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A PRIMER OF NOISE MEASUREMENT

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GENERAL RADIO COMPANY WEST CONCORD, MASSACHUSETTS, USA

INTRODUCTION

This booklet is for you, if you want to know something about noise measurement but lack the time, inclination, or background to read a text on acoustics. The few minutes you spend touring the following pages will give you an understanding of what a sound-level meter is and why and how it is used. Although the *Primer* is written around a specific sound-level meter, General Radio's compact, inexpensive Type 1565-A, most of the material included applies to the use of any sound-level meter meeting current American and International Standards.

If the *Primer* whets your appetite for acoustics, the literature listed on the inside back cover will provide you with a well-balanced diet.

One man's noise is another man's music.

NOISE

Almost every move we make produces noise. Moreover, as we invent machines to move for us, the situation gets worse, machines usually being even noisier than people. And, of course, as we and our machines multiply, noise multiplies. You can almost hear the population explosion.

But what man imposes, man disposes. He pollutes the air and water, then invents filters to remove the pollutants. He makes noise, but works to achieve freedom from noise.

Unfortunately for those who like simple problems and simple solutions, one man's noise is another man's music. So we must have instruments to give us cold, objective indications of sound level, just as we have speedometers to measure speed and sphygmomanometers to measure blood pressure and spelling ability. To measure the intensity of noise, we use an instrument called a sound-level meter.

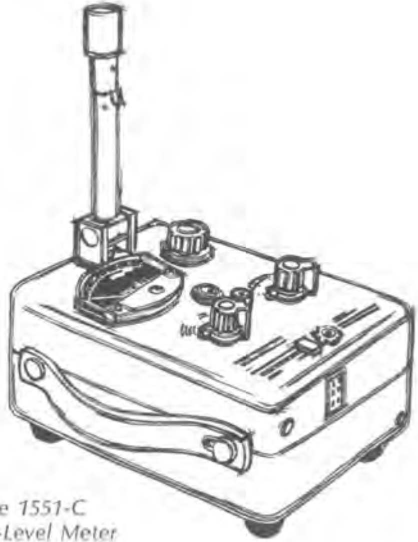
Type 1565-A Sound-Level Meter

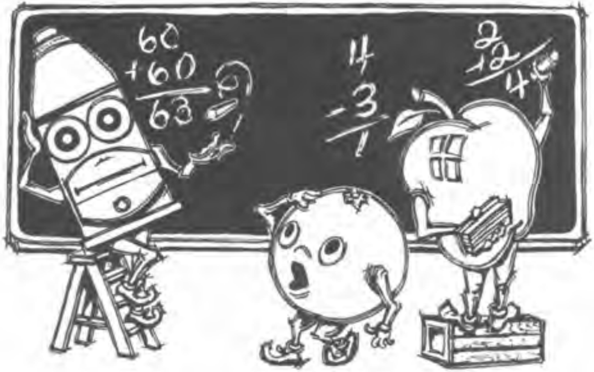
THE SOUND-LEVEL METER

The sound-level meter is the basic instrument of noise measurement. It contains a microphone to detect the sound being measured and convert it into an electrical signal, an amplifier to boost that signal to a level that can activate a meter, and a meter to indicate the sound-pressure level. It also contains weighting networks, which are used to tell something about the frequency, or pitch, of the noise.

The GR Type 1565-A Sound-Level Meter, shown at the left, is a sound-level meter in its simplest and least expensive form. It is small enough to be held and operated in one hand. It runs on a small flashlight battery. It is shaped to reduce the effect of sound reflections from the case. Most important is the fact that, despite its small size, it is a true sound-level meter, which means that it does everything that the American and International Standards say a general-purpose sound-level meter should do.

The 1565-A is a first-rate sound-level meter, more than adequate for routine noise measurements, but it is not the last word in such instrumentation. The Type 1551-C, shown at the right, is better equipped to operate with accessories (recorders, analyzers, special-purpose microphones, etc), has a wider sound-level range, a built-in calibration system, and other features that may or may not be worth the extra two hundred dollars or so, depending upon your present *and anticipated* needs.


Type 1551-C Sound-Level Meter



Decibels do not add and subtract the way apples or oranges do.

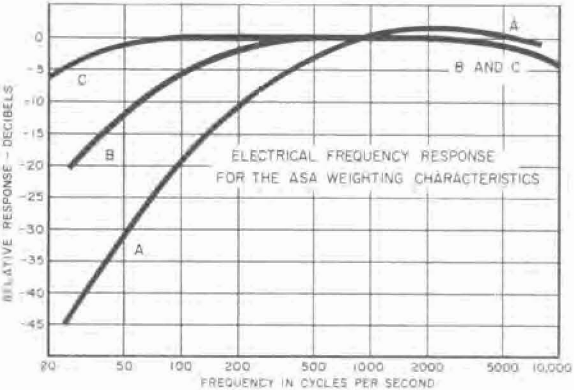
THE DECIBEL

Sound is basically just a rapid variation in atmospheric pressure, and a sound-level meter is an instrument that measures sound pressure. The range of sound pressures we can hear is enormous. If we were to talk about sound level in terms of units of pressure (bars, millibars, microbars, etc), we would find ourselves using an astronomical range of numbers. So we squeeze the whole range of audible sound pressures into a scale based on logarithms and ratios, and we wind up with some numbers we can cope with. We also come up with the decibel (dB), a unit that is arbitrary and artificial, but as convenient as a TV dinner. Using decibels instead of absolute pressure units, we cover the sound pressure levels of all the sounds we are ever likely to hear on a scale of 0 to about 140. If, instead, we insisted on using real units of pressure to cover the same range, we would have to operate on a scale of 10,000-000 to 1!

A couple of things ought to be made clear about the decibel, right off the bat. First, because of its logarithmic heritage, it doesn't add and subtract the way apples or oranges do. If you take a 60-decibel noise and add another 60-decibel noise to it, you get a 63-decibel noise. If you're strictly an apple-and-orange mathematician, you may take this on faith.

Second, because the decibel describes a ratio, you must always assume some reference value when using the unit. The reference pressure usually understood is 0.0002 microbar.

The exact relationship between decibels and sound pressure, if you really must know, is this: The sound pressure level in decibels is 20 times the logarithm of the ratio of the root-mean-square sound pressure in microbars to 0.0002.



Curves showing how the A, B, and C weighting networks discriminate against sounds at different frequencies.

ABOUT THESE WEIGHTING NETWORKS

Because our reasons for measuring noise usually involve people, we are ultimately more interested in the human reaction to sound than in sound as a physical phenomenon. Sound-pressure level, for instance, can't be taken at face value as an indication of loudness, because the frequency (or pitch) of a sound has quite a bit to do with how loud it sounds. For this and other reasons it often helps to know something about the frequency of the noise you're measuring. This is where weighting networks come in. They are the sound-level meter's means of responding more to some frequencies than to others, with a prejudice something like that of the human ear. The writers of the acoustical standards have established three weighting characteristics, imaginatively designated A, B, and C. The chief difference among them is that very low frequencies are discriminated against quite severely by the A network, moderately by the B network, and hardly at all by the C network. Therefore, if the measured sound-level of a noise is much higher on C weighting than on A weighting, much of the noise is probably of low frequency. If you really want to know the frequency distribution of a noise (and most serious noise measurers do), you use a sound analyzer. But if you're unable to justify the expense of an analyzer, you can still find out something about the frequency of a noise by shrewd use of the weighting networks of a sound-level meter.

Although certain weighting networks are recommended for specific kinds of measurements (for instance, the A network for auto and truck noise measurements), it's always a good idea to measure the noise on all three networks and to record the data. (The scientific approach to sound measurement, as with any measurement, is to write down all conditions of measurement — weighting networks, date, time, equipment serial numbers, description of background noise, etc. Proper record-keeping will inevitably lead to an awesome data book, which makes a splendid appearance and which may well prove helpful.)

HOW TO USE THE SOUND-LEVEL METER

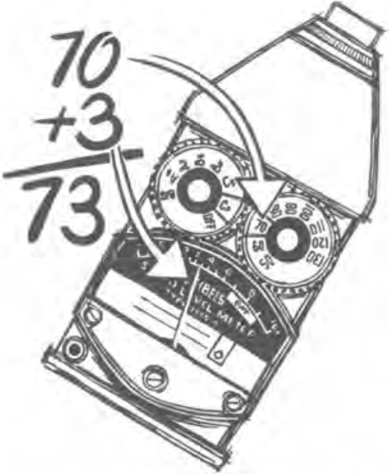
Point the microphone in a direction perpendicular to the noise path, keeping your body out of the path.

Most sound-level meters are pretty easy to operate, but GR's 1565-A is child's play. There are just two controls. One (the one on the left) we'll call the weighting control, the other, the level control.

To make a measurement, you simply point the microphone in a direction roughly perpendicular to the direction the noise is coming from (keeping yourself out of the way of the noise path), turn the weighting control to A, B, or C, turn the level control until the meter reads on scale, and read the measured sound pressure level in decibels directly from the sum of level control setting and meter reading. For instance, if the level control is set at 70 and the meter reads +3, the sound pressure level is 73 decibels.

For each of the three weighting networks, there are two positions of the weighting control, one for fast meter response and one for slow. Set for fast response, the meter needle will try to follow level changes as they happen, and it may appear to have St. Vitus' dance when you're trying to take a reading. Then you can switch over to the slow response to make the meter movement less jittery and more readable.

The sound-level meter runs on battery power, and it makes sense to check the battery each time you use the instrument, especially since it's so easy to do. You just switch the weighting control to the position marked BAT, and see that the meter needle moves to the area on the scale marked BAT. If it doesn't, you replace the battery.



To read sound pressure level, just add the numbers indicated on the meter and the level control.

TAKING CARE OF THE SOUND-LEVEL METER

The sound-level meter doesn't require any pampering. Just give it a good battery, don't drop it, and there's no reason why it shouldn't give you years and years of service. There are no tubes to wear out, the instrument being entirely transistorized.

You might like to reassure yourself every now and then that the sound-level meter is telling you the truth. One way to do this is to bring it to any General Radio office; an engineer there will be glad to calibrate it free of charge. If you'd rather do it yourself, we'll be happy to sell you the necessary calibrator. It's another $200 or so, but if you have enough sound-level meters you want to keep accurately calibrated, you can figure the cost per calibration in pennies.

The simplest way to check your sound-level meter is to make a measurement, when you first receive the instrument, of some sound that is not likely to change much from day to day and then to repeat the measurement periodically to see if you get roughly the same answer.

WHAT TO DO WITH THE SOUND-LEVEL METER

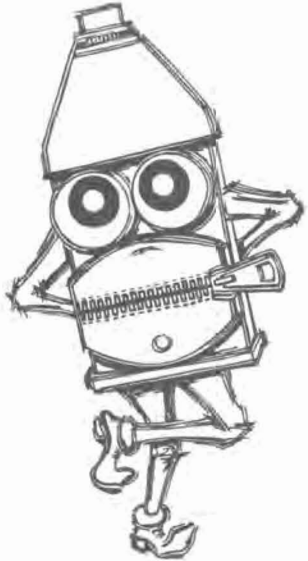
All right, so you have a new sound-level meter. You've already shown it off around the neighborhood, you've measured the levels of your children's voices, your dog's bark, the washing machine, TV commercials, and the traffic in front of your house. Now you're ready for some serious work back at the plant.

Of course, chances are that you already know what jobs you have in mind for the sound-level meter, or else you wouldn't have bought it in the first place. But you may know only that there's a noise problem that you want to eliminate, that the first step is to take measurements, and you're not really sure what comes next.

Your reason for wanting to eliminate noise probably falls in one of the following four categories:

(1) The noise is interfering with speech.
(2) The noise is a hazard to hearing.
(3) The noise is just plain annoying.
(4) The noise creates sales resistance to a product.

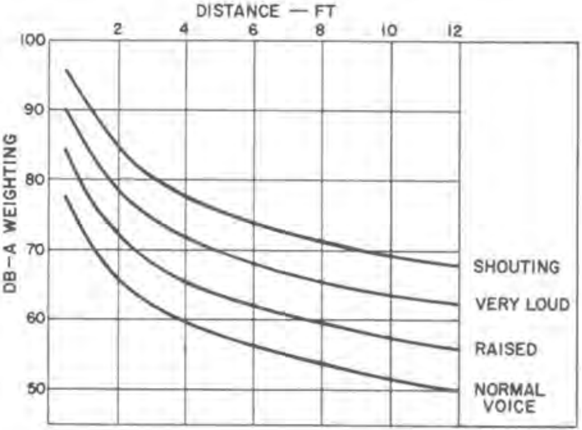
There are other good reasons, such as enforcement of municipal noise codes, investigation of building sites by architects, trouble-shooting of machinery, etc, but these are basically related to the four reasons given above. The tactics for detecting and reducing speech interference, hearing damage, and annoyance cover most of the techniques associated with the sound-level meter.



SPEECH INTERFERENCE

Noise that interferes with speech is not only annoying, but downright menacing if it interferes with spoken or shouted warnings. Because sounds that have about the same frequencies as speech are the worst offenders, the A weighting network gives the best indication of the speech interference or "masking" ability of a sound. Using the A weighting network and the curves at the right, you can easily tell how much noise you can put up with. For instance, suppose you want to talk in a normal voice and be fully understood 12 feet away. The curve labeled NORMAL VOICE crosses the 12-foot vertical line at 50 on the horizontal scale. That means that a noise level of over 50 dB on the A weighting scale will probably interfere with your conversation. If you're willing to shout, you can put up with 68 dB and still be heard at 12 feet. If the A-weighted noise level is 90 dB, you can see from the curves that your shouts wouldn't have much of a chance even two feet away. (The curves assume that you face the listener, that what you say is not familiar to him, and that there are no reflecting surfaces nearby.)

Telephone conversation will be difficult if the A-weighted sound level is above 70 dB and impossible above 85 dB. Maximum levels have been recommended for private offices (40 to 50 dB), small conference rooms (less than 40 dB), secretarial offices (60 to 65 dB), drafting rooms (55 to 65 dB), school rooms (less than 40 dB), and many other locations.



Curves showing how noise interferes with spoken or shouted conversation.

HEARING DAMAGE

Your hearing ability goes downhill once you pass 20. This normal, gradual slide, called presbycusis, shows up as a loss of sensitivity, especially at higher frequencies. Other possible causes of hearing loss are disease, accident, and exposure to excessive noise.

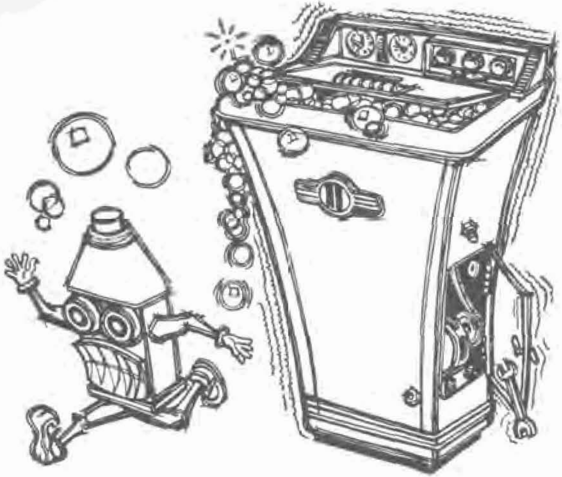
Susceptibility to hearing damage from noise varies widely among individuals, and it is impossible to state categorically that "so many dB causes hearing loss." Reaction also depends on the kind of noise and on how long one is exposed to it. A sound level of over 85 dB on the A weighting network justifies further analysis of the noise. An A-network reading of over 95 dB should be considered unsafe for daily exposure over a period of months and warrants noise-reduction methods or ear protection. If you're concerned with noise-induced hearing loss, we recommend writing for the latest information on the subject from the Research Center, Subcommittee on Noise of the Committee on Conservation of Hearing, American Academy of Ophthalmology and Otolaryngology, 3819 Maple Avenue, Dallas, Texas 75219.

ANNOYANCE

A noise doesn't have to interfere with conversation or be a health hazard to be annoying. The sound of a dripping faucet or of chalk squeaking against a blackboard or of the neighbor's son practicing on his clarinet can be thoroughly annoying, even if it looks innocent enough on a sound-level meter. The sound-level meter, after all, can give only an indication of level. It is absolutely incapable of being annoyed.

On the other hand, annoyance can be related to sound level. Almost any annoying noise is more annoying if it gets louder. Therefore a reasonable approach to the problem of annoyance is to try to reduce the sound level of the noise.

The sound-level meter is absolutely incapable of being annoyed.



PRODUCT NOISE

Manufacturers know that a housewife doesn't take kindly to a washing machine whose noise drowns out her telephone conversations or to a vacuum cleaner that sounds as if it belonged on a pad at Cape Kennedy. Noise reduction has thus become an important part of the design not only of household appliances but of many consumer products, from outboard motors to the automobiles in which an audible clock is a status symbol.

Appliance makers have in many cases established their own noise codes, specifying maximum levels on various weighting networks. Noise measurements made in the course of product development often involve frequency analysis to trace annoying components to their sources.

OTHER USES FOR THE SOUND-LEVEL METER

Architects, engineers, and acoustical consultants use sound-level meters in the planning of buildings, studios, schoolrooms, and other structures where proper acoustical design is important. Teachers use sound level meters to demonstrate principles of elementary physics. Singers use them to evaluate their projection. Law-enforcement officers use them to monitor traffic noise on the highway. Engineers use them in their efforts to produce quieter appliances, airports, engines, and a quieter life for us all.

AFTER YOU'VE MEASURED THE NOISE

You have been told, correctly, that measurement is the first step in the solution of a noise problem, and you have made your measurements. The noise, meanwhile, continues, apparently unintimidated by your bulging data book. But your day is near; you have the facts you need to act intelligently.

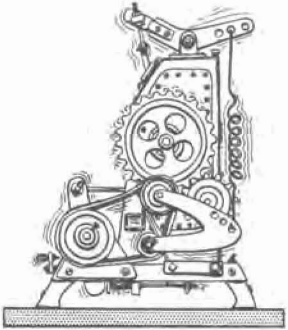
An effective noise-reduction program requires careful planning. The man who finds a noise level too high and immediately says, "We'll just slap some acoustical tile here and here; that ought to take care of it," will probably be disappointed at the results. Not that acoustical tile isn't a good way to reduce noise — it often is. But this approach is like shooting a person full of penicillin at the first sign of a cold. The more prudent course is to analyze the noise (either roughly with the sound-level meter, as discussed on page 24, or in detail with a sound analyzer), decide from this analysis what to do about it, and check results by further analysis. This procedure ensures that you're reducing the noise at the frequencies you're most concerned with — usually, those frequencies that are about the same as speech frequencies.

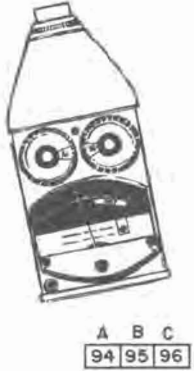
WHERE TO STRIKE

To reduce noise you can attack it either at its source or somewhere along its path to the listener. It's usually a good idea first to consider modifying the noise source by adding some extra lubricant, mounting the source differently, or perhaps even by changing the entire process. Look for ways to reduce vibration. You can usually reduce noise by one of the following approaches:

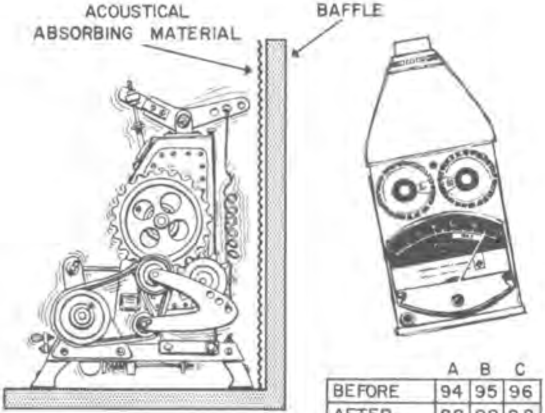
(1) by reducing the energy that causes the vibration,

(2) by changing the coupling between the





A noisy machine, with most of the sound energy at higher frequencies.



	A	B	C
BEFORE	94	95	96
AFTER	89	90	92
REDUCTION	5	5	4

The baffle and absorbing material reduce noise noticeably, but the level is still high.

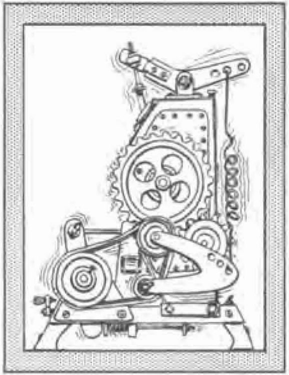
energy and the object that actually radiates the sound,

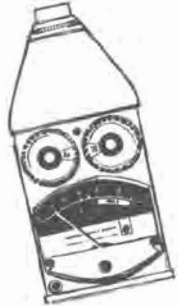
(3) by modifying the radiating object.

Changing the path of the noise may be as simple as moving the noise source and the listener farther apart, or turning the noise source around. Sound-absorbing material can help if it is placed near the source and if the listener is some distance away from the source. (Absorbing material is of little use to a listener who is just a few feet away from the noise source.)

If the noise is chiefly of high frequency, a a barrier somewhere along the path should help. Total enclosure of the noise source is even better. A complete, impervious enclosure is, in fact, one of the best ways of reducing noise level. Note that an enclosure of acoustical tile is not impervious; sound can leak through. Massive, leakproof walls, perhaps with acoustical treatment on the insides, constitute the best all-around protection.

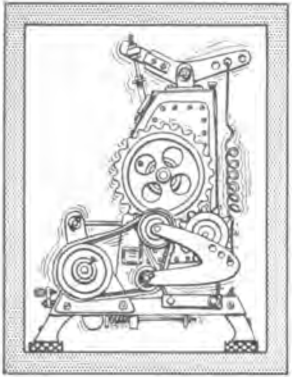
Another way of reducing noise along its path is to equip the listeners with ear plugs, cotton, or earmuffs. There are some obvious drawbacks — the interference with speech communication, for one — but such accouterments can be quite effective.





	A	B	C
BEFORE	94	95	96
AFTER	70	78	86
REDUCTION	24	17	10

The rigid sealed enclosure brings about a really worthwhile reduction at all frequencies.



	A	B	C
BEFORE	94	95	96
AFTER	64	72	78
REDUCTION	30	23	18

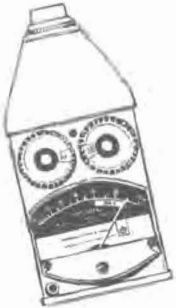
Use of vibration mounts introduces further reduction, especially at lower frequencies.

ANALYZING NOISE

The frequency characteristics of a noise, as mentioned earlier, have a lot to do with how loud it sounds and with the proper corrective measures. You can tell something about frequency with the sound-level meter alone. In the drawings shown, the original machine noise was measured as 94, 95, and 96 dB on the A, B, and C weighting networks, respectively. The closeness of the three readings to one another indicates that most of the sound energy is at higher frequencies, where the responses of the three networks are about equal. If the A-weighted reading had been much lower than the others, that would have been an indication that much of the sound energy was low-frequency and thus discriminated against by the A weighting network.

A sound-level meter, however, is no substitute for an analyzer when you really want to know the frequency distribution of a noise. There are many kinds of analyzers. Some "tune in" the noise in octave frequency bands (an octave is a 2-to-1 range of frequencies, like 707 to 1414 cycles per second), others cover one-third or one-tenth octaves, and still others have bandwidths measured in cycles rather than ratios. Some analyzers are specially designed to measure impact noise, some for vibration measurements. Some require a sound-level meter, some have it built in.

If your problems point to analysis, you'd probably be better off with a Type 1551 Sound-Level Meter. The Type 1551 has greater sensitivity and frequency range than the lower-cost 1565, and is otherwise better suited for labora-



	A	B	C
BEFORE	94	95	96
AFTER	59	68	75
REDUCTION	35	27	21

Acoustical absorbing material used inside the enclosure brings the noise level way down.

	A	B	C
BEFORE	94	95	96
AFTER	46	57	66
REDUCTION	48	38	30

Double sealed enclosures, with vibration mounts and absorbing linings, change former loud noise to a whisper.

tory work.

Here are capsule descriptions of the analyzers available from General Radio:

The 1564-A Sound and Vibration Analyzer has 1/3, 1/10 octave bandwidths, works directly from a microphone.

Type 1558-BP Octave-Band Noise Analyzer measures sound level in 10 octave bands, also works directly from a microphone.

Type 1556-B Impact-Noise Analyzer is designed specifically to measure the unique characteristics of impact noise, works from the output of either GR sound-level meter.

Type 1900-A Wave Analyzer measures level in 3, 10, or 50 cycle bandwidths, works from output of the 1551 sound-level meter. It is relatively expensive, but is so versatile that its features have features.

SOUND ADVICE

It is possible that a noise problem will defy your best efforts; some problems are like that. A reasonable course then is to look up an acoustical expert. Someone who has studied noise problems for many years can often find a more economical solution than would occur to a beginner. If you are forced to call in a consultant, the time spent reading this booklet and others on noise will help you understand what he's doing and make better use of his services.

A tip on where to find sound advice: The offices listed on the back cover are all staffed by engineers knowledgeable in sound and vibration measurement. They will advise you on a free, no-strings basis on any *instrumentation* problem, and, if they can't solve it for you, they will at least point you in the right direction.

UPLIFTING CONCLUSION

With so much sound-measuring equipment and counsel available, there is no longer any need to suffer the annoyance and hazards of excessive noise. By acquiring a sound-level meter, you will take the first step on that golden stairway to that promised land where

Like beacons on a sea of silence
Life's silver sounds invade the air:
The wind plays tunes upon the trees,
The stream sighs and from the mountain flees,
The rain's beat, the phoebe's call —
Ears were made for sounds like these.

INSTRUMENT SPECIFICATIONS

TYPE 1565-A SOUND-LEVEL METER

Sound-Level Range: 40 to 140 dB (re 0.0002 μbar).

Weighting: A, B, C weighting in accordance with American Standard ASA S1.4-1961 and IEC Publication 123, 1961.

Microphone: Lead-zirconate-titanate ceramic unit.

Output: At least 1.5 V behind 20 k Ω at meter full scale, for driving recorder, headphones, or impact-noise analyzer.

Meter: Rms response and fast and slow speeds, per ASA and IEC specifications.

Calibration: Can be pressure-calibrated at 400 c/s with a Type 1562-A Calibrator.

Operating Temperature Range: 0 to 50°C.

Operating Humidity Range: 0 to 90% R.H.

Temperature Coefficient of Sensitivity: Approx +0.03 dB/°C.

Power: One C battery. Battery life approx 35 hours for 2 h/day service.

Size: 3-1/16 by 7-3/8 by 2-1/8 in. **Weight:** 1-3/4 lb.

Price: (in USA) $365.00. Leather carrying case, $15.00.

TYPE 1561-A SOUND-LEVEL METER

Sound-Level Range (rms, dB re 20 $\mu N/m^2$): 31 to 150 dB.

Frequency Characteristics: A, B, and C weighting in accordance with USA Standard S1.4-1961, IEC Publication 123, 1961 and IEC Publication 179, 1965 for precision sound-level meters. Also provided is a flat response from 20 c/s to 20 kc/s to permit measurement of sound-pressure level. Jacks are provided for insertion of an external filter.

Microphones: The GR 1560-P7 Precision Microphone is supplied with portable models, with a 10-ft. cable to permit microphone to be located away from instrument.

Output (full-scale meter reading): 1.25 V behind 5500Ω; harmonic distortion <0.5%.

Meter: Rms response; fast and slow meter speeds in accordance with above USASI and IEC standards.

Calibration: Absolute calibration of the 1561 is set acoustically at 500 c/s and a level of 114 dB re 20 $\mu N/m^2$. Panel adjustment provided for standardizing gain with internal calibration circuit.

Operating Temperature Range: 10 to 50°C.

Operating Humidity Range: 0 to 90% R.H.

Power Supply: Portable model is supplied with either 3 Burgess type PM6 dry-cell batteries or 2 sets of rechargeable nickel-cadmium batteries and battery charger. Rack model contains ac power supply.

Size: (Portable) 10¾ by 6⅛ by 5¾ in. **Weight:** 5½ lbs.

Price (in USA): Portable model — with dry-cell batteries, $795; with 2 sets rechargeable batteries and recharger: $920.

TYPE 1562-A SOUND-LEVEL CALIBRATOR

Acoustic Output Frequencies: 125, 250, 500, 1000, 2000 c/s, ±3%. Sound Pressure Level: 114 dB (re 0.0002 μbar).

Accuracy: (WE640AA microphone or equivalent): ±0.3 dB at 500 c/s, ±0.5 dB at other frequencies.
Other microphones: ±0.5 dB at 500 c/s, ± 0.7 dB at other frequencies.

Electrical Output: 1.0 V ±20% behind 6000Ω.

Frequency Characteristic: Output is flat ±2%.

Distortion: Less than 0.5%.

Operating Environment: 0 to 50°C, 0 to 100% relative humidity.

Accessories Supplied: Carrying case, adaptors for 15/16-in. and 5/8-in. diameter microphones. (Fits 1-1/8-in. microphones without adaptor.) Battery included.

Dimensions: Length, 5 in. (130 mm); diameter 2-1/4 in. (55 mm).

Net Weight: 1 lb. (0.5 kg).

Price: (in USA) $265.00.

TYPE 1551-C SOUND-LEVEL METER

Sound-Level Range: 24 to 150 dB (re 0.0002 μbar).

Weighting: A, B, C weighting in accordance with American Standard ASA S1.4-1961 and IEC Publication 123, 1961. A fourth position provides flat response from 20 c/s to 20 kc/s, for use with very wide-band microphones.

Microphone: Highly stable ceramic type.

Output: 1.4 V behind 7 kΩ at meter full scale, for driving analyzers, recorders, oscilloscopes, and headphones.

Meter: Rms response and fast and slow speeds, per ASA and IEC specifications.

Calibration: Built-in calibration circuit standardizes sensitivity of electrical circuits within $\pm$ 1 dB at 400 c/s, as specified in ASA standards. Type 1562-A Calibrator can be used to check over-all calibration, including microphone.

Operating Temperature Range: 0 to 50°C.

Operating Humidity Range: 0 to 90% R.H.

Power Supply: Two D batteries and one $67^1/_2$-V battery are supplied. An ac supply is available.

Size: 7-1/4 by 9-1/4 by 6-1/8 in. **Weight:** 7-3/4 lb.

Price: (in USA) $645.00. Leather carrying case, $35.00.

OTHER SOUND AND VIBRATION INSTRUMENTS FROM GENERAL RADIO

ANALYZERS

- Type 1921 Real-Time Analyzer
- Type 1900-A Wave Analyzer
- Type 1564-A Sound and Vibration Analyzer
- Type 1558 Octave-Band Noise Analyzers
- Type 1556-B Impact-Noise Analyzer
- Type 1568-A Wave Analyzer

ANALYZER-RECORDER SYSTEMS

- Type 1910-A Recording Wave Analyzer
- Type 1911-A Recording Sound and Vibration Analyzer

MICROPHONES

- Type 1560-P5, -P6 Ceramic Microphones
- Type 1551-P1 Condenser Microphone Systems

CALIBRATORS

- Type 1565-Z Audiometer Calibration Set
- Type 1559-B Microphone Reciprocity Calibrator

VIBRATION-MEASURING EQUIPMENT

- Type 1553 Vibration Meters
- Type 1560-P11B, -P13, -P14 Vibration Pickup Systems
- Type 1557-A Vibration Calibrator

PREAMPLIFIERS

- Type 1560-P40 Preamplifiers

EARPHONE COUPLERS

- Type 1560-P81 Earphone Coupler
- Type 1560-P82 Earphone Coupler
- Type 1560-P83 Earphone Coupler

OTHER SOUND AND VIBRATION LITERATURE

For a more in-depth study of noise and acoustics, the following booklets are available from General Radio.

Primer of Plant-Noise Measurements — a booklet similar in style to this one but one which gives specific instructions on how to conduct plant-noise studies, particularly with regards to the requirements of the Walsh-Healey Act. No charge.

Simplified Pure-Tone Audiometer Calibration with Sound-Measuring Instruments (IN114) — an eight-page article that stresses the importance of checking audiometer calibration and how to do it with sound-measuring instruments. No charge.

Handbook of Noise Measurements — an advanced, comprehensive textbook that deals with the characteristics, effects, measurement, and control of sound and vibration. Price: $2.00.

Acoustics Bulletin — complete descriptions and specifications of GR's acoustical meters, analyzers, and recorders. No charge.

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