes and the exhaust air noise. Not all wrenches produce the same noise, and it pays to "buy quiet" where possible. Some wrenches have the air exhaust in the handle, which helps.

The impact noise from donging down will be difficult to deal with at source.

Drum, pallet and crate manufacture.

Drum making

	Start time	Elapsed time	Overload [%]	LAeq [dB]	LASmax [dB]	LASmin [dB]
Value			0.01	95.9	106.2	78.3
Time	11:24:04 a.m.	0:04:59				
Date	14/05/2009					

A noise level of 96 dB(A), with a maximum of 106 dB(A). The noise is from the nail guns, a combination of mechanical impact noise (piston assembly and front bumper) and jet exhaust from the compressed air. The diagram below shows a recording of the noise profile: the blue line is the average noise level, the green the maximum level and the red the "peak" or impulse noise.

The impulse noise reaches 134 dB(C), which is not in excess of the 140 dB L_{peak} DoL criterion.

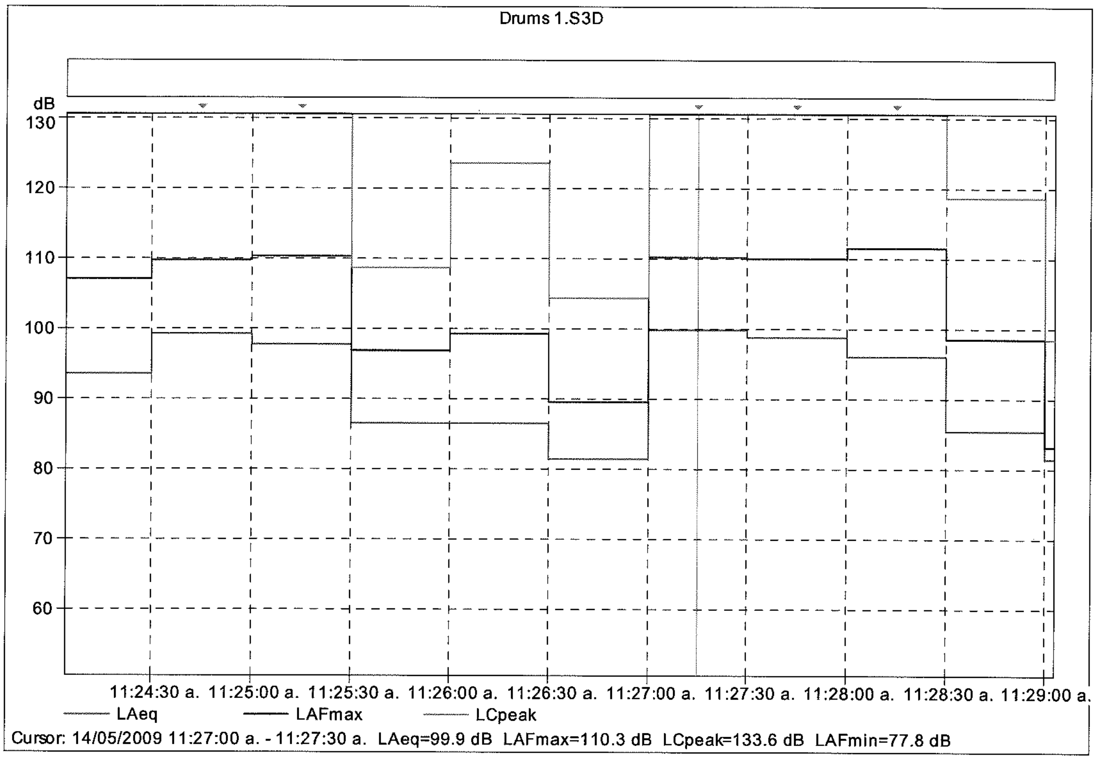


Figure5, noise from nail guns.

Source

The two major sources of noise are the impact of the piston assembly with the front bumper and the compressed air exhaust. An attached PDF shows how the noise can be reduced by fitting a muffler and fitting an additional, more resilient, bumper. These should be design features of nail guns, and it helps to "buy quiet). Not all nail guns have the same sound output.

Path.

As in all areas from which high noise levels originate, it helps if the sound can be contained or absorbed by baffles or barriers. This will stop sound transmission.

Receiver

As previously.

Pallets

	Start time	Elapsed time	Overload [%]	LAeq [dB]	LASmax [dB]	LASmin [dB]
Value			0	98.7	101.4	93.2
Time	11:51:18 a.m.	0:02:42				
Date	14/05/2009					

The noise here is higher at 99 dB(A) during the period measured. This is due to the higher cycle rate of the nail gun during pallet manufacture. The same comments apply.

Hearing protection programmes.

We advise that the recommendations and procedures stated in AS/NZS1269.3: 1998 "*Hearing Protector Program*" are followed carefully.
It is very important that an individual knows how to fit muffs, and even more important that they know how to fit plugs. Plugs should be inserted fully into the ear, and kept pressed in until they have expanded, approximately 30 seconds. If not so fitted, a degradation of one class or more may result. The EAR superfit 30 has an orange band which should be *just* visible if inserted properly.
It is most important that hearing protectors are regularly inspected and maintained. Hearing protectors need to be regularly inspected for damage or deterioration.
Hearing protectors selected from the list of recognised protectors that have been modified in any way can no longer be considered as tested and graded or classified, unless the testing laboratory has tested those modifications.
Adequate provision should be made for clean storage of protectors when not in use. Facilities should be readily available for the cleaning of reusable protectors. Hearing protectors should be cleaned and disinfected according to the manufacturer's instructions.
For devices in daily use it is recommended that earmuff cushions and foam inserts be replaced after 6 months and that the earmuffs be replaced after 1 year. Reusable earplugs should be replaced at least every 3 months.
It should be appreciated that these times are very approximate and highly dependent upon the care in use of the protector. Replacement may be necessary much earlier than indicated above.
Manufacturers and suppliers of hearing protectors must ensure that all purchasers are provided with information that will enable the protectors to be used in a safe and proper manner.
The following information must be provided in or on the package in which the protector is supplied:

- The method of adjusting and fitting the protector
- Instructions for cleaning and disinfecting the protector, if appropriate
- Maintenance requirements, if appropriate
- List of spare parts available for replacing worn or damaged components
- Mass of the protector (Earmuffs)
- Clamping force (Earmuffs & Ear Canal Caps)
- Notes warning about the effects of wear and tear and the effects of other items impairing seals
- Details of the mean, standard deviation and mean-minus-standard deviation attenuations. (these must be displayed so that they can be viewed without opening the package)
- A label showing the *Class* of the hearing protector

Information provided by a manufacturer or supplier of hearing protectors must be consistent with the hierarchy of the control of noise as required by the Act.

All the above should from part of safety training. A good time to check the condition and fit of protectors is at annual audiometric testing.

REDUCTION IN EFFECTIVENESS OF HEARING PROTECTORS

The removal of hearing protectors for even short periods of time can dramatically reduce their effectiveness and lead to under-protection for the wearer (see figure 1 below).

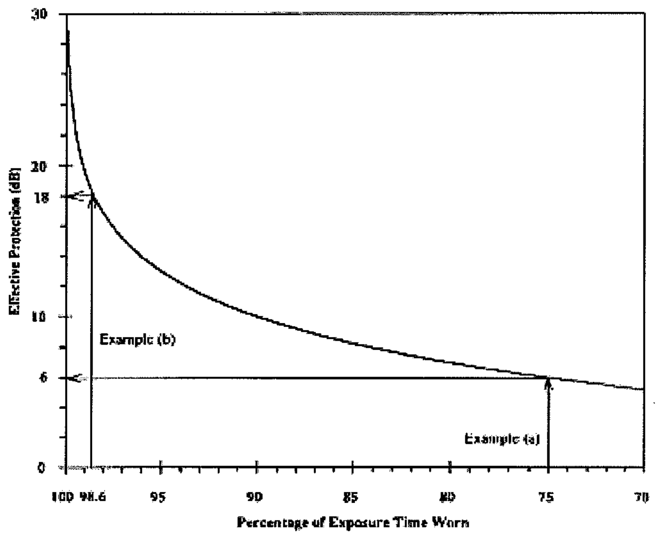


Figure 1: Reduction in the effective protection provided by a high-grade hearing protector with decreased wearing time in a given noise environment

Due to the difficulties of wearing hearing protectors for long periods of time in some environments, it is important that regular brief rest periods in quiet areas be provided, to maximise the proper use of protection when actually needed.

Over a working day, periods of a few minutes unprotected exposure are easy to accumulate, for example by placement and removal of the protectors while in the noisy area rather than before entering and after leaving it; or by removing hearing protectors briefly for purposes of comfort, communication or any other reason.

Examples:

(a) If not worn for 15 minutes during a total exposure time of 1 hour (worn 75% of the time), the effective protection provided by a high performance (30dB) hearing protector is only 6dB. This means that worn in this way, the high performance protector effectively gives the same protection as a low performance (6dbB) protector worn all the time (for the full hour of exposure).

(b) If not worn for 5 minutes during a total exposure time of 6 hours (worn 98.6% of the time), the effective protection provided by a 30dB hearing protector is only 18dB; making the effective protective value 12dB less than expected.

Health monitoring.

If minimisation is the control method of choice, then **both the environment and the health of individuals must be monitored.** All the areas tested should have periodic review of the noise levels, and, for **all** the jobs tested in this survey, **annual audiometric testing should be undertaken.**

The annual audiometric test is a good time to review the use of hearing protection, their condition and fit.

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