useful when there is only a limited time to collect the data, or the particular type of analyses desired cannot be decided at the time. It is very convenient to "sample" the noise with the tape recorder and then "analyze" it in the laboratory with a graphic recorder.

To be useful, the tape recorder has to be portable; it probably should operate from the 115 volt lines. Its power requirements should be low enough so that a converter operating on a storage battery will operate it. This makes it possible to operate it from an automobile or in other locations remote from power lines. This becomes particularly important in neighborhood annoyance problems.

Fidelity of recording, however, cannot be sacrificed for portability. High fidelity in the audible range is obviously of extreme importance. Moreover, the instrument must be so arranged, or modified, that it is capable of reproducing the level of the original noise. You must be able to calibrate it—and maintain the calibration. This is frequently done by replacing the continuous attenuators with step attenuators.

When recordings are made, it is desirable to play a known noise onto the tape for a reference. This can be done with a microphone calibrator. It has been said that in many cases higher precision noise measurements can be made by first recording on tape and then making the analyses in the laboratory, where time and interference is unimportant.

Our objective in any noise investigation is a survey of the area or the analysis of an industrial noise source.

*The measurement of noise is an art.* We have a lot of electronic instruments to aid us, but the results we get depends to a large extent on how we use the instruments.

*The development of a technic of measurements is very important—it is the art of noise measurement.*

*Microphone in Use on Cable:* The location of the microphone is surely the most important single factor. In survey work and measurements made to determine personal exposure, the best location is at the operator's ear level. However, when measurements are made the operator should be out of the way to prevent the shielding of the microphone.

The exact location of the microphone is important when machines are being analyzed, and when measurements are made close to the source of the noise. A small change in the location may give a measurable difference in level. The location becomes particularly important when changes are to be made and you want to determine what reduction has been achieved.

*Hood:* The calibration or sensitivity of the instruments change and measurements should *never* be made without checking the calibration of the instruments used. There is available a small hood, containing a loud speaker and attached oscillator with which the calibration can be checked in the field.

The db level of the noise, as indicated by the meter on the sound level meter or analyzer, is not simple to read. More often than not, the pointer is in constant, random motion, often over a range of several db. Very few industrial noises are constant in level. It is common to see the readings vary three, five, or even 10 db.

When this happens, the best reading is often difficult to decide upon. One rule commonly used is to record the reading as three db below the peak indicated by the meter if the variation is over six db. This peak reading depends to a considerable extent on whether the meter response is in the slow or fast position.

### Records

I believe the most important thing I have to say concerns the keeping of records. All too often records of measurements made some time ago are not clear because it is not known where the microphone was, how close it was, what was going on, how many machines were running, and so forth.

The type of work being done varies, and this to a large extent determines the details desired on the record form.

On the back of the form should be a place for a sketch—and this is most important. Below this, you should have space for a number of analyses. The locations should be indicated on the sketch by letter or description. There should also be a note as to the particular operation going on when the analysis was made.

In survey work, a blue print of the floor plan is very useful to spot the location of the readings taken.



The presentation of the results of the measurements is the *meat* of the investigation. The results are not much good if they are not seen, or, as more frequently happens, are not understood by the people who see them. It is important that they be presented so their significance can be readily appreciated. To me this means a report with a concise summary and clear, simple sketches and charts.

For example—the results of a general survey might be presented with figures showing the level in db throughout the area, so that the locations of high level are easily noted.

Or you might draw contours, like weather maps, to indicate the variation in noise level. You can then tell, for instance, when noise from a machine is bounding off a wall, and thus raising the general noise level in a whole area.

Frequently you will have some kind of band analysis taken of some of the noise when a general survey is made. This can be indicated by letters on the plan, and the curve of the noise can be included in the report on separate sheets.

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# Methods of Reducing Noise

By J. C. RADCLIFFE
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I would like to be able to say that you can find in one textbook the methods of reducing noise. I know of no such textbook. There have been numerous articles written in many scientific journals regarding specific noise control jobs. They usually follow certain prescribed avenues of control. But each one, even though following a certain avenue, must be tailor-made for the specific noise source.

If your company is planning a new building or manufacturing site, you are fortunate in the opportunity presented. Many dollars can be saved by building-in noise control features. The laying out of work processes, the location of noisy machines and the segregation of as many workers as possible from noisy areas will do much to minimize your future problems. (The article by Bonvallet & Karplus, in the December, 1953, *AIHA Quarterly*, gives general bands of noise levels to be expected in different types of industries, and specifically those being produced by different types of machines and processes.)

Operations involving *impacts* will be noisy, especially on large metal plates. Balancing noise reduction against costs of changes in work-processing must depend on particular applications. The following list of changes is given as a few obvious examples of alternate processes which cause noise reduction, without regard to economic factors. This is a guide for the engineer:

1. Welding instead of riveting.
2. Compression riveting instead of common pneumatic riveting.
3. Pressing or rolling instead of forging.
4. Grinding instead of chipping castings and welded joints.
5. Electrically-operated tools instead of unquieted pneumatic tools.
6. Selection of less noisy types of conveyors.
7. Avoidance of dropping hard materials during handling.
8. Mechanical stripping of work from dies instead of air blast stripping.
9. Low speed process machinery instead of high speed machinery.
10. Substitution of materials; for example, fabrication of plastics is usually less noisy than sheet metal fabrication.
11. Wide spacing banks or rows of noisy machines instead of close spacing.
12. Hot working of metals instead of cold working.
13. Belt drives instead of noisy gears.
14. Substitution of less noisy materials used in friction processes, as in brakes and clutches.