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~~Vibration and Flutter Branch~~

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AIRCRAFT NOISE

Since noise considerations may seriously affect the design and operation of aircraft, the NACA is reexamining some aspects of the aircraft noise problem. A survey is now in progress and we will present some of the preliminary results. Our studies at the NACA have been limited to the physical characteristics of the noise. Some of the material on other aspects of the problem has been obtained from outside sources such as the Air Materiel Command, the Bell Telephone Laboratories, and various other agencies and aircraft companies.

Noise is also known to have serious effects on man and in recent years research at various agencies has shown that some of these effects can be predicted if the spectrums are known. This first chart, in which intensity is plotted as a function of frequency, will illustrate some of the intensity levels that are significant. This chart is oversimplified because some of the effects on man are a function of frequency as well as intensity.

This shaded area represents the ranges of speech. The level of 85 decibels is believed by many scientists to be the maximum level to which an unprotected person may be exposed without incurring some impairment. We will now demonstrate a noise of about this level.

Since the decibel is a rather abstract quantity we would also like to demonstrate a level of 100 db which is about here on the chart and represents an increase of 15 decibels above the first level. The noise you will hear, will be that of a supersonic propeller at a distance of a half mile. (Short burst of prop noise) For comparison now we would like to demonstrate rocket noise at about the same intensity level. (Rocket noise) At levels in the order of 120 db most persons experience discomfort. At higher levels more and more discomfort is experienced until in extreme cases, pain and damage may occur.

In current noise studies of propellers, rockets and jets we encounter two basic types of noise spectrums as illustrated in this next chart. These two figures represent frequency analyses of noise from a supersonic propeller and solid fuel rocket respectively. Intensity on the vertical scale is plotted as a function of frequency on the horizontal scale.

Supersonic propeller noise which is associated with steady aerodynamic forces on the blades can be described by a line spectrum such as shown here. (left figure) Only a few predominating frequencies are present, as indicated by these blips in the light trace, and each frequency component has a constant intensity. You will recall in the demonstration that the propeller had a characteristic tone as if it consisted of several pure notes sounded simultaneously.

The other type of spectrum encountered is associated with turbulence and hence is of a random nature. This type is shown in the right hand figure and is called a continuous spectrum. Here nearly all frequencies from the sub-audible to the ultrasonic range are present and each one is fluctuating in intensity. This spectrum is characteristic of rockets and many types of jets and corresponds to the last noise demonstrated.

These spectrums are useful generally in describing the noise generated by various sources, but for any given source they usually vary somewhat as a function of direction. Hence, we must also know the directional properties of the noise in order to fully describe it. This next chart illustrates some of the directional properties of two types of noise sources. The propeller noise is most intense near the plane of rotation and is a minimum near the axis of rotation. The jet noise on the other hand is a maximum near the axis in the rear of the engine.

These distributions suggest that for single engine airplanes, the crew is in a relatively favorable position and may not need much protection from these noise sources. For airplanes with engines on the wings the problem is more severe since the fuselage may intersect these radiation patterns near their maximum values.

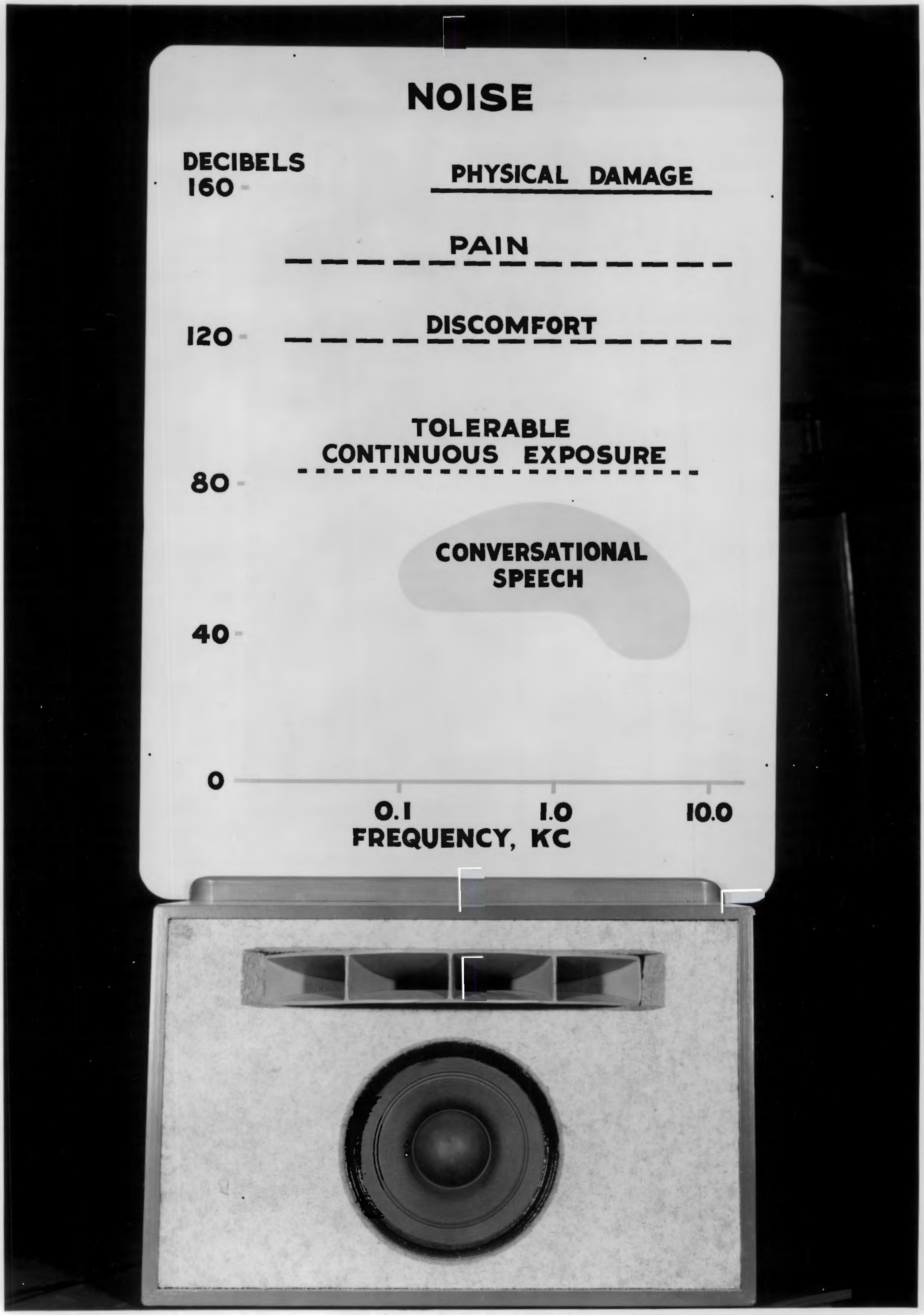
Service personnel and ground crews may not always be able to take advantage of these directional characteristics in the course of their work and hence the maximum values have significance. This next chart indicates the estimated maximum noise levels encountered for a distance of 30 feet and thrust rating or 10,000 lb. for these various units. Decibels are plotted along the horizontal scale. The levels associated with pain and physical damage from the first chart are shown here by these red lines. We see that all of these sources generate noise levels in the critical region. The fact that all these levels are so high suggests that some kind of personal protection should be furnished.

Personal protection for the range of speech frequencies is available in the form of ear plugs and helmets. Protection for the intense low frequencies which are felt by the whole body would probably be too cumbersome to be useful.

For in the interest of people inside the airplane it appears that satisfactory reduction may be obtained in the range of speech frequencies and above by conventional methods. Substantial reductions for the lower frequencies will probably necessitate the use of heavier cabin walls.

Intensive effort is being put into the muffling of jets on the ground and wherever a suitable structure could be built, satisfactory results have been obtained. The amount of noise reduction obtainable for a given amount of material is, in general, a function of the frequency; the higher frequencies being more readily attenuated than the lower ones. Where intense low frequencies are present, the resulting structures are large and massive.

The present programs of the NACA are aimed at an understanding of the physical characteristics of the noise. It is believed that a clear concept of this phase of the problem plus a further clarification of the tolerance levels are both necessary before a great amount of effort is expended in noise reduction.



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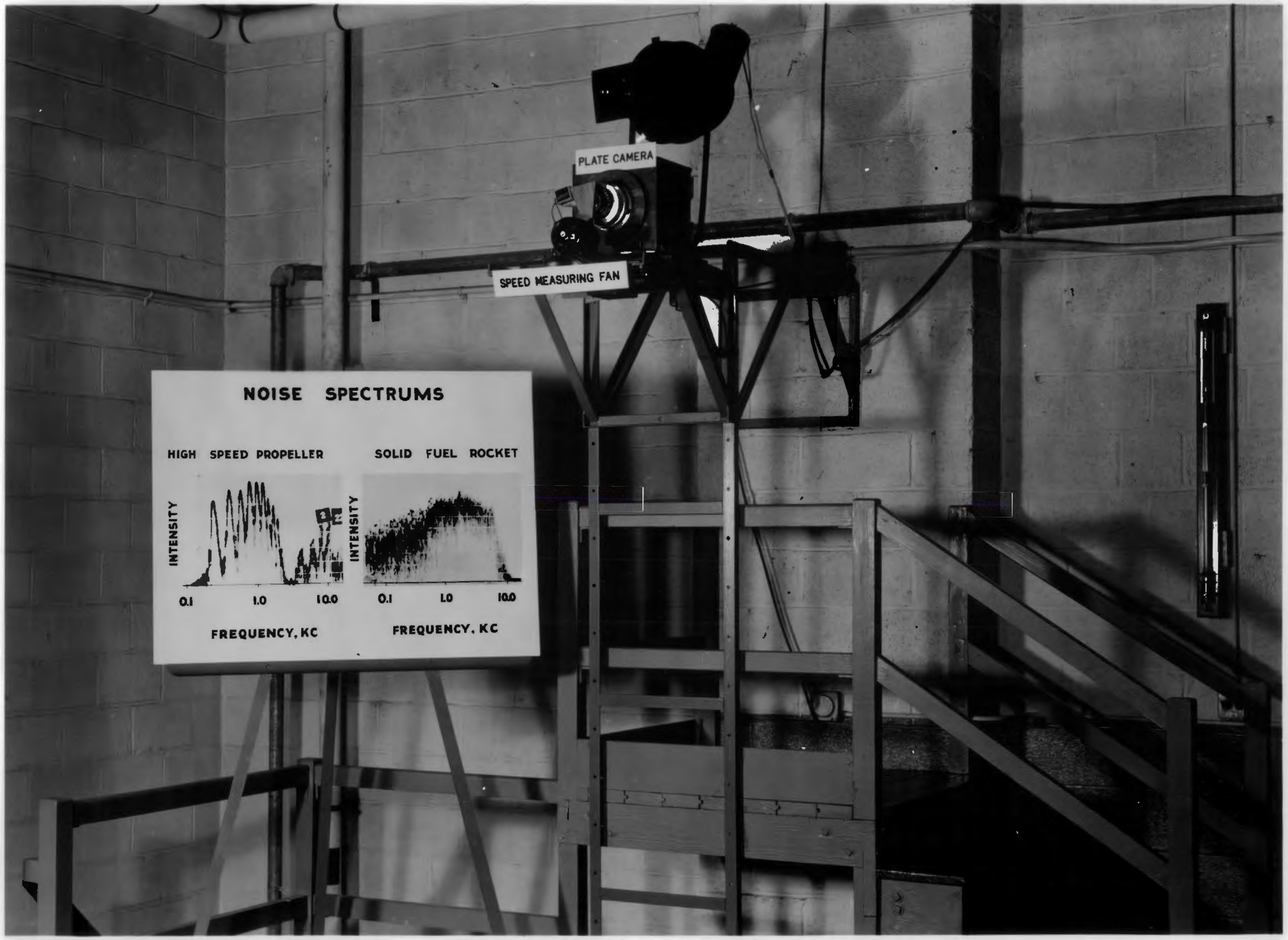

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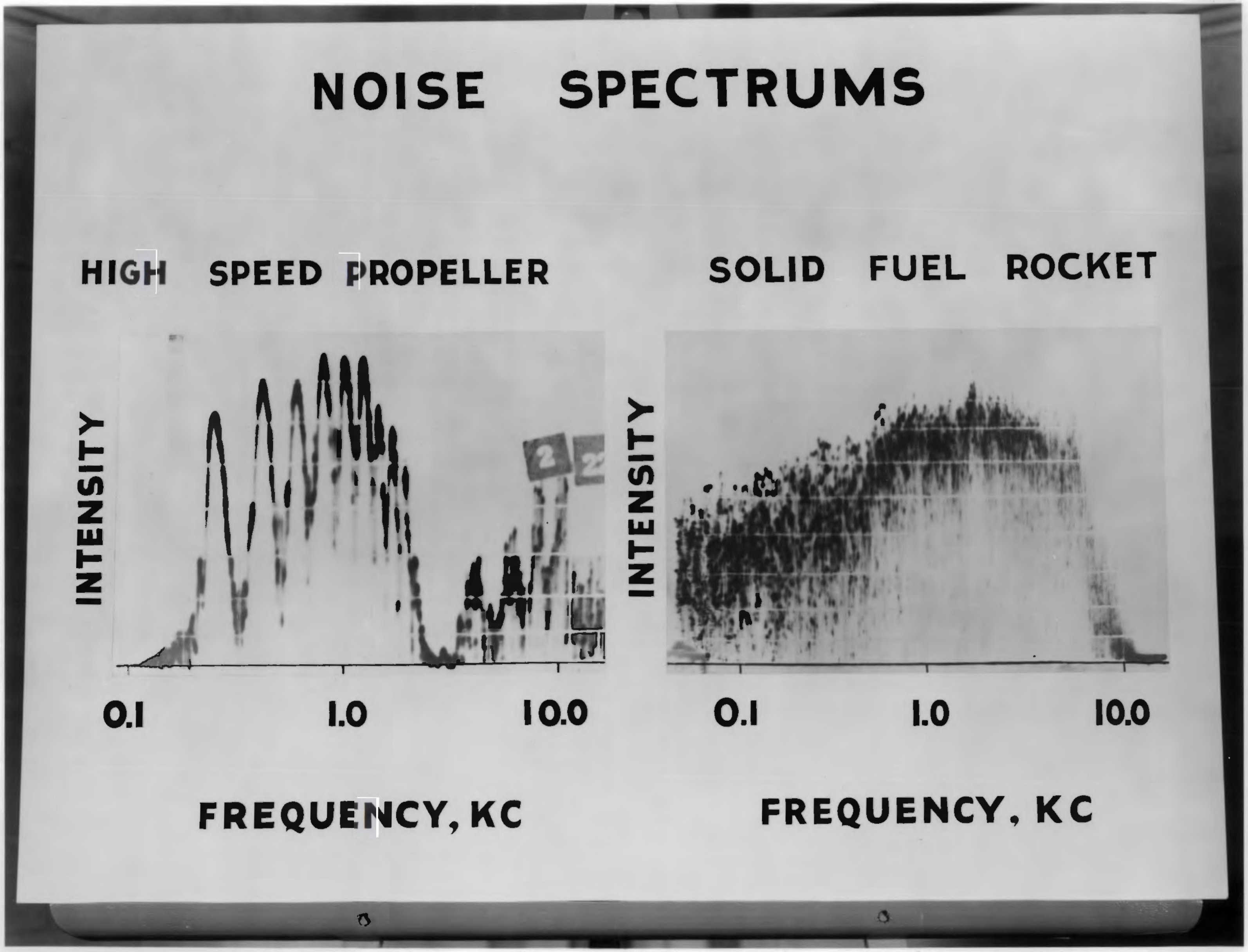

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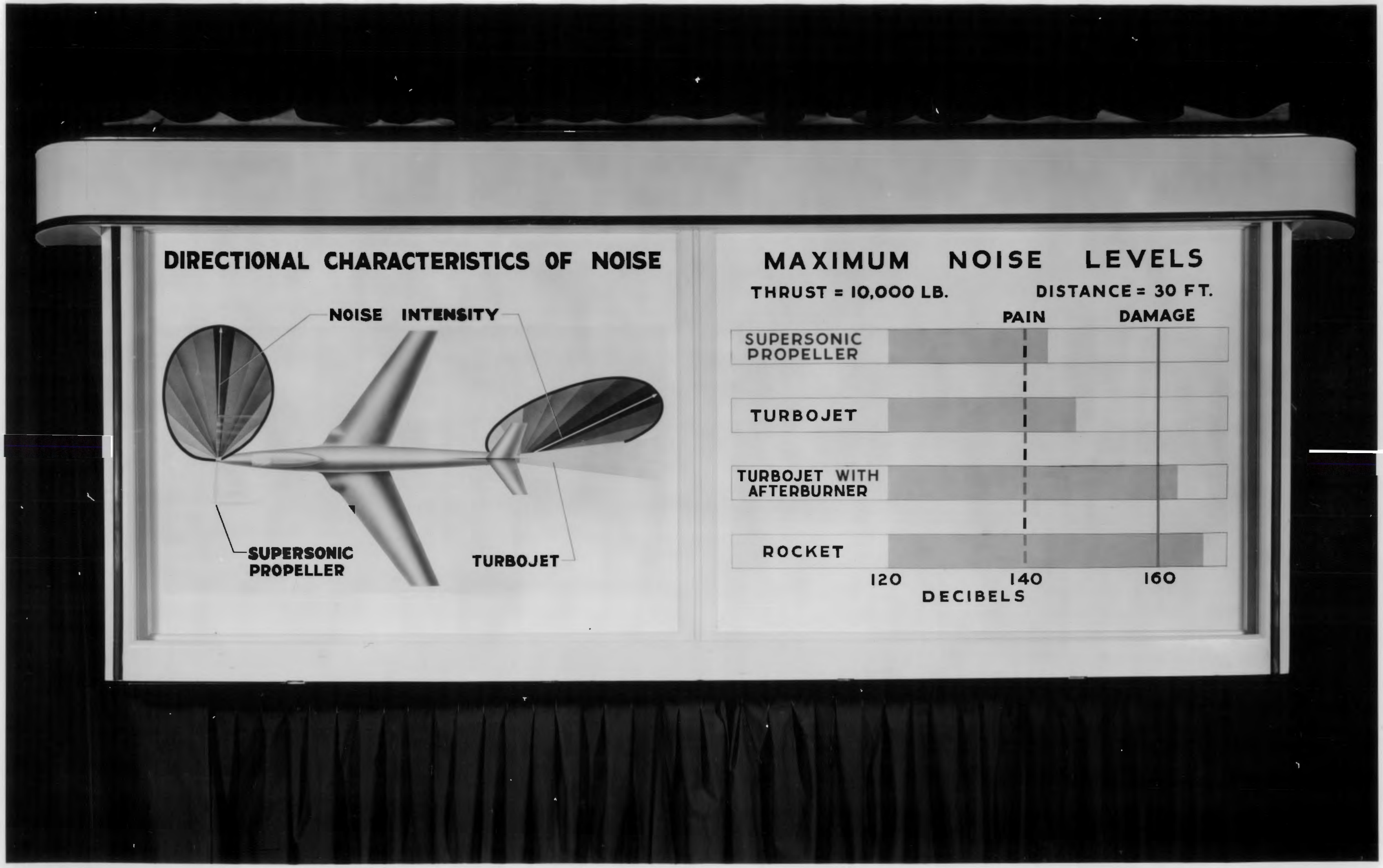

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