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REPORT FOR
Goldcrest Land plc

1-9 SANDYCOMBE ROAD
LONDON

NOISE ASSESSMENT

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REPORT NO. 3224/23/2016

STEPHEN MOORE
14th November, 2016

1.0 INTRODUCTION

1.1. This report considers the acoustic aspects of the proposal by Goldcrest Land plc for a mixed use development to include high quality office space and residential accommodation, on land at 1-9 Sandycombe Road, Richmond.

1.2. There is an overground railway line just beyond the eastern site boundary and a busy road network to the south. To the west, on Sandycombe Road and Raleigh Road, there are dwellings.

1.3. The site is currently occupied by commercial units which would be demolished. The proposal is to construct a part 3/part 4 storey building with commercial space on the ground floor and part of the first floor.

1.4. Moirhands were commissioned to examine the suitability of the site for residential purposes and specify the form and extent of mitigation to achieve the prescribed acoustical comfort conditions.

1.5. In this regard, the London Borough of Richmond require an acoustic assessment to be conducted to show that the site is suitable for the purpose intended.

1.6. This study provides a description of the prevailing noise environment existing on the site in terms of the most common noise indices; it describes the form and extent of mitigation to achieve the criteria specified in the various Standards and guidance documents and it gives an overview of the impact of the development on neighbouring users.

1.7. The outcome of the study is that noise ingress can be controlled to the desired levels. This requires the use of higher specification than normal glazing and an alternative means of ventilation. The residential element of the scheme would have no adverse impact on any neighbouring users.

1.8. Moirhands have been in practice as acoustical consultants for over 30 years. The organisation is a recognised authority on noise control and acoustic design and is called upon to advise on the acoustic aspects of retail units, theatres, concert halls, office blocks, power stations, factories, leisure facilities, housing developments and the like.

1.9. In recent years, the dominant part of our work has been the measurement and prediction of noise in the environment and in particular, the effects on existing dwellings and proposed new residential properties, and advising on measures to mitigate such noise.

2.0 THE SITE

2.1. The site is located at 1-9 Sandycombe Road, Richmond, London TW9. The location of the site is shown in Figure 1.

2.2. The site lies immediately to the west of the London Overground commuter line with regular services between Richmond and Stratford. TfL District Line tube trains also use this line.

2.3. Directly opposite the site, on North Road, there are established terraced dwellings and at the junction of North Road and the A316 Lower Richmond Road, there is a car dealership.

2.4. To the south of the site, Sandycombe Road rises up to meet the Manor Circus roundabout. There is a petrol filling station at this junction. On the opposite side of the roundabout to the PFS, there is a retail park which includes a Sainsbury's store, a restaurant, vehicle hire facility and some other commercial enterprises.

2.5. Richmond Station lies around 1km to the west of the site and Kew Station approximately the same distance to the north. There are some scheduled trains in the late evening and early morning periods and throughout the day, there are around 8 trains per hour on the line.

2.6. There are long established dwellings on Sandycombe Road, to the north of the site and a small commercial unit on the site just beyond the northern boundary which has an extant permission for redevelopment.

2.7. The site is broadly flat and the finished ground floor level of the development will be approximately 1.5m above the level of the railway tracks. There is nothing unusual about the site which would affect the transmission of noise from source to receiver.

2.8. Access to the site would be from Sandycombe Road.

3.0 NOISE PRINCIPLES AND RELEVANT GUIDANCE

3.1. The loudness of noise is measured in decibels. To give a frame of reference it is worthwhile to establish two noise levels which are at about the extreme ends of the range to be discussed here. At the low end, 30 to 40dBA is the normal noise level in a quiet living room; 30dBA is the noise level given as a goal for the night-time L_{eq} in suburban bedrooms by the World Health Organisation. At the high end is the noise level experienced at the pavement edge of a busy city centre street, a level of 75 to 80dBA.

3.2. The suffix 'A' in the dBA nomenclature simply means that the sound level is measured with a meter, which duplicates the frequency response of the human ear. Humans are most sensitive to sound at 2 to 4kHz (two to four octaves above middle C) and much less sensitive to sounds at very low or very high frequencies.

3.3. Noise is measured on a logarithmic scale and the levels cannot be added arithmetically. Two equal noise levels, when they occur together form a new level which is 3dBA higher than either one alone. Thus two ventilation fans each producing a level of 35dBA outside someone's window will produce, not 70dBA but 38dBA when both run together.

3.4. If one source is 10dBA below a louder source, then the combined effect will be virtually no different to the louder one alone.

3.5. Roughly speaking, most people will perceive that a sound level has been doubled when it is increased by 10dBA. It is also worth bearing in mind that a difference of 3dBA is the least which can be distinguished by the average human ear.

3.6. The ambient noise is generally caused by activity over a wide surrounding area, sometimes from many miles away. It has components due to wind in the trees, railways, air traffic, household appliances, children playing, dogs barking etc. In modern times the largest contributor is motor traffic.

3.7. The level of ambient noise can be very high but it will not appear loud unless there are clearly identifiable components in it. The brain automatically adjusts its response so that the background level becomes a threshold to which all new noises are referred.

3.8. Because of the many components in it, the ambient level fluctuates, often by as much as 10dBA and it is not always easy to put a precise value on it. It is clear, however, that it would be unrepresentative to take either the very lowest level observed or the very highest.

3.9. Noise in the environment is a constantly varying phenomenon and it is therefore inevitable that statistical measures of the noise are used to quantify the noise environment.

3.10. Over the years, many statistical indices have been postulated and some of the more common ones are given in the Glossary of Terms in the Appendix. Ambient noise levels are usually measured using the L_{eq} parameter. The L_{eq}, or continuous equivalent noise level is the *energy* average of the noise over a given time period. The energy average has the effect of weighting the measured level towards the peaks in the noise and is therefore higher than the arithmetic average of the noise over the same time period. The L_{eq} is generally accepted as being the index which most closely correlates to our subjective reaction to noise.

3.11. For the purpose of this study, the most relevant parameters are the L_{eq}, the L_{10}, the L_{max} and the L_{90}. The latter is termed the 'background' noise.

3.12. The relevant planning document in relation to the treatment of noise in the Planning function is the Noise Policy Statement for England (NPSE).

3.13. This document permits Councils to set their own targets relating to noise, having due regard to the available and authoritative guidance on the subject of noise in the environment and its effects on humans. For residential development, the criteria relating to intrusive noise set out in BS8233 normally apply. **BS8233:2014 –**

Table 4 **Indoor ambient noise levels for dwellings**

Activity	Location	07:00 to 23:00	23:00 to 07:00
Resting	Living room	35 dB $L_{Aeq,16hour}$	—
Dining	Dining room/area	40 dB $L_{Aeq,16hour}$	—
Sleeping (daytime resting)	Bedroom	35 dB $L_{Aeq,16hour}$	30 dB $L_{Aeq,8hour}$

NOTE 7 Where development is considered necessary or desirable, despite external noise levels above WHO guidelines, the internal target levels may be relaxed by up to 5 dB and reasonable internal conditions still achieved.

NOTE 4 regular individual noise events (for example, scheduled aircraft or passing trains) can cause sleep disturbance. A guideline value may be set in terms of SEL or $L_{Amax,P}$ depending on the character and number of events per night. Sporadic noise events could require separate values.

3.14. In relation to offices/retail/commercial spaces, intrusive noise levels should be constrained to be within the range 40-50dBA, depending on use.

3.15. BS6472-1:(2008) entitled "*Guide to Evaluation of human exposure to vibration in buildings (0.5Hz to 80Hz)*" is the Standard most often adopted for the purpose of the assessment of human response to somato-sensory perceptions of ground-borne motion.

3.16. Train vibration is intermittent in nature. The concept of 'energy summation' was devised to assess the severity of impulsive or intermittent vibration is encapsulated in the Vibration Dose Value (VDV).

3.17. Mathematically the VDV is defined as

$$\text{VDV} = \left[\sum a^4(t)dt\right]^{0.25}$$

where VDV is the vibration dose value (in $ms^{-1.75}$)

a(t) is the frequency weighted acceleration

T is the total period of the day (in seconds) during which vibration may occur.

3.18. Further, magnification of vibration can occur in buildings so that seemingly innocuous vibration levels on the foundation can become troublesome at higher floors in the building. Predictive routines are not sufficiently accurate, nor well developed, to be able to ascertain the likelihood of magnification problems.

3.19. This assessment has been carried out using the information contained in BS6472-1:2008.

PROCEDURES

3.20. In this case, the relevant Standard as far as external noise is concerned is ISO 9613-2 "Acoustics – Attenuation of sound during propagation outdoors – Part 2: General method of calculation."

4.0 THE PREVAILING NOISE ENVIRONMENT

4.1. Measurements and observations were made in the vicinity of the site covering the following periods:

24th/25th November 2015, between 13.00hrs and 12.00hrs

4.2. The measurement positions are shown in Figure 1. The measurements were made over 15 minute periods.

4.3. The salient results that are contained in Table 1 show that the site is affected by moderately high noise levels mainly due to trains, aircraft and traffic.

4.4. The instrumentation utilized for the survey included:

- Norsonics 118 Precision Integrating Sound Level meter
- Matching hand held Acoustic Calibrator
- Bruel & Kjaer type 2236 Precision Sound Level meter
- Bruel & Kjaer type 4231 hand-held acoustic calibrator
- Vibrock 901 vibration monitor
- eNVi monitoring system

4.5. In each survey, the microphone was stationed at a height of 1.5m above local ground level.

4.6. Before and after each measurement, the entire system was calibrated using the hand-held acoustic calibrator. No electronic drift was observed.

4.7. The weather conditions for the duration of the surveys were mostly fine with two short periods of light rain. Wind speeds were below 1.5m/s and temperatures ranged from 2 ^{o}C to 11 ^{o}C throughout the measurement period.

4.8 These conditions are conducive to obtaining representative estimates for the noise climate prevailing at the site.

5.0 BASIS OF ANALYSIS

5.1. The form and extent of mitigation needed to meet the acoustical objectives set out in BS8233 and related advice have been based on the following information:

- Goldcrest Architects' drg. no. P03_050 'Block Plan' dated Nov. 2016
- Goldcrest Architects' drg. No. P03_101 'First Floor' dated Nov. 2016
- Goldcrest Architects' drg. No. P03_201 'Building Elevations', dated Nov. 2016
- Goldcrest Architects' drg. No. P03_202 'Building Elevations', dated Nov. 2016
- BS8233 internal comfort criteria

  Living rooms - 35dBA (L_{eq}(16hr))

  Bedrooms - 30dBA (L_{eq}(8hr))

  - 45dBA L_{max}

  Vibration - below 'low probability of complaint' criteria suggested

- Noise & vibration survey data
- BS8233:(2014) 'Guidance on sound insulation and noise reduction for buildings.'
- BS6472-1:(2008) 'Guide to evaluation of human exposure to vibration in buildings.'

- Form of construction that gives a minimum level of sound insulation for walls of 52dB (R_w) and for the roof 45dB (R_w)
- Standard acoustical calculations, procedures and practices.

5.2. The highest L_{max} and the highest hourly L_{eq} occurring overnight have been used as the basis for the design of glazing to bedrooms.

6.0 DISCUSSION

6.1. The main sources of noise affecting the site are:

- Overground and District Line train movements
- Aircraft mainly on final approach to Heathrow
- Traffic on the A316
- To a lesser extent, traffic on Sandycombe Road and the neighbouring road network

6.2. The noise climate at both sites can be described as being moderately high but lower than many other sites in highly urban surroundings.

6.3. In quantitative terms, the 16hr L_{eq} is 64dBA and the 8hr night-time L_{eq} is 54dBA. Transient maximum noise levels reach 85.4dBA overnight. The worst-case L_{eq} (1hr) in the overnight period was 64dBA. None of these numbers suggest that the noise environment for future residents would be particularly high.

6.4. The sound insulation performance of the glazing to the habitable rooms facing towards the railway has been based on the need to limit night-time noise ingress to an L_{max} not exceeding 45dBA.

6.5. Based on a window area at first floor level being of the order of 70% of the facade area in some cases, the glazing system would have to provide a level of sound insulation of 39dB Rw for windows with a direct or oblique view of the

railway line. This level of sound insulation can be provided by many different glazing systems, for example, 10/12/6.8 or 6/12/13 Audioscreen glazing.

6.6. This level of protection will ensure that both daytime and night-time noise ingress expressed in terms of the Leq, would be below the values required by BS8233.

6.7. For windows which face towards Sandycombe Road, and allowing for the increase in noise level from road traffic at higher floors, the glazing would need to provide a minimum Rw of no less than 37dB.

6.8. There are many glazing systems available on the market and it will be a matter for the eventual supplier to ensure that the glazing installed can meet the minimum levels of insulation set out above. Test certificates proving that their systems can achieve the desired degree of insulation required must be supplied prior to installation.

6.9. All rooms will need to be fitted with an alternative means of ventilation. The system chosen should have a Dn,e,w of not less than 45dB.

6.10. Noise levels experienced on balconies at all floor levels will be up to 64 dBA (Leq, 16hr). This is above the level of 55dBA (Leq, 16hr). The amenity courtyard should include a 1.8m high close-boarded fence along the railway boundary.

6.11. The 55dBA criterion is based on recommendations made by the World Health Organisation relating to potential annoyance to some people when exposed to the stated level of noise.

6.12. Limiting residential development to sites where the external noise levels are below 55dBA is not a requirement of the new planning guidance, nor was it under the previous planning policy guidance note on noise.

6.13. The National Physical Laboratory report CMAM16 'Health Effects Based Noise Assessment Methods: A Review & Feasibility Study' presents a pragmatic assessment of the WHO guidance. It notes they are based on the lowest threshold at which the effects of environmental noise can be assumed to be negligible. It goes on to say that more than half of the UK population are exposed to noise levels greater than those recommended by the WHO and that limiting exposure to below this cannot be achieved without drastic action to virtually eliminate road traffic noise and other forms of transportation noise.

6.14. Their review of the literature concluded that there is no evidence that anything other than a small minority of the population exposed to WHO guideline values find them particularly onerous in the context of their daily lives. Summarising, they say: 'It would be unwise to use WHO guidelines as targets for any form of strategic assessment, since, given the prevalence of existing noise exposure at higher noise levels, there might be little opportunity for and little real need for any across the board major improvements".

6.15. Vibration levels affecting the site are low and fall into the 'low probability of adverse comments' category. There is therefore no need to isolate the building from the ground.

6.16. Any mechanical plant required to be installed to support the proper functioning of the new buildings will be designed to ensure noise emissions accord with the requirements of BS4142.

6.17. Glazing to any commercial element of the scheme should provide a minimum level of sound reduction of 32dB (Rw). Either a single pane of 6mm

float glass or 6/12/4 sealed double glazed units could achieve this level of insulation.

7.0 CONCLUSION

7.1. Goldcrest Land plc proposes to redevelop the site at 1-9 Sandycombe Road, Richmond, for a mixed use development comprising high quality office space and residential accommodation.

7.2. The proposal is to construct a part 3/part 4 storey building with commercial uses on the ground and part of the first floor, with residential above.

7.3. The site is in close proximity to transportation noise sources, particularly the London Overground railway line. This line is also used by TfL District Line tube trains. The A316 is close by and the site is under the Heathrow flight path which lies a few miles to the west. Noise is therefore a relevant planning consideration.

7.4. Noise surveys have been carried out which provide quantitative estimates for the prevailing noise environment at the site.

7.5. The noise environment is moderately high but is acceptable for the type of development proposed.

7.6. Glazing recommendations, have been suggested which will ensure that the requirements of BS8233 in terms of noise ingress, are achieved.

7.7. Vibration levels experienced on site are low and vibration isolation is not required.

7.8. Although noise on the balconies will be above 55dBA, the likely levels experienced on completion of the development will still be acceptable and no worse than those likely to be experienced in similar neighbouring developments. The amenity courtyard would benefit from a 1.8m high imperforate close-boarded fence along the railway boundary.

7.9. Provided the measures suggested in this report are implemented, the internal comfort criteria specified will be satisfied.

7.10. There is therefore no reason, on the grounds of noise why the proposal should not be approved.

ATTACHMENTS

GLOSSARY OF ACOUSTIC TERMS

The following definitions explain the technical terms used in the preceding text. They are a guide only and are intended to provide a qualitative understanding of the concepts involved in characterising and summarising acoustic information.

Audible Range: *the human hearing system is capable of detecting sound pressures from around 20 uPa up to approximately 20 Pa - a range of 1,000,000. Higher pressures can be detected but damage becomes increasingly likely.*

dB Scale: *condenses this unmanageable range of sound pressures by taking the logarithm of the ratio of the actual sound pressure to the threshold of hearing pressure (20 uPa). The ear also behaves roughly logarithmically. To determine the sound pressure level in dB terms, the following formula is used:*

SPL = 20 Log (rms pressure/20 uPa)

In dB terms, the threshold of hearing would be 0dB, the threshold of feeling, 120dB and somewhere between 130 and 140dB is generally recognised as being the threshold of pain.

Ambient Noise *The local noise level which comprises all noise, near and far and is normally expressed as an L_{eq}.*

A-weighting: *normal hearing covers approximately 3 decades of frequency starting from around 20Hz up to about 20kHz; sensitivity is greatest between about 2000Hz and 5000Hz. The 'A'-weighting is an electrical circuit built into a noise meter which imitates the frequency response of the ear.*

dBA: *a measurement of sound with the A-weighting filter switched in: the resultant level reflecting the subjective response of the noise under investigation.*
It is generally accepted that a change in noise level of 3dBA is the minimum that can be detected. A change of 1dBA is detectable but only under certain prescribed laboratory conditions. A 10dBA change in level corresponds to a doubling or halving of the loudness of a sound. Loudness and level are different concepts.

Hz: *unit of the frequency of a sound.*

FAST: *the response time of the sound level meter which is nearest to that of the human ear {time constant of 125ms}.*

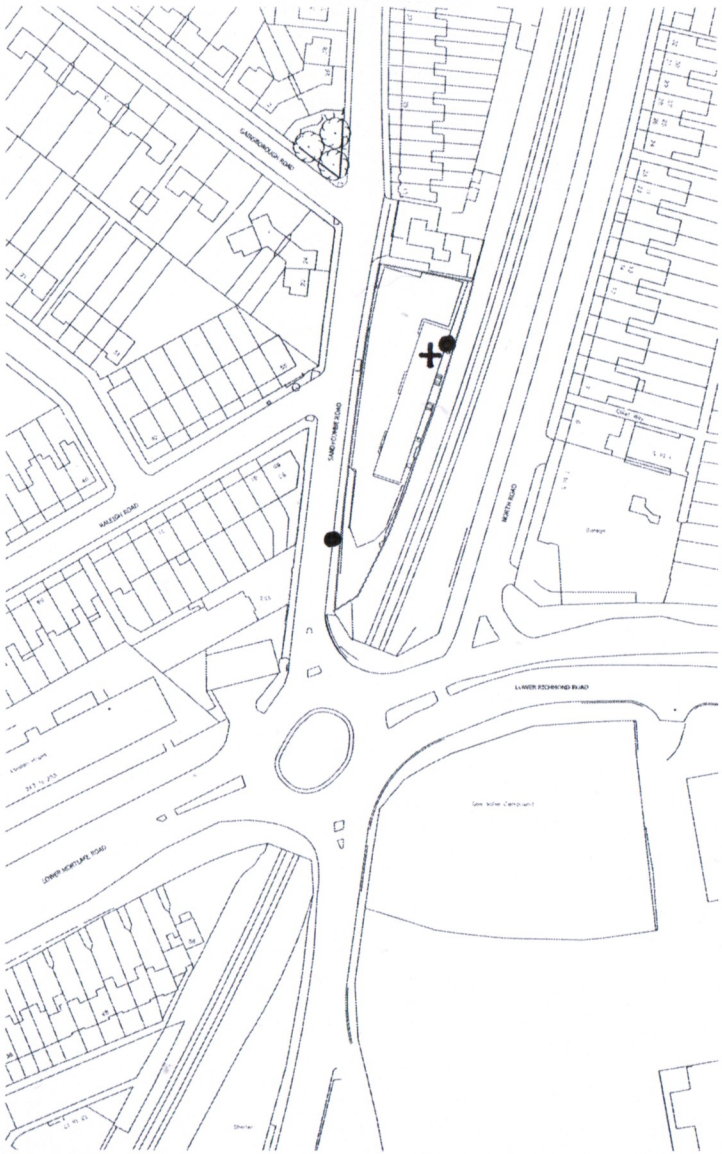
Environmental noise, in the main, is a fluctuating phenomenon. It varies in level both spatially and temporally and because this is the case, noise is characterised by a series of statistical parameters. In general the following are used to describe any particular noise environment. The list is by no means exhaustive.

L_{eq}	*is an 'average' of the noise level over a defined time period. The average is performed on an energy basis which has the effect of weighting the sound level to the peaks in the noise. Used commonly nowadays to describe a range of noises.*
L_{90}	*the A-weighted noise level exceeded for 90% of a specified measuring period. This index generally taken to be the background noise level i.e. that noise that would remain once all local noise sources had been 'switched off'.*
L_{10}	*the A-weighted noise level exceeded for 10% of a specified measuring period. Used largely to assess the noise from road traffic.*
L_{max}	*the highest A-weighted noise level recorded during a measurement period. This is not the same as Peak or Maximum Peak.*
SEL	*Sound Exposure Level - is effectively the L_{eq} of a noise event normalised to l second. In other words if a sound level equal to the SEL is maintained constant over a 1 second period, it would have the same acoustic energy as the measured noise event.*

Figure 1

● **Noise**

\+ **Vibration**



Rev	Date	Revision Description

Scale 1:1250

0 25000 50000 75000 100000 125000

This line measures 100mm when this drawing is printed @ A3

IF IN DOUBT ASK.
Dimension to be verified on Site.

Project: 1-9 Sandycombe Rd TW9 2EP

Scale: 1 : 1250@A3

Drawing Title: LocationPlan

Date: NOV 2016

Drawing #: P03 001

Status: Planning

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Site location and measurement positions

TABLE 1
SURVEY DATA

Position 1

Start time	Start date	Leq	Lmax	Lmin	L10	L90
12:57:58	24/11/15	64.6	80.64	46.51	66.7	49.7
13:12:58	24/11/15	63.68	79.98	46.4	66.9	49
13:27:58	24/11/15	63.48	81.4	46.53	64.1	49.4
13:42:58	24/11/15	64.97	83.37	45.05	65	49.4
13:57:58	24/11/15	66.08	84.27	46.28	65.7	49.2
14:12:58	24/11/15	64.38	82.17	45.2	66.5	48.8
14:27:59	24/11/15	65.53	83.75	46.28	66.9	49.4
14:42:59	24/11/15	65.22	82.18	46.87	67.5	49.4
14:57:59	24/11/15	62.13	78.13	46.62	58.9	49.1
15:12:59	24/11/15	62.66	80.14	45.59	59.2	48.5
15:27:59	24/11/15	64.56	83.71	45.64	58.4	48.7
15:42:59	24/11/15	63.71	81.34	44.69	58.3	47.9
15:57:59	24/11/15	62.25	81.6	45.64	58.7	48.4
16:12:59	24/11/15	64.32	83	45.74	59	49.1
16:28:00	24/11/15	62.37	81.99	44.25	58.8	48.7
16:43:00	24/11/15	63.3	79.82	46.18	59.8	49.1
16:58:00	24/11/15	60.4	80.88	45.49	58.2	48.1
17:13:00	24/11/15	63.31	79.68	46.22	59.7	49
17:28:00	24/11/15	61.72	80.6	45.08	57.7	48.6
17:43:00	24/11/15	63.74	81.59	46.34	59.5	48.8
17:58:00	24/11/15	62.99	81.16	45.92	59.1	48.7
18:13:00	24/11/15	64.67	84.3	45.28	57.9	48.8
18:28:01	24/11/15	62.46	82.62	45.54	58.7	48.8
18:43:01	24/11/15	64.87	83.3	45.53	60.7	48.4
18:58:01	24/11/15	63.24	82.54	44.99	58.3	48.3
19:13:01	24/11/15	64.72	83.9	44.58	59.9	48.3
19:28:01	24/11/15	62.17	79.91	43.77	59.4	47.1
19:43:01	24/11/15	61.25	82.8	44.82	57	47.8
19:58:01	24/11/15	64.21	84.09	43.02	59.2	46.8
20:13:02	24/11/15	62.66	80.03	43.97	58.8	46.3
20:28:02	24/11/15	62.77	80.81	41.67	58.9	46.7
20:43:02	24/11/15	64.04	83.34	42.12	60.4	46.6
20:58:02	24/11/15	63.12	82.33	42.49	57.6	46.5
21:13:02	24/11/15	63.12	80.37	43.36	57.2	45.1
21:28:02	24/11/15	64.2	83.65	42.4	58.1	45.8
21:43:02	24/11/15	61.14	79.33	42.24	56.4	45
21:58:02	24/11/15	64.78	83.19	41.72	57.8	44.5
22:13:03	24/11/15	63.27	82.68	41.61	57.6	44.5
22:28:03	24/11/15	63.86	83.32	40.43	54.1	43.6
22:43:03	24/11/15	63.52	83.39	40.5	53	43.3
22:58:03	24/11/15	60.25	79.7	40.03	50.4	43.3
23:13:03	24/11/15	63.89	81.69	37.44	54.6	43.1
23:28:03	24/11/15	65.41	84.32	38.83	53.1	41.3
23:43:03	24/11/15	62.29	83.56	38.08	51.2	41.1
23:58:03	24/11/15	61.46	80.2	39.1	48.7	41.2

TABLE 1
SURVEY DATA

00:13:04	25/11/15	62.36	84.21	37.46	50.3	41.6
00:28:04	25/11/15	60.59	80.07	36.68	49.1	40.4
00:43:04	25/11/15	57.82	81.44	34.91	50.7	37
00:58:04	25/11/15	54.14	75.78	34.44	45.1	37.1
01:13:04	25/11/15	42.28	55.35	33.62	45.6	36
01:28:04	25/11/15	40.87	54.04	32.16	43.1	34.8
01:43:04	25/11/15	39.97	55.35	30.81	42.6	34.6
01:58:04	25/11/15	40.49	56.24	31.85	43.3	34.5
02:13:05	25/11/15	43.13	56.84	31.99	46.6	35.3
02:28:05	25/11/15	40.51	60.59	31.02	42.9	32.8
02:43:05	25/11/15	39.42	53.23	29.09	42.4	31.8
02:58:05	25/11/15	39.94	57.61	28.78	43.3	30.6
03:13:05	25/11/15	40.43	55.29	28.05	44	31.8
03:28:05	25/11/15	61.73	85.43	28.36	45.6	32.1
03:43:05	25/11/15	39.8	56.08	28.75	43.3	31.6
03:58:06	25/11/15	58.07	84.04	29.44	47.6	34
04:13:06	25/11/15	41.34	54.27	30.33	44.5	33.7
04:28:06	25/11/15	53.03	71.32	31.55	56.3	34.8
04:43:06	25/11/15	49.11	68.51	33	52.9	36.6
04:58:06	25/11/15	50.96	71.38	34.64	53.5	38.1
05:13:06	25/11/15	48.78	69.76	34.02	50.3	38.5
05:28:06	25/11/15	61.87	83.56	35.05	50.9	39.5
05:43:06	25/11/15	62.17	81.34	38.59	58.8	43.2
05:58:07	25/11/15	64.19	79.43	43.15	67.6	48.6
06:13:07	25/11/15	65.63	82.97	44.85	69.1	49.1
06:28:07	25/11/15	63.56	79.93	45.78	67.4	49.7
06:43:07	25/11/15	63.76	79.75	45.87	67.7	49.6
06:58:07	25/11/15	62.71	78.63	46.57	67.3	49.5
07:13:07	25/11/15	62.4	81.54	46.47	66.7	50
07:28:07	25/11/15	63.34	81.43	47.25	66.4	50.3
07:43:07	25/11/15	63.24	81.66	46.32	66.4	49.9
07:58:08	25/11/15	62.38	80.92	46.27	66.6	48.9
08:13:08	25/11/15	59.79	76.52	46.4	62.6	49.2
08:28:08	25/11/15	61.82	77.78	44.92	64.6	48.7
08:43:08	25/11/15	63.69	84.28	45.94	64.7	49.1
08:58:08	25/11/15	63.98	82.34	44.24	67.4	48.7
09:13:08	25/11/15	63.06	81.41	45.87	65	48.8
09:28:08	25/11/15	63.77	80.08	44.2	68.1	49.5
09:43:09	25/11/15	64.26	82.34	45.67	67.2	48.8
09:58:09	25/11/15	62.7	79.07	44.2	65.5	47.7
10:13:09	25/11/15	63.51	79.14	45.71	65.9	48.2
10:28:09	25/11/15	65.47	83	44.45	67.2	48.1

Position 2

14:00:00	25/11/2015	65.4	78.6	46.3	68.5	49.5
15:00	25/11/2015	66.7	81.9	45.1	69.8	49
16:00	25/11/2015	66.1	82.5	47.3	70.5	50

TABLE 1
SURVEY DATA

		X	Y	Z
VDV	16HR	0.037	0.035	0.027
	8HR	0.032	0.022	0.022