

## Appendix 5K

### Vibration Levels for HGVs and Operational Plant

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DNS5-4-021

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#### 1.0 HGV GROUND-BORNE VIBRATION MONITORING (EXAMPLE RESULTS)

##### 1.1 Overview

- 1.1.1 This section provides a summary of the results (from other projects) of heavy goods vehicle (HGV) movements and other vehicles at close range distance from the kerbside.

##### 1.2 HGV Vibration Measurements

###### *Overview*

- 1.2.1 Measurements of ground borne vibration were undertaken at 3 locations relative to Scawby Road 'B1206' which passes through the village of Scawby, North Lincolnshire.
- i) Position 1: Junction of Scawby Road with access road to industrial site (2m).
  - ii) Position 2: 1m to 5m from access road leading to industrial site
  - iii) Position 3: 1m-2m from kerbside of Scawby Road within the village adjacent to front façade of property.

###### *Measurement Technique*

- 1.2.2 The methodology described below was employed during the vibration survey.
- 1.2.3 Vibration measurements were made, in the three mutually perpendicular axes, during the monitoring period. The Nomis seismograph was set to the 'continuous' and 'trigger' mode settings (trigger level of 0.1 mm/sec). The transducer was weighted with a sandbag to prevent any spurious movement other than from the ground.

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- 1.2.4 The seismograph has monitored the ground borne vibration in terms of Peak Particle Velocity (PPV).
- 1.2.5 The seismograph only triggered when some of the vehicles passed the monitoring positions. The following tables detail the results of the ground vibration survey.

### ***Results***

- 1.2.6 Monitoring results show the maximum vibration from HGVs to be 0.5mm/sec at 1m to 2m from kerbside. This is just above the level of perceptibility (i.e. 0.3mm/sec) and according to DMRB LA 111 guidance for vibration assessment would vary between negligible to minor impact. Dwellings are generally located between 5m and 10m from kerbside.

**Table 1 – Position 1: Scawby Road Ground Vibration Measurements**

Time:	Location:	Position:	Vibration level			
			X (m/s <sup>2</sup> )	Y (m/s <sup>2</sup> )	Z (m/s <sup>2</sup> )	
08:26	Scawby Road (corner) (2m from kerbside)	Cars near & far side	0.191	0.127	0.318	
08:26	Scawby Road (corner) (2m from kerbside)	HGV far side	0.191	0.127	0.254	
08:38	Scawby Road (corner) (2m from kerbside)	Cars near & far side	0.191	1.27	0.254	
08:39	Scawby Road (corner) (2m from kerbside)	Car far side Car	0.191	1.27	0.254	
08:39	Scawby Road (corner) (2m from kerbside)	near side	0.254	0.127	0.254	
08:43	Scawby Road (corner) (2m from kerbside)	Tractor far side	0.318	0.127	0.254	
08:44	Scawby Road (corner) (2m from kerbside)	Car near side	0.191	0.127	0.254	
08:45	Scawby Road (corner) (2m from kerbside)	HGV near side	0.318	0.254	0.508	
08:46	Scawby Road (corner) (2m from kerbside)	Car near side	0.254	0.191	0.254	
08:56	Scawby Road (corner) (2m from kerbside)	Straw Trailer (empty) near side	0.381	0.318	0.381	
08:57	Scawby Road (corner) (2m from kerbside)	Car near side	0.254	0.127	0.318	
08:57	Scawby Road (corner) (2m from kerbside)	HGV near side	0.381	0.254	0.445	
08:58	Scawby Road (corner) (2m from kerbside)	HGV Double Trailer nearside	0.254	0.191	0.445	
08:59	Scawby Road (corner) (2m from kerbside)	HGV far side	0.191	0.127	0.254	
08:59	Scawby Road (corner) (2m from kerbside)	Car near side	0.254	0.127	0.254	
09:00	Scawby Road (corner) (2m from kerbside)	HGV Double Trailer far side	0.254	0.127	0.254	
09:01	Scawby Road (corner) (2m from kerbside)	HGV far side	0.445	0.191	0.381	
09:03	Scawby Road (corner) (2m from kerbside)	Articulated HGV Far side	0.254	0.127	0.254	
09:08	Scawby Road (corner) (2m from kerbside)	Straw Trailer (empty) far side	0.254	0.127	0.254	
09:09	Scawby Road (corner) (2m from kerbside)	HGV (Brian Plant) far side	0.191	0.127	0.254	
09:11	Scawby Road (corner) (2m from kerbside)	HGV (Brian Plant) near side	0.254	0.127	0.318	
09:12	Scawby Road (corner) (2m from kerbside)	Straw Trailer (loaded) near side	0.254	0.127	0.254	
09:16	Scawby Road (corner)	HGV Tanker	0.254	0.127	0.254	
Highest Levels			Cars	0.254	0.127	0.318
Highest Levels			HGVs	0.445	0.254	0.508
Highest Levels			Straw Trailer	0.381	0.318	0.381
Highest Levels			HGV near side	0.381	0.318	0.508
Highest Levels			HGV far side	0.445	0.191	0.381

Table 2 – Position 2: Access Road

Time:	Location:	Position:	Vibration level		
			X (m/s <sup>2</sup> )	Y (m/s <sup>2</sup> )	Z (m/s <sup>2</sup> )
09:29	Access Road (2-3m)	Straw Trailer (loaded) far side	0.254	0.127	0.254
09:30	Access Road (2-3m)	HGV (Tanker) far side	0.318	0.318	0.254
09:31	Access Road (1m)	Straw Trailer (loaded) near side	0.318	0.318	0.318
09:31	Access Road (5m)	Straw Trailer (loaded) leaving junction	0.191	0.127	0.254
09:33	Access Road (1m)	Car near side	0.191	0.127	0.254
	Highest levels	Cars	0.191	0.127	0.254
	Highest levels	HGVs	0.318	0.318	0.254
	Highest levels	Straw Trailer	0.318	0.318	0.318

Table 3 – Position 3: 193 Scawby Road (on pavement)

Time:	Location:	Position:	Vibration level		
			X (m/s2)	Y (m/s2)	Z (m/s2)
10:59	Pavement (1-2m from Scawby Road)	HGV Far Side	0.254	0.127	0.254
11:02	Pavement (1-2m from Scawby Road)	Car near side	0.191	0.127	0.254
11:03	Pavement (1-2m from Scawby Road)	HGV Far Side	0.254	0.127	0.254
11:05	Pavement (1-2m from Scawby Road)	Car near side	0.254	0.127	0.254
11:05	Pavement (1-2m from Scawby Road)	HGV (flat bed) loaded near side	0.445	0.318	0.381
11:06	Pavement (1-2m from Scawby Road)	Car near side	0.191	0.127	0.254
11:07	Pavement (1-2m from Scawby Road)	Car near side	0.191	0.127	0.254
11:07	Pavement (1-2m from Scawby Road)	HGV Near Side	0.445	0.381	0.445
11:07	Pavement (1-2m from Scawby Road)	Car near side	0.191	0.127	0.254
11:07	Pavement (1-2m from Scawby Road)	HGV Near Side	0.254	0.254	0.254
Highest levels			Cars	0.254	1.270
Highest levels			HGVs	0.445	0.381
Highest levels			HGV near side	0.445	0.381
Highest levels			HGV far side	0.254	0.127

### 1.3 Vibration Monitoring Details – Road Traffic Movements

#### *Overview*

- 1.3.1 Vibration measurements were made, in the three mutually perpendicular axes at a **distance of 1 metre** from the kerbside of the road (case study is near Warrington, Cheshire).

#### *Instrumentation*

- 1.3.2 The following instrumentation was used for all vibration measurements:

**Table 4 – Vibration Instrumentation**

Manufacturer	Description	Type	Cal. Date
Nomis	Portable Field Seismograph	Mini-Supergraph	Aug 2010
Vibrocock	Portable Field Seismograph	V901	Jan 2010

- 1.3.3 The following set-up parameters were used on the Seismographs during vibration measurement:

Mode:        Nomis: Trigger

               Vibrock: Continuous PPV & VDV

Range:       Up to 2mm/sec

Scan Time: 10 seconds (trigger: 0.1 to 0.3mm/sec)

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### ***Survey Dates and Personnel***

#### ***Fixed Vibration Monitoring***

- 1.3.4 Vibration levels were measured over an 18-hour period commencing on 08 November 2010. The survey was conducted by Mr D.R. Kettlewell of Noise & Vibration Consultants Limited.

#### ***Spot Roaming Vibration Monitoring***

- 1.3.5 Measurements of vibration adjacent to Liverpool Road and other local roads were undertaken on 09 November 2010.

#### ***Meteorological Conditions***

- 1.3.6 Weather conditions were noted during the survey period. Dry, partly cloudy with a light north easterly wind (1-2m/s). Temperature 7-8deg C.

### ***Results***

- 1.3.7 The results of the vibration monitoring (road traffic movements) are set out below.



**Table 5 – Spot Roaming Vibration Measurements: Trigger Mode (Nomis seismograph)**

Date	Time	Position	Type of vehicle	Max PPV (mm/sec)	PPV (mm/sec)		
					X	Y	Z
09.11.10	08:21	Forrest Way	HGV ( <a href="#">non-site</a> )	0.635	0.254	0.127	0.635
09.11.10	08:21	Forrest Way	Car & Trailer	0.635	0.245	0.127	0.635
09.11.10	08:22	Forrest Way	Veolia HGV - Car 3m	0.889	0.191	0.127	0.889
09.11.10	08:36	Barnard St (1m <del>kerbside</del> )	Veolia HGV	0.953	0.381	0.127	0.953
09.11.10	08:36	1m <del>kerb</del> traffic lights	Veolia HGV	0.508	0.254	0.191	0.508
09.11.10	08:44	Liverpool Rd ( <del>Hepherd St</del> )	HGV ( <a href="#">non-site</a> )	0.987	0.381	0.987	0.635
09.11.10	09:07	Liverpool Rd ( <del>Hepherd St</del> corner)	HGV ( <a href="#">non-site</a> )	0.953	0.635	1.524	0.953
09.11.10	09:26	Liverpool Rd (Sloop Inn)	Bus nearside	0.381	0.254	0.254	0.381
09.11.10	09:27	Liverpool Rd (Sloop Inn)	Veolia HGV	0.635	0.381	0.254	0.635
09.11.10	09:31	Liverpool Rd (Sloop Inn)	HGV ( <a href="#">non-site</a> )	0.635	0.254	0.318	0.635
09.11.10	09:34	Liverpool Rd (Sloop Inn)	HGV ( <a href="#">non-site</a> ) opposite	0.508	0.191	0.254	0.508
09.11.10	09:34	Liverpool Rd (Sloop Inn)	HGV ( <a href="#">non-site</a> ) opposite	0.508	0.191	0.254	0.508
09.11.10	09:34	Liverpool Rd (Sloop Inn)	HGV ( <a href="#">non-site</a> ) nearside	0.381	0.191	0.191	0.381
09.11.10	09:36	Liverpool Rd (Sloop Inn)	Waste Lorry opposite	0.381	0.191	0.191	0.381
09.11.10	09:38	Liverpool Rd (Sloop Inn)	United Utilities HGV	0.381	0.254	0.191	0.381
09.11.10	09:42	Liverpool Rd (Sloop Inn)	Veolia HGV <del>opposite</del>	0.953	0.254	0.445	0.953
09.11.10	09:50	63 Liverpool Rd	HGV ( <a href="#">non-site</a> )	0.635	0.381	0.318	0.635
09.11.10	09:51	63 Liverpool Rd	Pedestrian Footsteps	0.445	0.191	0.127	0.445
09.11.10	09:52	63 Liverpool Rd	Cars	0.572	0.381	0.635	0.572
09.11.10	09:52	63 Liverpool Rd	United Utilities HGV	0.699	0.381	0.699	0.699
09.11.10	09:55	63 Liverpool Rd	Veolia HGV nearside	0.508	0.318	0.191	0.508
09.11.10	09:56	63 Liverpool Rd	Veolia HGV nearside	0.635	0.381	0.445	0.635
09.11.10	10:20	193 Liverpool Rd	Bus & Non-Site HGV	0.445	0.254	0.318	0.445
09.11.10	11:59	Liverpool Rd (Dale Rd)	Bus 2m from <del>kerb</del>	0.381	0.254	0.127	0.381
09.11.10	12:00	Liverpool Rd (Dale Rd)	HGV ( <a href="#">non-site</a> )	0.381	0.254	0.127	0.381

Peak Level	Liverpool Rd ( <del>Hepherd St</del> corner)	HGV (nearside) (1m <del>kerbside</del> )	0.987	0.987	0.381	0.987
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**Table 6 – Fixed Vibration Measurements: Continuous Mode (Vibrocock seismograph)**

Time	Position	Max PPV (mm/sec)	Event VDV (m/sec <sup>1.75</sup> )		
			x	y	z
13:00	Liverpool Road	0.700	0.010	0.016	0.033
14:00	Liverpool Road	0.650	0.011	0.017	0.031
15:00	Liverpool Road	0.600	0.011	0.017	0.027
16:00	Liverpool Road	0.475	0.041	0.043	0.066
17:00	Liverpool Road	0.375	0.011	0.018	0.015
18:00	Liverpool Road	0.475	0.011	0.018	0.015
19:00	Liverpool Road	0.475	0.012	0.018	0.015
20:00	Liverpool Road	0.525	0.012	0.018	0.015
21:00	Liverpool Road	0.500	0.012	0.018	0.014
06:00	Liverpool Road	0.650	0.012	0.018	0.016
07:00	Liverpool Road	0.700	0.013	0.018	0.031
08:00	Liverpool Road	0.850	0.013	0.019	0.029
09:00	Liverpool Road	0.875	0.013	0.019	0.032
10:00	Liverpool Road	0.975	0.012	0.018	0.038
11:00	Liverpool Road	0.925	0.012	0.018	0.035
12:00	Liverpool Road	0.625	0.011	0.017	0.027



Time	Position	Max PPV (mm/sec)	Event VDV (m/sec <sup>1.75</sup> )		
			x	y	z
23:00	Liverpool Road	0.300	0.013	0.019	0.013
00:00	Liverpool Road	0.200	0.013	0.019	0.012
01:00	Liverpool Road	0.450	0.013	0.019	0.012
02:00	Liverpool Road	0.375	0.013	0.019	0.012
03:00	Liverpool Road	0.150	0.013	0.020	0.012
04:00	Liverpool Road	0.175	0.013	0.019	0.012
05:00	Liverpool Road	0.425	0.013	0.019	0.014
06:00	Liverpool Road	0.650	0.013	0.019	0.020

	x	y	z
<b>VDV Daytime:</b>	<b>0.048</b>	<b>0.052</b>	<b>0.077</b>
<b>VDV Night:</b>	<b>0.022</b>	<b>0.032</b>	<b>0.024</b>

### Conclusion

- 1.3.8 Measurements recorded over the daytime and night-time period at the fixed location along Liverpool Road (1 metre from kerbside) is shown below in Table 7. This position represents an external monitoring position at a similar distance from the road as the dwellings adjacent to the road.

Table 7 – Results of Vibration Monitoring Fixed Location along Liverpool Road

Location	Time of Day	VDV m.s <sup>-1.75</sup>			PPV Range (mm/sec)
		X axis	Y axis	Z axis	
Liverpool Road (west bound)	Daytime	0.048	0.052	0.077	0.375-0.7

Location	Time of Day	VDV $\text{m.s}^{-1.75}$			PPV Range (mm/sec)
		X axis	Y axis	Z axis	
Liverpool Road (west bound)	Night-time	0.022	0.032	0.024	0.15-0.65

- 1.3.9 The above VDV results are below the daytime threshold of 0.2 to 0.4  $\text{m.s}^{-1.75}$  and night-time threshold of 0.1 $\text{m.s}^{-1.75}$  to 0.2 $\text{m.s}^{-1.75}$  where there is a 'low probability of adverse comment'. The results of PPV measurements are also well below any cosmetic damage criteria.
- 1.3.10 The results of spot vibration measurements along Liverpool Road at those properties closest to the kerbside and at traffic light junctions generally did not trigger the seismograph (which was set at 0.1mm/sec). Where the seismograph did provide a trigger, the results when the transducer was relatively close to the road, shows a range of between 0.127mm/s and 0.987mm/s PPV and therefore no significant vibration was recorded that exceeds any cosmetic or structural damage criteria or likely to exceed any nuisance criteria.
- 1.3.11 Based on vibration measurements presented above it is concluded that the general movement of HGVs does not normally give rise to any excessive ground borne vibration. Measurements of PPV with cars, buses and HGVs passing close to residential dwellings are at times above the perceptible level of 0.3mm/sec but below 1.0mm/sec outside the dwelling. To put these levels into perspective, vibration measurements show pedestrian footsteps to register a reading of 0.445mm/sec.
- 1.3.12 Taking into account vibration measurements recorded at property boundaries, which are at the closest approach to Liverpool Road and the local road network, the assessment of impact from road traffic vibration therefore concludes that in general there would be a negligible impact likely to occur with occasional peak transient vibration levels giving a slight impact albeit at a level that is not significant (i.e. neutral to minor adverse effect).

## 2.0 CHP PLANT OPERATIONAL VIBRATION

### 2.1 Overview

- 2.1.1 Vibration measurements were made in the three mutually perpendicular axes at close range distance from operational plant under load at an existing site in the UK.

### 2.2 Instrumentation

- 2.2.1 The following instrumentation was used for all vibration measurements:

**Table 8 – Vibration Instrumentation**

Manufacturer	Description	Type
Nomis	Portable Field Seismograph	Mini-Supergraph

- 2.2.2 The following set-up parameters were used on the Seismographs during vibration measurement:

Mode: Nomis: Continuous

Range: 0.01mm/sec to 5mm/sec

Scan Time: 96 seconds to 250 seconds

### 2.3 Survey Dates and Personnel

- 2.3.1 Ground-borne vibration levels were measured at an existing site in the UK during typical full load operating conditions at close range positions (i.e. 1m to 5m from key plant or buildings).
- 2.3.2 Transducer placed on flat ground and suitably weighted.
- 2.3.3 The survey was conducted by Mr D.R. Kettlewell of Noise & Vibration Consultants Limited.

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2.3.4 Plant levels measured around the site at key plant areas including:

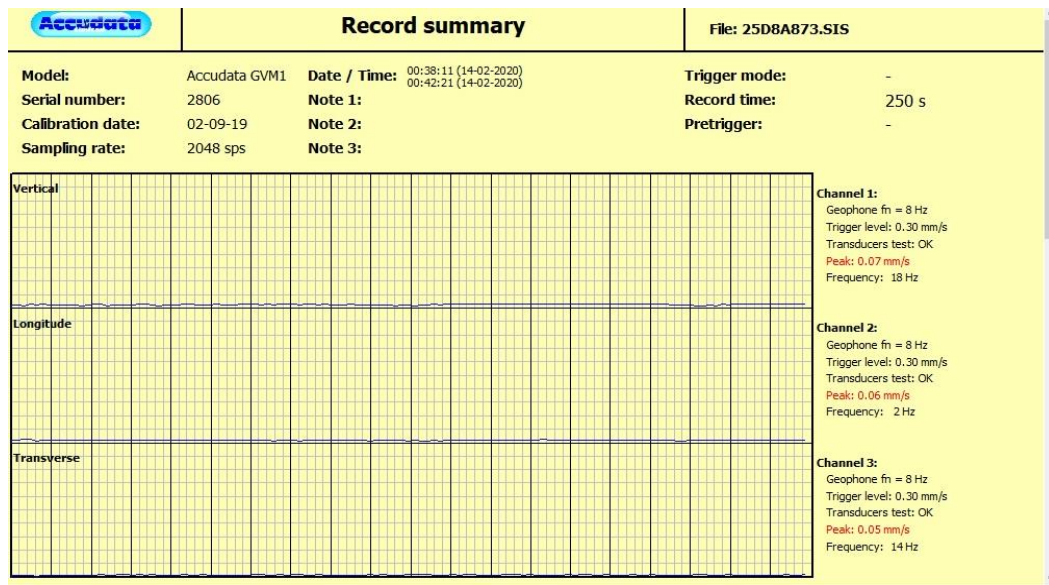
- i) Boiler Room
- ii) ACC Fans
- iii) Turbine Hall
- iv) HV Transformer
- v) Fan room
- vi) Bag Filter

## 2.4 Results

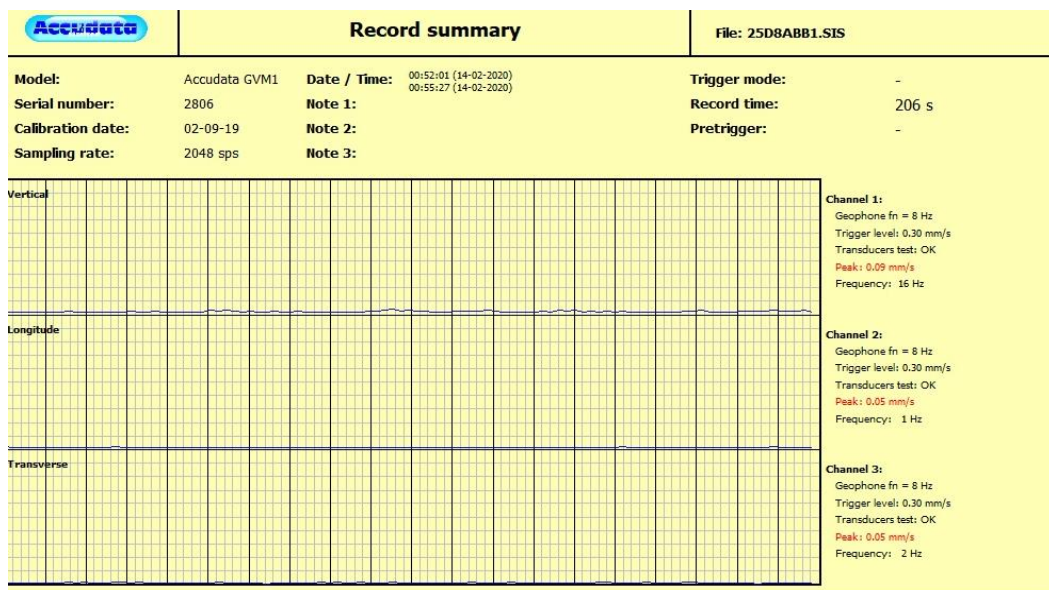
2.4.1 The results (see Insets 1-6 below) vary between 0.04mm/sec to 0.1mm/sec indicating **negligible vibration**.



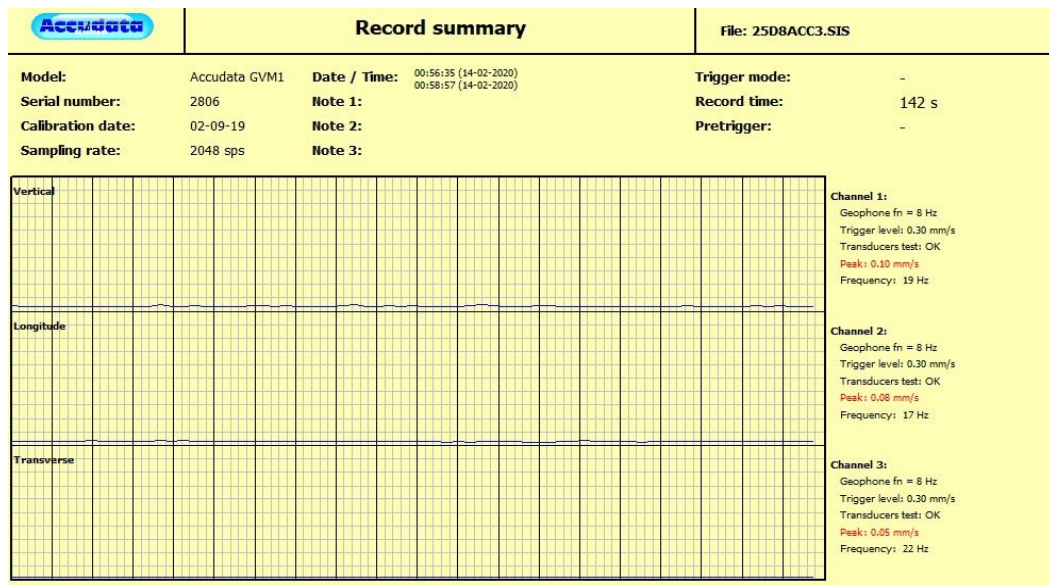
### Inset 1 – Boiler Room (inside)



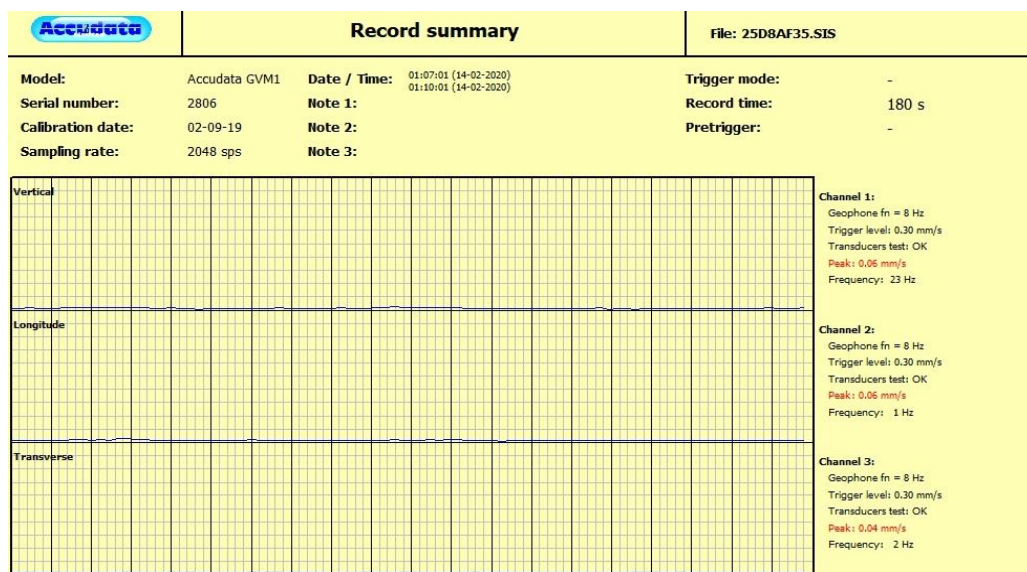
### Inset 2 – ACC Fans (below fans)



### Inset 3 – Turbine Hall

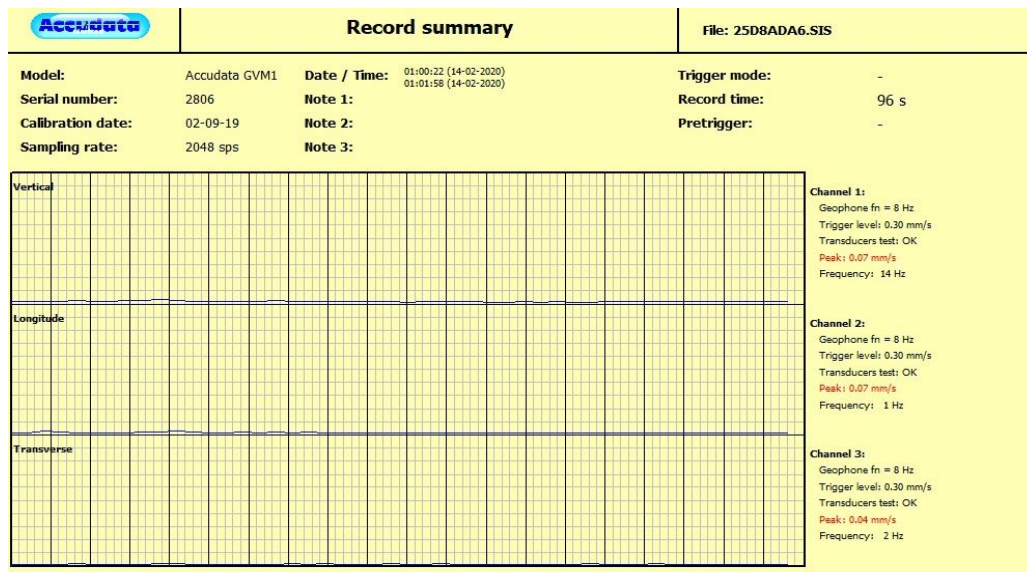


### Inset 4 – HV Transformer (5m)





### Inset 5 – Fan Room (inside)



### Inset 6 – Bag Filter (1m)

