

SECOND REPORT

of

SOUND MEASUREMENTS AND RECOMMENDATIONS

at

**PROPOSED RESIDENTIAL DEVELOPMENT,
ON SITE OF EXISTING INDUSTRIAL PREMISES,
STATION ROAD,
WOMBWELL,
BARNSELY,
SOUTH YORKS S73.**

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1.0 **Summary and Conclusions**

An application is being submitted for residential development on the site of existing industrial premises off Station Road, Wombwell. The site is adjacent to other industrial premises which will remain in use and to a sports ground which is used for kart racing. For this reason the applicant has commissioned this survey of the existing sound levels at the site. Our first report dated 30.04.08 described sound measurements at the site during periods of daytime and night and compared the results with guidance on the subject of noise affecting dwellings provided in PPG 24: 'Planning and Noise'. This second report takes account of a revised layout to mitigate kart racing noise.

- 1.1 The outdoor sound levels across the site were in the range 54-57 LA_{eq} during the daytime and 42-52 LA_{eq} at night. The dominant existing sound source affecting the whole site is road traffic at all times of day and night. In addition to this there is a low level hum affecting the north corner of the site only from existing industrial premises which will remain operational.
- 1.2 PPG24 divides residential developments into four Noise Exposure Categories from A (best) to D (worst). The results suggest that the site is in Noise Exposure Category B.
- 1.3 The existing industrial sound sources which are to remain are rated by the method of BS 4142 in the range from 5 dB below the daytime background to 3 dB above it. Existing industrial premises with a proposed change of occupation are predicted at worst to be rated up to 6 dB above the background.
- 1.4 In order to mitigate against the possibility of noise from the industrial units with changed occupancy it is recommended that fences to an acoustical standard are erected along the boundary of gardens onto Valley Road.
- 1.5 The proposal to mitigate kart racing noise relies on the sound shadow of a block of flats with an elevation incorporating non-habitable rooms facing the sports ground and thereby providing noise mitigation to the rest of the site. By this means the sound generated by kart races is rated at 6 dB above the background.
- 1.6 The results suggest that the interior sound level recommendations of BS 8233 and the World Health Organisation can be achieved by the use of conventional 4-16-4 double glazing to all windows throughout the development. Ceilings on upper floors may be constructed from a single layer of 12.5mm plasterboard. Background ventilation may be achieved within the interior sound criteria by using trickle vents but the criteria would be exceeded through open windows.

2.0 **Planning Requirements on Noise**

No formal requirements have been received on the assessment methods preferred by the Local Planning Authority with respect to noise affecting the development. As a starting point this report considers the guidance of PPG24 'Planning and Noise.'

2.1 **PPG 24: 'Planning and Noise'**

Guidance to local authorities on the considerations of noise affecting dwellings was issued in 1994 as Planning Policy Guidance 24: 'Planning and Noise'. Paragraphs 8, 9, 12 and Annexes 1, 2 & 3 deal specifically with noise from existing roads and mixed sources affecting dwellings. Four noise exposure categories are defined:

Road traffic and mixed sources	Noise exposure category			
	A	B	C	D
0700-2300 hours	below 55	55-63	63-72	above 72
2300-0700 hours	below 45	45-57	57-66	above 66

The noise quantities are assessed as dBA L_{eq} over the full time periods defined above. The guidance given within each category is:

Category A: Noise need not be considered as a determining factor in granting planning permission, although the high end of the category should not be regarded as a desirable level.

Category B: Noise should be taken into account when determining planning applications and where appropriate conditions imposed to ensure an adequate level of protection.

Category C: Planning permission should not normally be granted. Where it is considered that permission should be given, for example because there are no alternative quieter sites available, conditions should be imposed to ensure a commensurate level of protection against noise.

Category D: Planning permission should normally be refused.

2.2 **Interior Sound Levels**

PPG 24 also refers to the recommendations on interior sound levels given in BS 8233 and to sleep disturbance factors.

BS 8233: 1999

living rooms	30 dBA L_{eq}	for good resting conditions
	40 dBA L_{eq}	for reasonable resting conditions
bedrooms	30 dBA L_{eq}	for good sleeping conditions
	35 dBA L_{eq}	for reasonable sleeping conditions

World Health Organisation: 2000

Indoors generally	35 dBA L_{eq}	for speech intelligibility and moderate annoyance
Bedrooms	30 dBA L_{eq}	} to avoid sleep disturbance
	45 dBA L_{max}	

2.3 **BS 4142: 1997**

PPG24 refers to the use of BS 4142 for the assessment of noise from industrial or commercial premises. The method of BS 4142 is to measure outdoor sound levels at dwellings during emission of the industrial noise, measure the background level at the same location in the absence of the noise, and apply a correction factor to the measured levels for some specific factors which affect its acceptability (eg. hiss, whine, bangs, thumps, etc.). The corrected measured level is compared with the background from which it is concluded that:

- complaints are likely if the corrected measured level exceeds the background by about 10 dBA or more,
- a difference of about 5 dBA is 'of marginal significance',
- at differences below 5 dBA the lower the value the less likelihood there is of complaint.

When assessing noise from recreational and sporting developments PPG24 advises, "Depending on local circumstances and public opinion, local planning authorities may consider it reasonable to permit

higher noise emission levels than they would from industrial development...". For this reason we use the method of BS 4142 to assess the potential noise from the industrial premises which will remain adjacent to the site, and from kart racing on the sports ground. In accordance with the PPG24 guidance, the LPA may allow a higher rating from the sports ground sound sources than from industry.

3.0 **Sound Sources**

The site is bounded by existing residential properties on Station Road to the southeast, Valley Road along the northeast site boundary at the opposite side of which are industrial and commercial premises, industrial premises adjacent to the northwest boundary, and the sports ground along the southwest boundary.

Industrial Premises

The largest industrial building on the business park is currently occupied by Windowstyle UK and will be demolished to make way for the residential development. The development will thereby remove industrial noise which currently exists at all times of day and night.

Two existing factory and office buildings at the opposite side of Valley Road to the residential site are also occupied by Windowstyle. These will remain under the development proposal but will be divided into smaller units and re-let for mixed industrial or commercial use. The occupancy of them is unknown at this stage and their sound emission is estimated over a range of potential values in this report.

There are existing industrial premises on Valley Road and along the northwest boundary of the residential site which are operational and are unaffected by this proposal. The main sound sources associated with them were road traffic along Valley Road which were measured in our surveys and are expected to remain as now. The baseline of background sound at night affecting the north corner of the site only was provided by a low level hum from an industrial building at the opposite side of Valley Road which is not part of Windowstyle.

In summary, there was no audible sound from industrial buildings affecting the residential site other than that from Windowstyle which will be removed, from road traffic on Valley Road associated with other industrial premises, and the low level baseline of background sound at night audible at the north corner. Since Windowstyle currently provides the greatest contribution towards overall sound affecting the site, and

operates on a 24-hour, 7-day basis, our surveys were carried out during 30-minute periods at shift changes when the Windowstyle production ceases.

Road Traffic

Traffic along Station Road was intermittent during our daytime periods of survey and infrequent at night. Road traffic will be the main source affecting dwellings at the eastern corner of the site with a direct view of Station Road. The ambient sound levels from road traffic will reduce progressively across the site which lies in the sound shadow of existing dwellings. Distant road traffic from the direction of Wombwell and the A633 Barnsley Road provides the source of background sound affecting the whole site at all times.

Sports Ground

A sports ground is located adjacent to the southwest boundary of the site. The highest sound levels at the sports ground are caused by kart racing. Model cars are raced at the sports ground on separate occasions to kart races. The overall sound output of model car races is understood to be lower than that from kart races although the tonal content of the model car noise is believed to be more pronounced. We have attended a kart racing session at the premises for the specific purpose of sound measurement as part of a different exercise, and so data is available on the sound levels generated by kart racing.

4.0 Sound Measurements

Sound levels were measured at the site during the daytime and night of Tuesday 15th April 2008. Four measurement positions were used at the corners of the residential site as shown on the attached plan:

1. North corner facing industrial premises which will remain.
2. East corner facing Station Road.
3. South corner near but shielded from Station Road.
4. West corner away from industrial sources and Station Road.

Measurements were taken at times when all Windowstyle production had ceased for shift changes but all other industrial premises were believed to be operating normally. The sports ground was unoccupied at the survey times except when attended specifically during a kart racing session during a previous measurement exercise.

The microphone height was 1.2m above ground level in each case. Conditions during all survey periods were dry with no wind, being suitable for outdoor sound readings. All results were taken using a Bruel & Kjaer precision sound level meter type 2260.

Sound Descriptor	Daytime 1330-1400	Night 2130-2200
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Position 1. North corner facing industrial premises

Ambient	LA _{eq}	57.3	42.3
Background	LA ₉₀	50.0	39.6
Maximum	LA _{max}	76.6	50.5

Position 2. East corner facing Station Road

Ambient	LA _{eq}	55.3	51.3
Background	LA ₉₀	51.8	42.0
Maximum	LA _{max}	62.6	59.9

Position 3. South corner shielded from Station Road

Ambient	LA _{eq}	54.4	45.3
Background	LA ₉₀	52.4	41.8
Maximum	LA _{max}	62.4	53.7

Position 4. West corner adjacent to sports ground

Ambient	LA _{eq}	55.1	52.1
Background	LA ₉₀	52.0	42.8
Maximum	LA _{max}	66.3	63.2

Sound frequency spectra are shown below of the highest results of day and night L_{eq} and the highest L_{max} results at any time.

Sound pressure levels dB linear:

Frequency (Hz)	63	125	250	500	1k	2k	4k	8k
Daytime Leq	63.3	57.7	52.7	55.3	50.5	38.9	35.1	33.5
Night Leq	60.2	53.5	46.6	45.1	46.8	46.1	35.0	26.1
Night Lmax	81.3	72.6	71.2	71.9	75.6	66.2	54.6	49.1

5.0 **Noise Exposure Categories**

The results show L_{eq} sound levels of:

54-57 dBA L_{eq} during typical daytime,
42-52 dBA L_{eq} at night.

The results suggest that the site is in Noise Exposure Category B during the daytime (55-63 dBA) and at night (45-57 dBA).

6.0 **Sound Insulation to Outdoors**

6.1 **Interior Sound Levels**

The basis of sound insulation is that the outdoor noise must not cause indoor sound levels in excess of:

- 30 LA_{eq} or 45 LA_{max} in bedrooms from 2300-0700,
- 30-40 LA_{eq} in living rooms from 0700-2300 hours.

6.2 **Bedroom Windows Facing Road & Industry**

The sound levels inside an interior room are given by the formula:

$$SPL_{inside} = SPL_{outside} - R + 3 + 10 \log S - 10 \log A$$

For a furnished domestic room the terms 'A' for sound absorption and 'S' for surface area are generally self-cancelling, which is assumed to be the case. It is found that the design targets in bedrooms at the noisiest part of the site facing Valley Road and Station Road can be met by using conventional 4-16-4 double glazing. The calculation is:

Sound reduction indices dB:

Frequency (Hz)	63	125	250	500	1k	2k	4k	8k
Outer Walls	34	41	45	50	56	65	69	72
4-16-4 glazing	18	22	20	26	36	39	31	35
Wall and glazing	25	29	27	33	43	46	38	42

The calculation of the maximum sound levels reaching bedrooms with a direct view of road traffic and existing industrial sources is shown overleaf for the highest sound levels measured at the site.

Sound pressure levels dB linear, Lmax:

Frequency (Hz)	63	125	250	500	1k	2k	4k	8k
Outdoor SPL	81.3	72.6	71.2	71.9	75.6	66.2	54.6	49.1
3dB Reflection	3	3	3	3	3	3	3	3
Wall and Glazing	25	29	27	33	43	46	38	42
Indoor SPL	60	47	47	42	36	23	20	10
A weighted	34	31	38	39	36	25	22	8

The overall level represented by the above spectrum is **43.5 LA_{max}** which is the prediction inside bedrooms at night. The same calculation applied to the ambient sound levels at night predicts **19 LA_{eq}** inside bedrooms. These are both below the sleep disturbance thresholds.

It is recommended that bedrooms throughout the site may be fitted with 4-16-4 double glazing.

6.3 Living Room Windows Facing Road & Industry

By using the highest daytime results in the calculation of 6.2 shows that conventional 4-16-4 double glazing will achieve 26 LA_{eq} in living rooms which is well within the design target of 40 LA_{eq}.

It is recommended that all living room windows throughout the development may be fitted with 4-16-4 double glazing.

6.4 Ventilation

It has not been specified at this stage whether the requirements for interior sound levels will apply to generally to background ventilation only or to full rapid ventilation. A decision will be needed from the LPA on this aspect of their requirements before the ventilation can be finalised.

If the interior sound criteria are to be applied to background ventilation then conventional non-acoustic trickle vents may be used at all windows. If the interior sound criteria are to be applied to rapid ventilation as a blanket requirement across the whole site then they would not be achievable by using open windows at any part of this development, and mechanical systems would be needed to all rooms. Mechanical or ducted systems can be designed to incorporate sound attenuation in the form of in-line silencers. The acoustic design of a ventilation system is usually handled by the supplier as part of his product quotation and is not included in this report.

6.5 **Roof Materials**

The sound insulation of a conventional pitched roof with plasterboard ceiling is usually governed by the plasterboard layer since the sound insulation of the outer roof is limited by ventilation apertures. Single 12.5mm plasterboard alone offers sound reductions of 26 & 29 dB at 500 & 1000 Hz being the frequencies of sound which dominate the outdoor noise. There will be a small but unquantified sound reduction from the thermal quilt and the outer roof. Taking these factors into account it is estimated that the overall sound reduction across a roof and bedroom ceiling will meet the design targets if single plasterboard is used for ceilings on the upper floor.

It is recommended that ceilings on the upper floors of all dwellings may be constructed from one layer of 12.5mm plasterboard.

6.6 **Gardens**

There is often a requirement for the sound levels in gardens and amenity spaces not to exceed 50-55 dBA L_{eq} . The daytime sound levels were within this range except at measurement position no.1 on the footway of Valley Road where road traffic noise was marginally greater than it will be in the nearest garden to the road. It is anticipated that the outdoor sound levels in rear gardens caused by existing sound sources, ie. road traffic and existing industrial premises, will be within the design target without the need for mitigation measures.

7.0 **Assessment of Industrial Noise to BS 4142**

Sound from the existing industrial premises excluding Windowstyle is audible at the development site only at its northern corner at night, where the baseline of background sound is caused by a low level hum from the industrial building at the opposite side of Valley Road. This will remain the only sound source from existing industrial premises with impact on the proposed residential site.

Sound from the proposed industrial units is predicted in the Appendix to this report as affecting the nearest dwellings, located off Valley Road directly opposite the entrance to the service yard.

These two different sound sources and receptor positions are assessed separately by the method of BS 4142.

Specific Noise Levels

The continuous sound level from the industrial source as received at the north corner of the site was measured in our survey at 38.1 dBA of continuous sound. The sound levels at the nearest dwellings to the proposed industrial units are predicted in the Appendix as 42-58 LA_{eq} (1-hour) during the daytime and 32 LA_{eq} (5-minutes) at night.

Acoustic Feature

The existing industrial source affecting the north corner has a distinct low frequency hum. A correction of 5 dB must be added to the measured value to account for 'acoustic feature'.

The greatest contributor to the sound levels from the proposed industrial units is caused by the movements of vehicles. Since the background is already dominated by road traffic noise the sound from this development will be similar in nature to the background. For this reason no correction for 'acoustic feature' is added to the predicted sound levels from the proposed units.

Rating Levels

The noise rating level at the north corner of the site is 43 dB at all times of day and night. The rating levels at the dwellings opposite the proposed industrial units are up to 58 dB during the daytime and 32 dB at night.

Background Comparison

Comparison of the rating levels with the background levels (as reported in section 4.0) shows:

Location/ Time	Rating Level dB	Backgnd Level LA ₉₀	Comparison v. Background
North corner			
Daytime	43	50	5 dB below background
Night	43	40	3 dB above background
Opposite Proposed Industrial Units			
Daytime	58	52	up to 6 dB above background
Night	32	40	8 dB below background

BS 4241 Conclusions

The conclusions at the north corner of the site are that complaints about industrial noise are unlikely during the daytime, and that at night the low level of hum from an existing industrial building will be audible but its rating is less than 'of marginal significance'.

At dwellings proposed directly opposite the industrial units which are intended for change of occupancy, the worst-case predictions during the daytime are 'of marginal significance'. The night predictions at these dwellings are unlikely to cause complaints. In order to protect the dwellings against the possibility of daytime noise, which is predicted from vehicle movements and loading activities, a later section of the report recommends the provision of acoustic fences along the residential site boundary with Valley Road.

8.0 Assessment of Noise From Kart Racing

Kart racing takes place at the sports ground located adjacent to the southwest boundary of the site. As part of a previous consultancy exercise in March 2004 we were commissioned to take sound measurements at various positions on the sports ground when karts were being raced. The measurements were taken during a championship race meeting in which karts were being driven as hard as is likely to take place on this track, the event being chosen by the organisers as being as noisy as was likely at any time in 2004. It is understood that the sound generation during current periods of kart racing is unlikely to exceed the measured values but the intensity of racing has increased since 2004, so that the measured sound levels may now exist for a full one-hour period. The measurement positions included one at 10m from the edge of the track near the centre of the straight section adjacent to the boundary with the development site.

Sound levels were measured at this position for the duration of two races, each with 8 competing karts. In both cases the classification of the karts was described by their 125cc, 2-stroke engines.

Sound Descriptor		Race 1	Race 2
10m from track edge towards site boundary			
Ambient	LA _{eq}	80.3	82.9
Background	LA ₉₀	71.8	73.6
Maximum	LA _{max}	88.7	93.4

Sound frequency spectrum of highest result, race 2:

Sound pressure levels dB linear:

Frequency (Hz)	63	125	250	500	1k	2k	4k	8k
At 10m, Leq	67.9	73.9	78.0	79.5	77.1	76.2	73.6	70.9

The nearest approach of the kart track to the boundary of rear gardens on the residential site will be approximately 20m at the south corner of the site. At plots further northwest the distance from the track edge to garden boundaries increases to approximately 30m. This will provide a sound decay of 3 to 5 dBA respectively below the above results.

Sound Predictions on developed site

It is proposed to erect a three-storey block of residential flats with a continuous elevation along the boundary between the sports ground and the residential development. The elevation of the three-storey block will be 20m from the boundary. The building will create a sound shadow which will reduce the sound levels from racing activities on the sports ground as received at dwellings on the rest of the development. It is proposed to have no habitable rooms in the elevation facing the sports ground and to use the outdoor space between it and the boundary for parking only. By this means the racing noise will not affect any habitable rooms or amenity spaces other than after receiving noise attenuation by the height of the three-storey building.

The height of the three-storey building will be 10m to the ridge and the ground height is 0.5m above that of the sports ground. The height of the sound source on the karts is 0.5m above track level and the nearest receptor is the elevation of the nearest dwellings facing the sports ground at a distance of 50m from the boundary, 70m from the kart track. From the geometry of this cross-section the effective barrier height to kart noise will be 10m and the sound will turn downwards through 32° as it passes over the ridge of the flats building towards the nearest dwellings. The sound reduction is given in *Woods Practical Guide to Noise Control* as shown in the calculation table below:

Sound pressure levels dB linear:

Frequency (Hz)	63	125	250	500	1k	2k	4k	8k
At 10m, measured	67.9	73.9	78.0	79.5	77.1	76.2	73.6	70.9
Distance decay	8	8	8	8	8	8	8	8
Barrier Loss	14	16	19	22	22	22	22	22
In garden, dB lin	46	50	51	50	47	46	44	41
In garden, dBA	20	34	42	47	47	48	46	39

The above table gives a spectrum of sound predictions over the range of sound frequencies. The overall values is 53 dB LA_{eq}.

Specific Noise Levels

It is reported by the LPA that the sound generated by kart racing may now be continuous over a full one-hour assessment period. The specific noise level in the most affected gardens at the nearest dwellings to the track is 53 dB.

Acoustic Feature

The kart noise is intermittent and attracts attention. A correction of 5 dB is added to the specific level to account for 'acoustic feature'.

Rating Levels

The noise rating level is predicted at 58 dB.

Background Comparison

Comparison of the rating levels with the daytime background level (as reported in section 4.0) shows:

Position	Rating Level dB	Backgnd Level LA ₉₀	Comparison v. Background
Nearest dwelling	58	52	6 dB above background

BS 4241 Conclusions

The conclusion of a BS 4142 assessment is that the kart sound is 'of marginal significance'. It was reported in section 2.3 that PPG24 anticipates a more lenient interpretation of a BS 4142 conclusion when the source of noise is caused by recreational and sporting activities than in the case of industrial noise sources, for which BS 4142 is primarily intended. In this application the noise source involves both recreation and sport. The BS 4142 rating is given above for completeness and for consideration by the LPA.

Parking Area

In order to minimise the impact of kart noise on residents of the three-storey block of flats it is proposed to erect between the flats and the sports ground boundary an earth bund of height 2.5m with an acoustic fence of height 2.5m along its ridge. This is estimated to reduce kart noise as received in the residents' parking area by 16 dBA to an overall 62 dB LA_{eq}.

APPENDIX TO REPORT

SOUND FROM INDUSTRIAL UNITS WITH CHANGED OCCUPANCY

A.1 Sound Sources Inside Units

The two existing industrial buildings will be divided and re-let as smaller units for industrial or commercial use, all of which are speculative at this stage. Since the sound sources inside the buildings cannot be defined under these circumstances a range of typical sound levels is described and used in the predictions.

The occupational sound levels for employees working within the units provide an immediate reference which is meaningful as an interior noise statement. Noise levels are considered which fall below the 'exposure action values' of the Control of Noise at Work Regulations 2005, those which exceed the 'lower exposure action value' and those which exceed the 'upper exposure action value'. Although the noise exposures of employees within the new units is of no direct importance to this planning application, the use of the 'action values' with reference to production interiors provides a basis for prediction which can be broadly related to many different types of potential activity.

In addition to these sound levels which are typical of production lines, predictions have been based on sound levels within warehouses. Sound levels were measured inside existing warehouses for non-food goods where hand picking, non-powered hand trucks and gas powered forktrucks were used. Measurements were taken during one-hour periods of normal working.

Activity	Sound Level LA _{eq} over activity period	Measurement Distance
Production interior:		
below action levels	75 dBA L _{eq} (8-hour)	{ at
lower action value	80 dBA L _{eq} (8-hour)	{ work
upper action value	85 dBA L _{eq} (8-hour)	{ place
Warehouse interior:		
'busy' area - fork & pallet trucks	61 dBA L _{eq} (30-min)	{ at
'quiet' area - picking/hand trucks	52 dBA L _{eq} (30-min)	{ working
		{ area

A.2 **Vehicle Sound Measurements**

The units will share an outdoor service yard for delivery vehicles to enter, turn, reverse onto loading bays and be loaded or unloaded. Since all units are speculative there are no existing delivery movements to provide estimates of vehicle call rates, durations or sound levels. For the purpose of sound predictions, sound levels were measured during the movements and loading of articulated vehicles without refrigerators at a distribution warehouse where the call rate was high thereby providing a substantial base of measurement data (Wm. Morrisons, Wakefield 41).

Articulated vehicles arrived, reversed onto loading bays, were loaded or unloaded by personnel directly into the warehouse interior using pallet trucks, then departed. Diesel forklifts were used in some cases between the warehouse interior and the waiting road vehicle, their sound being measured separately. Measurements were time-averaged over the period during which the activity took place, generally between 40 and 60 seconds per vehicle manoeuvre and 15-20 minutes loading.

The assessment periods defined in BS 4142 are one hour during the daytime (0700 to 2300 hours). It is assumed for the purpose of sound predictions that during the daytime no more than three delivery vehicles per hour will move in and out of the yard serving all of the Units, and there will be no deliveries or collections at night.

Reverse Alarms

Reverse warning beepers were not used during the above measurement exercise and were measured separately.

Car Parks

Sound levels during the parking and departure of cars were measured and time-averaged over periods of 10 seconds per car movement to provide a baseline for measurement.

Activity	Sound Level LA_{eq}	Distance
HGV movements	64 - 68 dBA	30m
loading at bays	51 dBA	30m
diesel forklift loading	62 dBA (15-min)	15m
reverse alarms	75 dBA at sides of HGV	10m
reverse alarms	95 dBA at rear of HGV	10m
car arrival or departure	62 dBA L _{eq} (10-sec)	10m

A.3 **Sound Reaching Dwellings From Vehicles**

The nearest proposed dwellings have rear elevations towards Valley Road at 40m from the nearest elevation of an industrial unit. The service yard and the loading doors to all Units will have a direct sightline to some dwellings on Valley Road and Access Road no.1 as shown on Chris Carr Associates drawing no. 21.75 P1.

The outdoor sources affecting dwellings will consist of sound from vehicles in the service yard turning and reversing onto loading bays, being loaded or unloaded, then departing. There is a possibility that some vehicles may be loaded or unloaded by forktrucks in the outdoor yards rather than being loaded directly into the buildings at the bays. This possibility is quantified in the predictions. The nearest loading bay is 50m distance from the nearest dwelling.

A.4 **Predicted Sound Levels**

The sound levels of vehicles and activities at other premises given in section A.2 were measured at distances as convenient at those premises. The distances to dwellings in this application are different and will have different sound decays. Each sound source and its contribution to the overall sound at the nearest dwellings is summarised below. The quantities are shown per vehicle either arriving or departing and loading or unloading.

Activity	Sound Level LA_{eq}	Duration
HGV in service yard	52 to 66 dBA	40-90 sec
Pallet loading inside vehicle	37 to 47 dBA	15 min
Forktruck loading in yard	42 to 52 dBA	15 min
Car arrival or departure	38 to 48 dBA	10 sec

Reverse Alarms

The peak sound levels reaching dwellings from conventional reverse beepers are predicted up to 79 dBA L_{max} in cases where the vehicle is reversing with its rear tailgate towards the dwellings and 59 dBA L_{max} where a side of the reversing vehicle is facing dwellings.

A.5 Predictions of Sound from Indoor Sources

Sound transmission from sources inside the buildings will be through their outer fabric then as airborne sound across the outdoor distance to dwellings. The following sound reduction indices are typical of the construction and are assumed in the sound predictions:

Sound reduction indices dB:

Frequency (Hz)	63	125	250	500	1k	2k	4k	8k
Wall/roof materials	16	16	23	30	33	40	46	50
Roof glazing	13	16	20	25	30	36	42	48
Doors	13	17	21	26	29	31	34	34
Average SRI	14	16	21	27	30	33	36	36

Sound levels are calculated by taking the measured results from inside existing production and warehouse areas, translating these through the sound insulation of the building exterior fabric to outdoors, then over the outdoor distance to dwellings by the following formulae:

Outdoors-to-indoors:

$$SPL_{\text{outdoors}} = SPL_{\text{indoors}} - R - 6 \text{ dB}$$

Distance calculation:

$$SPL_1 - SPL_2 = 10 \log (r_1/r_2) \text{ dB}$$

for distances 1.5m to 6m where the buildings form line sources,

$$SPL_2 - SPL_3 = 20 \log (r_3/r_2) \text{ dB}$$

for distances greater than 6m where the buildings are point sources.

$SPL_{1, 2 \& 3}$ are sound pressure levels at distances $r_{1, 2 \& 3}$ from the building facade, and R is its average sound reduction index.

The number of Units in the conversion proposal and their floor areas have not been determined at this stage. For the purpose of sound prediction the most intensive situation is assumed in which operational sound may be generated across the full floor area of the existing buildings. In reality it is likely that significant internal areas will form office space, thereby giving a conservative tolerance margin to the predictions.

The calculation of sound from the interior of the nearest unit to the dwellings is shown overleaf. A typical sound frequency spectrum is taken for a light industry such as printing at the overall interior sound level of 90 dBA.

Sound pressure levels, dB linear:

Frequency (Hz)	63	125	250	500	1k	2k	4k	8k
SPL inside unit	80	81	82	83	86	82	81	78
Cladding loss	20	22	27	33	36	39	42	42
Outdoors at 1m	60	59	55	50	50	43	39	36
Distance loss	22	22	22	22	22	22	22	22
SPL at dwellings	38	37	33	28	28	21	17	14

The above table gives sound level predictions across the frequency range outdoors at the nearest dwellings from production activities well above the upper exposure action value at 90 dBA inside the nearest units. When expressed as a single-figure quantity this is:

Sound level at dwellings from 90 dBA inside unit = 32 LA_{eq}

Since none of the interior activities is known at this stage it is assumed for the purpose of estimation that the same interior sound level exists in all Units. The overall sound levels at the nearest dwellings caused by interior activities at all Units will be:

Activity	Interior Sound LA _{eq} in units	LA _{eq} at Dwellings
Production interior:		
below action values	75 dBA	20 dBA
at lower action value	80 dBA	25 dBA
at upper action value	85 dBA	30 dBA
above upper action value	90 dBA	35 dBA
Warehouse interior:		
busy warehouse	61 dBA	6 dBA
quiet warehouse	52 dBA	0 dBA

A.6 Time-averaged Levels for Planning Assessment

Daytime Activities

By the method of BS 4142 the assessment period is one hour during daytime 07.00 to 23.00 hours. The sound levels received at dwellings in a typical hour are predicted from the individual contributions from outdoor sources listed in section A.4 and from continuous sound from the building interiors listed above in A.5. The worst-case sound

predictions assume that there will be three delivery vehicle movements in and out per hour inclusive of all Units.

Daytime Sound Generation

The overall sound level at the dwellings is made up from:

52-66 LA_{eq} for 240-540 sec from HGV movements in yard,

37-47 LA_{eq} for 45 min from on-bay loading, or

37-47 LA_{eq} for 30 min from on-bay loading plus

42-52 LA_{eq} for 15 min from forktruck loading,

36-48 LA_{eq} for 100 sec from ten car movements.

The sum of all of the above contributions gives the overall prediction during the daytime which is **42 to 58 dBA L_{eq} (1-hour)** irrespective of the loading method.

Daytime Sound From All Activities

Sound from sources inside the industrial buildings must be added to that from the delivery and loading activities quantified above. It can be seen from the table of predictions in A.5 that this is negligible by comparison, being between 0 and 6 LA_{eq} at the dwellings for typical warehouse activities and between 20 and 35 LA_{eq} for production activities ranging from relatively quiet to very noisy shopfloor sound levels.

It is concluded that the overall outdoor predictions from all sound sources both outdoors and inside the buildings are **42 to 58 dBA L_{eq} (1-hour)**

Night Sound From All Activities

It is assumed that there are no deliveries, collections or loading activities at night. Sound is generated only by sources inside the buildings as predicted in section A.5. The worst-case prediction at the nearest dwellings is **32 LA_{eq} (5-minutes)**.
