NOISE POLLUTION SCENARIO IN MAHARASHTRA DURING DIWALI, 2005

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FOREWORD

Noise pollution due to bursting of fire crackers during Diwali was surveyed at 11 cities in the State of Maharashtra. Measurements were done for 3 days through November 1-3, 2005 during 7 PM to 12 PM at 100 locations. Results are presented in this report.

It was generally observed that this year's Diwali was much quieter. Even duration of bursting of fire crackers was reduced particularly in Mumbai and Pune city where by 11 PM at most of the areas in city there was hardly any activity. This is also an indication of public support to the cause of prevention and control of noise pollution.

During Diwali, mass awareness campaign was organised by the Board through print and electronic media. Police Department was also seen alert and attentive to the problem of noise pollution during the festival.

Noise pollution monitoring was done by the officers of the Board and services of the expert consultants were also engaged for augmentation. The entire planning, coordination and report preparation was done by Dr. Ajay Deshpande, Regional Officer. Efforts put in by all concerned are appreciated.

Dr. Dilip B. Boralkar
Member Secretary
November 4, 2005

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1. Introduction

During Diwali festival, noise pollution increases considerably, due to bursting of the fire crackers. In order to assess the situation at various cities in the state of Maharashtra, a survey was carried out for three days, during November 1-3, 2005. Noise level measurements were done during 7 pm to 12 pm. Locations were selected in residential areas and near to the building where actually people stay. The levels recorded are the levels actually faced by the people staying in the building and at ground floor level. The noise levels adjacent to traffic, congested roads and the place of actual fire crackers bursting are obviously even higher. Those are recorded only at few select places for comparison purposes.

1.1 Noise levels were measured with following considerations.

- Resident human being and nuisance to them is the focus of study
- Distance of 4 m from the source of noise in case of fire crackers
- Measurements were done at the ground floor level
- Setting on **dB(A) Fast Leq** for measurement of all noise levels
- General range of noise levels dB(A) and L_N was also recorded.
- L_N setting for 75 dB, i.e. % of time noise exceeded 75 dB
- All instruments were calibrated at 94 dB
- Data collected for 30 minutes at each location for each monitoring, during 7 pm to 9 pm (day time) and from 9 pm to 12 midnight (night time).

2. Noise measurement

The explanation below is presented to facilitate the understanding of the data generated.

Noise v/s Sound

These two words are quite often used interchangeably, which is not very correct. **Noise has been defined as unwanted sound**. A good lyrical song may be liked by us and hence is not a noise. But the same song can be unwanted during examination study time. What we measure with these instruments is the general total sound level in the area, and not Noise. Noise is subjective concept.

Noise Level Measurements

A young, audio-metrically healthy normal male adult responds to sound waves of frequency range of 20 to 16,000 Hz, where as children and women have capacity to respond to 20,000 Hz. The speech zone lies in the range of 500 to 2,000 Hz. The human ear is most sensitive in the range of 2,000 to 5,000 Hz.

Bel B

a logarithmic measure of sound intensity, invented by engineers of the Bell telephone network in 1923 and named in honour of the inventor of the telephone, Alexander Graham Bell (1847-1922). If **one sound is 1 bel louder than another, this means the louder sound is 10 times more intense than the fainter one**. A difference of 2 bels corresponds to an increase of 10 x 10 or 100 times in intensity. The beginning of the scale, 0 bels, can be defined in various ways (see decibel) originally intended to represent the faintest sound that can be detected by a person who has good hearing. In practice, sound intensity is almost always stated in decibels. One bel is equal to approximately 1.151293 *nepers*.

Decibel dB a symbol indicating that a measurement is made using a logarithmic scale similar to that of the decibel in that a difference of 10 dB- corresponds to a factor of 10. In each case, the actual measurement a is compared to a fixed reference level r and the "decibel" value is defined to be 10 log10(a/r). Many units of this kind have been used and only a few of the more common ones are mentioned in the next entries. In each case the dB symbol is followed by a second symbol identifying the specific measurement. Often the two symbols are not separated (as in "dBA"), but the Audio Engineering Society recommends that a space be used (as in "dBA"). In India it is often written as dB(A).

dB A, dB C units of sound intensity, exactly like the decibel except that before the measurement is made sounds of high and low frequencies, heard poorly or not at all by the human ear, have been filtered out. The letters A and C refer to two filtering methods. The writers of the acoustical standards have established three weighting characteristics and these are A, B & C. The “A” weighting network filters out very low frequencies very severely, “B” moderately and “C” hardly filters out any.

Time Weightings The two time weightings are called Fast and Slow responses. Slow responses refer to averaging time of up to 1 second to 0.5 seconds (500 ms) and the Fast response is 125 ms to 200 ms. However, it may vary as per requirement of the purchaser specifications. **dB(A) Fast** closely matches to the simulation of Human ear sensitivity.

dB(A) Fast This setting is used in measurement of noise in present exercise. ‘A’ weighing filters out lower frequencies very severely. Fast response (125 to 200 milli-second) was selected to cover cracker bursting sound.

Noise Rating Systems

The human response to Noise depends upon the frequency of the sound, the type of noise (continuous, intermittent or impulsive) and the time (day or night) it occurs. Thus the Noise rating system should take frequency into account, differentiate between day time and night time noise and be capable of describing the cumulative noise exposure. The following two systems are presently in vogue:

The L_N Concept

If measurements are made over a period of time, the parameter L_N represents or indicates as to how frequently a particular sound level is exceeded. Say L30 = 70 dB(A), then it represents that 70 dB(A) was exceeded 30% of the measuring time.

The Leq Concept

The equivalent continuous equal energy level, Leq can be applied to any fluctuating Noise Level. It is that constant Noise Level that over a given time, expends the same amount of energy as the fluctuating level over the same time period.

Location of monitoring

The sound level measurement has to be done where human being is facing the sound or at employee's place of working. It may be near or far from the actual Noise Source.

Standards

These are depending on the location and period of day. Industrial areas obviously have somewhat higher acceptable sound levels than those prescribed for residential areas. The collected night standards are stringent than the day time standards.

Standards by Law in India

Noise has been recognised as ambient air pollutant. Standards in this regard are laid down under Environment (Protection) Rules, 1986 and under the Model Rules of the Factories Act, 1948.

3. Cities covered

Following cities were covered in the survey.

1. Mumbai
2. Thane
3. Navi Mumbai
4. Nashik
5. Nagpur
6. Kalyan
7. Dombivali
8. Ambernath
9. Ulhasnagar
10. Kolhapur
11. Aurangabad

4. Monitoring Locations

The schedule of locations for each city is given below.

4.1 Mumbai : 45 Locations

South Mumbai

1. Colaba
2. Mantralaya
3. Mazgaon
4. Girgaon
5. Worli / Haji Ali
6. Prabhadevi
7. Mahim
8. Parel / Lal Baug
9. Byculla
10. Dadar-East
11. Sion
12. Hindu Colony
13. Matunga / Parasi Colony
14. Kamathipura
15. Malabar Hill

Eastern Suburbs

16. Chembur
17. Trombay
18. Kurla
19. Ghatkopar-East
20. Ghatkopar-West
21. Mulund-West
22. Mulund-East
23. Sakinaka
24. Powai
25. Wadala
26. Dharavi
27. Sewree / Tata Memorial Hospital
28. Kalina
29. Vikroli (Kannamwar Nagar)
30. Bhandup

Western Suburbs

31. Sahar
32. Santacruz-West
33. Vile Parle-East
34. Bandra-West (Kala Nagar)
35. Goregaon
36. Jogeshwari
37. Varsova
38. Marve
39. Borivali-West
40. Dindoshi
41. Kandivali
42. Dahisar
43. Juhu
44. Gorai
45. Borivali-East

4.2 Thane

46. Main Road / Shiv Mandir
47. Tembhi Naka
48. Gokhale Road
49. Pokharna
50. Wagle Estate

4.3 Navi Mumbai

51. Swami Vivekanand Nagar, CBD
52. Nerul Sector-11,
53. Vashi Sector-1
54. Vashi Sector-9
55. Koparkhairane Sector-10
56. Airoli
57. Rabale
58. Ghansoli
59. Koperkhairane- Balaji Towers
60. Vashi Sector-15

4.4 Kalyan

61. Katemanivali
62. Birla College
63. Bail Bazar

4.5 Dombivali

64. Municipal Office –East
65. Kopar Village
66. Navapada

4.6 Ambernath

67. Kamse Station
68. Near Railway Station - West
69. Sai-Section

4.7 Ulhasnagar

70. Shivaji Chowk No. 3
71. Camp No. 05 Bus Stop
72. Camp No. 01 Gol Maidan

4.8 Nashik

73. Panchavati
74. C.B.S.
75. Dahi Pool
76. BITCO Chowk
77. CIDCO Residential

4.9 Nagpur

78. Ajani Chk.
79. Civil Lines
80. Dharm Peth
81. Itwari
82. Civil Hospital
83. Deshpande Layout
84. Shankar Nagar
85. Mahal
86. Sadar
87. Kalamna

4.10 Aurangabad

88. Gulmandi
89. City Chowk
90. Kranti Chowk
91. CIDCO Residential
92. Usmanpura

4.11 Kolhapur

93. Tara Rani
94. Rajaram Puri
95. Mahalaxmi Mandir
96. Bhavani Mundap
97. Bindu Chowk
98. Shivaji Chowk
99. Papachi Tikti
100. Khas Baug Maidan

5. Standards and Guidelines

The Central Pollution Control Board constituted a Committee on Noise Pollution Control. The Committee recommended noise standards for ambient air and for automobiles, domestic appliances and construction equipment, which were later notified in Environment (Protection) Rules, 1986 as given below:

Area Code	**Category of Area**	**Limits in dB(A), Leq**	
		Day time	**Night time**
A	Industrial area	75	70
B	Commercial area	65	55
C	Residential area	55	45
D	Silence Zone	50	40

Note:

1. Day time is reckoned in between 6 a.m. and 9 p.m.

2. Night time is reckoned in between 9 p.m. and 6 a.m.

3. Silence zone is referred as areas up to 100 meters around such premises as hospitals, educational institutions and courts. The Silence zones are to be declared by the Competent Authority.

4. Use of vehicular horns, loudspeakers and bursting of crackers shall be banned in these zones.

5. Mixed categories of areas should be declared as one of the four above mentioned categories by the Competent Authority and the corresponding standards shall apply.

5.1 Standards for fire Crackers

A. (i) The manufacture, sale or use of fire-crackers generating noise level exceeding 125 dB(AI) or 145 $dB(C)_{pk}$ at 4 meters distance from the point of bursting shall be prohibited.

(ii) For individual fire-cracker constituting the series (joined fire-crackers), the above mentioned limit be reduced by 5 $\log_{10}(N)$ dB, where N = number of crackers joined together.

B. The broad requirements for measurement of noise from fire-crackers shall be -

(i) The measurements shall be made o n a hard concrete surface of minimum 5 meter diameter or equivalent.

(ii) The measurements shall be made in free field conditions i.e., there shall not be any reflecting surface upto 15 meter distance from the point of bursting.

(iii) The measurement shall be made with an approved sound level meter.

C. The Department of Explosives shall ensure implementation of these standards.

Note: dB(AI) A-weighted impulse Sound Pressure Level in decibel $dB(C)_{pk}$ C-weighted Peak Sound Pressure Level in decibel.".

- Manufacture and bursting of joined crackers should be banned.
- Bursting of crackers during night between 9 p.m. and 6 a.m. should be banned.
- Bursting of crackers may be permitted only during public festivals.

Monitoring results

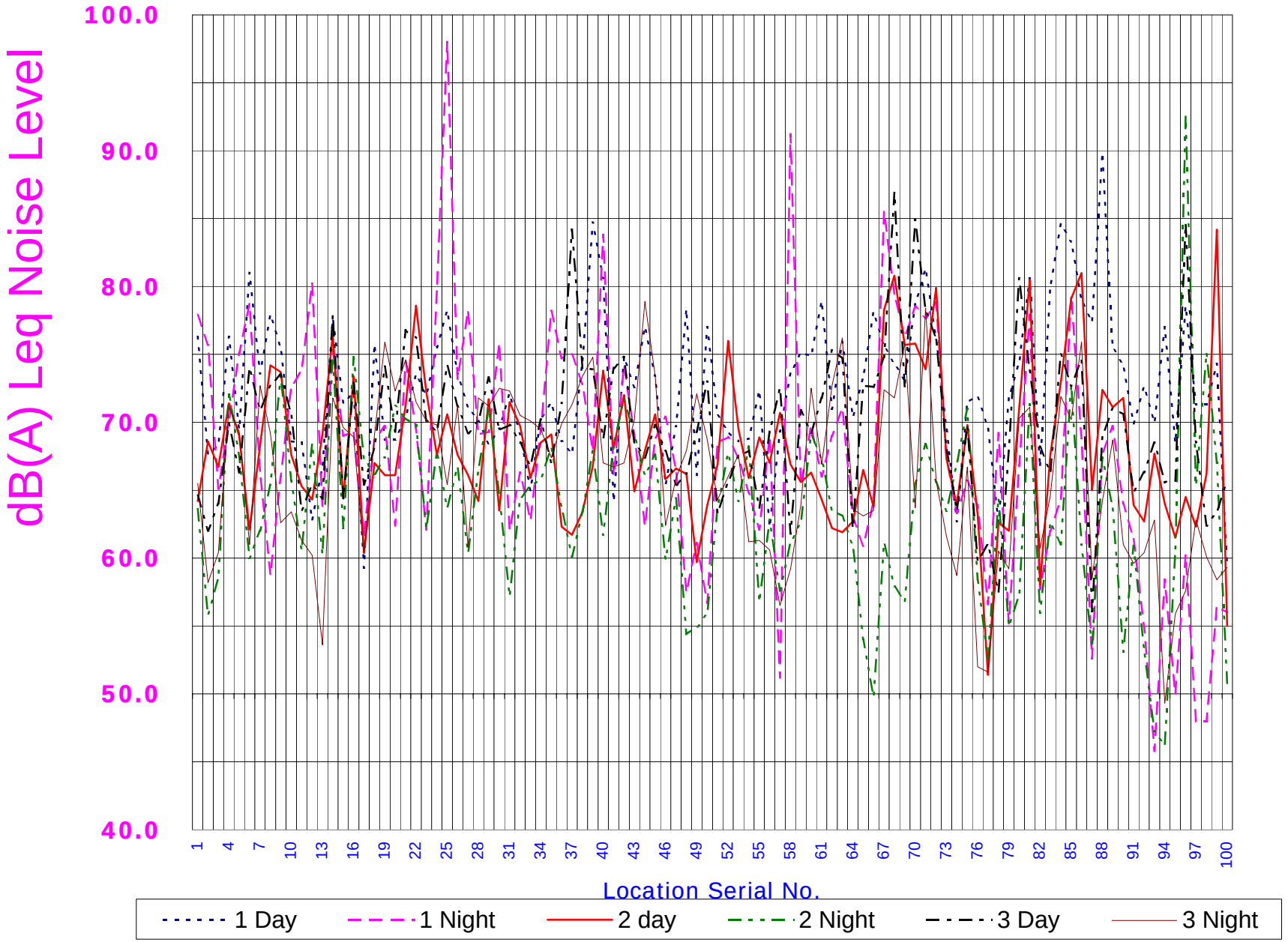
The results of noise level monitoring are presented below.

City	Location	Sr.	1.11.05 Day Leq	1.11.05 Night Leq	2.11.05 Day Leq	2.11.05 Night Leq	3.11.05 Day Leq	3.11.05 Night Leq
Mumbai South	Colaba	1	76.3	77.9	64.2	63.6	64.6	65.5
Mumbai South	Mantralaya	2	67.7	75.7	68.6	55.8	62.0	58.2
Mumbai South	Mazgaon	3	68.3	65.1	66.7	58.5	64.0	60.4
Mumbai South	Girgaon	4	76.3	70.1	71.4	72.2	69.9	71.1
Mumbai South	Worli / Haji Ali	5	69.5	75.1	69.0	67.5	66.3	69.3
Mumbai South	Prabhadevi	6	81.0	78.7	62.1	60.0	74.0	61.0
Mumbai South	Mahim	7	73.6	66.3	68.3	62.0	70.9	72.7
Mumbai South	Parel / Lal Baug	8	77.9	58.8	74.2	65.4	72.7	69.2
Mumbai South	Byculla	9	75.5	66.0	73.7	73.4	73.5	62.6
Mumbai South	Dadar-East	10	68.6	72.6	67.6	65.7	70.6	63.4
Mumbai South	Sion	11	68.5	73.8	65.3	60.6	63.5	61.3
Mumbai South	Hindu Colony	12	62.8	80.2	64.3	68.4	65.4	60.2
Mumbai South	Matunga / Parasi Colony	13	66.7	63.8	69.1	60.3	64.4	53.6
Mumbai South	Kamathipura	14	77.6	75.3	76.5	74.8	77.8	71.8
Mumbai South	Malabar Hill	15	71.4	69.0	64.4	62.2	64.4	69.6
Mumbai East	Chembur	16	72.2	69.3	73.4	74.8	72.9	68.9
Mumbai East	Trombay	17	59.3	61.7	60.4	67.3	65.4	60.3
Mumbai East	Kurla	18	75.7	68.7	67.0	66.2	68.1	69.1
Mumbai East	Ghatkopar-East	19	68.7	69.7	66.1	67.4	74.1	75.9
Mumbai East	Ghatkopar-West	20	68.7	62.4	66.1	71.2	69.3	72.3
Mumbai East	Mulund-West	21	70.4	74.4	71.3	70.3	76.8	74.6
Mumbai East	Mulund-East	22	73.5	69.5	78.6	69.8	76.2	71.5
Mumbai East	Sakinaka	23	72.0	62.1	72.2	62.2	70.1	70.1
Mumbai East	Powai	24	75.5	79.8	67.6	67.8	69.3	69.8
Mumbai East	Wadala	25	78.2	98.0	70.6	63.7	74.2	65.4
Mumbai East	Dharavi	26	73.6	73.2	67.6	66.7	71.2	71.2
Mumbai East	Sewree / Tata Memorial Hospital	27	71.1	78.2	66.1	60.4	69.2	60.8
Mumbai East	Kalina	28	70.1	69.1	64.2	66.5	70.1	71.8
Mumbai East	Vikroli (Kannamwar Nagar)	29	68.4	69.3	71.7	71.0	73.3	71.2
Mumbai East	Bhandup	30	69.5	75.8	63.5	64.7	69.4	72.5
Mumbai West	Sahar	31	72.1	62.1	71.5	57.2	69.8	72.3

Mumbai West	Santacruz-West	32	69.1	66.3	69.7	64.4	68.5	70.5
Mumbai West	Vile Parle-East	33	65.0	62.8	65.9	65.3	66.8	70.1
Mumbai West	Bandra-West	34	70.3	69.4	68.5	65.8	70.2	69.5
Mumbai West	Goregaon	35	71.4	78.2	69.1	68.1	67.0	67.4
Mumbai West	Jogeshwari	36	68.6	74.7	62.3	63.7	71.4	69.9
Mumbai West	Varsova	37	67.7	75.0	61.7	60.1	84.2	71.3
Mumbai West	Marve	38	74.5	72.8	63.4	63.4	74.0	73.4
Mumbai West	Borivali-West	39	84.7	67.9	66.8	67.9	73.9	74.8
Mumbai West	Dindoshi	40	80.6	83.8	73.8	61.7	68.8	67.0
Mumbai West	Kandivali	41	64.2	66.1	68.1	68.4	74.0	66.7
Mumbai West	Dahisar	42	74.8	74.1	72.0	71.7	74.8	67.0
Mumbai West	Juhu	43	72.6	69.1	64.9	69.1	68.5	70.2
Mumbai West	Gorai	44	77.0	62.4	67.9	66.1	67.4	78.9
Mumbai West	Borivali-East	45	73.4	68.8	70.6	67.6	69.8	73.4
Thane	Main Road / Shiv Mandir	46	65.4	70.4	65.8	59.9	67.9	62.4
Thane	Tembhi Naka	47	69.7	66.5	66.6	64.4	65.4	65.9
Thane	Gokhale Road	48	78.3	57.5	66.2	54.4	66.2	67.9
Thane	Pokharna	49	66.1	61.1	59.7	54.9	69.3	72.1
Thane	Wagle Estate	50	77.0	56.7	63.9	55.9	73.0	68.7
Navi Mumbai	Swami Vivekanand Nagar, CBD	51	70.5	68.5	66.9	63.8	63.3	64.3
Navi Mumbai	Nerul Sector-11,	52	69.3	68.9	76.0	67.7	65.6	66.0
Navi Mumbai	Vashi Sector-1	53	68.6	67.4	69.5	64.2	67.5	67.6
Navi Mumbai	Vashi Sector-9	54	68.8	64.8	65.9	68.2	67.9	61.2
Navi Mumbai	Koparkhairane Sector-10	55	72.3	62.1	68.9	56.8	63.7	61.3
Navi Mumbai	Airoli	56	62.3	68.9	67.0	62.8	69.3	60.6
Navi Mumbai	Rabale	57	69.3	51.2	70.7	57.6	72.5	56.5
Navi Mumbai	Ghansoli	58	73.6	91.2	66.9	61.1	61.8	59.2
Navi Mumbai	Koperkhairane- Balaji Towers	59	75.1	65.4	65.6	62.6	70.9	63.9
Navi Mumbai	Vashi Sector-15	60	74.9	69.7	66.3	69.1	69.2	72.5
Kalyan	Katemanivali	61	78.9	66.0	64.3	67.3	71.8	66.9
Kalyan	Birla College	62	71.0	69.0	62.2	63.5	75.3	72.7
Kalyan	Bail Bazar	63	75.9	71.0	61.9	63.1	74.7	76.2
Dombivali	Municipal Office –East	64	70.4	63.0	62.7	60.9	62.2	63.6
Dombivali	Kopar Village	65	73.3	60.9	66.5	54.0	72.7	63.1
Dombivali	Navapada	66	78.1	64.1	63.8	49.8	72.6	63.5
Ambernath	Kamse Station	67	75.6	85.5	78.3	61.1	74.8	72.4
Ambernath	Near Railway Station - West	68	74.3	79.4	80.8	57.9	86.9	71.8
Ambernath	Sai-Section	69	73.1	76.3	75.7	56.8	72.5	75.8

Ulhasnagar	Shivaji Chowk No. 3	70	78.7	78.5	75.8	65.5	84.9	63.7
Ulhasnagar	Camp No. 05 Bus Stop	71	81.3	77.7	73.9	68.4	78.2	78.4
Ulhasnagar	Camp No. 01 Gol Maidan	72	76.1	78.8	79.9	65.6	76.2	65.7
Nashik	Panchavati	73	69.6	67.4	67.3	63.5	68.1	61.6
Nashik	C.B.S.	74	62.7	63.3	63.9	66.9	63.5	58.7
Nashik	Dahi Pool	75	71.5	65.7	69.8	71.0	69.7	66.7
Nashik	BITCO Chowk	76	71.9	63.9	63.2	58.4	59.8	52.0
Nashik	CIDCO Residential	77	69.6	56.6	51.4	52.6	61.0	51.6
Nagpur	Ajani Chk.	78	62.6	69.2	62.6	64.4	57.5	60.5
Nagpur	Civil Lines	79	71.8	55.2	62.0	55.0	67.9	59.2
Nagpur	Dharm Peth	80	74.4	66.8	71.0	57.2	80.6	70.3
Nagpur	Itwari	81	80.6	77.9	80.5	71.3	73.8	71.1
Nagpur	Civil Hospital	82	66.7	57.7	58.0	56.0	68.2	60.7
Nagpur	Deshpande Layout	83	80.0	62.0	67.6	62.6	66.3	64.6
Nagpur	Shankar Nagar	84	84.6	64.3	73.0	61.0	75.0	71.9
Nagpur	Mahal	85	83.3	79.3	79.1	72.7	72.7	70.2
Nagpur	Sadar	86	79.0	68.8	81.0	61.0	74.6	75.9
Nagpur	Kalamna	87	77.4	52.6	65.0	53.4	56.1	58.5
Aurangabad	Gulmandi	88	89.8	67.7	72.4	67.4	69.0	64.2
Aurangabad	City Chowk	89	75.5	69.7	71.1	63.7	71.0	68.7
Aurangabad	Kranti Chowk	90	74.2	64.0	71.8	53.1	70.6	61.0
Aurangabad	CIDCO Residential	91	69.9	61.4	63.9	60.9	64.9	59.6
Aurangabad	Usmanpura	92	72.6	54.9	62.7	53.2	66.3	60.4
Kolhapur	Tara Rani	93	70.0	45.8	67.7	47.2	68.5	62.8
Kolhapur	Rajaram Puri	94	77.0	58.4	64.0	46.2	65.6	49.3
Kolhapur	Mahalaxmi Mandir	95	68.5	50.0	61.5	60.5	65.7	55.9
Kolhapur	Bhavani Mundap	96	78.5	60.2	64.5	92.5	84.6	57.6
Kolhapur	Bindu Chowk	97	71.3	48.0	62.3	65.4	68.5	62.8
Kolhapur	Shivaji Chowk	98	71.3	48.0	66.2	75.1	62.4	60.1
Kolhapur	Papachi Tikti	99	74.3	56.4	84.2	67.0	63.4	58.4
Kolhapur	Khas Baug Maidan	100	59.4	56.0	55.0	50.8	65.7	59.3

Noise Levels Diwali 2005



7. Observations

1. The duration of bursting of fire crackers on Diwali day (1.11.05) was found much reduced. After 10 pm, at most of the locations there was hardly any activity.

2. On 2nd and 3rd November, the bursting of fire crackers was sporadic and negligible in terms of increase of noise pollution.

3. The ambient noise levels at all locations was in the range of 55-75 dB(A). These values are higher than the stipulated limit of 55 dB for day time and 45 dB for night. However, these are much lower than the values observed in last year.

4. The noise levels were much higher during 8 and 9 pm but were found reduced afterwards.

5. Maximum dB(A) Leq averaged over 30 minute was less than 80 dB at all locations. (Except few incidences)

6. Vehicular traffic is also one of the major factors causing higher noise levels expressed as cumulative average in terms of Leq. (Linear Equivalent)

7. Peak levels of noise were found as high as 118 dB(A) at ground floor at 4 m distance from fire cracking area. However this level was found intermittently only during the fire cracking.

8. From detailed observations recorded during the monitoring, duration of fire cracking is mostly limited prior to 10 pm.

9. South Mumbai area is relatively less active in the night time and noise levels were found to be lower.

10. Some of the residential areas were noisy even after 10 pm.

11. The fire crackers with light illumination were used more than the noisy ones.

12. The emission of smoke was found more in the light illuminating fire crackers. Levels of SO_2 (Sulphur dioxide) and RSPM (respirable suspended particulate matter) was found marginally higher on Diwali day.

8. Conclusion

1. Diwali has been less noisy than the last year according to survey conducted by the Board but noise levels were still above the safe limits in most of the areas.

2. Noise levels though found exceeding the limits, there was overall reduction in terms of duration of noise and its intensity as compared with last year or so.

3. Duration of bursting of crackers was seen reduced considerably all over the state. In fact, most of Mumbaikar had stopped use of fire crackers by 10 pm or so.

4. In totality, one can say this Diwali was low on noise pollution.

5. Public awareness and support in matters of environment protection has increased. This is one of the main contributors in bringing down noise pollution during the Diwali.

Annexures

Noise & its effects

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Noise

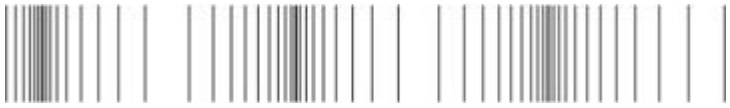
Noise is defined as unwanted sound. Noise is an inescapable part of everyday life - the television, a plane flying overhead, a faulty muffler on the passing car, dogs barking, children laughing. Mild noise can be annoying; excessive noise can destroy a person's hearing. People do not easily become accustomed to noise. The slightest unwanted sound can become very annoying if it continues for any length of time. While the continuous hum of a busy freeway may be ignored by some nearby residents, others will never be able to ignore it and increasingly will find it irritating.

How Humans Hear

The visible part of the ears are sound gathering scoops that guide sound waves along a one-inch canal which acts as a resonating chamber. When they reach the eardrum, they become vibrations. These vibrations are picked up in the middle ear by three tiny linked ear bones and are mechanically passed deeper to the inner ear where hair cells translate them into electrochemical impulses. The auditory part of the brain interprets this stimulus and decides how far away it is, where it is, and what it is.

What The Ears Hear

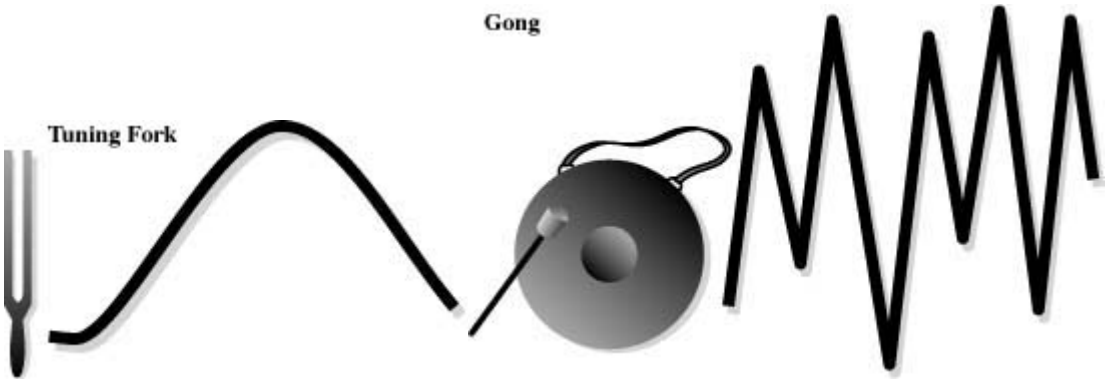
Sound is the result of **waves compressed atmospheric particles traveling** through the air. The waves are created when atmospheric particles alternately are squeezed closer together than normal, then pulled farther apart than normal. Sound waves move outward from the vibrating source and weaken as they travel. They may be reflected or bent by obstacles so the sound that reaches the ear may be different from the sound that was originally generated.



Waves are created when atmospheric particles alternately are squeezed closer together than normal, then pulled farther apart than normal.

Measuring Sound

The frequency and intensity of sound are measured. Sound producing vibrations are repetitive or cyclical and are measured in Hertz (Hz) which notes the number of cycles that occur per second (cps). The greater the frequency, the higher the pitch. Children's ears respond to frequencies as high as 40,000 Hz, while the range for adult ears narrows considerably, mostly by loss in the high-frequency range.



The intensity or force of a sound determines its loudness and is measured in decibels (dB). The greater the force, the louder the

sound. Each three-decibel increase doubles the loudness. The difference between 100 dB of a garbage truck and 110 dB of a race car represents an increase of more than 300 percent.

The Difference Between Sound and Noise

Not all people are affected the same way by the same sounds. Often, we take for granted the sounds we hear everyday. On different occasions and in varying situations, however, common everyday sounds can interfere with our routine task. When this happens, sounds become noise.

What may be a disturbing noise for one person may be a pleasant sound for someone else. For example: A couple lives in a small town and every morning a nearby rooster crows at daybreak. The wife finds it a pleasant way to awaken each day; the husband can't stand it. He awakens before the rooster crows and waits for it to begin. When it does, he flies into a rage. Train whistles, children playing, someone coughing during a symphony, and people talking in a movie are examples of sounds that can evoke extreme reactions.

Sounds generally considered to be pleasant, create variations in pressure with a regular pattern. Sound waves commonly translated as noise often have irregular patterns. The patterns created by human voices have both irregular and regular sound pulses. An adult with good hearing can hear frequencies between 20 and 20,000 hertz (Hz); frequencies between 2000 Hz and 8000 Hz are considered most annoying. Those below 500 Hz or above 10,000 Hz are considered less annoying.

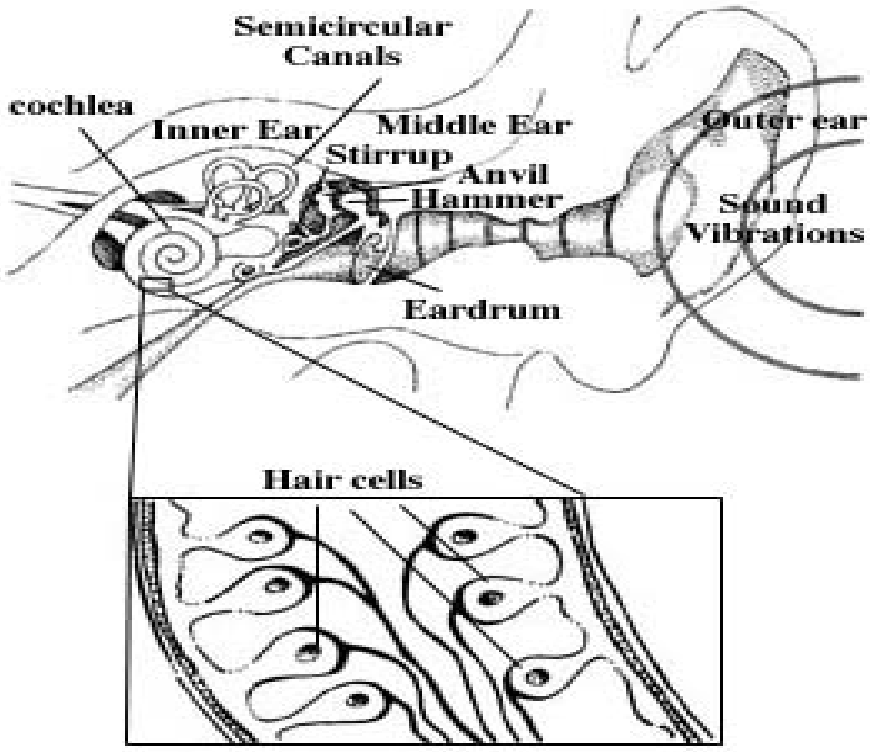
Noise as an Irritant

It is not so much the pitch or loudness of a sound that makes it unbearable as it is its repetitive nature, the distraction it causes and the lack of control over it. A voice in normal conversation is normally around 60 dB. Normal city or freeway traffic registers 70 dB. According to the Organization of Economic Cooperation and Development study 1991 State of the Environment publication, people consider noise to be the main local environmental problem, sometimes even more important than air pollution or the quality of drinking water.

Noise as a Psychological Fact

Introverted people seem to be more bothered by noise than extroverted people. Individuals prone to depression, hypochondria and anxiety or who are going through a difficult emotional experience such as divorce or unemployment tend to be more sensitive to extraneous sounds and consider them noise.

How Noise Damages the Ear



Normal hearing depends on the health of the three components of the human ear: the inner, middle and outer ear. There are three kinds of hearing loss: conductive, sensory and neural. Conductive hearing loss occurs when something happens to the outer or middle ear, such as excessive ear wax, a damaged ear drum or fluid in the middle ear. Neural hearing loss is caused by damage to auditory nerves. Sensory hearing loss is caused by damage to the inner ear (cochlea) and is the most common form associated with noise.

The cochlea contains thousands of tiny hair cells which transmit sound impulses to the auditory nerve. An explosion of 140 dB can cause permanent deafness, for it destroys certain cells in the inner ear that do not regenerate. The middle ear has a reflex action that reduces the transmission of sound and helps prevent damage. It is too slow, however, to protect against sudden bursts of sounds such as gunshots. Extended exposure to excessive noise levels can reduce the ability of the hair cells to transmit sound by flattening or disfiguring them or by causing them to fuse together. Sensory hearing loss is generally irreversible, but further loss can be prevented by using protective equipment or by reducing the amount of noise in the work place. The most common causes of conductive hearing loss in the work place would be damage to the eardrum due to a blow to the head or an explosion.

Safe Range

Sound\	Decibels (dB)
Stream flow, rustling leaves\	15
Watch ticking, soft whisper\	20-30
Quiet street noises\	40
Normal conversation\	45-60
Normal city or freeway traffic\	70
Vacuum cleaner\	75
Hair dryer\	80
Motorcycle, electric shaver\	85
Lawn mower, heavy equipment\	90
Garbage truck\	100
Screaming baby\	115

Injury Range

Race car, loud thunder, rock band\	120-130
Jack hammer 3 feet	
Jet airplane's takeoff from 120 feet\	120
Pain threshold\	130
Rocket launch from 150 feet\	180

Noise Damages More Than The Ears

In addition to contributing to hearing loss, too much noise can affect health in other ways too. There are immediate effects that may be temporary or may become longer lasting. These include cardiovascular problems with an accelerated heartbeat and high blood pressure, gastric-intestinal problems, a decrease in alertness and ability to memorize, nervousness, pupil dilation and a decrease in the visual field. Effects that my be longer lasting include insomnia, nervousness, bulimia, chronically high blood pressure, anxiety, depression and sexual dysfunction.

A Health Problem or a Social Irritation

Noise generates conflicts between the participating and nonparticipating groups. There is a difference between loudness of an unwanted sound and the annoyance it causes. People generally tolerate noise more easily if they are causing it, if they feel it is necessary, and/or if they know its source.

Every exposure to loud noise destroys some hair cells. Continuous exposure to noise no louder than people shouting, over a period of years for 8 hours a day, 5 days a week can cause some degree of hearing loss. This type of hearing loss is permanent.

Noise in the Workplace

"This office is so noisy, I can't think!" When noise levels in a workplace are loud enough to require people to raise their voices in order to talk, the sounds are above 85 decibels. If people are exposed to such noise levels for 8-hours a day, the Occupational Safety and Health Act (OSHA) requires a formal hearing conservation program be developed. This can include noise measurements, engineering controls to reduce noise, hearing examinations for exposed employees and personal protective equipment. Sound below 85 decibels is not regulated. Noise levels above 58 dB can interfere with voice communications and for some people can affect thought processes.

Employees may sense noise in two ways. They may hear it as it travels through the air from its source. Less frequently, employees may "feel" the noise as the noise source vibrates and sends vibrations through the building structure.

According to OSHA's permissible noise exposures table, the higher the decibel level, the shorter the acceptable duration of exposure per day. For example, the operator of a jack hammer (100 dB) may spend no more than two hours per day exposed to that noise level. Airport employees who work around jet airplanes as they rev up their engines (120 dB) may spend no more than 15 minutes per 8 hour day exposed.

A Growing Concern

Noise pollution is an increasing problem in developing countries with the noises associated with road traffic being the major contributor. Two percent of the U.S. population consider aircraft to be a major noise nuisance. Among the sources of neighborhood noise problems and countless complaints and court cases are stereo systems, household appliances and barking dogs.

Possible Solutions

When complaints are made about noise, try to identify which specific characteristic of the noise is offensive so control measures can be explored. Is the noise too loud, too unpredictable, too high pitched? Solutions may include such actions as having neglected equipment and systems serviced, or enclosing noisy machines in a separate room. When noise sources are diffused, isolating people with dividers may offer some relief if they are at least 5 feet high and are placed as close to the floor as possible.

A separate conference room is needed for confidential conversations. Noise can penetrate drop ceilings, travel long distances above ceilings before reentering the work space through transfer grills or other openings. Conference rooms need slab-to-slab walls with appropriate sound absorptive interiors. Repainting acoustical ceilings can reduce the sound absorption properties.

Active noise control systems may eliminate an annoying noise or may generate a desirable noise. An active noise control system may produce a sound that is out of phase with the disturbing noise and cancel it out. Another system may produce background noise sometimes called "white noise" to mask other noises or for privacy. Determining the level of background noise is often a compromise. It should be able to provide speech privacy and yet not interfere with speech intelligibility. Music is an acceptable approach except that musical tastes are so diverse it is difficult to find selections that are acceptable to everyone. Ventilation systems can provide a marking effect unless it kicks on and off periodically. In that case it may be more disruptive than helpful.

People who work in a very noisy environment or who have excessively noisy leisure time activities should wear ear protectors. With protectors, employees can remain in that environment for 8 hours. The highest permissible noise exposure for the unprotected ear is 15 minutes per day.

Other countries are addressing noise issues. Australia is the most advanced with noise reduction regulations. Examples of what some Australian states are doing to reduce noise include:

- Lawn mowers, chain saws and jack hammers must carry a "noise" label.
- When police in Adelaide, a city in southern Australia, spot an unsafe or noisy car on their roads, they suspend the car's registration until it is repaired in an authorized garage.
- In New South Wales and in some parts of the U.S., noisy vehicles can be stopped and tested by the side of the road.

Switzerland is the only country that requires that the best possible technology for reducing noise always be used. Contractors, for example, must encapsulate already low-noise-producing truck engines with the costs covered by the users. The Swiss Society of Engineers and Architects has defined the required norms for soundproofing building interiors: stairwells, lifts and heating and ventilation systems.

Effects of noise

The WHO suggests that noise can affect human health and well-being in a number of ways, including annoyance reaction, sleep disturbance, interference with communication, performance effects, effects on social behaviour and hearing loss. Noise can cause annoyance and frustration as a result of interference, interruption and distraction. Activity disturbance is regarded as an important indicator of the community impact of noise (Australian Environment Council 1988). The AEC national noise survey assessed two major disturbances, for example, to listening activities and sleep: 41% of respondents reported experiencing disturbance to listening activities and 42% to sleep (table 1.21).

TABLE 1.21: Disturbance from various noise sources, Australia 1986

Type of noise	Noise heard	Disturbs listening	Disturbs sleep	Moderately annoyed	Highly annoyed	Most like to eliminate
Traffic	45%	13%	12%	21%	6%	17%
Barking dogs	45%	8%	15%	21%	9%	16%
Lawn mowers	44%	9%	2%	13%	3%	6%
Noisy neighbours	15%	4%	5%	8%	4%	5%
Trail bikes	13%	4%	2%	7%	4%	5%
Aircraft	24%	9%	2%	8%	2%	5%
Garbage collection	26%	-	7%	8%	2%	3%
Neighbours TV/music	14%	4%	4%	6%	3%	3%
Railway	17%	5%	3%	6%	2%	3%
Noisy parties	10%	3%	5%	6%	3%	2%
Burglar alarms	7%	2%	2%	3%	1%	1%
Construction noise	5%	1%	1%	2%	1%	1%
Entertainment venue	3%	1%	1%	1%	1%	1%
Sporting venue	4%	1%	-	1%	-	1%
Factory/shop	3%	-	-	1%	1%	1%
Air conditioner	4%	-	1%	1%	-	-
Scare guns	2%	-	-	-	-	-
Shopping centre	1%	-	-	-	-	-
Other	2%	1%	1%	-	-	2%
Total	85%	41%	42%	-	-	71%

Note:
1. Percentages are based on total sample of 2,332 (779 in NSW).
Source: Australian Environment Council 1988

Research into the effects of noise on human health indicates a variety of health effects. People experiencing high noise levels (especially around airports or along road/rail corridors) differ from those with less noise expo sure in terms of: increased number of headaches, greater susceptibility to minor accidents, increased reliance on sedatives and sleeping pills, increased mental hospital admission rates.

Exposure to noise is also associated with a range of possible physical effects including: colds, changes in blood pressure, other cardiovascular changes, increased general medical practice attendance, problems with the digestive system and general fatigue.

There is fairly consistent evidence that prolonged exposure to noise levels at or above 80 dB(A) can cause deafness. The amount of deafness depends upon the degree of exposure.

Major noise sources

Road traffic

Road traffic noise is one of the most widespread and growing environmental problems in urban NSW. In 1991 it was estimated that in Sydney:

- 1.5 million residents were exposed to outdoor traffic noise levels defined by the OECD as undesirable (between 55 and 65 dB(A)), where sleep and amenity are affected
- 350,000 of these residents were estimated to experience noise levels considered as unacceptable (greater than 65dB(A)), where behaviour patterns are constrained and health effects are demonstrable (ABS 1997b).

In 1994 the NSW Road Traffic Noise Taskforce reported that road traffic noise has become a major urban environmental problem because:

- historically, land use planning has not been well integrated with transport planning, allowing residential developments and major transport corridors to occur in close proximity without appropriate buffer zones or treatment to buildings
- there has been an increasing community reliance on road transportation, and a reluctance to implement or accept

partial solutions involving greater use of public transport (see section 5.6)

- traffic on many existing roads through built-up areas has increased well beyond expectations prevailing during planning or construction of the roadways
- potential solutions, apart from new vehicle noise standards are complex, often costly, and require coordinated actions by a number of agencies and the community
- while there is high community awareness of the problem, there is a general lack of understanding of its extent and possible solutions.

The impact of road traffic noise on the community depends on various factors such as road location and design, land use planning measures, building design, vehicle standards and driver behaviour.

Motor vehicle ownership in NSW has increased substantially over the last 30 years (see section 5.6); and general levels of road traffic noise throughout NSW have increased through this period.

Although some site specific measurements have been taken in response to particular issues, there is a general lack of consistent data on the impact of road traffic on noise levels within the state and even within urban areas. The lack of background noise data collected both before and after construction of new roads or expansion of existing ones, making it difficult to assess the impact on ambient noise levels. In response to this lack of data, the RTA is developing a comprehensive road traffic noise database of all its road traffic noise measurements. RTA information indicates that many of the major roads within Sydney have traffic volumes in excess of 30,000 vehicles per day. This volume of traffic produces a noise level of about 70 dB(A) L_{eq} (L_{eq} is the average noise level which would occur if noise levels were uniform) (data supplied to EPA by RTA, 1997).

Air traffic

In the Sydney metropolitan area it has been the cause of considerable community concern, particularly since the opening of the third runway at Sydney's Kingsford Smith airport and with the planning of a second Sydney airport. The extent of aircraft noise impact depends on the types of aircraft flown, the number of flights and flight paths.

Between 1990 and 1996 total aircraft movements at Sydney airport increased by 37% to meet the increasing demand at the airport (figure 1.35). The in crease in the number of flights, an important factor in overall noise levels, has led to an increase in general noise

levels associated with air traffic. The third runway at Sydney airport was opened by the Commonwealth government in November 1994. Airport operations changed to accommodate the new runway and included the introduction of new flight paths. The change in operations at Sydney airport led to changes in the noise levels experienced by the community. Many affected areas reported that they were being exposed to higher noise impacts than predicted in the environmental impact statement or that impacts were occurring in areas where no aircraft noise was predicted. Recent changes to the operation of Sydney airport have led to an increase in the level of complaints (see section 1.7.5).

Rail traffic

There are two main sources of noise and vibration relating to the operation of the rail network: the operation of trains and the maintenance and construction of rail infrastructure.

The level of noise associated with rail traffic is related to the type of engine or rolling stock used, the speed of the train and track type and condition. Major NSW population centres are served by electric trains which are generally quieter than diesel. Areas affected by freight trains often experience higher noise levels than areas affected by passenger trains. The problem of noise is compounded by the requirements of railway operations (especially night operations) and factors such as stopping patterns and topography which can lead to localised problems.

Rail noise can be considerable, but generally affects a far smaller group of the population than road or aircraft noise as it is generally confined to residents living along rail lines in urban areas (ABS 1997b). While changes to locomotives and rolling stock mean that they have become quieter over the last few years, railway noise remains a problem because of longer, more frequent and faster trains and the build up of the urban environment.

The Hunter Valley is the most important centre for coal production for export purposes in NSW. Large coal trains used to carry the coal are a source of noise related complaints in the area. In response to this Freight Rail Corp organised an extensive study of rail related noise. The study found that the majority of the sites monitored along the Sydney to Newcastle line and along major coal routes, on occasions, exceeded at least one of the EPA targets for environmental noise of railway operation. For residents adjacent to existing railway lines the target levels are the maximum level of 85 dB(A) and an L_{eq} level of 60 dB(A). Although noise associated with freight trains is generally higher than that from passenger trains, the study also indicated that passenger traffic was a significant component of overall noise along the Sydney-Newcastle line.

Freight Rail Corp and Rail Access Corp are currently compiling a profile of noise associated with all freight and passenger trains in NSW.

Cost of transport noise

The economic costs of noise can include costs associated with building noise barriers alongside major transport routes, insulating affected buildings and the lowering of property prices for residential and commercial buildings. Noise costs are difficult to quantify and so estimates can vary widely (ABS 1997b). Other costs, such as annoyance and impacts on human health or fauna are even more difficult to quantify. There are very few studies of the cost of rail noise.

A study of Australian transport and the environment reports the following studies estimating costs of road traffic associated noise (ABS 1997b):

- the National Roads Transport Commission (1995) estimated annual noise costs to be between $200 and $400 million
- the National Roads Transport Commission (1995) also report an estimate made by the Interstate Commission in 1990 of $534 million
- a study of the effects of transport noise on residential property values adjacent to arterial roads in Melbourne estimated the annual cost ranged from $43-86 million for 1992 (EPA Vic 1994)
- in 1991 it was estimated that it would cost $750-880 million to reduce traffic noise experienced in all Sydney residences to levels close to the OECD recommended level of 57 dB(A) (NRMA 1991).

In Australia a number of estimates have been made of the impact of aircraft noise on housing prices and have found significant negative relationships between the two. These estimates show that noise depressed house values by between 6-23% (EPA 1995b). Generally it appears that the impact per unit of noise increases at higher noise levels.

Neighbourhood & domestic noise

Other significant sources of noise annoyance in Sydney include barking dogs, car alarms, garbage recycling, lawn-mowers, building construction and household noise. A significant proportion of complaints received by local councils, the police and the EPA are related to neighbourhood noise (EPA 1993a). The national noise survey found that noise from barking dogs and road traffic have the

greatest impact on residential communities (table 1.21). Noise from barking dogs is of particular concern because it is unpredictable and often happens repeatedly.

Incompatible land use

Generally the determination of land use zoning includes the separation of activities which are incompatible due to noise levels. For example, heavy industrial area will be separated from residential areas by light industrial, recreational facilitates and/or retail activities. However, changing land uses over many decades and earlier inappropriate zoning controls have resulted in unacceptable noise levels for some areas and uses.

The Department of Urban Affairs and Planning (DUAP) has developed environmental impact statement guidelines for major developments which address siting issues, for which noise generation is a consideration, in addition to ensuring noise impact assessment is carried out as part of the assessment process (DUAP 1996).

To address land use planning along rail corridors, the rail sector has developed a strategy to encourage inclusion of noise and vibration generated by existing and future rail operations in the development process. A key aim of the strategy is to improve awareness of council planners, developers and the community to rail noise and vibration related issues. As part of this initiative in December 1995 the rail sector distributed a series of educational guidelines to all councils with rail lines in their area. This was followed in March 1996 by an educational workshop for councils.

Increased awareness of the issue of incompatible land use planning has led to a number of councils, including Hornsby, Sydney City, Botany, Fairfield and Sutherland in Sydney, introducing codes for noise in development plans.

Noise control measures

Responsibility for noise control

In NSW no single government authority has the responsibility or capacity to be able to minimise all forms of noise pollution. The state is excluded from control of noise in a number of areas by commonwealth legislation. These include aircraft noise, where noise limits could affect trade, and the setting standards for noise emissions from new vehicles. In areas where the state does have powers to control noise the EPA has an overall responsibility for environmental noise (as distinct from occupational noise), under the *Noise Control Act 1975*. The Act deals with the prevention, minimisation and abatement of noise and vibration and empowers

the EPA, the Waterways Authority, local government and the police for these purposes.

The EPA controls noise from scheduled premises those required by the Noise Control Act to have a licence and noise associated with rail traffic and the construction or upgrading of freeways and toll roads. The Police and local councils are generally responsible for neighbourhood noise issues and have authority to issue noise abatement directions to control noise from premises and for noise from burglar alarms. Local councils have an essential role in minimising the effects of excessive noise, particularly in their local residential areas, from smaller factories, non-scheduled premises and public places. The Waterways Authority has specific responsibilities in relation to noise from vessels in navigable waters.

Airservices Australia is responsible for control of environmental noise associated with aircraft arriving and departing from Sydney (Kingsford Smith) airport. The Federal Airports Corporation, as the airport owner and operator is responsible for noise associated with noise at the airport including on-ground air movements.

The *Environmental Planning and Assessment Act 1979* provides responsibility and opportunity for controlling environmental noise through the planning process. Consideration of the implications of environmental noise at the planning stage can often avoid or minimise the need for supplementary noise controls. However, in some instances noise reduction or mitigation measures are essential, for example:

- controls on noise levels generated from a source (e.g. vehicle/machine design, driver/operator behaviour)
- controls on noise transmission (e.g. through the use of noise barriers)
- measures to reduce the level of sound reaching a receiver (e.g. soundproofing sensitive or affected buildings).

Reducing road traffic noise

The Noise Control (Motor Vehicles and Motor Vehicle Accessories) Regulation 1995 prescribes noise levels for classes of motor vehicles and restricts allowable noise levels for vehicles manufactured at variable times depending on the class of the vehicle. In addition, the EPA conducts a noisy vehicle testing program on passenger cars, motor bikes and trucks. However, despite progress in addressing the problem of individually noisy vehicles, the rise in traffic volume has meant an increase in traffic noise overall.

The Road Traffic Noise Committee was formed in December 1995 to facilitate the implementation of the recommendations made by the

Road Traffic Noise Taskforce. Initiatives completed or currently under way as part of this process include:

- developing the EPA environmental criteria for road traffic noise (see below)
- releasing the Roads and Traffic Authority's (RTA) community education information about traffic noise and homes
- in 1996, 250 RTA Vehicle Inspectors were trained by the EPA in measuring and identifying noisy vehicles and were declared Authorised Officers under the Noise Control Regulations
- researching road traffic noise for which the RTA has allocated $230,000 for 1996-97
- promoting, at a national level, a new Australian Design Rule for heavy vehicle exhaust breaks (a joint effort by the EPA and the RTA).

The EPA, in consultation with the RTA, is currently finalising environmental noise criteria to indicate noise levels that will guide the development of strategies to protect people and communities from excessive levels of road traffic noise. The environmental criteria will improve the management of road traffic noise for new or upgraded roads, and will apply to: new roads, bridges or freeways; new road use or upgrading of an existing road, bridge or freeway; or new development near an existing road.

In response to community concerns about noise from major arterial roads, the NSW Government introduced the Noise Abatement Program. A noise complaint register was developed by the RTA as a first step to implementing the program, which provides noise abatement measures to reduce noise in sensitive locations such as residences and schools. These include noise mounds, noise attenuation walls and quieter road surfacing. In 1995-96 a total of $8,223,000 was spent under the program benefiting at least 1,200 homes, 5 schools and 3 churches (information supplied to EPA by RTA). A further $14,720,000 has been allocated for 1996-97.

Some local councils are addressing the issue of road traffic noise by introducing traffic management initiatives to reduce noise. These include use of traffic calming measures, resealing of council-controlled roads and blocking of streets to limit access to certain routes.

At a federal level the National Road Transport Commission is developing a new Australian Design Rule to limit noise from exhaust brakes on new heavy vehicles. An education campaign to limit the use of exhaust brakes on current vehicles is also under preparation. Both of these are planned to be implemented in December 1997.

Since traffic volumes and noise levels are connected, the continuing growth in traffic volume within many urban areas of NSW (see section 5.6) can only further increase the noise levels. Reducing reliance on private transport and utilising public transport is a strategy which will reduce traffic volumes and noise. To reduce the impact of environmental ambient noise levels to the population in NSW it is important to consider transportation needs in an integrated fashion to reduce the impact to the community.

Reducing air traffic noise

A range of measures have been introduced by the Commonwealth government to reduce or mitigate some of the noise impact associated with Sydney airport, including:

- a noise amelioration program that includes insulation and acquisition of the most affected properties, including houses, schools, child care centres, nursing homes and hospitals. As of 31 January 1997, $64,326,000 had been spent on insulation (the average cost for a house is $38,000) and $31,900,000 on land acquisition (data supplied to EPA by Commonwealth Department of Transport & Regional Development 1997)

- the introduction of an aircraft noise levy in October 1995 for each jet aircraft landing at the airport. The level of the levy is based on the noise characteristics of the aircraft. Money from the levy is being used to pay for noise amelioration measures.

The Commonwealth government, through Airservices Australia, is now pursuing a policy of sharing the noise from aircraft using the airport. Further changes designed to continue the policy of sharing aircraft noise across Sydney have been proposed in a long term operating plan for the airport. In November/December 1996, there were 11,847 complaints associated with aircraft noise from Sydney airport (data from Airservices Australia's Noise Inquiry Unit). This represents an increase of 241% compared to the same period in 1995.

The issue of air traffic related noise is one of the major community concerns regarding the proposed second Sydney airport. An environmental impact statement for the proposal is currently being prepared.

Reducing rail traffic noise

Under the provisions of the *Noise Control Act 1975* in NSW the railway system is classified as scheduled premises and as such the EPA has a regulatory role, and seeks to achieve noise targets for rail

operations throughout the state to minimise the impact on local residents.

The railway sector has, in recent years, recorded an increase in the identification and reporting of noise problems by the community. There is a range of initiatives to address this issue, including:

- retrofitting existing locomotives to reduce noise emitted
- upgrading existing track to continuously welded rail which removes rail joints-a significant source of noise and vibration
- designing new bridges to reduce noise and retrofitting of existing bridges with noise attenuation devises
- deploying quieter rolling stock in noise sensitive areas
- use of electric locomotives at night time wherever possible in the Sydney metropolitan area
- altering the holding pattern of trains to avoid them being held at signals for extended periods in built up areas.

Recent noise reduction initiatives are shown in table 1.22.

TABLE 1.22: Benefits & costs of two rail noise reduction initiatives

Sydney Harbour Bridge noise control works	Pre-works: 66-99 dB(A) After works: 56-91 dB(A)	Installation of highly resilient rail fasteners, re-rail with continuous welded rail, and reduce operating speed.	$2.5m	1996
Towards a Quieter Railway - Hunter Region	Varied between locations	Modification of freight trains, and improvements of track condition.	$5m	Ongoing

Note:
1. Lmax = maximum noise level.
Source: Data supplied to EPA by Rail Access Corp/Freight Corp 1997.

Noise and vibration studies are regularly carried out by the rail sector. These include studies carried out before and after major track work to ensure that noise and vibration levels do not increase as a result of track work. There are currently two major studies, one is taking detailed measurements of noise levels generated by trains in operation to enable baseline noise levels to be identified for each train type, and the second is identifying the causes of, and possible solutions to, the on-going problem of curve squeal.

In many areas both freight and passenger rail transport are likely to increase. For example, Freight Rail Corp and industry forecasts, which take into account projected growth in Hunter Valley coal

output, show that the annual haulage figure could exceed 60 million tonnes per annum by 2000, compared to 44.6 million tonnes in 1995-96 (Freight Rail Media Release 22 September 1996). Since noise annoyance is influenced by the number of operations there is the potential for annoyance to increase.

Reducing industrial noise

The EPA issues licences for the management of scheduled premises. When issuing a licence the EPA sets initial noise limits that are achievable with the operation of plant and equipment currently installed, operated and maintained effectively. To achieve further improvements in noise exposure to residents, negotiations with the licensed premises are carried out and can be incorporated in the licence as Pollution Reduction Programs (PRPs) (see Case Study: Illawarra for further details on PRPs). The EPA is currently working with industry to reduce noise levels from major sources.

PRPs are only one of the ways that major improvements that can be achieved. A desire to improve relationships with the local community can lead to the voluntary implementation of measures to reduce noise levels. Recent major improvements on industrial sites that have achieved significant reductions in noise levels include:

- TRW-Forging Operation in Marrickville, which has achieved noise levels below background noise levels at a cost of $3.8 million
- Visy Paper at Smithfield has spent $1.375 million reducing noise levels
- CSR Humes in the southern tableland region has achieved noise levels below background noise levels
- Bega Cooperative on the south coast has achieved a 9 dB(A) reduction in noise levels at a cost of $100,000.

Reducing neighbourhood noise

Although the *Noise Control Act 1975* has not changed for several years, a number of initiatives have been introduced in the last two years to cover aspects of local noise nuisance not previously dealt with. The regulation under the Act was revised in September 1995 with the creation of separate regulations covering community noise issues and motor vehicle noise. This was followed in 1996 by a regulation controlling marine vessel noise.

The Noise Control (Miscellaneous Articles) Regulation 1995 was introduced to cover community noise issues not covered by previous legislation. It includes limitations on burglar alarms for both

residential and commercial premises. Changes have been made to the night-time control of common domestic noise sources such as power tools, air conditioners, amplified music and lawn mowers. Under the new regulation only one warning to the offender is required and the warning is valid for 28 days. If an offence is committed within this period a fine can be issued without further warnings. The previous regulation warning was only active for 12 hours which meant it was not very effective with repetitious offences typical in suburban areas.

The Noise Control (Motor Vehicles and Motor Vehicle Accessories) Regulation 1995 controls the noise of individual motor vehicles. It includes a provision to control noise from a range of accessories including horns, alarms, refrigeration units and sound systems. It also places responsibility to ensure compliance of repairs/modifications of vehicles on the vehicle repairer.

The Noise Control (Marine Vessels) Regulation 1996 controls noise from boats in terms of the impact of noise to shoreline communities and residences. It includes controls on music on boats at night; controls on noisy exhausts; and a new vessels defect system to ensure all powered vessels operate to a standard.

Noise from barking dogs has been identified as a considerable problem in Sydney. Problems with dog noise are difficult to manage since control cannot be achieved by imposing noise level limits. Dog noise can be minimised by encouraging the owner to manage the dog in such a way that the barking behaviour is modified. Control of dog noise is the responsibility of local councils.

Reducing noise in schools

In addition to the measures introduced to reduce the source and transmission of noise, measures can be undertaken to noise proof buildings thereby reducing the occupant exposure to noise.

A number of techniques are used to reduce noise levels in schools and emanating from schools, including:

- building finishes and construction details designed to minimise noise impacts in sensitive areas such as music rooms, technology workshops and gymnasiums
- a range of solutions to deal with road traffic noise, including acoustically sealing walls closest to the noise source, mechanically ventilating rooms and construction of barriers between the noise source and the affected site
- measures to deal with air traffic noise, including orientation of rooms to reduce noise exposure; use of noise attenuating materials and construction techniques; larger than normal

roof overhangs and heavily insulated roofs with acoustically absorbent eaves linings; and soft finishes to the ground immediately adjacent to windows to reduce sound reflection into openings

- careful siting of rooms housing noise producing activities (e.g. music rooms and workshops) to minimise impacts on neighbours beyond the school boundaries. This may also include careful location of windows.

These design parameters have been developed by the Department of School Education and Department of Public Works and Services in line with the strategy for environmentally sustainable design in schools (see also section 1.3.5). Similar measures are used to minimise noise intrusion in other sensitive buildings such as hospitals. Design and building techniques can also be used to reduce traffic noise levels in the home. Details of these can be found in *Reducing Traffic Noise. A Guide for Homeowners, Designers and Builders* (SPCC/RTA/Department of Housing 1991).

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