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THE EFFECT OF A ROW OF HELMHOLTZ RESONATORS ON THE TURBULENCE IN A BOUNDARY LAYER

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This report covers the period from 5 May to 30 September on the subject project.

Detailed acoustic measurements were made of the resonators' response as the free stream speed was varied from 30 mph to 155 mph. The average sound pressure level (SPL) and peak frequency response are shown in figures (1) & (2). Figure (1) clearly shows the existence of strong tuning between the boundary layer and the resonator for the Helmholtz (f_0) mode as well as for the first standing wave (f_1) mode. The narrow speed range for tuning and the gap between the strong tuning for the Helmholtz mode and the first standing wave mode is evident. Figures (2) and (3) show the frequency at which the peak SPL response occurred at each speed. The peak response for the Helmholtz mode occurred at a free stream velocity of 26 m/s (at which Re_Θ = 6,560) with a resonant frequency of 570 Hz and a sound pressure level of 141 dB. The peak response for the first standing wave occurs at the maximum wind tunnel speed of 70 m/s (at which Re_Θ = 14,900) Hz with a resonant frequency of 1,890 Hz and a sound pressure level of 154 dB. At resonance the microphones do not maintain a constant SPL, but rather it fluctuates in a seemingly random fashion. The values presented here are time averaged rms values. Of interest was the occurrence of phase locking between adjacent resonators with a phase lag of 180^o.

So far laser velocimetry measurements have been unsuccessful. Meaningful repeatable LV measurements have not been obtained. This is due to the fact that the seed used, atomized sugar solution, rapidly begins to stick to the wind tunnel screens and in doing so significantly changes the boundary layer. For example, at a particular position in the boundary layer, the velocity can decrease by 4% in as short a time as 15-30 minutes, compared to 1-2 hours required to obtain a boundary layer profile. The summer months have been spent on this problem. Currently we are investigating methods of drying the seed and alternative seeding methods. Modifying the tunnel so that the seed is introduced after the screens is undesirable but will be done if necessary. As a last resort, the measurements will be made with hot film anemometers.

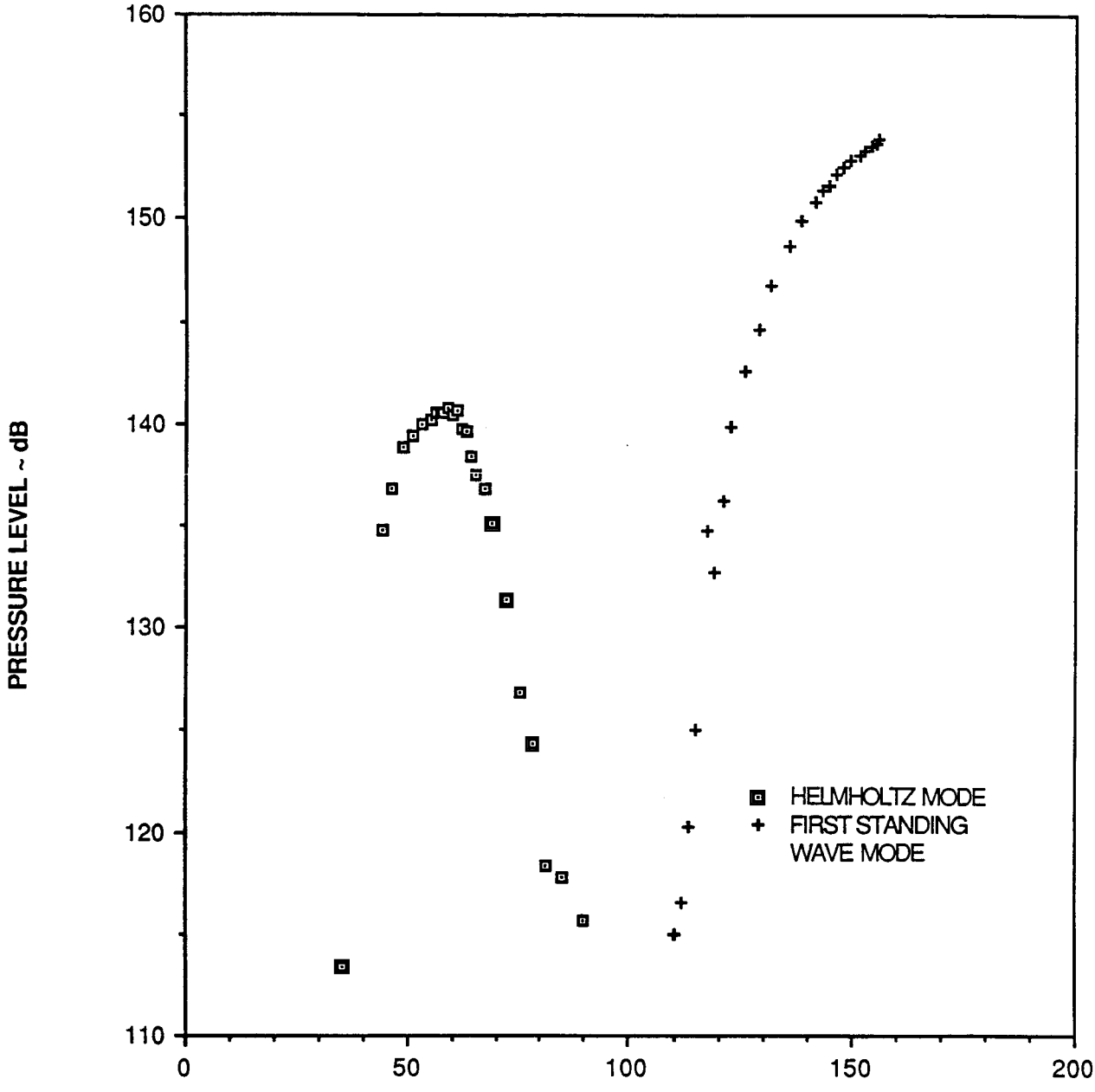

FIGURE 1. CAVITY SOUND LEVEL vs. FREE STREAM VELOCITY.

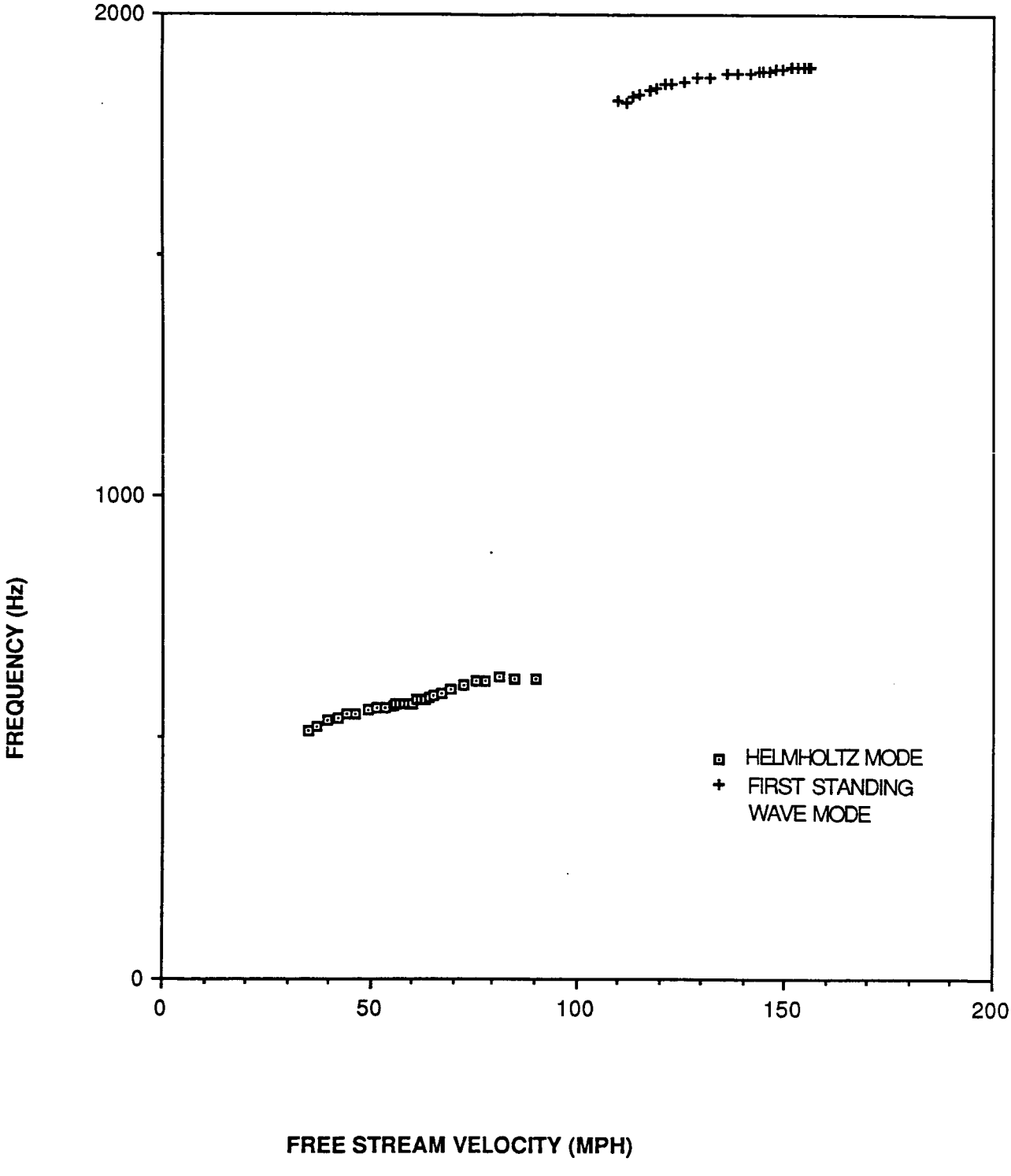

FIGURE 2. PEAK FREQUENCY RESPONSE vs. FREE STREAM VELOCITY.

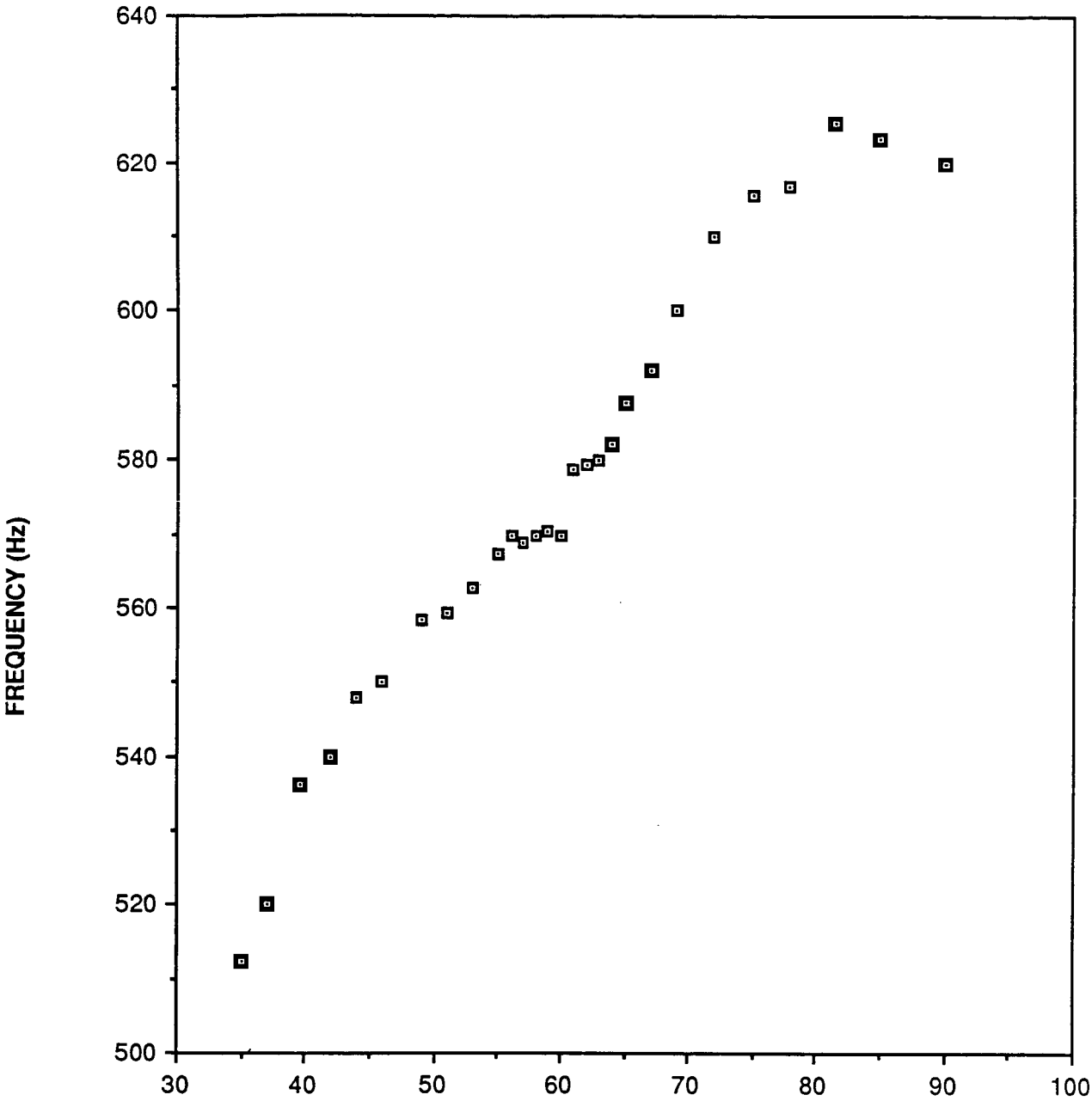

FIGURE 3a. FREQUENCY vs. FREE STREAM VELOCITY; HELMHOLTZ MODE.

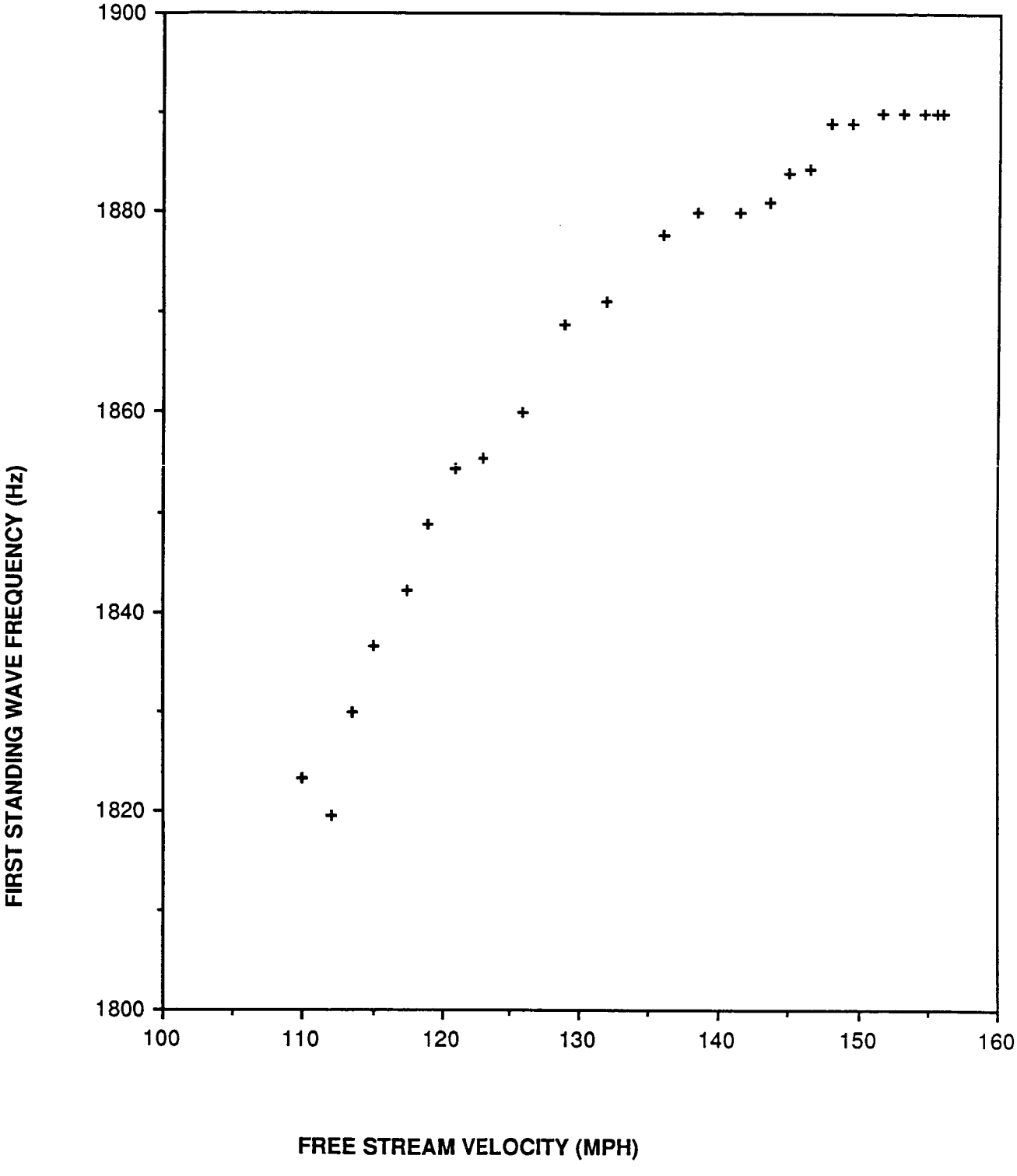

FIGURE 3b. FREQUENCY vs. FREE STREAM VELOCITY; FIRST STANDING WAVE MODE.