ALLEGED DAMAGE TO THE RESIDENCE OF H. C. DeWITT DUE TO TRAFFIC-INDUCED VIBRATIONS

MICHIGAN DEPARTMENT OF STATE HIGHWAYS

ALLEGED DAMAGE TO THE RESIDENCE OF H. C. DeWITT DUE TO TRAFFIC-INDUCED VIBRATIONS

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This report covers the results of an investigation concerning alleged vibration damage to the H. C. DeWitt residence at 20220 Cameron Ave., Detroit, Michigan. Location of the house with respect to the roadway is shown in Figure 1.

In a letter dated November 13, 1970, to F. C. Skebensky, Senior Engineer of the Metropolitan District, Mr. DeWitt stated his belief that the damage to his house resulted from road construction activities, heavy truck traffic on a nearby ramp of the I75 Freeway, and vibration caused by truck exhaust noise. Mr. Skebensky sent a request to the Testing and Research Division to have vibration measurements made at the site.

Research Laboratory representatives visited Mr. DeWitt on December 9, 1970, to discuss the problem and inspect the house. The DeWitt's indicated plaster cracks on the walls at several locations, and peeling paint in the bathroom area toward the rear of the house. Plaster on the ceilings was bulging downward, and had come loose from its supports in a few places.

Mr. DeWitt did not seem as concerned about vibration transmitted through the ground as much as vibration of the house and its contents caused by the noise of truck exhaust. Noise from the Freeway lanes is quite noticeable at the site, but is not nearly as strong as noise from trucks on the exit ramp. Truck traffic is heavy on the exit ramp, since it serves nearby Eight Mile Rd.

It was decided that measurements should be made of both ground and airborne vibration at the site. Since ground vibrations are affected by frost penetration, and noise measurements change with snow cover, measurements were deferred until spring. The noise and vibration survey was conducted on April 14, 1971.

Ground vibrations decrease quite rapidly with distance from the source and, since little vibration was noticeable near the house, a measurement site was chosen across the street nearer the ramp (Fig. 1). Two 2-1/2 g accelerometers to measure vertical and horizontal accelerations, were mounted on a 4-ft long steel stake, driven into the ground. Recordings of truck-induced ground vibrations were made over a one-hour period, resulting in a maximum acceleration of less than 0.01 g. The relative significance of such a vibration can be determined from the fact that a 120-lb man walking on the sidewalk near the accelerometers produced readings of 0.015 g. Comparison traces of truck-induced and 120-lb pedestrian vibrations are shown in Figure 2.

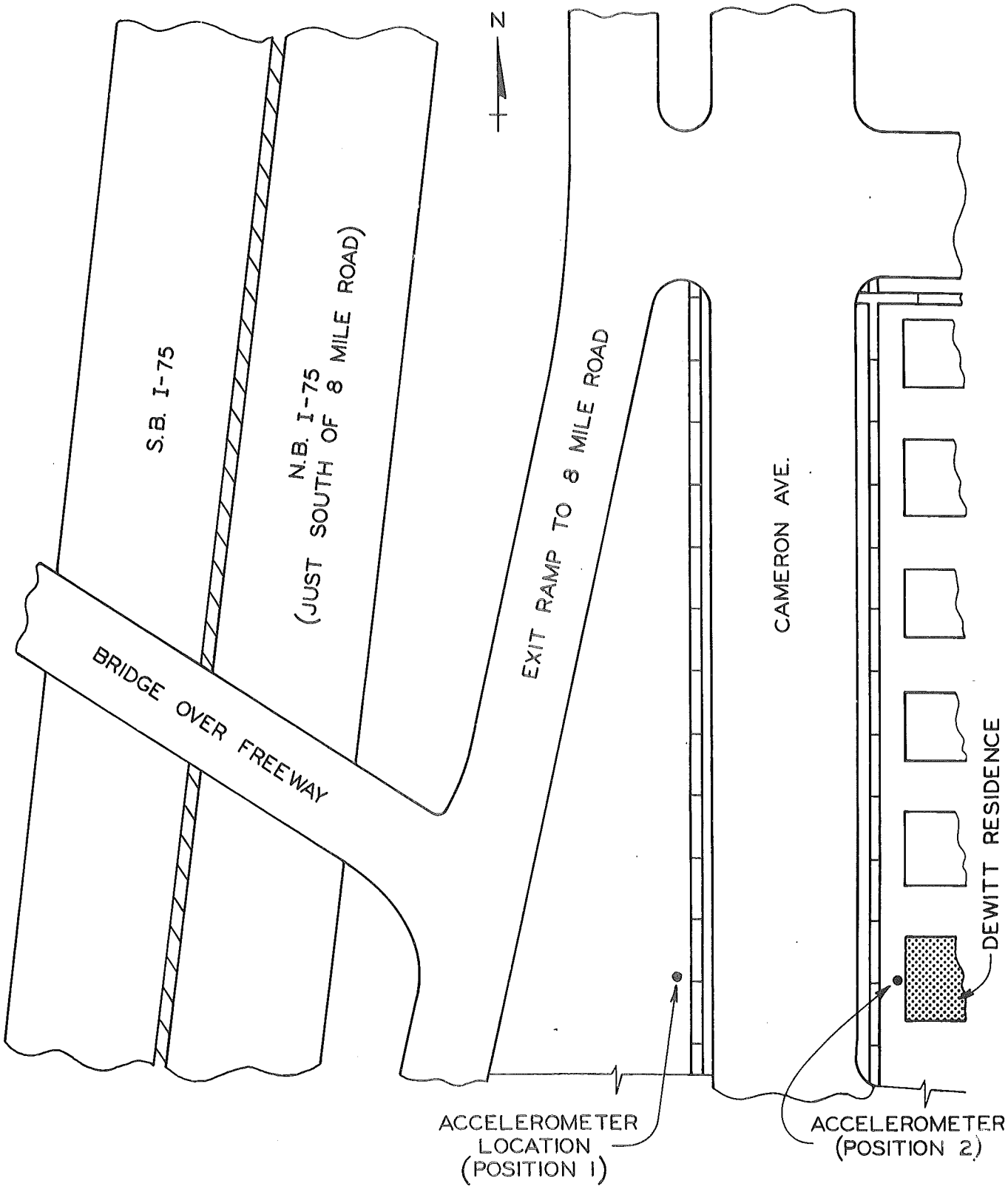

Figure 1. Location of DeWitt residence with respect to adjacent roadways.

Since vibrations of this magnitude are not significant from a damage standpoint, and since ground vibrations at the house would be still lower because of the increased distance from the roadway, no further ground vibration measurements were made. These results indicated that if significant vibration did exist at the house, it must be airborne.

Recordings of the horizontal accelerations of the front wall of the house were obtained by attaching an accelerometer to the outside of the wall, near the center. Vibrations due to typical truck traffic were recorded for one hour. Analysis of the recordings indicated that the house front was subjected to a continuing vibration of about 0.002 g, with maximum values less than 0.01 g due to truck engine noise. The maximum noise and wall acceleration occurred when trucks accelerated and changed gears while crossing the bridge over I75, directly in front of the house (Fig. 4, top).

Normal household activity was conducted to provide measurements for comparison with those indicated above. A man walked across the front porch and closed the front door in a normal manner. In general, the man walking and door closing produced maximum accelerations approximately 1-1/2 and 2-1/2 times greater, respectively, than the maximum values produced by truck noise (Figs. 3 and 4).

Available research information concerning the effects of building vibration due to highway traffic, is restricted mainly to ground motion. Some of the findings are of interest and are included below.

People are much more sensitive to vibration than is generally realized. Humans can feel vibrations of 0.0001-in. deflection, and motion of 0.001 in. at 20 cycles per second is annoying. Vibration below 0.01 g is "noticeable," above 0.04 g is "unpleasant," and above 0.25 g "intolerable" at certain frequencies.

Harris and Creede have indicated in Vibrations Handbook that earth vibrations above 0.1 g may cause minor plaster cracking in residential structures. Langefors in Sweden, Edwards in Canada, and Bumines in the United States have made experiments correlating peak particle velocity in the earth with damage to structures. Their results agree very closely with each other and are in general agreement with the acceleration criterion of Harris and Creede. It also is noted that building vibrations generally exceed in magnitude the earth vibrations that caused them. The factors noted above usually result in expressions of concern from people unwillingly subjected to such vibrations.

Since the vibration magnitudes monitored at the DeWitt residence are far below the amount determined from previous research to be damaging, and since normal household activities produced vibrations considerably higher than those resulting from traffic, we cannot conclude that the damage to the residence is a direct result of traffic-induced vibration. We must conclude instead that the plaster cracking and loosening are the end result of normal use and of the cyclic effects of changes in moisture and temperature. Plaster cracking of the type exhibited is not unusual in older homes. While the low-level vibration may aid in the removal of plaster once it is loose, the initial loosening appears to be from other causes.

Vibration, even if present in larger amounts, should not cause peeling of the paint as has occurred in the DeWitt house. Such problems are usually due to moisture or faulty paint.

In summary, it appears that Mr. and Mrs. DeWitt and their neighbors, along with countless other people, are the victims of ever increasing noise in urban areas. It seems reasonable to conclude that similar complaints will be heard with increasing frequency as people become more aware and less tolerant of the "noise pollution" of their environment. Effective legislation and enforcement are badly needed to reduce vehicle noise to more reasonable levels. To this end, the Department should lend all possible support.

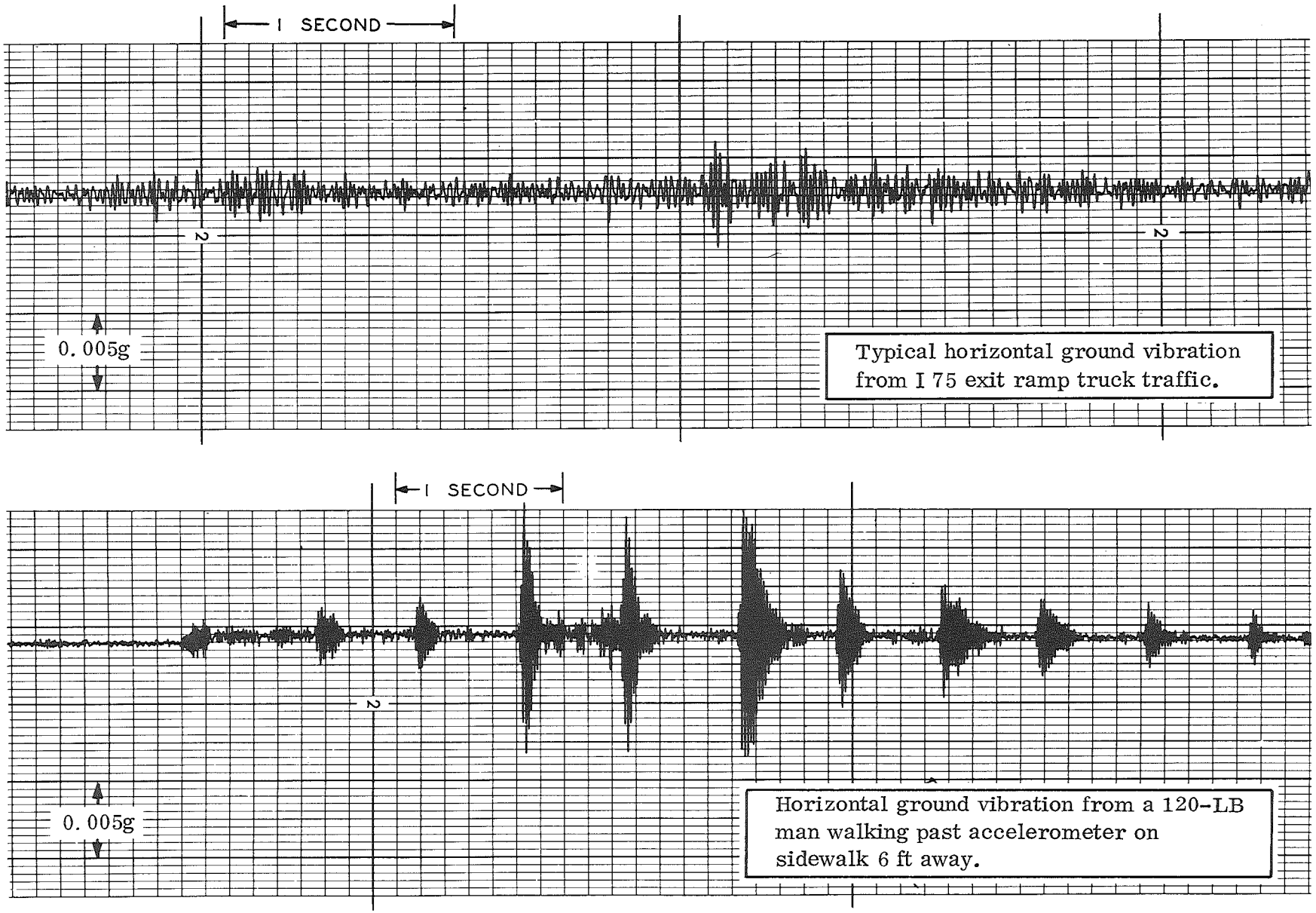

Figure 2. Traces from accelerometer located across street from DeWitt residence (Position 1).

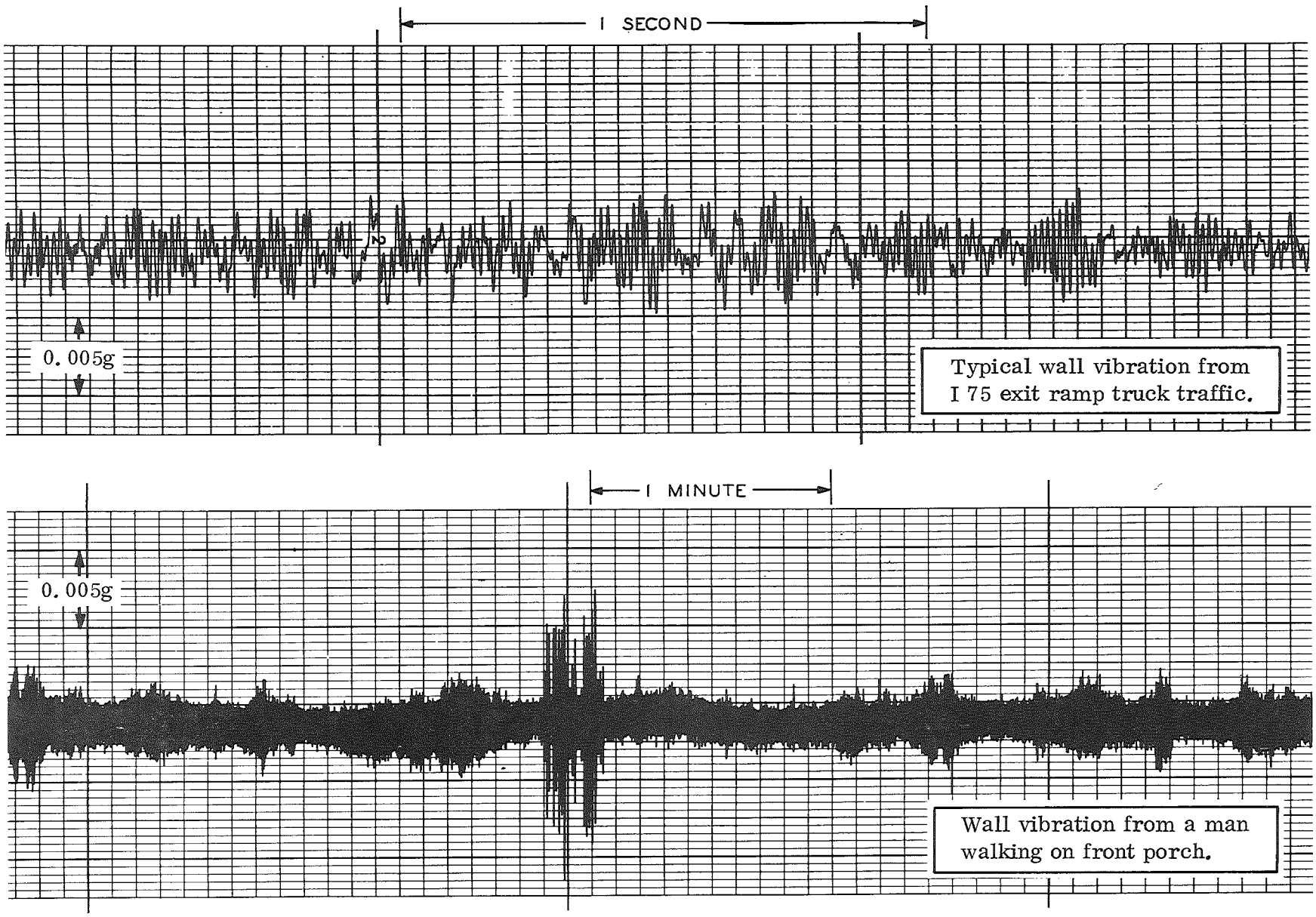

Figure 3. Traces from accelerometer mounted on front outside wall of DeWitt residence (Position 2).

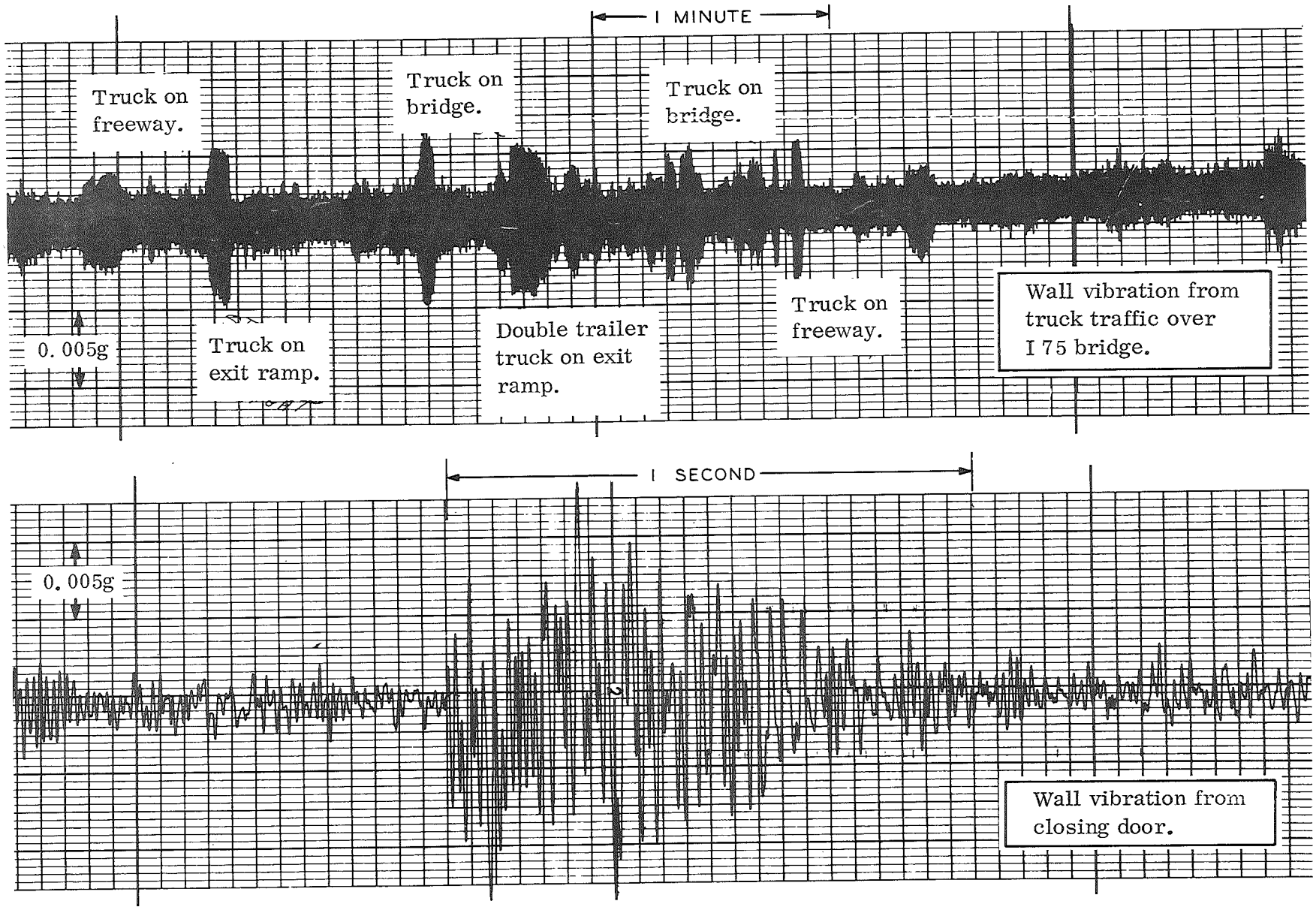

Figure 4. Traces from accelerometer mounted on front outside wall of DeWitt residence (Position 2).