frequencies, for then the total power in the noise would be infinite. White noise, therefore, means that the spectrum is flat over the range of interest, for example, throughout the audio-frequency range. Because of its flat spectrum, white noise is particularly convenient as a starting point for many experiments.

3.4.4 Importance of Knowing the Spectrum.

In most experiments involving random noise, knowledge of the spectrum of the noise being used is vitally necessary. When noise is used as a driving-point signal to determine the response of some system, the response is meaningful only when the input spectrum is known, and is usually most conveniently studied when the input spectrum is flat. There are, of course, cases where other spectra are more convenient. If, in such cases, a filter can be constructed whose response has the shape of the desired spectrum, white noise is the proper input for that filter to produce the desired spectrum at its output.

3.4.5 Noise-Spectra Measurements.

The spectrum of a noise can be measured with any wave analyzer whose frequency range is appropriate. For the output indication to be free of fluctuations that might cause reading errors, the product of analysis bandwidth and the averaging time must be large. As in the measurement of the amplitude distribution, the spectrum can only be measured accurately by averaging over a relatively long time interval.

Wave analyzers generally indicate the voltage in the analysis passband. The indication is therefore proportional to w(f), not W(f). It is convenient to reduce all measurements to a common bandwidth basis, and the most-often-used bandwidth is one cycle. Units for W(f) are "volts squared per cycle bandwidth," and considerable use has been made of the unit "volts per root-cycle" for w(f). Now that "cycles" have become "hertz," this term is even more cumbersome, and is perhaps best replaced by "volts in a 1-hertz band."

In order to convert to volts in a 1-hertz band, it is necessary to divide the voltage indication of the analyzer by the square root of the analysis bandwidth. For example, using the General Radio Type 1900 Wave Analyzer, multiply by the factors given in Table 3-3 to convert measured values of random noise to volts in a 1-hertz band.

TABLE 3-3
Correction factors for converting voltage indication of the Type 1900 Wave Analyzer to voltage in a 1-hertz band.

ANALYZER BANDWIDTH	CORRECTION FACTOR[1]
3 Hz	0.650 (-3.7 dB)
10 Hz	0.357 (-9.0 dB)
50 Hz	0.159 (-15.9 dB)

[1]These numbers include the correction for the average-responding voltmeter in the 1900 Wave Analyzer.

In a constant-percentage-bandwidth analyzer, the analysis bandwidth is directly proportional to the center frequency of the pass band. This necessitates dividing the voltage indication by the square root of the frequency as well as by the correction factor for the fractional bandwidth itself. When using constant-percentage-bandwidth analyzers, such as the General Radio Type 1564 Sound and Vibration Analyzer or the Type 1558 Octave-Band Analyzer, multiply the analyzer voltage indication by the appropriate conversion factor in Table 3-4.

TABLE 3-4
Correction factors for converting voltage indication of a constant-percentage-bandwidth analyzer to voltage in a 1-hertz band.

BANDWIDTH	CORRECTION FACTOR
1/10 Octave	$3.80/\sqrt{f}$
1/3 Octave	$2.08/\sqrt{f}$
1 Octave	$1.19/\sqrt{f}$

3.4.6 Spectra of Type 1382 Random-Noise Generator.

The noise output of the Type 1382 Random-Noise Generator is adjustable to either of three different spectral shapes. The spectrum level of the WHITE noise is substantially constant from 20 Hz to 20 kHz, and is 3 dB down at 50 kHz. The spectrum level of PINK noise slopes downward at 3 dB per octave, from 20 Hz to 20 kHz. The spectrum of USASI noise, as specified in USASI (formerly ASA) Standard S1.4, "American Standard Specification for General Purpose Sound-Level Meters" (1961), reflects the combined effect of two RC networks acting independently on white noise. One is a high-pass network with corner frequency at 100 Hz and a cutoff slope of 6 dB per octave; the other is a low-pass network with a corner frequency of 320 Hz and the same cutoff slope. These three spectra are shown in Figure 3-3. The output voltage is the same for any position of the NOISE SPECTRUM control, so the spectral levels at certain frequencies vary widely from one spectrum to another. The relative spectral levels are as indicated in Figure 3-3.

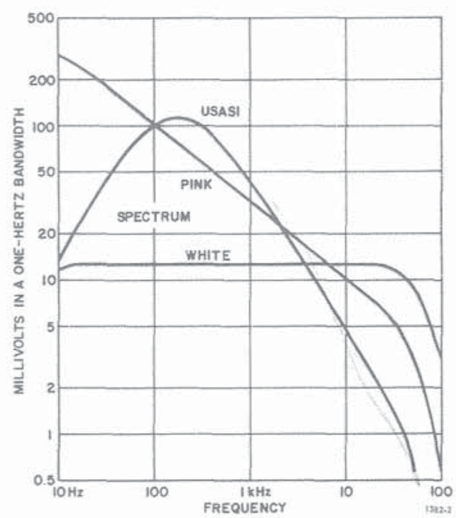

Figure 3-3.
Voltage spectra of the 1382 for the three different output spectra at 3 volts, rms, output level.

3.5 STATIONARITY.

A random noise is said to be stationary[3] if its various statistical parameters such as the amplitude distribution and the spectral intensity do not change with time. Random noise,

[3]Bennett, op. cit., p. 52–54.