2013 Ride, Alton Towers

Noise Impact Assessment

JOB NUMBER:			DOCUMENT REF:			
1	Client Use	A Lawrence	B Cahill	B Cahill	B Cahill	Dec 2011
		Originated	Checked	Reviewed	Authorised	Date
Revision	Purpose Description	ATKINS				

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EXECUTIVE SUMMARY

This noise assessment has been prepared by Atkins Limited on behalf of Alton Towers Operations Limited. It has been prepared in support of a planning application for a rollercoaster attraction (referred to in this report as the proposed 2013 ride) within the Alton Towers Resort in Staffordshire.

Measurements of a similar coaster at Thorpe Park have been used to model and predict noise levels from the proposed 2013 ride. The proposed ride is planned to be located approximately where the “Black Hole” coaster once stood, in the X-sector area of the park.

Standard noise modelling techniques have been used to predict L_{Amax} and octave band noise levels from the new coaster. The acoustic characteristics of the ride are similar to those of rides already in operation in the Resort.

The BS 4142 method for assessing the impact of industrial-type noise was used in order to give an indication of the likelihood of noise complaints. The analysis showed that complaints about noise from the proposed ride are not likely.

1. INTRODUCTION

1.1 Alton Towers Operations Limited requested Atkins Acoustics, Noise and Vibration to investigate and report upon the likely noise effects associated with a planned new coaster to be located on the “Black Hole” site in the X-sector area of the Resort.

1.2 For the purposes of assessing the potential noise impact of the new ride, noise levels have been predicted at the nearest properties to the ride location including those on and near Farley Lane and at the nearest properties in Farley.

2. ASSESSMENT OF NOISE INTRUSION

2.1 There is no specific published advice on the assessment of community responses to Theme Park noise. However, in general a noise may provoke complaints if its level exceeds, by a certain margin, that of the pre-existing background noise; or when it attains a certain absolute level.

2.2 British Standard 4142, 1997 "Method for Rating Industrial Noise affecting mixed Residential and Industrial areas" gives a method for assessing the likelihood that an industrial noise source may give rise to complaints. The method consists of determining the "Specific Noise Level" (that due to the industrial noise source, expressed in terms of dBL_{Aeq}) at the assessment location, applying a +5 dB correction, if appropriate, to derive the "Rating Level" and comparing that with the "Background Level" (dBL_{A90}, exceed for 90% of the assessment period). The +5 dB correction is applied if the noise from the new industrial noise source contains a distinguishable, discrete, continuous note (whine, hiss, screech, hum, etc.) or the noise contains distinct impulses (bangs, clicks, clatters or thumps) or the noise is irregular enough to attract attention. There is an implicit assumption that the "new noise" source will be distinguishable from existing noise sources.

2.3 The likelihood of complaints is assessed by subtracting the Background Level from the Rating Level. The greater the difference in noise levels, the greater the likelihood of complaints. A difference of around +10 dB or more indicates that complaints are likely. A difference of around +5 dB is of marginal significance. If the Rating Level is more than 10 dB below the Background Level then this is a positive indication that complaints are unlikely.

2.4 The World Health Organisation recommends that, in order to minimise noise annoyance in outside recreational spaces such as gardens and patio areas, L_{Aeq} noise levels should not exceed 50 to 55 dB. The WHO recognises that these target levels are already exceeded in many urbanised areas and near roads.

3. SOURCE NOISE LEVELS AND NOISE PROPAGATION

PROPOSED COASTER NOISE LEVELS

3.1 Noise from the planned new coaster was modelled based on a similar one located at Thorpe Park. The Thorpe Park ride, “Saw” is the same type and manufacturer as the proposed ride, including a “beyond vertical” drop. Third octave band measurements were conducted on 2 November 2011 using a calibrated Norsonics type 118 sound level meter, tripod mounted at a height of 1.2 m above ground level. Weather conditions were suitable for noise measurements, with low wind speeds and remaining dry. Measurements were taken at appropriate times to avoid nearby rides influencing the measured noise levels, particularly Samurai and Colossus, which were both operating during the measurement period.

3.2 Maximum noise levels were measured at known distances from a selection of track sections. The meter recorded third octave band and overall dB(A) levels in terms of the L_{eq} and L_{max} indices. The noise levels, normalised to a distance of 10m and aggregated into octave bands, are shown in Table 3.1. The highest level from each octave band has been used for noise modelling purposes.

Table 3.1 – L_{max} Noise Level at 10m from “Saw” Coaster at Thorpe Park

	Octave Band Mid Frequency (Hz)							
Noise Source	**63**	**125**	**250**	**500**	**1k**	**2k**	**4k**	**dB(A)**
Lift	74.5	72.1	69.2	73.8	73.4	67.3	65.1	78.9
Section 1	73.2	72.1	68.8	67.7	75.6	69.3	62	78.9
Section 2	63.8	69.3	68.5	64.3	74.1	64.7	55.2	76.5
Section 3	64.1	72.8	70.2	65.5	73	70.1	60.2	77.8
Small Loop	66.7	74.1	74.7	64.4	74.1	68.5	60.1	78.4
Large Loop	77.2	72.8	75.2	68	72.5	68.6	60	77.8
Section 4	70.6	74.5	69.2	71	76.8	69	65.2	80.4
Section 5	70	74.6	74.4	72.2	72.8	68.9	61.3	79.5
Section 6	67.4	69.1	69.8	64.7	68	69.3	60.2	75.3
Highest L_{max}	**77.2**	**74.6**	**75.2**	**72.2**	**76.8**	**70.1**	**65.2**	**80.4**

3.3 Table 3.1 shows that the noise spectrum of a fully laden trains was broad band. Whilst some noise measurements included riders screaming, there was no clear pattern that riders particularly screamed more on particular track sections. Generally, the track running noise dominates the noise from the coaster, although the data used for modelling includes the effects of riders screaming.

NOISE PROPAGATION

3.4 Several factors affect the propagation of noise, especially when the distance between the noise source and receiver is in excess of a few hundred metres. The main factor is distance. Due to hemispherical spreading of the sound waves from a point source, the noise level attenuates at a rate of 6 dB for every doubling of distance. A level of, say, 76 dB(A) at 10 metres would therefore reduce to 70 dB(A) at 20 metres, 64 dB(A) at 40 metres, and so on.

3.5 In addition to attenuation due to hemispherical spreading, the travelling sound wave may also be partially absorbed by the ground surface, depending upon the type of ground cover and the average height of noise propagation above the ground. For noise sources well above ground level, the effect becomes minimal.

3.6 Additional attenuation may be brought about by the presence of woodland planting. The rate of attenuation of noise depends upon such factors as the overall planting density, the depth of the tree belt, the amount of low level shrub cover and the height and type of trees. The excess attenuation is also frequency dependent, increasing with increasing frequency, as shown in Table 3.2.

Table 3.2 – Attenuation per 100 metres Through Woodland

	Octave Band Mid Frequency (Hz)						
Woodland Type	63	125	250	500	1k	2k	4k
"Average" Woodland	2	3	3	4	5	8	11
General Forest	4	5	6	8	10	13	16
Bare Deciduous	0	0	0	0	0	3	6
ISO 9613 (dense foliage)	2	3	4	5	6	8	9

3.7 The "General Forest" and "Bare Deciduous" data in Table 3.2 are derived from The Noise Advisory Council's "A guide to Measurement and Prediction of the Equivalent Continuous Sound Level L_{eq}", 1978 and the "Average Woodland" figures as the average of these two. Table 3.2 also includes the attenuation rates suggested in ISO 9613 ("Attenuation of sound during propagation outdoors", 1996) for densely foliated woodland. The ISO data assumes that both the noise source and receiver are outside the woodland so that, with an adverse (downwind) wind direction, a maximum of only 200 m of woodland is effective, irrespective of its actual depth. The ISO figures approximate well to those shown for “Average” Woodland.

3.8 Landforms, buildings, walls or any other solid obstruction that cuts the line of sight between the source of noise and receiver has the potential to reduce the noise. The effectiveness of the “barrier” depends upon its height and its location relative to the source and receiver. The attenuation is frequency dependent, being related to the path difference, expressed in terms of wavelength, between the “direct” sound wave and that “diffracted” over the top of the barrier. As the frequency increases (shorter wavelength) so does the barrier attenuation. Table 3.3 shows the thin barrier attenuation for various path differences (in metres) between the direct and diffracted sound waves. It will be seen that a barrier that just cuts the sight line between the source of noise and the receiver produces a reduction of 5 dB across the entire frequency spectrum.

Table 3.3 – Frequency Dependent Thin Barrier Attenuation

Path Difference	Octave Band Mid Frequency (Hz)(and wavelength (m))						
(m)	63 (5.4)	125 (2.7)	250 (1.4)	500 (0.7)	1k (0.3)	2k (0.2)	4k (0.1)
0	5	5	5	5	5	5	5
0.1	6	7	8	9	12	14	17
0.2	7	8	9	12	14	17	20
0.5	8	10	12	15	18	21	24
1.0	10	12	15	18	21	24	27
1.5	11	14	17	20	23	26	29
2.0	13	15	18	21	24	27	30

3.9 The data in Table 3.3 applies to barriers whose thickness is less than the wavelength of sound in each frequency band (also shown in the Table). For “thick” barriers such as buildings or land forms, the equivalent thin barrier height and location may be derived by the intersection of two straight lines both just grazing the nearest top edges of the thick barrier, one drawn from the receiver and the other drawn from the source.

3.10 Atmospheric effects include air absorption, wind speed and direction and temperature gradients. Air absorption depends upon frequency, air temperature and relative humidity, as well as the distance between the noise source and the receiver. Table 3.4 gives values for air absorption per 100 metres of the propagation path, extracted from ISO 9613 which reproduces data from the American National Standards Institute.

Table 3.4 – Air Absorption per 100 metres

Temperature (°C)	Relative Humidity (%)	Octave Band Mid Frequency (Hz)						
		63	125	250	500	1k	2k	4k
15	40	0.02	0.05	0.12	0.22	0.45	1.31	4.57
	60	0.01	0.04	0.12	0.23	0.41	0.95	3.03
20	40	0.02	0.05	0.14	0.26	0.47	1.12	3.61
	60	0.01	0.04	0.12	0.28	0.48	0.93	2.54
25	40	0.01	0.05	0.15	0.32	0.54	1.07	3.01
	60	0.01	0.03	0.12	0.32	0.60	1.02	2.32

3.11 Various models have been developed to asses the effects of vector winds and temperature gradients. One such model (CONCAWE Report 4/81) makes use of Pasquill Stability Categories which describe the general atmospheric stability, relating primarily to time of day and extent of cloud cover. These Categories have been combined with vector wind speeds to define six Meteorological Categories. Categories 1 to 3 represent conditions under which noise levels are reduced relative to the neutral Category 4 and generally relate to upwind conditions. Categories 5 and 6 represent enhancement of the noise, relative to Category 4, and are most often associated with downwind propagation. During daytime hours weather conditions usually relate to Meteorological Categories 3, 4 or 5. Table 3.5 shows, for distances relevant to Alton Towers, that octave band noise levels are generally within about 5 dB of those associated with neutral conditions.

Table 3.5 – Effect of Atmospheric Conditions on Noise Levels

Distance (m)	Met Category	Octave Band Mid Frequency (Hz)						
		63	125	250	500	1k	2k	4k
500	3	-1	-1	-4	-4	-6	-5	-4
	4	0	0	0	0	0	0	0
	5	+1	+2	+4	+4	+5	+3	+4
1000	3	-2	-1	-4	-4	-6	-5	-5
	4	0	0	0	0	0	0	0
	5	+1	+3	+5	+5	+5	+3	+5
2000	3	-3	-2	-4	-4	-6	-5	-5
	4	0	0	0	0	0	0	0
	5	+2	+4	+6	+6	+5	+3	+5

3.12 For typical coaster noise spectra this table translates into an increase of about 5 dB(A) for downwind propagation and a decrease of about 5 dB(A) for upwind propagation, relative to neutral conditions.

4. EXISTING NOISE CONDITIONS

4.1 Previous noise level surveys, conducted in various areas around Alton Towers, were generally updated in 2009 at a time when the Resort was open and all rides operating normally. Weather conditions were dry and generally sunny with wind speeds of no more than about 1 ms^{-1}.

4.2 Representative measurements have been chosen to characterise properties potentially affected by noise from Alton Towers. The locations most relevant to this study are described in Table 4.1.

Table 4.1 – Nearest Noise Sensitive Receptors

Location	Site Description/Notes
Pink Lodge and Pine Trees, Farley Lane	Traffic noise from Farley Lane dominates the noise climate at Pink Lodge. Pine Trees is set back and noise levels are expected to be lower.
Farley Park Farm, Farley Lane	Farley Park Farm is set back from Farley Lane, and noise levels are expected to be similar to other locations a similar distance from the road.
Longshaw Lane, Farley Area	Several properties are set back from the road through Farley.

4.3 A summary of the 2009 measured levels is given in Table 4.2. The currently experienced background levels are in general agreement with those measured in previous years except that noise levels at Pine Trees and Farley Park Farm have not been measured, and noise levels have been estimated on the basis of other similar nearby locations.

4.4 Background noise levels in the area of Farley that is relatively uninfluenced by traffic on Farley Lane, were typically in the mid to upper 30s dBL_{A90}, due to general environmental noise sources such as birdsong, distant traffic and aircraft, and the rustling of leaves in the breeze. Although some noise from the Resort, such as track running noise and screams were variously audible, the corresponding dBL_{Amax} levels were not reliably measurable against the background. Background noise levels were in the upper 30s to low 40s dBL_{A90} in those areas of Farley that are more influenced by traffic on Farley Lane.

4.5 Noise levels at Pink Lodge, in close proximity to Farley Lane and the western perimeter of the Resort, were dominated by traffic on Farley Lane, with individual vehicles producing levels of between the mid 70s and low 80s dBL_{Amax}. The measurements near Pink Lodge showed that noise levels from some elements of the Oblivion ride were clearly audible and similar to previous years, being measurable when coinciding with lulls in traffic noise. The other rides in this area of the Resort (Enterprise and Submission) made no measurable contribution to the noise levels at this location.

Table 4.2 – Typical Measured Existing Noise Levels, 2009

Location	Unit	Octave Band Mid Frequency (Hz)							dB(A)	Comments
		63	125	250	500	1k	2k	4k		
Pink Lodge	L_{90}	54	48	48	47	47	40	32	50	Traffic on Farley Lane dominant. Oblivion lift, drop, breaking and screaming clearly audible. Other rides in area barely audible. Still air, occasionally from SW <1m/s.
	L_{10}	70	63	61	60	62	57	49	65	
	L_1	80	72	69	68	69	63	56	72	
	L_{max}	86	80	75	75	73	70	65	78	
	L_{eq}	68	61	58	57	58	53	47	61	
Longshaw Lane, Farley Area (representative of Pine Trees and Farley Park Farm)	L_{90}	47	39	35	33	33	29	23	38	Birdsong dominant. Track running noise and screams occasionally just audible but not measurable against L_{A90} (due to birds). Distant aircraft and cars on Farley lane. Still air, occasionally from SW <1m/s.
	L_{10}	58	54	48	45	42	45	47	55	
	L_1	66	65	57	55	52	54	58	62	
	L_{max}	71	70	63	60	59	59	61	65	
	L_{eq}	56	52	47	43	42	43	48	51	

4.6 Noise from within Alton Towers is variously audible in the Farley area, depending upon the prevalence of uncharacteristic wind directions, such as those from the southeast. The noise environment in this area is also influenced by traffic on Farley Lane.

4.7 All the existing noise level measurements were conducted under near still air conditions. As wind speeds increase, from whatever direction, the background noise levels also increase due to the movement of trees and bushes. This effect is especially important when trees are in close proximity to properties, such as at Farley and along Farley Lane. Low wind speed background noise levels therefore represent probably the most stringent circumstance against which to compare noise levels from the planned replacement coaster.

5. FUTURE NOISE CONDITIONS

MODELLING PROCEDURE

5.1 Except at Pink Lodge and Pine Trees, the footprint dimensions of the new ride are small compared to the distances to the noise-sensitive receivers. For those receptors further away, the proposed ride has been modelled as a "point" source of noise. At Pink Lodge and Pine Trees adjustments have been made to the end modelling result to account for the smaller separation distance to the proposed ride.

5.2 The frequency-dependent and other propagation factors described in Chapter 3 were applied and the resultant noise levels calculated at each receiver. This procedure was conducted for each of the 7 octave bands between 63 Hz and 4 kHz, the appropriate A-weighting corrections were applied and the A-weighted octave band levels logarithmically summed to give the corresponding L_{Amax} level. Insufficient definitive information was available regarding ride timings and running speeds, and therefore the L_{eq} levels have been derived based on available information.

CORRECTION FACTORS

5.3 Noise attenuation due to air absorption (Table 3.4) has been used, based upon a summer air temperature of 20°C and relative humidity of 60%. The assessment also includes the effect of additional ground absorption (see paragraph 3.5).

5.4 Barrier screening (see paragraph 3.8) has been taken into account at properties where the surrounding topography clearly provides screening, and has been ignored in all other cases.

5.5 Woodland attenuation (see paragraphs 3.6 to 3.7) has been taken into account. The "Average" woodland attenuation figures given in Table 3.2 have been used in the modelling. As the woodland is mixed deciduous and evergreen and the Resort is not fully open during the winter months (November to February), the use of "Average" woodland represents a reasonable approximation to the situation when the Resort is operational. The propagation distance through woodlands has been limited to 200m except where there is a significantly reduced depth of woodland when this correction has been ignored or limited to 100m.

PREDICTED NOISE LEVELS

5.6 The predicted L_{max} and L_{eq} levels at each receiver location are shown in Table 5.1. The table also includes, for comparative purposes, the measured existing noise levels shown in Table 4.2.

Table 5.1 – Comparison of Ride and Existing Noise Levels

Location	Unit	Octave Band Mid Frequency (Hz)							dB(A)
		63	125	250	500	1k	2k	4k	
Pine Trees	Ride L_{max}	42	39	39	35	38	26	14	40
	Ride L_{eq}	40	37	37	33	36	24	12	38
	Existing* L_{90}	47	39	35	33	33	29	23	38
	Existing* L_{eq}	56	52	47	43	42	43	48	51
Pink Lodge	Ride L_{max}	52	48	49	45	48	38	28	50
	Ride L_{eq}	50	46	47	43	46	36	26	48
	Existing L_{90}	54	48	48	47	47	40	32	50
	Existing L_{eq}	68	61	58	57	58	53	47	61
Farley Park Farm	Ride L_{max}	37	33	33	28	31	17	0	33
	Ride L_{eq}	35	31	31	26	29	15	<0	31
	Existing* L_{90}	47	39	35	33	33	29	23	38
	Existing* L_{eq}	56	52	47	43	42	43	48	51
Longshaw Lane, Farley Area	Ride L_{max}	36	32	32	27	29	15	<0	31
	Ride L_{eq}	34	30	30	25	27	13	<0	29
	Existing L_{90}	47	39	35	33	33	29	23	38
	Existing L_{eq}	56	52	47	43	42	43	48	51

*Existing noise levels from alternate location.

5.7 Table 5.1 shows that the L_{Amax} levels from the ride will be at least 5 dB(A) lower than the existing L_{A90} (background) levels at Farley Park Farm and properties at a greater distance from the proposed ride. At Pine Trees and Pink Lodge the L_{Amax} noise levels from the proposed ride are expected to be approximately equal to the existing background noise levels. At Pine Trees and Pink Lodge it is likely that noise from the proposed ride would be audible.

NOISE IMPACT ASSESSMENT

5.8 The BS 4142 method for assessing the likelihood of noise complaints was outlined in Chapter 2 of this report. It should be remembered that the method is strictly only applicable to noise sources of an industrial nature, so may not be applicable to coaster running noise and screams – neither of which could be described as "industrial". The use of the +5 dB "character correction", which should only be applied in those areas where the noise is actually audible, is also debateable when the existing noise environment has similar acoustic characteristics – the new coaster has no noise characteristics that would distinguish it from many other rides in the Resort. In view of the uncertainties associated with the use of BS 4142 and hence the weight that should be placed upon its conclusions, the "absolute" noise level criteria recommended by the World Health Organisation should not be disregarded. Table 5.2 gives BS 4142-type assessments using the predicted L_{Aeq} levels from the ride.

Table 5.1 – BS 4142 Assessments

	Location			
	Pine Trees	Pink Lodge	Farley Park Farm	Longshaw Lane
Specific level (L_{Aeq})	38	48	31	29
Rating level	38	48	31	29
Background (L_{A90})	38	50	38	38
Rating level – L_{A90}	0	-2	-7	-9
Complaints Likely?	No		Approaching a positive indication that complaints are unlikely	

5.9 This analysis indicates that the proposed ride is unlikely to give rise to noise complaints.

5.10 Table 5.1 shows that the predicted ride noise levels at Pine Trees, Farley Park Farm and Longshaw Lane are well below the lowest target level of 50 dBL_{Aeq} recommended by the WHO. At Pink Lodge the predicted noise level is approximately equal to WHO criteria, but the existing L_{Aeq} at this location (61 dB) is significantly above this level, being dominated by traffic on Farley Lane. These conclusions relate to neutral atmospheric conditions.

5.11 Atmospheric effects increase downwind noise levels by typically about 5 dB(A) and decrease upwind levels by the same amount (Table 3.5). At 45° to the direction of the wind, the increase is approximately 3 dB(A), with reductions of about 2 dB(A) at 90° and 3 dB(A) at 135°. Table 5.3 shows the approximate effect of wind direction upon noise levels from Alton Towers, including the proposed ride.

Table 5.2 – Approximate Effect of Wind Direction on dB(A) Noise Levels

Wind Direction from:	Location			
	Pine Trees	Pink Lodge	Farley Park Farm	Longshaw Lane
N	-2	-2	-3	-3
NE	+3	+3	-2	-2
E	+5	+5	+3	+3
SE	+3	+3	+5	+5
S	-2	-2	+3	+3
SW	-3	-3	-2	-2
W	-5	-5	-3	-3
NW	-3	-3	-5	-5

5.12 Although the Specific noise levels shown in Table 5.2 would vary with wind direction as shown in Table 5.3, the background noise levels will increase whatever the wind direction due to the movement of trees and bushes local to the receiver.

5.13 The BS 4142 analysis shown in Table 5.2 therefore represents a likely worst case in terms of the difference between the Rating and Background levels and hence the likelihood of complaints.

6. SUMMARY AND CONCLUSIONS

6.1 Noise measurements at selected locations around a similar ride at Thorpe Park were used as the basis for modelling and predicting the noise levels from the proposed 2013 Coaster at Alton Towers. Maximum noise levels from the proposed coaster were calculated using standard noise propagation parameters. L_{Aeq} levels were derived from L_{Amax} levels using information available about the proposed ride.

6.2 Previous ambient noise level surveys in surrounding areas showed that there had been no consistent noise level changes in the last 15 years, apart from some subjective noise reduction due to the removal of Thunderlooper and the Corkscrew.

6.3 The predicted noise levels from the 2013 ride are equal to or below the background levels in residential areas near the proposed ride.

6.4 The BS 4142 method for assessing the impact of industrial-type noise was used in order to give an indication of the likelihood of noise complaints. The analysis showed that complaints about noise from the proposed ride are not likely.

6.5 The WHO noise level limit approach has been adopted by the rest of Europe and in this country for all types of noise source, other than industrial. Noise levels due to the proposed Coaster will be below 50 dB L_{Aeq} in all residential areas.