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DEPARTMENT OF NATIONAL DEVELOPMENT

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS.

RECORDS

RECORDS 1960 No. 55

VOLKSWAGEN VIBRATION TESTS, CLAYTON VICTORIA 1960

by

P.J. ANTHONY and F. JEWELL

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ABSTRACT

Ground vibrations caused by the working of two compressors at the factory of Volkswagen (A/Asia) Pty.Ltd., Clayton, have been measured.

The ground accelerations at several places near the compressors are calculated, and are compared with the acceleration regarded as safe by the U.S. Bureau of Mines.

It is concluded that only on the compressor foundations do the ground accelerations exceed the accepted safety limits for building structures.

1. INTRODUCTION

In response to a request from W.C. Jewell and Associates, Consulting Engineers, the Bureau of Mineral Resources, Geology and Geophysics, carried out vibration tests at the factory of Volkswagen (A/Asia) Pty.Ltd., Clayton Victoria. Details were required of the amplitude and frequency of the ground vibrations caused by two Atlas Copco air compressors, mounted on concrete foundations.

A Sprengnether Portable Blast and Vibration Seismograph was used to record the vibrations at several places near the compressors; the work was carried out by P.J. Anthony of the Engineering Group of the Bureau, on 14th April 1960.

The Sprengnether seismograph records on a moving photographic strip the ground motion in three mutually perpendicular directions. Timing lines are printed on the record at 20-millisecond intervals. The magnification factor of the instrument is 100, i.e. a displacement of one inch on one of the three traces of the record represents a ground movement of 0.01 inches.

2. RESULTS

Plate 1 shows the positions of the seismograph during the tests. Plate 2 shows copies of some of the seismograph records, from which the ground displacements and vibrational frequencies were scaled.

Table 1 shows the components of ground displacement (taken as half the peak-to-trough amplitude) corresponding to the various positions of the seismograph. As the longitudinal, vertical and transverse components of the vibration are in phase, the resultant displacement is computed merely by taking the square root of the sum of the squares of the three components.

Vibrations of various frequencies were recorded, the main ones being 8.5 c/s, 17 c/s and higher frequencies in the region of 60 or 70 c/s. The largest amplitudes recorded were those in positions 1, 2 and 3. The motion was mainly horizontal in a direction from the compressor to the seismograph (shown as transverse component, table 1). This component died away very rapidly as the instrument was moved away from the machine but the smaller vertical component died away much less rapidly. The high-frequency vibrations were negligible anywhere except on the foundations of the compressors.

In addition to the low-frequency vibrations, Compressor A produced vibrations of about 55 c/s and Compressor B produced vibrations of about 70 c/s; apart from this, the effects of the two compressors were similar regardless of load. As acceleration is proportional to the square of the vibration frequency, the accelerations near Compressor B are rather higher than those of Compressor A.

The ground accelerations shown in table 1 were calculated from the equation

$$a = 4\pi^2 f^2 A$$

where a is maximum acceleration
f is frequency
A is amplitude of vibration

Plate 3 is a graph showing the way in which ground acceleration varied with distance from the compressors. The acceleration in position 7, 22 feet from compressor B, is anomalously high, but the rapid attenuation with distance is quite evident.

Various authorities have cited differing criteria for assessing the damaging effect of ground vibrations on built-up structures. Thoenen and Windes (1942) of the U.S. Bureau of Mines concluded that ground acceleration is the most useful index of damage; they proposed the following classification, applicable to buildings :-

Acceleration greater than 1.0 g	:	Damaging
Acceleration between 0.1 g and 1.0 g	:	Slightly damaging (Caution zone)
Acceleration less than 0.1 g	:	No damage (Safe zone)

(where *g* is the acceleration due to gravity, 385 in/sec^2).

Mallock (1902) put forward a convenient criterion for assessing the effect of vibrations on human beings, viz.:

Acceleration greater than 0.04 g	:	Unpleasant
Acceleration greater than 0.01 g	:	Perceptible

Clearly the vibrations recorded in the present tests can be considered safe according to Thoenen and Windes, at distances over 8 ft. from the nearest compressor foundation; they cannot even be deemed unpleasant at these distances according to the Mallock criterion.

3. CONCLUSIONS

The ground accelerations in the immediate vicinity of the compressors exceed the safe limit for buildings adopted by the U.S. Bureau of Mines. At distances over 8 ft. from the nearest compressor foundation however, the ground accelerations are attenuated to a safe level. Immediately around the compressors the predominant vibration frequency is 55 to 60 c/s; beyond 8 ft. from the foundations the predominant frequency is 17 c/s.

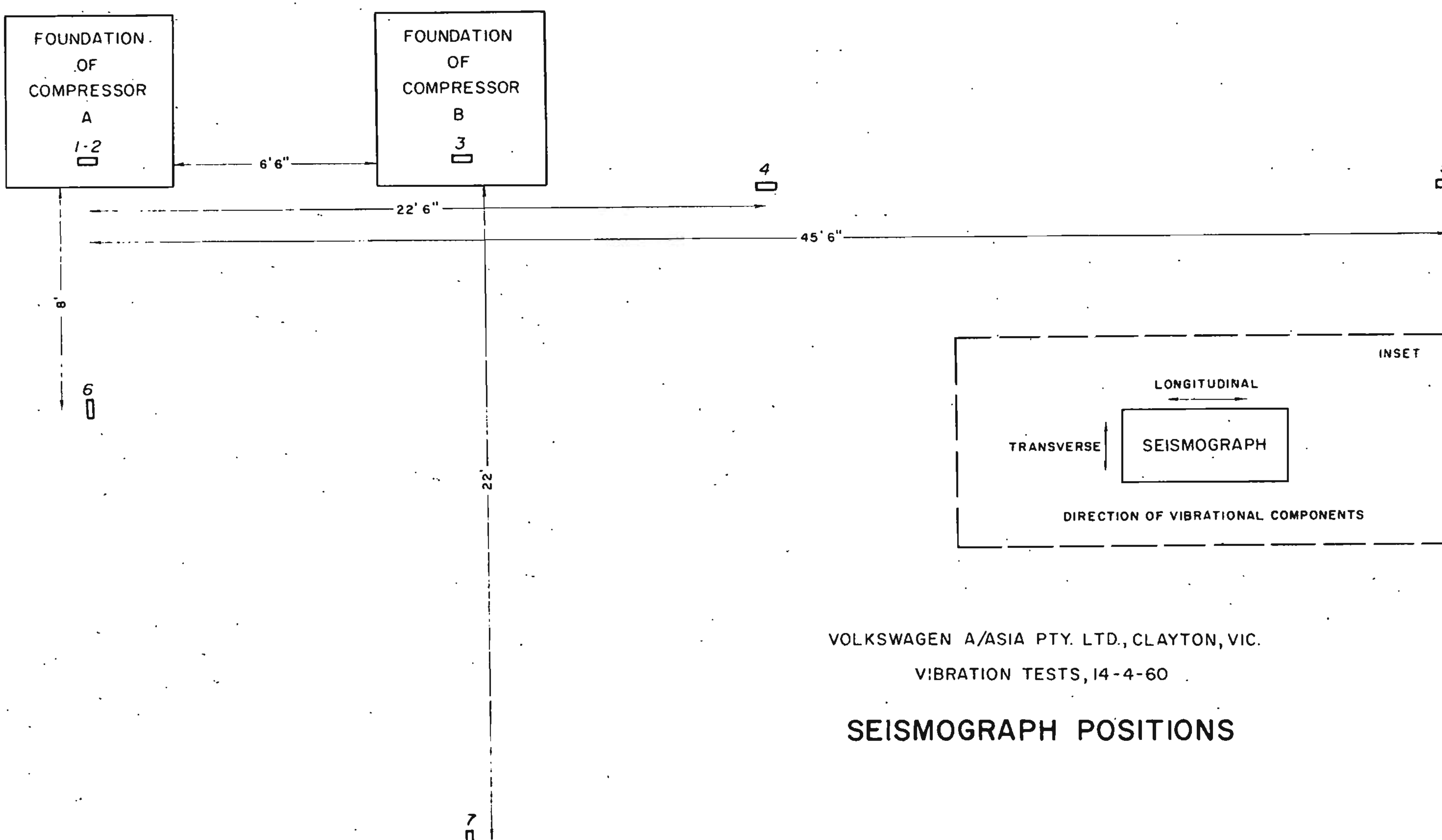
4. REFERENCES

MALLOCK, H.R.A., - Vibrations produced by the working of the traffic on the Central London Railway. U.K. Board of Trade Report, 1902 Cd. 951.

THOENEN, J.R. and WINDES, S.L., 1942 - Seismic effects of quarry blasting. Bull. U.S. Bur. Min. 442.

TABLE 1.

Position of Recorder	Distance from Nearest Compressor (feet)		Longitudinal Displacement (in.)	Longitudinal Freq.	Longitudinal Acceleration (units of g)	Vertical Displacement (in.)	Vertical Freq.	Vertical Acceleration (units of g)	Transverse Displacement (in.)	Transverse Freq.	Transverse Acceleration (units of g)	Resultant Displacement (inches)	Resultant Acceleration (units of g)
			Components of Vibration										
1.	on foundation A	Low freq. Component	0.0004	8.5	0.0029	0.0005	8.5	0.0037	0.0012	17	0.0359	0.0014 } 0.0023	0.036 } 0.328
		High freq. Component	0.0005	55	0.155	0.0008	55	0.248	Very Small			0.0009	0.292
2. (Record 1)	on foundation A	Low freq. Component	0.0004	8.5	0.0029	0.0005	8.5	0.0037	0.0013	17	0.0389	0.0014 } 0.0023	0.039 } 0.317
		High freq. Component	0.0004	55	0.124	0.0008	55	0.248	Very Small			0.0009	0.278
3.	on foundation B	Low freq. Component	0.0003	8.5	0.0023	0.0004	8.5	0.0029	0.0012	17	0.0359	0.0013 } 0.0021	0.036 } 0.418
		High freq. Component	0.0003	70	0.150	0.0007	70	0.350	Very Small			0.0008	0.382
4.	10½		Very Small			0.0002	17	0.0060	Very Small			0.0002	0.006
5.	33½		Very Small			Very Small			Very Small				
6. (Record 2)	10½		0.0001	17	0.0030	0.0003	17	0.0089	Very Small			0.0003	0.009
7. (Record 3)	23½		Very Small			0.0003	17	0.0089	Very Small			0.0003	0.009



VOLKSWAGEN A/ASIA PTY. LTD., CLAYTON, VIC.

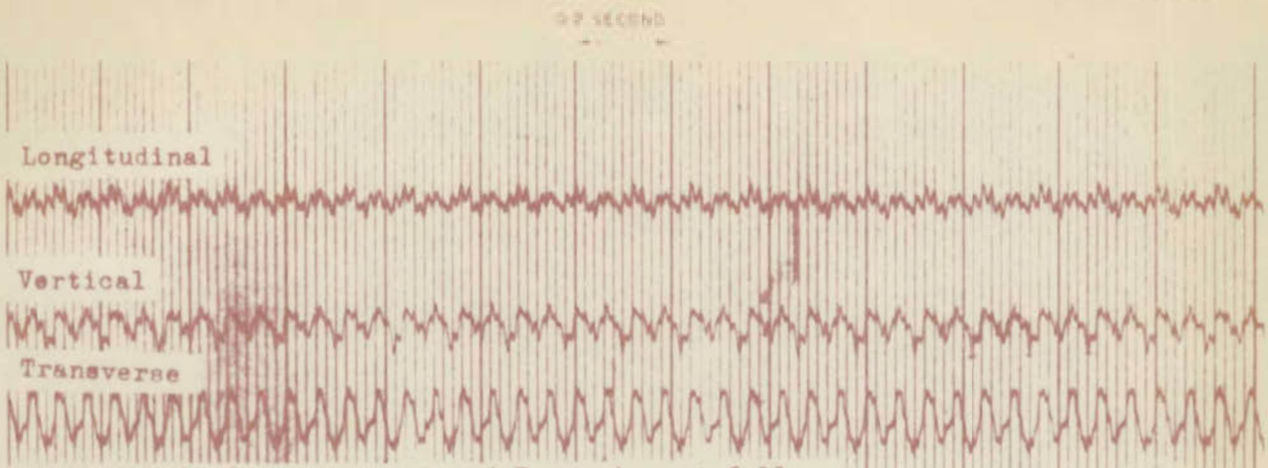
VIBRATION TESTS, 14-4-60

SEISMOGRAPH POSITIONS

PLATE I

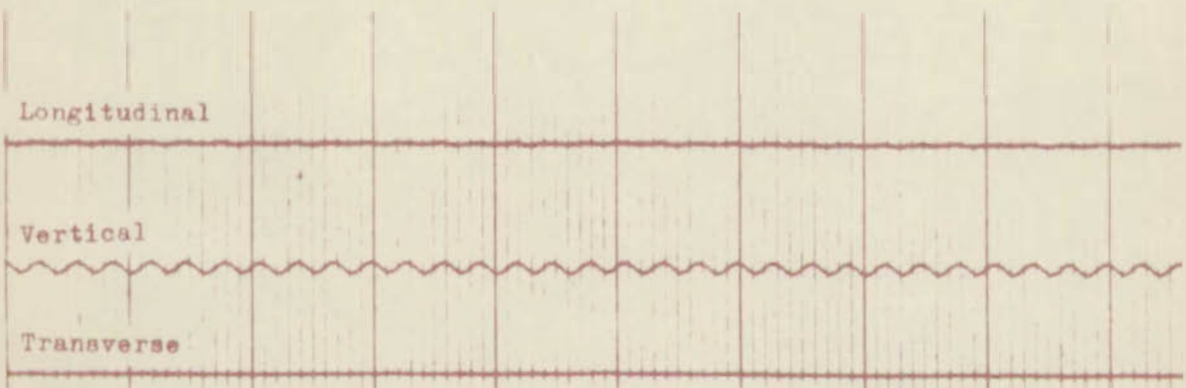
Geophysical Branch, Bureau of Mineral Resources, Geology and Geophysics.

G344-43



RECORD No1. Compressors A and B running at full load. Recorder on concrete foundation of compressor A.

RECORD No2. Compressors A and B running at full load. Recorder on concrete floor 8 feet from compressor A foundation.



RECORD No3. Compressors A and B running at full load. Recorder on concrete floor 22 feet from compressor B foundation.

Volkswagen A/Asia Pty. Ltd., Clayton, Vic.
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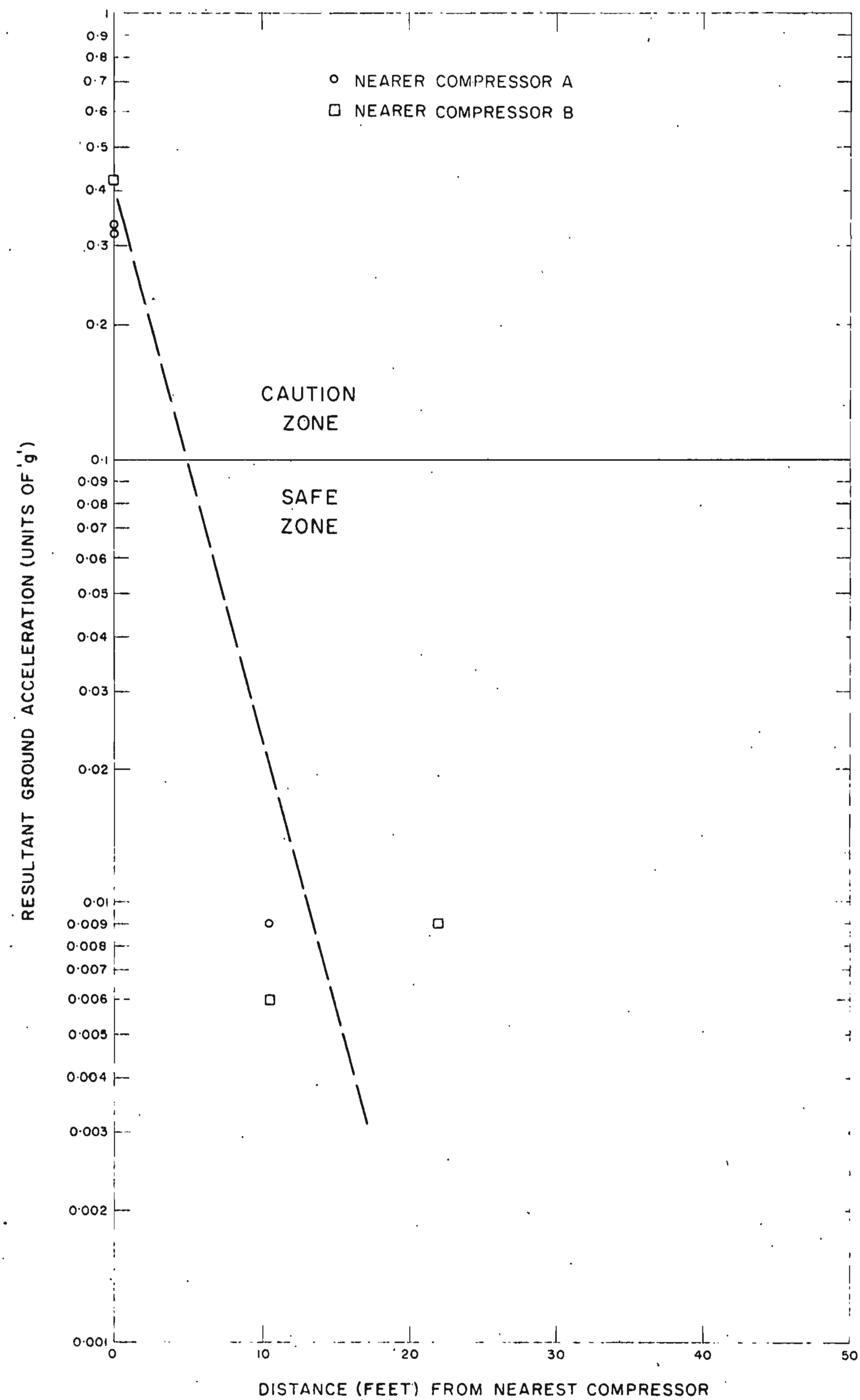
VIBRATION RECORDS

(Using Sprengnether Vibration Seismograph)



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GROUND ACCELERATIONS