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NOISE AND VIBRATION SIGNATURE ANALYSIS IN PRESS NOISE REDUCTION

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Over the past four years the study of press noise has advanced considerably. This paper reviews some of the work in which ISVR has been involved, much of it in a Department of Industry sponsored project in collaboration with the Machine Tool Industry Research Association.

The simplest measure of press noise, for evaluating hearing damage risk, is the A weighted L_{eq} which is currently deemed to quantify the magnitude of the risk. From a sample of several thousand observations, the logarithmic average of individual operator L_{eq}'s (the industry L_{eq}) in the UK is 98.5 dB(A) and this adequately confirms that there is a real problem. In the context of some 70,000 presses installed the problem is not only acute but also widespread, The trouble with such L_{eq} measurements is that whilst they quantify the problem they do little to tell us which way the solution lies. Much more subtle forms of measurement must be applied if the reduction of press noise is to be achieved effectively and to the satisfaction of the press users.

Much can be found out if a microphone signal, suitably weighted, is displayed on an oscilloscope in parallel with a marker indicating the position of the press in its stroke. In such cases analysis is then performed by using the ear and the brain which, with some experience, will provide much more early information than a Fourier transform from a black box. However, it is desired to reduce, normally the A weighted L_{eq} and it is most useful to see how this function ie. $\int P_A^2\,dt$, builds up through the cycle.

Examination of an oscilloscope and use of ears are not very good at this - the subjective loudness of short duration sounds has long been a topic of interest and diverse opinions. The use of a digitised version of the noise signature to enable the integral to be compared with different phases of the press vibration was presented in 1977 (1) and has proved a valuable analytical tool.

Comparison of vibration signatures with noise signatures almost invariably shows a much more rapid decay of vibration than sound pressure. This implies that either we have spent 3 years putting our accelerometers in unrealistic places or that reverberation in the average press shop is responsible for, typically, 30%-50% of the noise dose of the machine operator even when he is quite close to the machine. The existence of a reverberant field is obviously of some significance. Work by MTIRA (2) suggested a broad band A weighted absorption coefficient of around 0.2 for factory spaces but since press noise is low frequency dominated a lower effective value would be expected. Changes to factory acoustics might be worth 2-3 dB(A) but at a price of at least £10 per square metre of plant area this is expensive noise control, and it is not enough in a 98.5 dB(A) environment.

However, the comparison of the vibration signatures with the noise signature and the press operating cycle does allow much better diagnosis of which part of the machine operation is responsible for how much noise, and whether it is a working part of the cycle, or a parasitic phenomenon which can be modified without incurring the wrath of the press tool designer (no less an exponent of black magic than the noise control engineer and jealously guarding his speciality).

Though of course some press noise comes from the actual metalworking, a surprising amount does not, as our survey has shown (3,4). In many instances spring loaded elements, strippers or draw rings, are used to control the movement of metal within the tools and their forces are applied impulsively. However, there is no requirement for the rapid application of these forces and if they are controlled properly, much noise reduction is possible.

The old problem of mechanical clutch noise is reducing because new machines are much more frequently fitted with friction clutches which are intrinsically quieter. It is arguable whether there should be research into paliatives for the old machines.

Air noise, from clutch/brake actuation cylinders and component blow outs is significant in many press shops, and of course appears on no vibration signatures.

The ultimate in matching noise and vibration signatures uses the technique of carpet plots of noise and vibration energy split in both time and frequency domains. Figure 1 shows a time history for a small press and the noise carpet plots before and after modification. This presentation is both useful for diagnosis and to explain the problem to the press user. The example here is of a small press whose noise output is controlled by stripper and die cushion impacts, which have been substantially reduced without prejudicing production. A reduction of 4.5 dB(A) L_{eq} here was quite adequate and the cost per machine of about £15 compares very favourably with machine enclosure or room treatments.

Amongst the most insidious noise amplifiers is wear in the press mechanism and the allied factor of poor lubrication. The reduction of noise when a press was rebuilt has already been demonstrated at 6-10 dB(A) (5). In this case it was demonstrated (6) that the rebuilt press effectively behaved as a linear structure, and thus the working forces (in simple piercing operations) and the resulting noise output were virtually coherent. In a recent project the possible use of coherence measurements as an indicator of clearance, for field tests, has been examined (7).

The hypothesis was that even in the presence of clearance the acceleration on the slide would remain almost coherent with the punch force but the vibration of the frame and consequent noise would not. If so simple field measurements of noise and slide acceleration on a two channel tape recorder could be analysed to indicate whether rebuilding the machine would result in large noise reductions.

Clearances were produced in the press by shimming out the bearings at both ends of the connecting rod but the split line on the main bearings was in the wrong plane and these could not be made loose. The results as indicated in Figure 2 show a definite reduction in the fraction of the noise coherent with the slide acceleration but these did not match up very well with the changes in noise.

Further investigation is needed and ideally a second set of over size main bearing shells should be tested. There is some cause for thinking that the technique can be used, but it is certainly not yet in a state of development suitable for field use.

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FIGURE 2

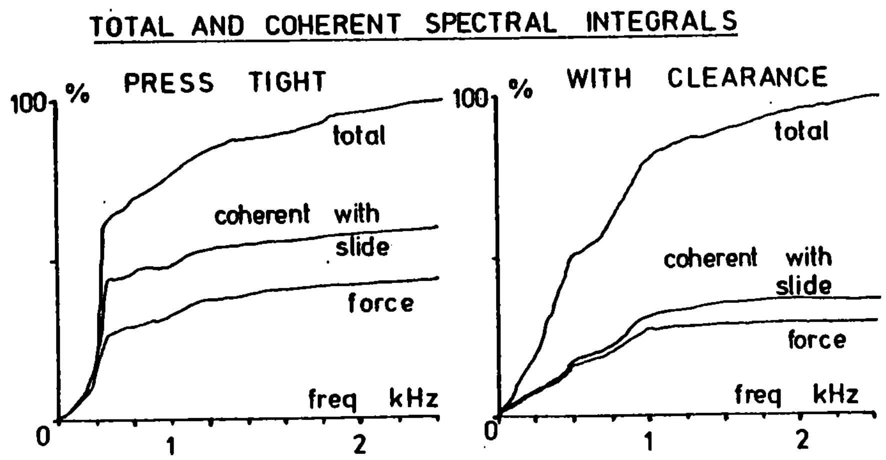

FIGURE 1

TIME HISTORIES AND CARPET PLOTS OF PRESS NOISE

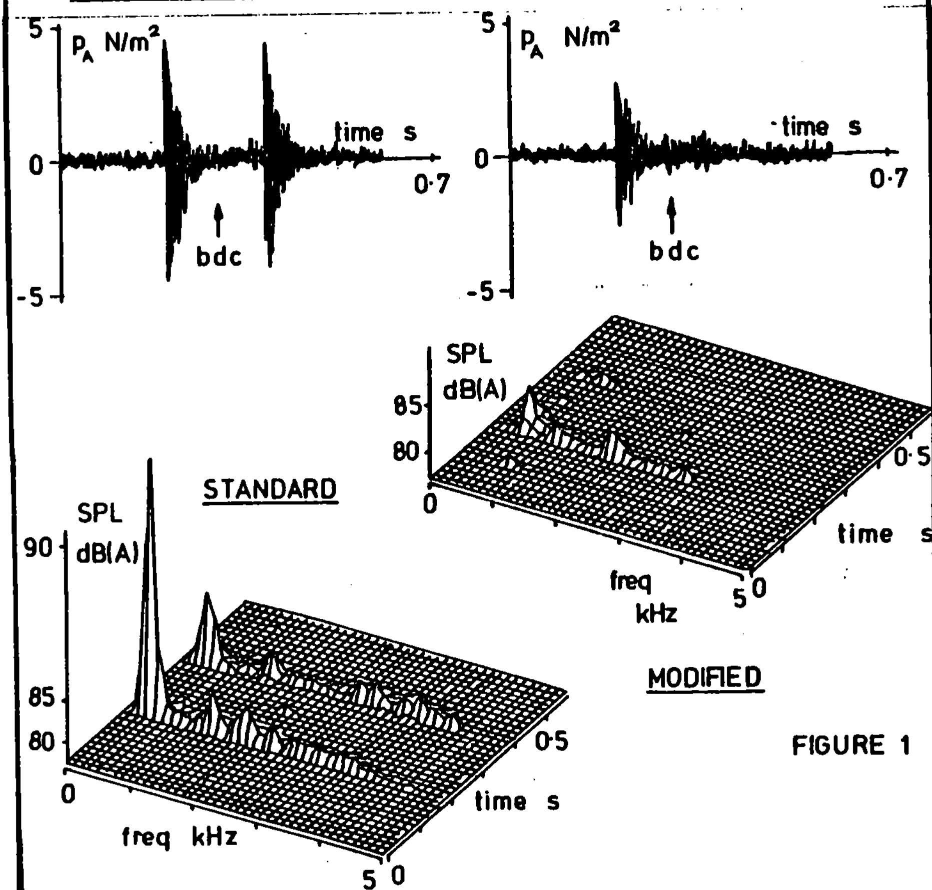

FIGURE 1