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New Waste To Energy Plant of MVV in Dundee:

Comparison of Sound Emission of existing DERL Waste Incineration Plant in Dundee and its resulting Sound Immission in the Neighbourhood, with first Forecast of expected Sound Emission and Noise Contribution to the Neighbourhood from planned MVV Plant

Notes Nr. M132032/02

Dear Sirs,

Within this document, results of a measurement campaign in Dundee, Scotland, in October 2016 concerning the sound pressure levels inside the plant as well as the sound power levels of the main noise sources of DERL plant will be shown. Furthermore, the caused sound immission in the vicinity, based on the measured main noise sources, was calculated with a sound propagation model to compare the determined rating levels with the latest measurement results of environmental noise investigations done by c-chec in 2016.

1 Sound Emission Data of DERL Plant in October 2016

In this chapter, sound emission data of the main noise sources with respect to the sound immission will be presented. The data given within this chapter were measured during a measurement campaign from 19th to 20th of October in 2016 at DERL plant in Dundee. Measurements were performed by Dipl.-Ing. Jochen Sperber of Müller-BBM GmbH, Germany, using a class 1 sound investigator Bruel & Kjaer, Type 2260. Measurements were assisted by Mr. Michael Dutkowskij M.R.S.C. A.I.E.M.A od DERL, Dundee.

1.1 Sound Pressure Levels inside Rooms

The sound pressure levels inside the different rooms have been measured by averaging by time and space inside each building. The measurement durations were chosen in such way that energy equivalent levels were constant with oscillations below 1.0 dB. The following sound pressure levels were measured:

Table 1. A-weighted, time and spatial averaged sound pressure levels L_{pA} inside the rooms of the buildings.

Room / Building	Averaged Part of Room / Building	L_{pA} [dB(A)]	Characteristics
Waste Reception Hall	Part with Vehicle Movements	73	2 Wheel Loaders working, 1 Hammer mill in Operation
Waste Reception Hall	Part with Vehicle Movements	77	1 Wheel Loaders working, 1 Forklift working, 1 HGZ unloading
Compressor Room	Whole room	86	3 Compressors in Operation, Door open
Boiler House 1 and 2	Level 6	76	2 Boilers in Operation
Boiler House 1 and 2	Level 4	75	2 Boilers in Operation
Boiler House 1 and 2	Level 3	75	2 Boilers in Operation
Boiler House 1 and 2	Level 2	79	2 Boilers in Operation
Boiler House 1 and 2	Level 1	80	2 Boilers in Operation
Boiler House 1 and 2	Level 0	81	2 Boilers in Operation
Turbine Hall	Whole Room	80	Turbine in Operation
Condenser	Part below Turbine Hall	83	Turbine in Operation
Lube Oil Cooler Turbine	Room next to Turbine Hall	87	Turbine in Operation
Switch Gear Building Flue Gas Treatment Plant	Whole Room	66	Flue Gas Treatment Plant in Operation
Switch Gear Building Plant	Whole Room	73	Plant in normal Operation
Shredded Refuse Derived Fuel Store	Part of Gangways	62	Waste Transport in Operation, Hammer Mills not in Operation
Control Room	Whole Room	53	Level without Conversation of Staff, Plant in normal Operation

The room levels shown above respectively the sound emission over the enveloping façade and roof elements will not be included in the sound propagation model because of its relatively small sound emission, caused by good transmission losses of the buildings, in comparison to the more noisy noise sources set up outside.

1.2 Sound Power Levels for individual Noise Sources outside Rooms

The Sound Power Levels for individual Noise Sources outside Rooms have been measured in dependence to the procedures described in EN ISO 3746. The following sound power levels were measured:

Table 2. A-weighted sound power levels L_{WA}.

Noise Source	**Part of Noise Source**	**L_{WA} [dB(A)]**	**Characteristics**
Gas Oil Tank Pumps	Pumps and Motors Gas Oil Tank Pumps	110	Gas Oil Tank Pumps in Operation
Cooling Tower	Air Outlet West	104	Normal Operation High-frequent Noise caused by probably Gearbox
Cooling Tower	Air Outlet East	99	Normal Operation
Cooling Tower	Air Intake South	95	Normal Operation High-frequent Noise caused by probably Gearbox
Cooling Tower	Air Intake North	90	Normal Operation
Cooling Tower Motor	Motor West	91	Normal Operation High-frequent Noise caused by probably Gearbox
Cooling Tower Motor	Motor East	86	Normal Operation
Flue Gas Treatment Plant	Whole Plant, including 2 Flue Gas Fans and 2 FGR Fans	101	Normal Operation
Flue Gas Fan 2 and FGR Fan 2	Fan Casings and Motors	99	Normal Operation
Flue Gas Fan 1 and FGR Fan 1	Fan Casings and Motors	97	Normal Operation
Cooling Fan for Hammer Mills	Air Intake Cooling Fan 1	98	Hammer Mill 1 and Cooling Fan 1 in Operation
Cooling Fan for Hammer Mills	Casing and Motor Cooling Fan 1	97	Hammer Mill 1 and Cooling Fan 1 in Operation
Odour Abatement Plant, RDF Fans	Casing and Motor RDF Fans 1 and 2	99	RDF Fans 1 and 2 in Operation
Odour Abatement Plant, OAP Fan	Casing and Motor OAP Fan 1	93	OAP Fan 1 in Operation
Compressor Room	Air Intake through open Door	87	3 Compressors in Operation
Boiler House Air Intake	Air Intake northern Façade	80	Normal Operation
Wheel Loader	Driving Outside	90	No Working outside

Most of the noise sources shown in Table 1 are in constant operation, except maintenance works or damages.

Gas Oil Tank Pumps are only in operation for working of start-up or supporting burners.

Hammer Mills and Colling Fans are working on demand, not constantly.

Wheel Loaders are normally not operated outside buildings.

Other unsteady noise sources, like flue ash loading, driving of waste lorries and similar, normally don't appear during night-time and were therefore not measured. These noise sources will not be taken into account in the sound propagation calculation described in the following chapter.

Stack openings after the flue gas treatment plant and after the odour abatement plant could not be measured and will therefore not been taken into account in the following considerations. Based on our experience, stack openings should (normally) not increase the overall sound power level of DERL in a relevant way.

1.3 Remarks to measured Sound Emissions

During the measurement campaign, the following remarkable items were obtained:

- The Fan West of cooling tower showed comparatively high sound emission, which could be caused by motor, gearbox or the fan itself. The noise is radiated by all western parts of the cooling tower: motor, air intake and air outlet.
- The Cooling Fans for Hammer Mills are set up in free space. Air intake of fans is not damped by silencers, fan speed is quite high and casing is not housed or insulated. This, in sum, leads to a comparatively high sound emission.
- The Gas Oil Pumps have very high sound emission, compared to the whole plant in total.

2 Sound Immission obtained by measured Sound Emission

In this chapter, results of the sound propagation calculation based on the measurements carried out in October 2016 will be shown. Only the noise sources mentioned in Table 1 have been taken into account. Noise emitted over building elements, by HGVs or by noise sources not mentioned in Table 1 will not be taken into account.

Sound immissions will be calculated for two different operating conditions,

- Operation 1: Only stationary main noise sources according to Table 1(Cooling Tower, Flue Gas Treatment Plan, Odour Abatement Plant, Compressors, Boiler) in Operation.
- Operation 2: All stationary main noise sources according to Table 1, additional unsteady main noise sources from Table 1 (Gas Oil Tank Pumps, Cooling Fan for Hammer Mills, Wheel Loader).

That means, Operation 1 describes a condition of minimum sound immission caused by DERL during night-time, Operation 2 describes an assumed condition of maximum sound immission by DERL during night-time.

Special operating conditions, like start-up, emergency blow-down and similar will not be taken into account at all.

The Receptor points were taken from the map of environmental noise investigations done by c-chec, obtained by MVV. The surrounding area will be modelled as flattened ground by acoustic view. Receptor points will be calculated in a height of 4 meters above ground.

All levels at the receptor points will be calculated as well as downwind values (worst case scenario for each receptor point) as well as long-term average A-weighted sound pressure levels (according to EN ISO 9613-2) each.

The following table shows the results of the two calculated operating conditions:

Table 3. Calculated A-weighted energy equivalent sound pressure levels L_{eq} at receptor points.

Receptor Point No.	**Sound Immission L_{eq} [dB(A)]**			
	Downwind conditions		Long-term average A-weighted sound pressure levels	
	Operation 1	Operation 2	Operation 1	Operation 2
Location A	34	36	32	35
Location B	30	38	29	36
Location C	38	39	37	37
Location D	40	43	38	41
Location E	34	36	33	34
Location F	40	41	38	39
Location G	38	41	37	40
Logger 1	49	52	48	50
Logger 2	37	39	35	38

3 Comparison of calculated Sound Immissions with Sound Immissions obtained by measurements of c-check

3.1 Downwind conditions

In the following table, the calculated sound immissions for downwind conditions according to Table 3 will be compared to the measurement results at 20th of June and 27th of June 2016 obtained by c-check reported on 4th of October 2016 for measurements carried out during night-time (23:00 – 07:00):

Table 4. Calculated, A-weighted energy equivalent sound pressure levels L_{eq} for downwind conditions at the receptor points compared to the measurement results of c-check in 2016.

Receptor Point No.	**Calculated Sound Immission L_{eq} [dB(A)] Downwind conditions**		**Wingspan of Noise Levels from c-check measurements in June 2016 during night-time [dB(A)]**	
	Operation 1	Operation 2	L_{90}	L_{eq}
Location A	34	36	37 – 39	39 – 53
Location B	30	38	37 – 40	40 – 42
Location C	38	39	44 – 45	57 – 58
Location D	40	43	44 – 45	50 – 53
Location E	34	36	39 – 41	42 – 58
Location F	40	41	38 – 40	42 – 55
Location G	38	41	34 – 40	49 – 58
Logger 1	49	52	46	48
Logger 2	37	39	41	46

As it can be seen from Table 4, the energy equivalent noise levels obtained by c-check during night-time are higher than the calculated sound immission caused by DERL during night-time at conservative downwind conditions, even for Operation 2. Only for Logger 1, which is comparatively near to DERL and which is probably the most effected receptor point by sound generated by DERL, higher levels will be calculated than the measurement results show.

Looking at the 90 percentage percentile values of the c-check measurements, only southern receptor points F and G as well as Logger 1 show similar values between calculation and measurement.

3.2 Long-term average conditions

In the following table, the calculated sound immissions for downwind conditions shown in Table 3 will be shown next to the measurement results obtained at 20th of June and 27th of June 2016 by c-check reported on 4th of October 2016 for measurements carried out during night-time (23:00 – 07:00):

Table 5. Calculated, A-weighted energy equivalent sound pressure levels L_{eq} (Long-term average A-weighted sound pressure levels) at receptor points compared to measurement results of c-check in 2016.

Receptor Point No.	**Calculated Sound Immission L_{eq} [dB(A)] Long-term Average**		**Wingspan of Noise Levels from c-check measurements in June 2016 during night-time [dB(A)]**	
	Operation 1	Operation 2	L_{90}	L_{eq}
Location A	32	35	37 – 39	39 – 53
Location B	29	36	37 – 40	40 – 42
Location C	37	37	44 – 45	57 – 58
Location D	38	41	44 – 45	50 – 53
Location E	33	34	39 – 41	42 – 58
Location F	38	39	38 – 40	42 – 55
Location G	37	40	34 – 40	49 – 58
Logger 1	48	50	46	48
Logger 2	35	38	41	46

As it can be seen from Table 4, energy equivalent noise levels obtained by c-check during night-time are higher than the calculated sound immission ad long-term conditions caused by DERL during night-time, even for Operation 2. Only for Logger 1, which is comparatively near to DERL and which is probably the most effected receptor point by sound generated by DERL, good comparison of the values of energy equivalent noise levels can be seen.

Looking at the 90 percentage percentile values of c-check measurements, only southern receptor points F and G as well as Logger 1 show similar values between calculation and measurement.

4 Comparison of measured Sound Emissions and MVV Planning's for new Plant

MVV has made a first estimation of the sound emissions of the main noise sources of their planning's to the new Waste to Energy Plant in Dundee, which should be set up immediately southern of the existing plant.

When going on line with the new plant, the existing DERL plant is designated to be shut down that means sound emission only from one plant will be existing at the same time.

By comparing the aimed sound emission levels of the new plant with the measured sound emission levels of the existing plant, it is unlikely that the total sound emission will be higher later on than it is up to now.

5 Conclusions to sound immission / rating levels in the neighbourhood as a first forecast

Taking into account an assumption of comparable sound emission now and later on, sound immission would be mainly effected by the different locations, that means by moving the acoustical centre of gravity roughly 100 meters in southern direction.

That means the noise sources will be more far away from the locations A, B, C and D later on, rising of sound immission / rating levels, compared to, now, will be unlikely for these receptor points.

In southern direction, the new plant will be closer to locations E, F and G later on.

For the nearest receptor point, Location F, the distance to the acoustical centre of gravity of the plant is reduced from approximately 470 meters to approximately 370 meters, that means by roughly 27 percent. Sound immission would increase by approximately up to 1.0 dB for the locations southern of the plant, when sound emission of the new and the old plant would be comparably the same.

To meet this target, a detailed sound modelling of the new plant will be conducted by Müller-BBM in terms of engineering process of the new plant. Sound emission of the new plant will be planned and installed with compensating effect in respect to the theoretical increase of sound immission mentioned above when moving the centre of gravity to south.

To fulfil this, sound emission of the new plant as well as set-up of the new plant will be engineered in a way that proportional sound immission of the new plant in normal operation (like operations 1 and 2 in this document) at long-term conditions will not exceed the maximum noise levels of 90 percentage percentile levels wingspread measured by c-check for locations A to G as shown in Table 5 of this document.

According to British Standard BS 4142:2014, that in this case it will be avoided for the new plant to have an adverse impact or significant adverse impact to the energy equivalent noise levels at the receptor points nearby the plant.

Neither a difference of + 10 dB nor a difference of + 5 dB is likely when having a look at the impacts of the new plant, according to clause 11 in BS 4142:2014.

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