

1. DESCRIPTION OF THE OPERATION OF THE BRAKE TEST STRIP

- 1.1. During the brake test, the operator runs the vehicle under test on the strip and then applies the brake at around the midpoint of the test strip to investigate if the car braking system functions normally. The vehicle runs at a maximum speed of 30 km/hr before braking and the duration of each test on the brake test strip would take around 20 seconds. As confirmed by the Hong Kong Police Force (HKPF), the maximum number of use is 5 times per day and no more than 1 time in 30 minutes. The main noise sources of the operation of the brake test strip are the engine, exhaust and braking system of the vehicle under test, and tyre/ road surface interaction. The noise from activities before and after the test such as driving the vehicle slowly to the starting point will last around 10 seconds and the noise will be insignificant as compared with the noise from the test.
- 1.2. Based on the on-site observation, noise emission from the operation of the brake test strip was not steady but had a varying pattern. The noise generated from its operation would increase after the test started, reach its peak at the braking point and die down afterwards. The noise emitting characteristics of the brake test strip would be different from other fixed plant which involves stationary noise source emitting noise in a steady manner. In view of the nature of the noise emission from the brake test strip operation, Sound Exposure Level (SEL), i.e. L_{eq} normalized to 1 second, was measured to determine the noise emission level from the event. The equivalent sound pressure level ($L_{eq30min}$) from the brake strip test operation at the NSRs was calculated taking into account the corrections for distance attenuation, barrier effect and façade reflection.

2. INSTRUMENTS

- 2.1. Sound level meters meeting the requirements of Class 1 instruments defined in IEC 61672-1 were used.

3. METEOROLOGICAL CONDITIONS

- 3.1. The measurements were made when the ambient air temperature was within the range from 5°C to 40 °C. The tests would not be carried out if the wind speed, including gusts, at microphone height exceeded 5m/s during the sound measurement interval.

4. BACKGROUND NOISE

- 4.1. The noise measurement was conducted at the HKPF Quarry Bay Police Vehicle Pound at 33 Hoi Chak Street, Quarry Bay. It was relatively remote with low pedestrian and traffic flows. The background noise level was steady and it was measured for the duration of 1 minute immediately before and after a series of vehicle tests. The measurements were made with the same microphones and microphone locations used during the test. The lowest background noise level was adopted. During the background noise measurement, no vehicle examination

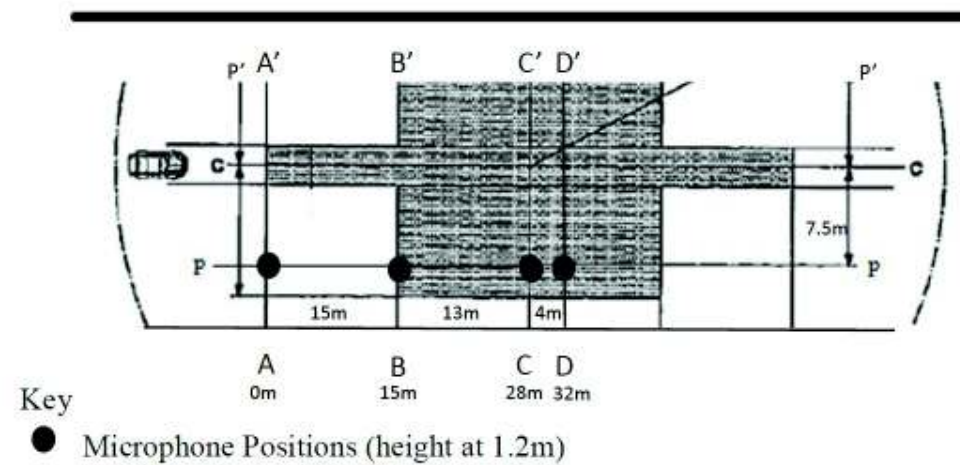
activities in the vehicle pound were conducted. The measured background noise level was shown in *Table 2*.

5. MICROPHONE POSITIONS

- 5.1. The distance from the microphone positions on the microphone line PP' to the perpendicular reference line CC on the brake test strip was maintained at 7.5m.
- 5.2. The microphone set-up was shown in *Figure 1* and the measurement was conducted on 24 June 2015. The total length and the width of the test strip were around 100m and 5m respectively. Based on the site observation, it was noticed that in general, the actual length used for the braking test would be around 30m from the starting point of the brake test strip and it was the concerned length for the noise measurement for determining the noise level of the brake test strip. The microphones were positioned along the strip within the applicable length of the braking test. Noise emission from the braking test including the engine noise at the starting point, acceleration noise within the acceleration zone and braking noise at the braking point was measured.
- 5.3. To measure the noise emission from the braking test, 4 microphones were positioned along the strip as detailed in *Table 1* below and they were located at 1.2m above the ground level.

Table 1 Details of the microphone positions

Position ID	Description	Predominant noise component
AA'	Starting point of the braking test.	To capture the engine noise and the acceleration noise.
BB'	Midpoint between the starting point and the braking point which will be located at 15m from the starting point of the braking test.	To capture the acceleration noise and engine noise.
CC'	Braking point will be located at 28m from the starting point. The operator will apply the brake at about this point.	To capture the braking noise.
DD'	End point of the braking test where the vehicle will stop.	To capture the braking noise.

Figure 1 The test site dimensions

5.4. Before the test, noise measurements were conducted at the both sides of the vehicle to be tested and the difference in the noise levels at the both sides of the vehicle was less than 1.0 dB and was considered insignificant. During the trials, noise measurements were conducted on the left side of the vehicle.

5.5. Immediately prior to and following the test, the accuracy of the sound level meters was checked using an acoustic calibrator. Measurements were accepted as valid as the calibration levels before and after the test agreed to within 1.0dB.

6. CONDITION OF THE VEHICLE

6.1. A 24 tonne heavy vehicle was used in the test to obtain the noise level under the worst case scenario.

6.2. Before the measurements started, the vehicle was brought to its normal operating condition. There was a 1-min wait, at idle with engine on, between runs to reduce the variation of results.

7. SPEED

7.1. The maximum test speed for test strip was 30km/ hour. The maximum speed was reached at the middle of the test track, which was also the braking point during the measurement.

8. DETERMINATION OF SOUND EXPOSURE LEVEL (SEL) AND EQUIVALENT SOUND PRESSURE LEVEL ($L_{EQ(30MIN)}$)

8.1. The highest measured A-weighted Sound Pressure Level ($L_{eq(20sec)}$) was adopted to determine the noise level of the operation of the brake test strip. The Sound Exposure Level (SEL), L_{eq} normalized to 1 sec interval, during the event which lasted for 20 seconds was

determined. The highest measurement result from the four microphones in each second was adopted to determine the $L_{eq(20sec)(max)}$ in Step 1 in Section 11. The highest SEL obtained from the 3 trials was adopted and it was then converted into the Equivalent Sound Pressure Level ($L_{eq(30min)}$) taken into account the maximum number of events which would occur within a 30-minute assessment period. Corrections for distance attenuation, barrier effect and façade reflection were applied in the determination of the noise level at NSRs due to the operation of the brake test strip.

9. RESULT

Date:	24 June 2015
Time:	10:30 – 12:00 (a.m.)
Location:	HKPF Quarry Bay Police Vehicle Pound
Measurement Equipment:	Sound Level Meter 1: Brüel and Kjær 2250 Sound Level Meter 2: Solo-Slm 01dB Sound Level Meter 3: Brüel and Kjær 2270 Sound level Meter 4: Brüel and Kjær 2260 Sound Level Calibrator: Rion NC-73
Measurement duration of Each Test	Around 20 seconds

Table 2 Background noise level

Position	Background Noise ($L_{eq(1min)}$), dB(A)			
	AA'	BB'	CC'	DD'
Before the trials	62.5	63.1	63.9	63.8
After the Trials	63.2	63.8	63.5	63.3
Lowest background noise	62.5			

Table 3 Noise measurement results of the operation of the brake test strip

Position	$L_{eq(20sec)}$, dB(A)				
	AA'	BB'	CC'	DD'	Max
Trial 1	77.8	80.5	79.1	79.3	81.6
Trial 2	78.4	77.9	78.6	79.3	81.5
Trial 3	78.6	77.9	76.4	74.8	79.7

10. EVALUATION OF THE NOISE PROFILE OF THE OPERATION OF THE BRAKE TEST STRIP

- 10.1. The highest maximum $L_{eq(20sec)}$ from the three trials as shown in **Table 3** was adopted to determine the noise level of the brake test strip as a conservative approach. It is observed that the vehicle under test took about 20 seconds to reach position DD' from position AA' during the braking test. The noise measurement data is shown in **Annex**.

11. SAMPLE CALCULATION OF OPERATIONAL NOISE LEVEL FROM BRAKE TEST STRIP

Step 1 - Conversion of L_{eq} to SEL

SEL is L_{eq} normalized to 1 second. The equation for calculating SEL is:

$$SEL = L_{eq(20s)(max)} + 10\log(\text{Time})$$

$$L_{eq(20\text{ sec})(max)} = 81.6 \text{ dB(A)}$$

$$\text{Time} = 20 \text{ Sec}$$

$$SEL = 94.6 \text{ dB(A)}$$

Step 2- Determination of Noise Source Strength, $L_{eq(30min)}$

Taken into account the number of events which will occur within the 30min assessment period, the operation noise level of the brake test strip, $L_{eq(30min)}$ is:

$$L_{eq(30min)} = SEL - 10\log(T) + 10\log(N)$$

$$\text{Assessment Period (T)} = 1800 \text{ Sec}$$

$$\text{Number of event within the assessment period (N)} = 1$$

$$L_{eq(30min)} \text{ at } 7.5\text{m from the strip} = 62 \text{ dB(A)}$$

Step 3- Calculation of Operational Noise Level at NSR, $L_{eq(30min)}$

The length of the brake test strip is finite. As a conservative approach, infinite line source distance attenuation is applied. Barrier correction where appropriate and façade correction were considered in determining the noise level from the brake test strip at the NSR.

$$L_{eq(30min)} \text{ at NSR} = L_{eq(30min)} \text{ at } 7.5\text{m from the strip} - 10 \log(d/7.5) + \text{barrier correction} + \text{façade correction}$$

$$\text{Distance between NSR and the brake test strip (d)} = \text{Refer to Appendix 5.6}$$

$$\text{Barrier correction (for NSR facing away from the Depot)} = -10 \text{ dB(A)}$$

$$\text{Façade correction} = 3 \text{ dB(A)}$$

Project No.: 1158

Chai Wan Government Complex and Vehicle Depot
Appendix 5.9 Noise Measurement for determination of Noise Level of Brake Test Strip

Annex: Noise measurement data

Position	Trial 1					Trial 2					Trial 3				
	AA'	BB'	CC'	DD'	Max	AA'	BB'	CC'	DD'	Max	AA'	BB'	CC'	DD'	Max
	L _{eq} (1sec)					L _{eq} (1sec)					L _{eq} (1sec)				
1	66.6	67.2	65.8	65.2	67.2	64.2	65.8	66.2	65.6	66.2	64.1	63.9	65.2	64.4	65.2
2	65.5	66.5	66.1	66.6	66.6	65.5	65.1	65.8	65.2	65.8	64.9	64.0	65.3	65.0	65.3
3	66.1	66.2	66.2	65.2	66.2	65.8	66.2	64.9	64.8	66.2	66.0	65.0	64.9	65.2	66.0
4	66.8	67.8	66.5	65.0	67.8	66.6	65.8	65.3	64.7	66.6	65.2	64.9	64.4	63.8	65.2
5	67.5	68.5	67.1	66.8	68.5	68.2	65.6	65.5	64.1	68.2	67.8	64.7	66.2	65.6	67.8
6	71.5	69.6	68.1	68.4	71.5	72.4	68.5	67.1	64.3	72.4	73.2	68.6	68.1	67.8	73.2
7	74.8	75.3	74.3	73.8	75.3	75.6	71.5	68.1	65.9	75.6	76.2	70.5	71.5	69.7	76.2
8	80.1	85.8	81.0	80.8	85.8	84.9	76.1	74.3	68.2	84.9	86.2	77.8	78.8	78.4	86.2
9	85.8	86.3	78.4	73.1	86.3	84.3	82.3	81.0	71.9	84.3	85.3	86.5	78.8	80.6	86.5
10	82.9	78.4	75.3	75.0	82.9	81.2	77.8	78.4	79.7	81.2	81.0	78.1	74.1	73.1	81.0
11	78.5	81.4	77.7	79.6	81.4	81.3	77.8	75.3	80.7	81.3	81.2	79.1	78.6	75.5	81.2
12	80.5	83.2	80.6	83.5	83.5	79.6	82.4	77.7	76.8	82.4	80.7	82.3	83.1	78.1	83.1
13	79.5	80.7	87.7	87.5	87.7	78.8	83.4	80.6	78.6	83.4	78.2	82.0	79.6	78.5	82.0
14	77.4	86.4	85.3	85.8	86.4	82.9	79.7	87.7	85.8	87.7	81.0	81.2	83.1	81.3	83.1
15	78.3	85.1	82.8	83.1	85.1	79.2	85.1	85.3	89.4	89.4	76.5	78.2	78.0	75.0	78.2
16	77.6	76.1	74.0	67.0	77.6	72.0	75.1	77.0	77.5	77.5	67.7	68.7	68.4	72.4	72.4
17	69.8	68.0	69.2	67.1	69.8	67.0	68.2	69.2	68.8	69.2	64.8	67.4	67.0	67.1	67.4
18	64.6	67.2	68.9	67.6	68.9	66.5	65.5	65.8	66.3	66.5	64.5	65.1	67.0	67.0	67.0
19	65.1	66.5	67.2	67.1	67.2	64.6	65.2	65.9	66.6	66.6	64.6	67.2	66.9	65.6	67.2
20	65.4	65.9	66.9	66.5	66.9	66.1	66.0	65.8	67.3	67.3	64.5	65.4	66.6	67.0	67.0

Project No.: 1158

Chai Wan Government Complex and Vehicle Depot
Appendix 5.9 Noise Measurement for determination of Noise Level of Brake Test Strip

Position	Trial 1					Trial 2					Trial 3				
	AA'	BB'	CC'	DD'	Max	AA'	BB'	CC'	DD'	Max	AA'	BB'	CC'	DD'	Max
	L _{eq} (1sec)					L _{eq} (1sec)					L _{eq} (1sec)				
1	77.8	80.5	79.1	79.3	81.6	78.4	77.9	78.6	79.3	81.5	78.6	77.9	76.4	74.8	79.7