Aughinish Alumina Ltd.

Askeaton, Co. Limerick

IE Licence Reg. P0035-06

Annual Environmental Report

2019

This page is intentionally blank

Aughinish Alumina Ltd.

Industrial Emissions Licence
Register No. P0035-06

Annual Environmental Report 2019

March 2020

Contents

List of Tables

List of Figures

Attachments

1. Introduction

This document comprises the Aughinish Alumina Limited (AAL) Annual Environmental Report (AER).

The report covers the period from the 1st January 2019 to the 31st December 2019 and has been prepared in accordance with Schedule E of AAL's Industrial Emissions Licence (P0035-06).

1.1 Description of the Activity

AAL was granted a revised Industrial Emissions Licence (IE Licence) in July 2014. The Licence grants AAL permission to carry out the following activities in accordance with the requirements and conditions set out in the Licence:

- The production of inorganic chemicals;
- The combustion of fuels installations with a total rated thermal input of 50MW or more; and
- The recovery or disposal of waste in a facility

The AAL plant extracts alumina from bauxite using the Bayer Process, a chemical method that has been developed and refined over the past century and is used by over 40 alumina extraction plants worldwide.

Approximately 70% of the bauxite processed by AAL comes for Guinea in West Africa with the remainder coming from Brazil. The finished product, alumina, is exported for further processing through smelting to aluminium metal.

The production output of the plant in 2019 was 1,860,970 tonnes of alumina (1,875,265 tonnes of alumina hydrate).

1.2 Management Structures

Since March 2008, AAL has been wholly owned by United Company RUSAL, which is the largest integrated aluminium company worldwide.

AAL has a structured management approach to the operation of the business in terms of product quality, process control, environment, safety, training and analytical capability. Training of personnel is a key function in the successful operation of the plant.

The IE Licence requires the company to establish and maintain an Environmental Management System (EMS) and the conditions of the licence outline the form that the EMS should take at AAL. In 2019, AAL retained certification of its EMS to the international standard ISO14001:2015 and for its QMS to ISO9001:2015. Additionally, in 2019 the company retained certification to ISO50001 for energy management.

Safety, environmental, energy and quality management systems are audited on an on-going basis by a combination of internal audit teams and external certification surveillance audits.

1.3 Organisational Structure

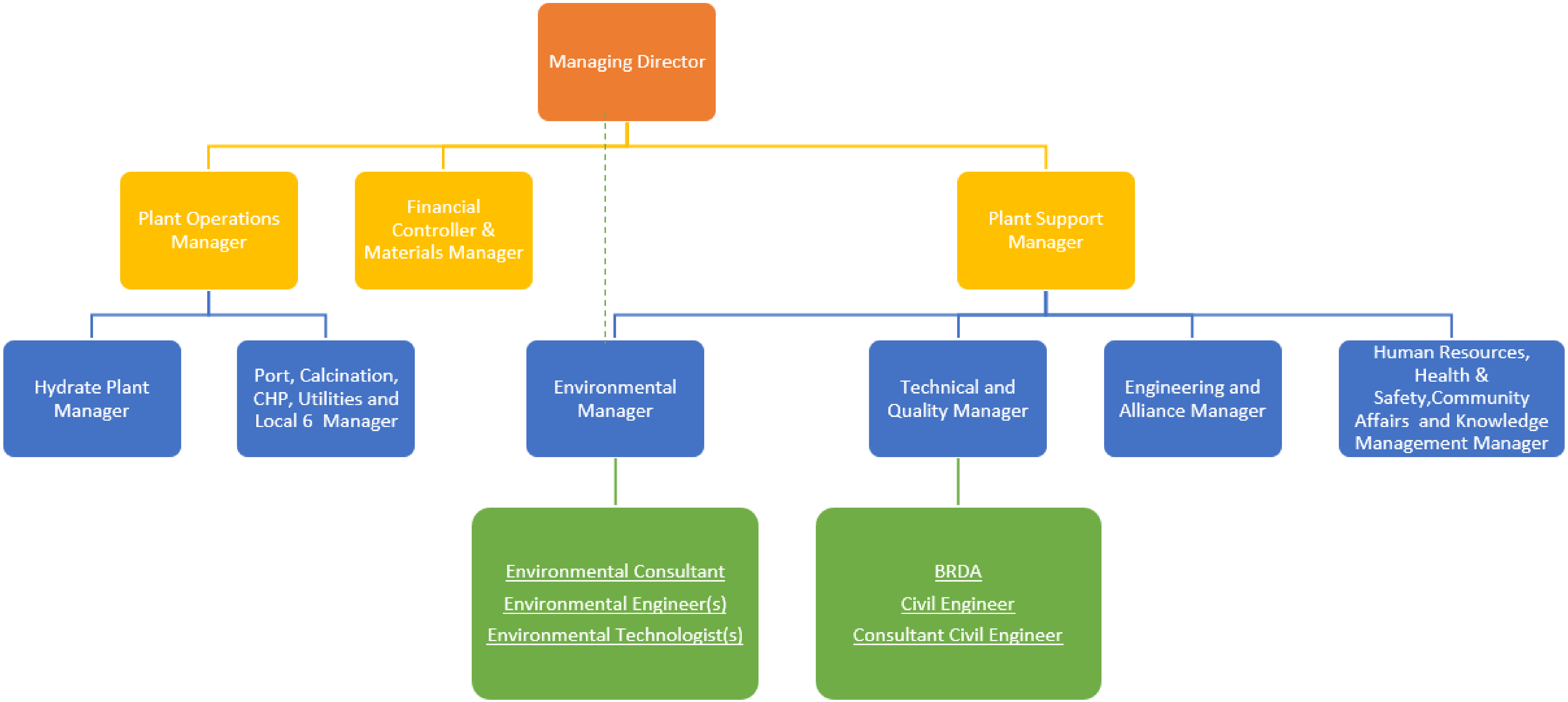
AAL operates a management structure with a strong emphasis on teamwork. The company structure in 2019 is set out in the organogram overleaf and outlines the responsibility for day-to-day management of environmental issues at the plant.

In 2019, a dedicated Environment Manager was appointed and has overall responsibility for environmental management. The Environmental Manager is supported in the day-to-day activities by the Environmental Engineers. The Engineers have responsibility for the maintenance of the Environmental Management System, undertaking specific projects of an environmental nature and evaluating compliance with the IE Licence.

The Environmental Technologists are responsible for environmental monitoring activities including sampling and analysis of all emissions and discharges from the site.

The environmental department work closely with the team that has responsibility for Bauxite Residue Disposal Area (BRDA) operations. The BRDA team includes a Civil Engineer and a Civil Consultant Engineer with the Technical and Quality Manager having overall responsibility for the BRDA.

The Contractor Alliance comprises three main contractor companies providing various engineering, operational and maintenance services all of whom are based on-site. As part of contractor induction training, an Environmental Manual is issued to each contractor. This contains information on site environmental requirements and instructions for environmental management and control to ensure compliance with the IE Licence. Contractors are routinely updated through regular training and safety briefings.


Managing Director
Plant Operations Manager
Financial Controller & Materials Manager
Plant Support Manager
Hydrate Plant Manager
Port, Calcination, CHP, Utilities and Local 6 Manager
Environmental Manager
Technical and Quality Manager
Engineering and Alliance Manager
Human Resources, Health & Safety,Community Affairs and Knowledge Management Manager
Environmental Consultant
Environmental Engineer(s)
Environmental Technologist(s)
BRDA
Civil Engineer
Consultant Civil Engineer

1.4 Environmental Policy

RUSAL
AUGHINISH

Statement of Environmental Policy

Rusal Aughinish produces metal grade alumina and alumina trihydrate using Bayer process technology. The company operates a combined heat and power plant (CHP) to generate electricity for its operations as well as for supply to the National Grid. The owner supplies bauxite ore, finances the operation and delivers finished product for customers.

Protection of the environment is a high priority for top management, every employee and contractors on-site as well as other relevant interested parties. Our Environmental Management System (EMS) has been developed and implemented considering the nature, scale, environmental impacts, risks and opportunities associated with operation, as well as the needs and expectations of interested parties.

We will protect and enhance the environment through

- *Fulfilment of all compliance obligations, including Irish and European legislation as well as the relevant needs and expectations of interested parties.*
- *Continually improve our EMS performance consistent with defined environmental objectives*
- *Review environmental objectives to ensure relevance to the organisation*
- *Use of best practices to prevent and mitigate pollution*
- *Protection and enhancement of biodiversity*
- *Ensuring RUSAL Aughinish's environmental policy is communicated to all employees and contractors and is made available to interested parties.*

By fulfilling these objectives, we will have due regard to the environmental expectations of our many interested parties.

Signed:

Seán Garland

Seán Garland MD

October 2019

MANAGEMENT SYSTEM CERTIFICATION
DNV·GL
ISO 9001=ISO 14001

2. Emissions

AAL implements a comprehensive environmental monitoring programme to assess the significance of emissions from site activities. The programme includes emissions to air, effluent discharges, surface water and waste monitoring. An overview of the results of monitoring conducted during 2019 is presented in this section.

This section also includes an evaluation of compliance with the conditions and schedules of the IE Licence, together with a summary of environmental incidents reported to the Agency during 2019.

Summary information on all emissions, discharges and waste arising from operations at AAL has been submitted to the Agency via the Environmental Performance Reporting (EPR) on-line application. Monitoring data, summarised in the following sections, shows continued compliance with IE Licence Conditions and Emission Limit Values (ELV's).

2.1 Emissions to Air

There are 15 IE licensed air emission points at AAL. The primary sources of emissions to air in 2019 were the Gas Boilers (Emission Point Ref. A4-A, A4-B), Combined Heat and Power Plant (CHP) (Emission Point Refs. A3-A and A3-B), Calciners (Emission Point Ref. A2) and HFO Boilers (Emission Point Ref. A1). The gas boilers were installed and commissioned in 2014 and replaced the HFO boilers as primary sources of steam.

The remaining emission sources comprise bag houses, cyclone exhausts for control of particulate emissions from materials handling operations, and three diesel fired boilers for heating buildings.

2.1.1 HFO Boiler Emissions

The HFO boilers are no longer utilised as a primary generator of steam. B boiler has been fully decommissioned with only A and C boilers utilised infrequently as back up to the gas boilers in 2019. A summary of the actual mass emissions for the licensed parameters during the reporting period is tabulated in Table 1 below.

Actual mass emissions of oxides of sulphur (as SO_2), as tabulated below, are generated by calculation, based on the sulphur content of the fuel and the quantity of fuel oil consumed in 2019. Nitrogen oxides mass emissions (as NO_2) are derived from measured NO_2 values, and estimated exhaust gas flow rates. Dust mass emissions from the boilers are calculated from the measured particulate emissions and estimated exhaust gas flow rates. The gas flow rate estimation is based on the quantity of fuel used, as there is a stoichiometric relationship between air flow and fuel consumption.

Licensed mass emissions are based on emissions concentration and flow rate at ELV, taking a 365 day operational period.

Table 1 Mass Emissions to Air – HFO Boilers

Emission Point Ref. A1 Boilers	Mass Emission (kg) 2018	Mass Emission (kg) 2019	Licensed Mass Emissions (kg)
Oxides of Sulphur (as SO_2)	19,824	49,445	5,474,299
Nitrogen Oxide (as NO_2)	7,004	17,603	2,415,132
Dust	140	847	161,009

Emissions of sulphur dioxide, nitrogen oxides and dust from the main site boilers were significantly below licensed mass emission rates permitted for these parameters.

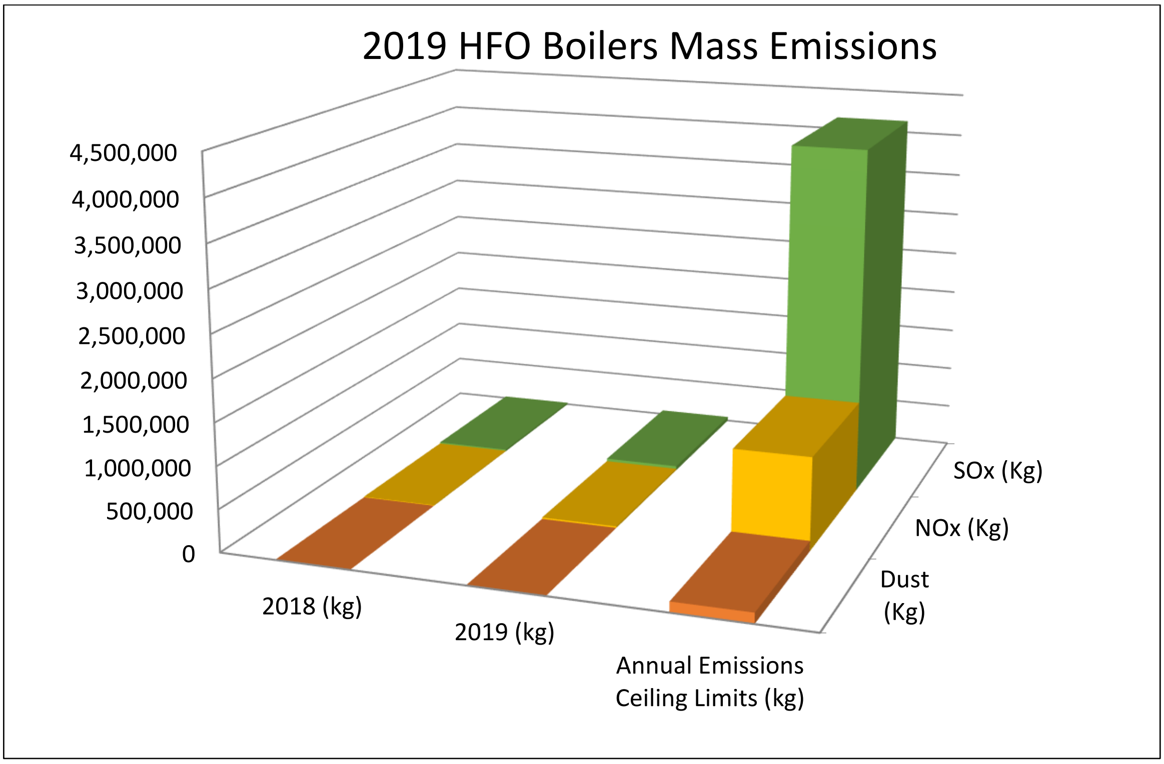


Figure 1 HFO Boiler Mass Emissions 2019

2.1.2 Gas Boiler Emissions

Emissions from the gas boilers are summarised in Table 2 below as actual annual mass emissions (in kgs) for the licensed parameters during the 2019 reporting period.

Table 2 Mass Emissions to Air - Gas Boilers

Emission Point Ref. A4-A & A4-B – Gas Boilers	Mass Emission (Kgs) 2018	Mass Emission (Kgs) 2019	Licensed Mass Emissions (Kgs)
Nitrogen Oxides (as NO_2)	89,866	93,840	227,760
Carbon Monoxide	24,952	12,974	227,760

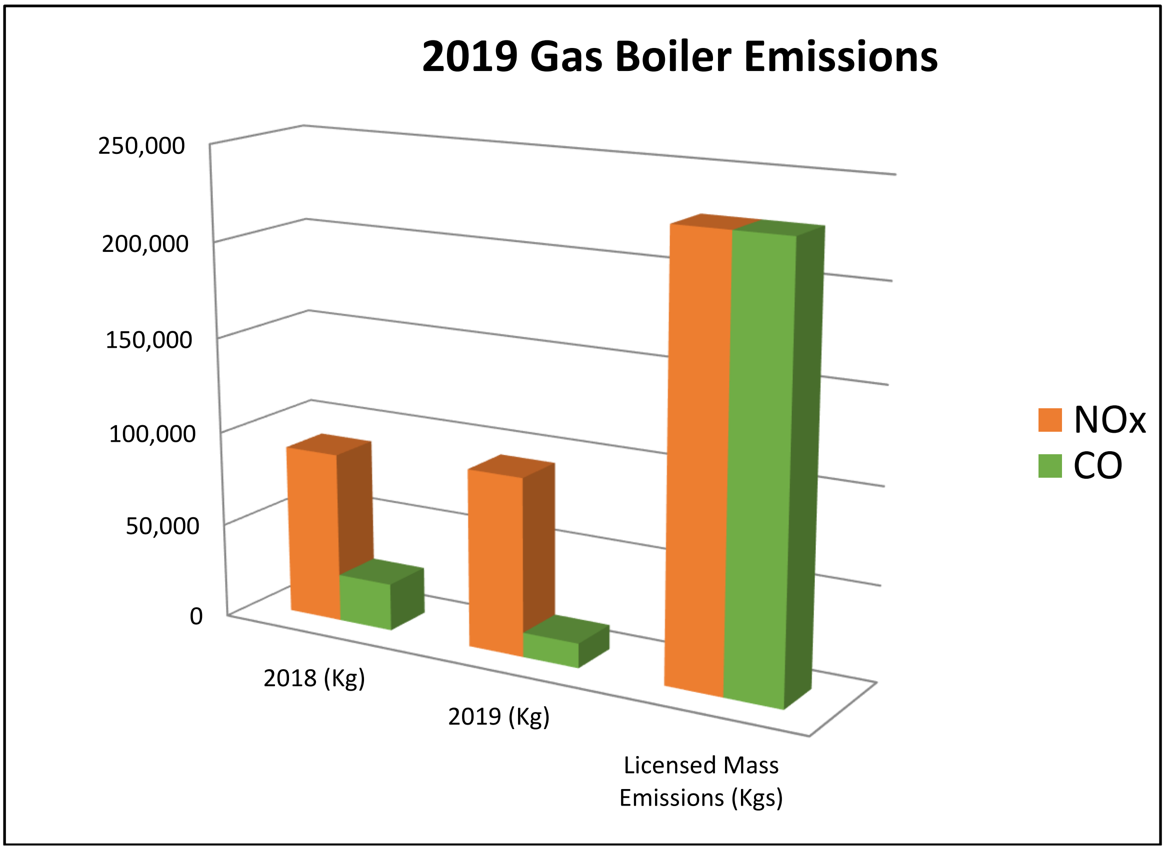


Figure 2 Gas Boiler Mass Emissions 2019

2.1.3 Calciner Emissions

Emissions from the calciners are summarised in Table 3 below as actual annual mass emissions (in kgs) for the licensed parameters during the 2019 reporting period.

The calciners operated on natural gas only in 2019 so there were no emissions of oxides of sulphur. Particulate mass emissions are based on the measured particulates, monitored as part of the IE Licence requirements, and estimated exhaust gas flow rates.

Table 3 Mass Emissions to Air - Calciners

Emission Point Ref. A2 – Calciner	Mass Emission (Kgs) 2018	Mass Emission (Kgs) 2019	Licensed Mass Emissions (Kgs)
Oxides of Sulphur (as SO_2)	0	0	7,029,024
Particulates	61,855	44,054	235,060
Nitrogen Oxides (as NO_2)	464,491	493,829	878,628

Emissions of sulphur dioxide, particulates and nitrogen oxides from the calciners were significantly below licensed emission rates permitted for these parameters.

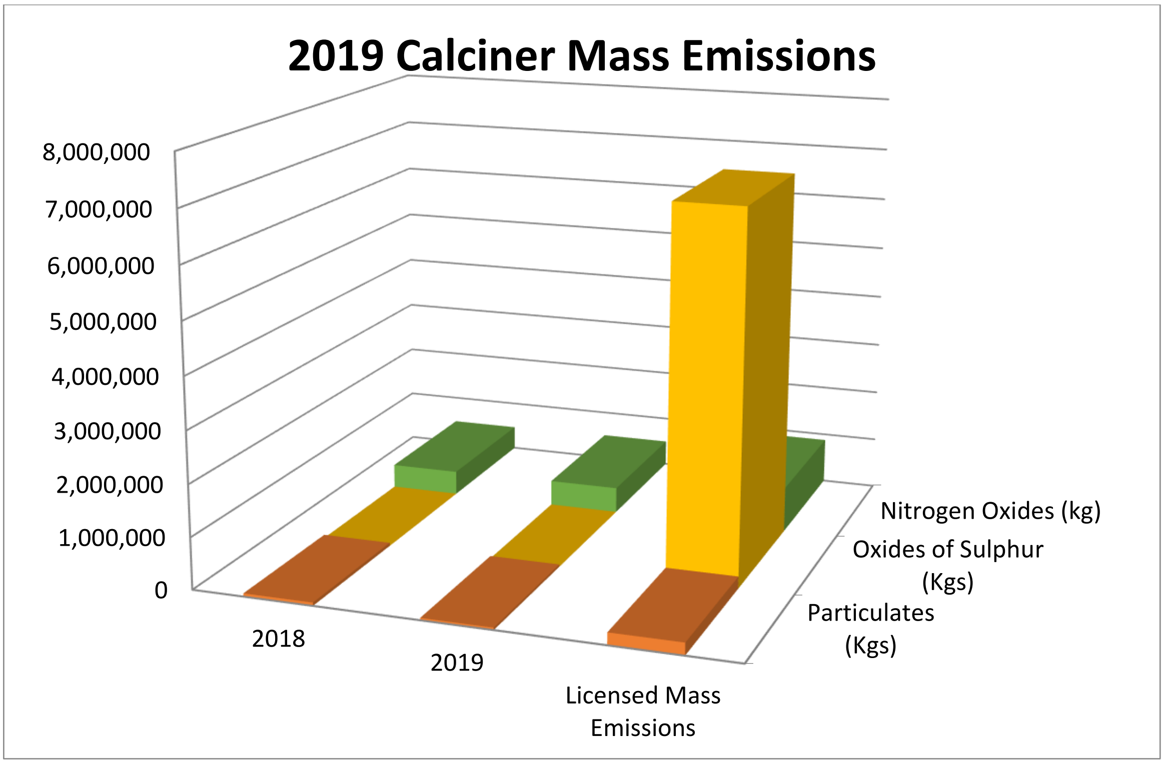


Figure 3 Calciner Mass Emissions 2019

2.1.4 CHP Emissions

Schedule C.1.2 of the IE Licence requires continuous monitoring of oxides of nitrogen (as NO_2). Monitoring of carbon monoxide (CO) became a new requirement in IE Licence P0035-06 issued in July 2014.

The licence requirements for the CHP heat recovery steam generator stack are as outlined below:

- No 24-hour value shall exceed the emission limit value of 75 mg/Nm^3 for Nitrogen Oxides and 100mg/Nm^3 for Carbon Monoxide.

- No hourly value shall exceed twice the ELV.

The NO_2 and CO monitoring results for 2019 are shown in Table 4 below and are significantly below the licensed emission limit values.

Table 4 Mass Emissions to Air - CHP

Emission Point Ref. A3A & A3B – CHP	Mass Emission (Kgs) 2018	Mass Emission (Kgs) 2019	Licensed Mass Emissions (Kgs)
Nitrogen Oxides (as NO_2)	389,597	363,213	946,080
Carbon Monoxide	79,043	66,087	1,261,440

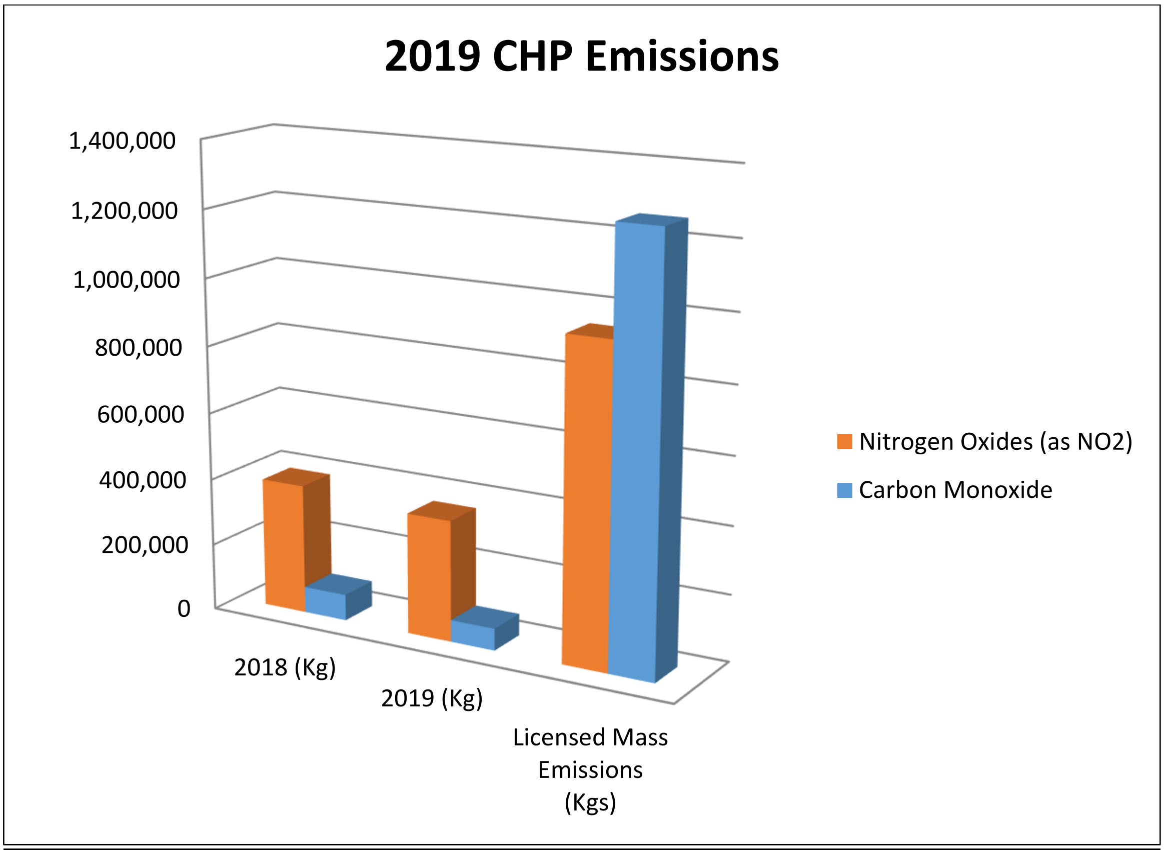


Figure 4 CHP Mass Emissions 2019

2.1.5 Other Emission Points (Dust Collection Units)

There are 9 other licensed process air emission points. These emissions are from dust collection units (DCUs) associated with bauxite and alumina handling and conveying operations at the plant.

Actual mass emissions of particulates from each of the licensed emission points are tabulated below and are based on average monitoring results and total hours of operation during 2019.

The combined actual annual mass emission of particulates from the licensed emission points was 6,360kg during 2019, which is significantly lower than the permitted annual mass emission for the combined sources of 174,567 kg.

In addition, each individual sample collected during the monitoring periods were significantly below the relevant emission limit value for that source.

Table 5 Summary of Particulate Emissions from Dust Collection Units

Emission Point Ref./Description		Mass Emission (kg) 2018	Mass Emission (kg) 2019	Licensed Emission (kg)
5	Transfer Tower 4 & 5 Exhaust Fan	N/A	2,593	51,757
6	Bauxite Crusher Scrubber Exhaust Fan	8,463	2,029	49,034
8	Transfer Tower 3 Scrubber Exhaust Fan	N/A	N/A	21,535
11	Alumina Loader Dust Fan FA49AL03 Outer	N/A	N/A	20,659
12	Alumina Loader Dust Fan FA49A Inner	537	285	9,682
16	Alumina Silo 1 Exhaust Fan FA12A017	1629	517	6,570
17	Alumina Silo 2 Exhaust Fan FA12A018	3145	577	6,570
18	Alumina Silo 3 Exhaust Fan FA12A019	904	263	4,380
19	Alumina Silo 1/2 Exhaust Fan FA12A020	523	96	4,380
Total		**15,201**	**6,360**	**174,567**

2.1.6 Emissions to Air Compliance Summary

Compliance with the relevant emission limit values (ELV’s) for emissions to atmosphere is evaluated as follows for all active boilers, calciners and CHP emissions.

HFO Boiler Emissions

The overall annual level of compliance with emission limit values for continuous monitoring of HFO boiler emissions to atmosphere is tabulated below for the 48-hour and the monthly average compliance requirements as specified in Condition 4.1.2 of the IE Licence. The parameters evaluated are sulphur dioxide and nitrogen oxides. It should be noted that Boiler B is fully decommissioned.

It is noted that the total run-time for the HFO boilers in 2019 was 908 hours.

- No monthly mean shall exceed the ELV (750 mg/Nm^3 for NOx and 1700 mg/Nm^3 for SO_2)
- 95% of 48-hour mean values shall not exceed 825 mg/Nm^3 for NOx
- 97% of 48-hour mean values shall not exceed 1,825 mg/Nm^3 for SOx

The evaluation indicates that HFO boiler emissions were fully compliant with both the 48-hour (Table 6) and monthly average (Table 7) emission limits as specified in Condition 4.1.2 of the IE Licence.

Table 6 Evaluation of Compliance with 48-hour Average ELV’s – HFO Boilers

Parameter	**Oxides of Sulphur (as SO_2)**		**Nitrogen Oxides (as NO_2)**	
No. Measurement Intervals	**183**		**183**	
Boiler Ref.	**A**	**C**	**A**	**C**
No. of Periods above 1.1 x ELV	0	0	0	0
% of 48-hour periods below 1.1 x ELV	100%	100%	100%	100%
Target % below 1.1 x ELV for compliance	97%	97%	95%	95%
Compliant	**Yes**	**Yes**	**Yes**	**Yes**

Table 7 Evaluation of Compliance with Monthly Average ELV's – HFO Boilers

Parameter	**Oxides of Sulphur (as SO_2)**		**Nitrogen Oxides (as NO_2)**	
No. Measurement Intervals	**12**		**12**	
Boiler Ref.	**A**	**C**	**A**	**C**
No. of Periods above ELV	0	0	0	0
% of monthly periods below ELV	100%	100%	100%	100%
Target % monthly periods below ELV for compliance	100%	100%	100%	100%
Compliant	**Yes**	**Yes**	**Yes**	**Yes**

Gas Boiler Emissions

For gas boiler overall compliance is assessed in accordance with Condition 4.1.1:

- 100% of validated monthly average values shall not exceed 100mg/Nm^3 for NOx & CO.
- 100% of validated daily average values shall not exceed 110mg/Nm^3 for NOx & CO.
- 95% of validated hourly average values shall not exceed 200mg/Nm^3 for NOx & CO.

The evaluation confirms that gas boiler emissions were fully compliant with all the parameters specified in Condition 4.1.1 of the IE Licence as summarised in Table 8 below.

Table 8 Evaluation of Compliance – Gas Boilers

Parameter	**IEL ELV (mg/m3)**	**Actual 2019 (mg/m3)**	**Comment**
A4-A (D Boiler) Monthly average NO_X	100%< 100	100%< 100	Compliant
A4-A (D-Boiler) Daily average NO_X	100%< 110	100%< 110	Compliant
A4-A (D Boiler) Hourly average NO_X	95%< 200	99.99%< 200	Compliant
A4-B (E Boiler) Monthly average NO_X	100%< 100	100%< 100	Compliant
A4-B (E-Boiler) Daily average NOX	100%< 110	100%< 110	Compliant

A4-B (E-Boiler) Hourly average NO_X	95%< 200	100%< 200	Compliant
A4-A (D Boiler) Monthly average CO	100%< 100	100%< 100	Compliant
A4-A (D-Boiler) Daily average CO	100%< 110	100%< 110	Compliant
A4-A (D Boiler) Hourly average CO	95%< 200	100%< 200	Compliant
A4-B (E Boiler) Monthly average CO	100%< 100	100%< 100	Compliant
A4-B (E-Boiler) Daily average CO	100%< 110	100%< 110	Compliant
A4-B (E-Boiler) Hourly average CO	95%< 200	100%< 200	Compliant

Calciner Emissions

The requirements for Calciner particulate emissions as outlined in Condition 4.1.3 of the IE licence are as follows:

- No daily mean value shall exceed the ELV (50 mg/Nm^3)
- No hourly mean shall exceed twice the ELV (100 mg/Nm^3)
- 97% of hourly mean values shall not exceed 1.2 times the ELV (60mg/Nm^3)

An evaluation of the continuous monitoring data for 2019 is summarised in Table 9.

Table 9 Evaluation of Compliance – Calciners

Parameter	ELV (mg/m3)	Actual 2019 (mg/m3)	Comment
Daily Average Particulates	100% < 50	100% < 50	Compliant
Hourly Average Particulates	100% < 100	100% < 100	Compliant
Hourly Average Particulates	97% < 60	99.98% < 60	Compliant

In addition, for quarterly non-continuous monitoring of particulates and nitrogen oxides (as NO_2), individual results were fully compliant with the relevant ELV's for calciner emissions.

CHP Emissions

In accordance with Schedule C.1.2, continuous monitoring of Oxides of Nitrogen and Carbon Monoxide was assessed. A summary of evaluation of compliance of CHP emissions is presented in Table 10 below. In all cases, the emissions were compliant with the relevant ELVs.

Table 10 Evaluation of Compliance - CHP

Parameter	IEL ELV (mg/m3)	Actual 2019 (mg/m3)	Comment
A3-A (GT1) Monthly average NO_X	100%< 75	100% < 75	Compliant
A3-A (GT1) Daily average NO_X	100%< 82.5	100% < 82.5	Compliant
A3-A (GT1) Hourly average NO_X	95%< 150	100% <150	Compliant
A3-B (GT2) Monthly average NO_X	100%< 75	100% < 75	Compliant
A3-B (GT2) Daily average NO_X	100%< 82.5	100% < 82.5	Compliant
A3-B (GT2) Hourly average NO_X	95%< 150	100% < 150	Compliant
A3-A (GT1) Monthly average CO	100%< 100	100%< 100	Compliant
A3-A (GT1) Daily average CO	100%< 110	100%< 110	Compliant
A3-A (GT1) Hourly average CO	95%< 200	100%< 200	Compliant
A3-B (GT2) Monthly average CO	100%< 100	100%< 100	Compliant
A3-B (GT2) Daily average CO	100%< 110	100%< 110	Compliant
A3-B (GT2) Hourly average CO	95%< 200	99.98%< 200	Compliant

Dust Collection Units

Other particulate emissions are required to be sampled on a bi-annual basis.

All monitoring results for each of the emission points were fully compliant with the specified emission limit values set out in the IE licence.

2.1.7 EN14181 Compliance Summary

As per the European Directive 2001/80/EC on emissions to air from large combustion plant (LCP) and the EPA Guidance document AG3 (Air Guidance Note on the Implementation of I.S. EN 14181), AAL carries out annual monitoring of emissions from the boiler and gas turbine (CHP) continuous emissions measuring systems (CEMS) against Standard Reference Methods (SRMs) so as to validate their accuracy.

In 2014/2015, QAL 2 Testing was undertaken by RPS Consultants on the CEMS for the primary steam generating sources for the site, as required - D gas boiler, E gas boiler, GT1 and GT2.

QAL 2 Testing was required in 2019 for E boiler and was completed by Element Materials Technology Ireland.

The current calibration functions for the relevant CEMS are shown in Table 11 below.

It is noted that Annual Surveillance Testing (AST) of D gas boiler, GT1 and GT2 were carried out in 2019 by Element Materials Technology Ireland. As a result of the testing, the calibration functions outlined in Table 11 remain unchanged.

D and E gas boilers replaced A, B and C HFO boilers as primary sources of steam generation since 2014. A and C HFO boilers are back-up units for D and E gas boilers, as required.

Table 11: EN14181 CEMS Calibration Functions

Unit	Parameter	Established Calibration Function		Year Established	Next QAL2 Required
		A	B		
A Boiler	NOx	0	0.85	2013	*
	SOx	2.583	1.202	2013	*
D Boiler	NOx	0.284	1.026	2015	2020
	CO	-1.335	0.958	2015	2020
E Boiler	NOx	-0.0667	1.1115	2019	2024
	CO	-0.0814	0.9629	2019	2024
GT1	NOx	1.272	0.9189	2015	2020
	CO	3.042	0.965	2015	2020
GT2	NOx	1.324	1.0085	2015	2020
	CO	3.26	0.9436	2015	2020

*QAL2 not required for HFO boilers as only used as backup units. HFO boilers are limited to no more than 17,500 operating hours starting from 1st January 2016 and ending no later than 31st December 2023.

2.2 Emissions to Water

AAL has two licensed discharges of treated effluent to the Shannon Estuary as follows:

Table 12 Licensed Discharges to Water

Licence Reference	Receiving Water	Characteristics
W1-1	Shannon Estuary	Treated Industrial (Process) Effluent
Sanitary Effluent	Shannon Estuary	Treated Sanitary Effluent

Discharges of treated industrial (process) and sanitary effluents to the Shannon Estuary are made at an outfall point close to the AAL Marine Terminal. Both discharges are sampled continuously for both flow and pH, and for other parameters at weekly, quarterly and bi-annual frequencies, as specified in Schedules C.2.1 (Control of Emissions to Water) and C.2.2 (Monitoring of Emissions to Water) of the IE Licence.

2.2.1 Process Effluent (W1-1)

Treated process effluent is discharged to the Shannon Estuary at emission point W1-1. Summary monitoring results for 2019 are tabulated in Table 13 below.

Screening for heavy metals, VOC's (Volatile Organic Compounds) and toxicity is also carried out and results are detailed in Sections 2.2.2, 2.2.3 and 2.2.4 respectively.

The data reported in Table 13 is for the 12 months of 2019. Figures for 2018 are included by way of comparison.

It is noted that annual mass emissions for all parameters during the reporting period were within licensed emission limit values (ELV's).

Table 13 Process Effluent (W1-1) Mass Emissions

Parameters	Mass Emissions (kg) 2018	Mass Emissions (kg) 2019	Licensed Emissions (kg)
Volume (m^3)	4,656,823	5,131,610	10,950,000
BOD	292,083	196,213	861,400
Suspended Solids	54,296	66,359	547,500
Oils Fats & Greases	4,657	5,132	164,250

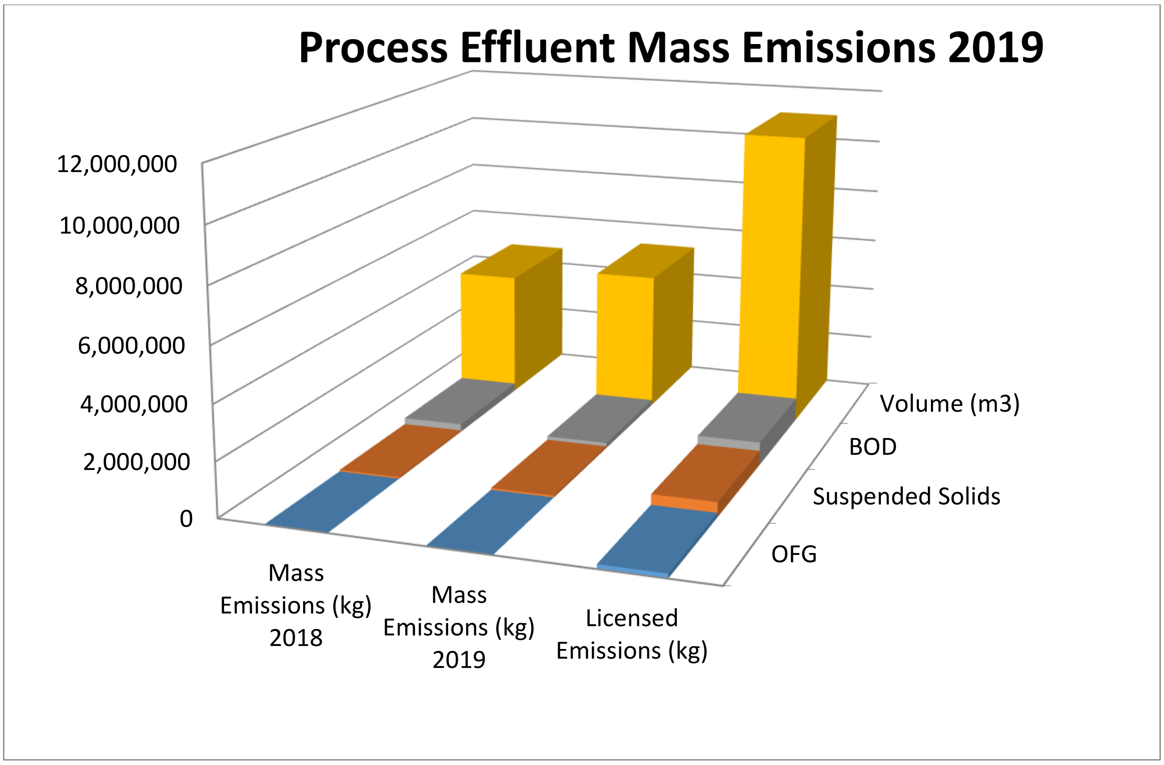


Figure 5 Process Effluent Mass Emissions 2019

2.2.2 Heavy Metal, Aluminium and Soda Analysis

AAL is required to analyse treated process effluent for heavy metals, aluminium and soda under IE Licence Schedule C.2.2 Monitoring of Emissions to Water.

Heavy Metals

Heavy metal analysis of the effluent discharged at emission point W1-1 was undertaken by Fitz Scientific Ltd. on a quarterly basis during 2019. Analytical results are shown in Table 14 below.

Table 14 Process Effluent (W1-1) - Heavy Metal Results

Parameter	Conc. (mg/l) Q1	Conc. (mg/l) Q2	Conc. (mg/l) Q3	Conc. (mg/l) Q4
As	0.0294	0.0430	0.0646	0.0330
Cd	0.0001	0.0003	0.0020	0.0005
Cr	0.0170	0.0150	0.0126	0.0165
Cu	0.0150	0.0180	0.0120	0.0064
Hg	0.0002	0.0002	0.0007	0.0002
Ni	0.0090	0.0060	0.0088	0.0015
Pb	0.0002	0.0002	0.0050	0.0001
Zn	0.0970	0.0240	0.0132	0.0130
Ti	0.0180	0.0050	0.0050	0.0050
Fe	0.0610	0.0400	0.0296	0.0448
Mg	0.1500	2.7800	10.2000	6.2000

Aluminium & Soda

The results of the analyses for aluminium and soda are detailed in Table 15. The figure provided for each parameter is the average result for the 2019 monthly and quarterly monitoring intervals. 2018 data is provided for comparison.

Table 15 Process Effluent (W1-1) Soda & Aluminium Analysis

Parameter	Units	Annual Average 2018	Annual Average 2019	ELV
Aluminium	mg/l Al	3.83	2.07	Not specified
Soda	g/l Na_2O	3.29	2.69	Not specified

2.2.3 Effluent VOC Screen

Screening of industrial effluent (at W1-1) for VOC's is undertaken biannually as specified in Schedule C.2.2 of the IE Licence. Biannual sampling and analysis was undertaken in January and July 2019.

The VOC concentration in the samples taken in January and July 2019 were <5 µg/l.

Table 16 Process Effluent (W1-1) - VOC Analysis

Date	Units	Test	Method	Result	ELV
29/01/2019	µg/l	VOC	USEPA 542.2	< 5	Not specified
30/07/2019	µg/l	VOC	USEPA 542.2	< 5	Not specified

Note: Values denoted less than (<) are below the relevant threshold or limit of detection for that test

The VOC results are included as ***Attachment 1***.

2.2.4 Toxicity

Schedule B.2 (Emissions to Water) and Schedule C.2.2 (Monitoring of Emissions to Water) of the IE Licence requires biannual toxicity testing of the treated effluent. The ELV for toxicity is 5 Toxic Units (TU).

Samples of treated effluent (24 hour flow proportional composite samples) were collected and submitted to the Aquatic Services Unit, Environmental Research Institute, Lee Road, Cork for toxicity testing in May 2019.

In August 2019, samples of treated effluent (24 hour flow proportional composite samples) were collected and submitted to City Analysts Limited, Ringsend, Dublin 4 for toxicity testing.

The acute toxicity of each sample was analysed on suitable sensitive aquatic indicator species i.e. *Tisbe battagliai* and *Vibrio fischeri*.

The results (see Table 17) show that both effluent samples were compliant with the ELV for toxicity.

The toxicity testing reports are included as ***Attachment 1***.

Table 17 Process Effluent - Toxicity Testing Results

Test Parameter	Q2 2019 Results (TU)	Q3 2019 Results (TU)	ELV (TU)
48h LC_{50} to *Tisbe battagliai*	4.0	<3.1	5
30 min EC_{50} to *Vibrio fischeri*	2.0	<2.2	5

Note: Values denoted less than (<) are below the relevant threshold or limit of detection for that test

2.2.5 Sanitary Effluent

Treatment of sanitary effluent is provided for by a proprietary biological effluent treatment plant, which comprises an activated sludge (aeration) stage and a settlement/clarification stage, prior to discharge. The system discharges to the industrial effluent discharge pipeline at a point upstream of the final discharge at W1-1.

Annual mass emissions are tabulated in Table 18 below. 2018 data is provided for comparison.

Table 18 Sanitary Effluent Mass Emissions

Parameter	Mass Emissions (kg) 2018	Mass Emissions (kg) 2019	Licensed Emissions (kg)
Volume (m^3)	20,456	19,643	87,600
BOD	41	108	2,190
Suspended Solids	69	69	3,066

The annual volumetric discharge mass emissions for all parameters were significantly below licence limits for the monitoring period.

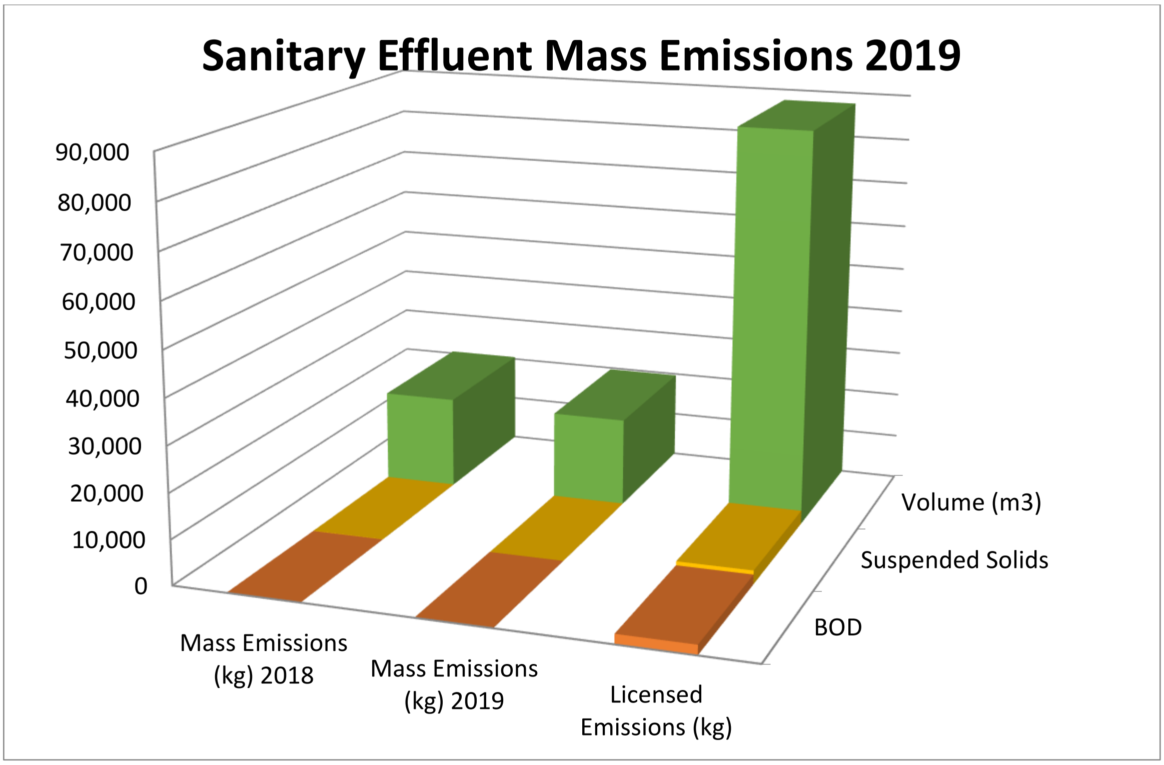


Figure 6 Sanitary Effluent Mass Emissions 2019

2.2.6 Surface Water Monitoring

Monitoring of surface water run-off from the site is undertaken at five discharge locations referred to as Surface Streams (SS).

Monitoring results for each emission point are summarised in Table 19 as the average value for the monitoring period.

Table 19 Surface Water Discharge Monitoring Results

Emission Point Reference	pH	Conductivity (µS/cm)	Na_2O (g/l)
Frequency	**Monthly**	**Monthly**	**Monthly**
SS 1	8.0	126	0.01
SS 2	8.1	149	0.01
SS 3	8.3	132	0.01
SS 4	8.1	111	0.01
SS 5	8.1	170	0.01

(Note: Results are numerical average of 2019 data)

2.2.7 Surface Water Monitoring at the BRDA

Monitoring of surface water run-off in the area of the existing BRDA is undertaken at three licensed locations – Mangan's Lough, the OPW Channel and Phase 2 West Robertstown Gate.

Results for each emission point are detailed in Table 20 and show the average value over the monitoring period. As the surface water in the area is subject to saline intrusion, the soda and conductivity values are subject to sodium interference owing to the presence of sodium salts in the brackish water.

Table 20 BRDA Surface Water Monitoring Results

Description	pH	Conductivity µS/cm	Soda (Na_2O) g/l
Mangan's Lough	7.4	1,136	0.28
OPW Channel	7.7	2,542	0.59
West Robertstown Gate	8.2	3,710	0.93

(Note: Results are numerical average of 2019 data)

2.2.8 Discharges to Water Compliance Summary

All discharges of treated process wastewater and sanitary effluent during the reporting period complied fully with the relevant emission limit values set out in the IE Licence.

3. Waste Management

The national waste database table, providing a summary of waste arising at the AAL facility has been compiled for the calendar year 2019. The information is tabulated on Tables 21 and 22.

3.1 Waste Quantities 2019

Table 21 Summary Information on Waste Quantities Generated

	2015	2016	2017	2018	2019
Total Quantity of waste produced in calendar year (tonnes)	**1,509,598**	**1,516,557**	**1,573,708**	**1,495,596**	**1,548,585**
Quantity of waste disposed of on-site	1,507,468	1,514,519	1,571,677	1,493,710	1,546,213
Quantity of waste disposed of off-site	751	748	696	659	701
Quantity of waste recovered on-site	0	0	0	0	0
Quantity of waste recovered off-site	1,379	1,289	1,335	1,200	1,671
	2015	**2016**	**2017**	**2018**	**2019**
Quantity of Non-Hazardous waste produced in calendar year (tonnes)	**1,490,269**	**1,498,168**	**1,556,636**	**1,480,433**	**1,532,128**
Quantity of non-hazardous waste disposed of on-site	1,488,267	1,496,215	1,554,813	1,478,702	1,529,989
Quantity of non-hazardous waste disposed of off-site	739	737	690	645	604
Quantity of non-hazardous waste recovered on-site	0	0	0	0	0
Quantity of non-hazardous waste recovered off-site	1,263	1,216	1,133	1,087	1,536
	2015	**2016**	**2017**	**2018**	**2019**
Quantity of Hazardous waste produced in calendar year (tonnes)	**19,329**	**18,389**	**17,072**	**15,135**	**16,456**
Quantity of hazardous waste disposed of on-site	19,201	18,304	16,864	15,008	16,224
Quantity of hazardous waste disposed of off-site	12.5	11.1	6.4	14.7	97.3
Quantity of hazardous waste recovered on-site	0	0	0	0	0
Quantity of hazardous waste recovered off-site	116	74	202	113	135

The quantities of waste disposed of to the plant Bauxite Residue Disposal Area (BRDA) are estimated using a number of methods:

- Volumes of red mud disposed of to the BRDA are calculated from the annual production figures and the determined mud factor generated by analysis of the bauxite ores used during the reporting period.
- Volumes of salt cake, process scale and other process wastes are based on the number of containers multiplied by typical container net weight.

There was an overall increase of 52,989 tonnes of waste generated on site in 2019 compared to 2018. This increase was attributed primarily to fluctuations in bauxite quality.

Results of quarterly waste analysis carried out by AAL during 2019 are included as ***Attachment 2***.

Table 22 Information on Individual Waste Streams

LoW Code	Haz (Y/N)	Description of Waste	Name of Waste Collection Contractor	Waste Collection Permit No.	Name of Waste Disposal/ Recovery Contractor	Method of Disposal/Recovery	Location of Disposal/ Recovery	Waste Licence/ Permit No.	Quantity (Tonnes/ annum)
15 01 11	Y	Aerosol Cans	John Malone Transport	NWCPO-11-01394-02	Rilta Environmental Ltd., Greenogue Business Park, Rathcoole, Co. Dublin	R4 Recycling/reclamation of metals & metal compounds	(b) Off-site Ireland	W0192-03	2.75
17 06 01	Y	Asbestos	John Malone Transport	NWCPO-11-01394-02	Rilta Environmental Ltd., Greenogue Business Park, Rathcoole, Co. Dublin	D1 Deposit on, in or under land	(c) Off-site Abroad	W0192-03	90.3
15 02 02	Y	Mixed wastes	John Malone Transport	NWCPO-11-01394-02	Rilta Environmental Ltd., Greenogue Business Park, Rathcoole, Co. Dublin	D1 Deposit on, in or under land	(c) Off-site Abroad	W0192-03	0.4
20 01 01	N	Cardboard	United Metals	NWCPO-10-05657-02	Greenstar, Dock Road, Limerick	R3 Recycling/reclamation of organic substances which are not used as solvents	(b) Off-site Ireland	W0082-03	10.8
16 05 06	Y	Chemical Waste	Rilta	NWCPO-09-01192-02	Rilta Environmental Ltd., Greenogue Business Park, Rathcoole, Co. Dublin	R1 Use as a fuel (other than in direct incineration) or other means to generate energy	(b) Off-site Abroad	W0192-03	3.70
18 01 03	Y	Clinical Waste	SRCL	NWCPO-09-01178-03	SRCL Ltd., 420-430 Beech Road, Western Industrial Estate, Naas Road, Dublin 12	D9 Physico chemical treatment	(b) Off-site Ireland	W0054-02	0.148
20 01 99	N	Conveyor Belting	Quarry Plant Supplies	N/A	Pat O'Connor, Quarry Plant Supplies, Straffan, Co. Kildare	R11 Uses of residual materials obtained from any of the operations numbered R1-R10	(b) Off-site Ireland	N/A	118.4

LoW Code	Haz (Y/N)	Description of Waste	Name of Waste Collection Contractor	Waste Collection Permit No.	Name of Waste Disposal/ Recovery Contractor	Method of Disposal/Recovery	Location of Disposal/ Recovery	Waste Licence/ Permit No.	Quantity (Tonnes/ annum)
17 04 01	N	Copper	United Metals	NWCPO-10-05657-02	United Metals, Eastway Business Park, Limerick	R4 Recycling/reclamation of metals & metal compounds	(c) Off-site Abroad	WFP/L/2016 /147A/R2	2.4
16 11 04	N	Flue Stack Residue (Refractory Waste)	N/A	N/A	Aughinish Alumina Ltd.	D1 Deposit on, in or under land	Site landfill	IEL P0035-06	80
20 01 21	Y	Fluorescent Bulbs	Irish Lamp Recycling	NWCPO-08-01115-02	Irish Lamp Recycling, Athy, Co Kildare	R4 Recycling/reclamation of metals & metal compounds	(b) Off-site Ireland	WFP-KE-14-0072-01	4
20 03 01	N	General Waste	Greenstar	NWCPO-13-11193-05	Greenstar, Dock Road, Limerick	D1 Deposit on, in or under land	(b) Off-site Ireland	W0082-03	118.0
01 03 99	N	Lime Grits/Stone	N/A	N/A	Aughinish Alumina Ltd.	D1 Deposit on, in or under land	Site landfill	IEL P0035-06	6,902
06 04 04	Y	Mercury Liquid	Irish Lamp Recycling	NWCPO-08-01115-02	Irish Lamp Recycling, Athy, Co Kildare	R4 Recycling/reclamation of metals & metal compounds	(b) Off-site Ireland	WFP-KE-14-0072-01	0.012
15 01 04	N	Metal Containers (empty IBC's & drums)	John Malone Transport	NWCPO-11-01394-02	Rilta Environmental Ltd., Greenogue Business Park, Rathcoole, Co. Dublin	R4 Recycling/reclamation of metals & metal compounds	(b) Off-site Ireland	W0192-03	0.9
16 01 07	Y	Oil Filters	Enva	NWCPO-08-01116-02	Enva Portlaoise, Clonminam Industrial Estate, Portlaoise, Co. Laois.	R11 Uses of residual materials obtained from any of the operations numbered R1-R10	(b) Off-site Abroad	W0184-02	0.10
13 08 99	Y	Oily Rags / Oil Dry	John Malone Transport	NWCPO-11-01394-02	Rilta Environmental Ltd. Greenogue Business Park, Rathcoole, Co. Dublin	D10 Incineration on land	(b) Off-site Ireland	W0192-03	3.7

LoW Code	Haz (Y/N)	Description of Waste	Name of Waste Collection Contractor	Waste Collection Permit No.	Name of Waste Disposal/ Recovery Contractor	Method of Disposal/Recovery	Location of Disposal/ Recovery	Waste Licence/ Permit No.	Quantity (Tonnes/ annum)
20 01 01	N	Paper/Documents	DGD Papers	NWCPO-11-05669-02	DGD Papers Ltd., Bay M1, Raheen Business Park, Limerick	R3 Recycling/reclamation of organic substances which are not used as solvents	(b) Off-site Ireland	WFP-LK-2013-09C R1	2.0
20 01 39	N	Plastic containers (clean empty IBC's & drums)	John Malone Transport	NWCPO-11-01394-02	Rilta Environmental Ltd., Greenogue Business Park, Rathcoole, Co. Dublin	R3 Recycling/reclamation of organic substances which are not used as solvents	(b) Off-site Ireland	W0192-03	28.7
15 01 10	Y	Plastic containers (contaminated empty IBC's & drums)	John Malone Transport	NWCPO-11-01394-02	Rilta Environmental Ltd., Greenogue Business Park, Rathcoole, Co. Dublin	R3 Recycling/reclamation of organic substances which are not used as solvents	(b) Off-site Ireland	W0192-03	41.0
01 03 99	N	Process Waste (tank cleanout scale, sludge etc)	N/A	N/A	Aughinish Alumina Ltd.	D1 Deposit on, in or under land	Site landfill	IEL P0035-06	16,399
01 03 09	N	Red Mud	N/A	N/A	Aughinish Alumina Ltd.	D1 Deposit on, in or under land	Site landfill	IEL P0035-06	1,400,137
01 03 07	Y	Salt Cake	N/A	N/A	Aughinish Alumina Ltd.	D1 Deposit on, in or under land	Site landfill	IEL P0035-06	16,224
01 03 99	N	Sand	N/A	N/A	Aughinish Alumina Ltd.	D1 Deposit on, in or under land	Site landfill	IEL P0035-06	106,471
19 08 05	N	Sanitary Effluent Sludge	Ecojet	NWCPO-12-05685-02	Ecojet Ltd., Bay M1, Raheen Business Park, Raheen, Limerick	D8 Biological Treatment	(b) Off-site Ireland	D0013-01	486.0

LoW Code	Haz (Y/N)	Description of Waste	Name of Waste Collection Contractor	Waste Collection Permit No.	Name of Waste Disposal/ Recovery Contractor	Method of Disposal/Recovery	Location of Disposal/ Recovery	Waste Licence/ Permit No.	Quantity (Tonnes/ annum)
17 04 07	N	Steel & Aluminium & Nickel Scrap Metal	United Metals	NWCPO-10-05657-02	United Metals, Eastway Business Park, Limerick	R4 Recycling/reclamation of metals & metal compounds	(c) Off-site Abroad	WFP/L/2016 /147A/R2	977.2
20 01 38	N	Timber Reels (used)	United Metals	NWCPO-10-05657-02	United Metals, Eastway Business Park, Limerick	R11 Uses of residual materials obtained from any of the operations numbered R1-R10	(b) Off-site Ireland	WFP/L/2016 /147A/R2	2.8
19 12 04	N	Used Hosing & Belting (Rubber)	United Metals	NWCPO-10-05657-02	Greenstar, Dock Road, Limerick	R11 Uses of residual materials obtained from any of the operations numbered R1-R10	(b) Off-site Ireland	W0082-03	245.4
20 01 25	N	Vegetable Oils & Greases	Frylite	WCP-DC-10-1297-01	Frylite Dublin Ltd., Unit J1, Ballymount Industrial Estate, Dublin 12	R3 Recycling/reclamation of organic substances which are not used as solvents	(b) Off-site Ireland	WFP-DS-10-0009	1.8
02 03 99	N	Waste Food	Mr Binman	NWCPO-12-11056	Greenstar, Dock Road, Limerick	R3 Recycling/reclamation of organic substances which are not used as solvents	(b) Off-site Ireland	W0082-04	20.0
20 01 38	N	Wood - recycling	Hegarty Metals Recycling	WCP-DC-08-1120-01	Greenstar, Dock Road, Limerick	R3 Recycling/reclamation of organic substances which are not used as solvents	(b) Off-site Ireland	W0082-03	125.0
13 02 08	Y	Waste engine, gear and lubricating oils	John Malone Transport	NWCPO-11-01394-02	Rilta Environmental Ltd., Greenogue Business Park, Rathcoole, Co. Dublin	R9 Used oil re-refining or other reuses of previously used oil	(b) Off-site Ireland	W0192-03	53.4

LoW Code	Haz (Y/N)	Description of Waste	Name of Waste Collection Contractor	Waste Collection Permit No.	Name of Waste Disposal/ Recovery Contractor	Method of Disposal/Recovery	Location of Disposal/ Recovery	Waste Licence/ Permit No.	Quantity (Tonnes/ annum)
13 07 03	Y	Other fuels	John Malone Transport	NWCPO-11-01394-02	Rilta Environmental Ltd., Greenogue Business Park, Rathcoole, Co. Dublin	R9 Used oil re-refining or other reuses of previously used oil	(b) Off-site Ireland	W0192-03	32.2
09 01 04	Y	XRay Fixer Replenisher	SRCL	NWCPO-09-01178-03	SRCL Ltd./Ecosafe Systems, 420-430 Beech Road, Western Industrial Estate, Naas Road, Dublin 12	R4 Recycling/reclamation of metals & metal compounds	(b) Off-site Ireland	W0054-02	0.7
09 01 07	N	XRay Film	Enva	NWCPO-08-01116-02	Enva Shannon, Smithstown Industrial Estate, Shannon, Co. Clare	R4 Recycling/reclamation of metals & metal compounds	(b) Off-site Ireland	W0041-01	0.20
								TOTAL	1,548,585

Hazardous Waste

Non Hazardous Waste

4. Monitoring and Enforcement

4.1 Monitoring

The EPA, and their representatives, made 6 separate monitoring visits or inspections during 2019.

- In February 2019, an EPA Inspector visited the site for an unannounced site inspection.
- In June 2019, an EPA Inspector visited the site for an unannounced site inspection.
- In September 2019, EPA representatives conducted monitoring of air emissions from Calciner emission point reference A2.
- In September 2019, EPA personnel collected samples of treated process effluent and sanitary effluent for analysis.
- In October 2019, an EPA Inspector visited the site for an unannounced site inspection.
- In November 2019, an EPA Inspector visited the site for an audit of the in house air monitoring team.

All monitoring results received from the EPA were compliant with the relevant emission limit values of the IE licence.

4.2 Third Party Inspections

AAL obtained certification to the international environmental management system (EMS) standard ISO14001 in 2000. DNV-QA (Det Norske Veritas Quality Assurance) carried out a successful audit of the ISO 9001:2015 / ISO 14001:2015 system in November 2019 where AAL retained its certification.

AAL operates a rigorous internal audit schedule in order to ensure conformance with plant operating systems (production, quality, safety, environmental) and to facilitate the process of continual improvement in those systems. In 2019, AAL conducted 12 ISO14001 and 7 ISO9001 internal audits.

4.3 Enforcement

One non-compliance was recorded related to non-notification of damage to cladding on the alumina air slide gallery tower.

5. Resource Consumption

5.1 Energy Consumption

Owing to the nature of the Bayer process used at AAL for alumina manufacturing and post extraction processing, energy represents the most economically significant impact to the process.

For this reason, AAL was designed with energy efficiency in mind. Heat recovery and power efficiency are two of the key process efficiency targets that receive close scrutiny.

Table 23 Energy Consumption 2017 – 2019

Source	2017 (MW)	2018 (MW)	2019 (MW)
Heavy Fuel Oil	0.5	0.8	3.5
Power (Electrical)	43.5	42.9	43.3
Diesel	0.3	0.4	0.3
Natural Gas	710.9	710.1	696.5
Total	**755.3**	**754.3**	**743.6**

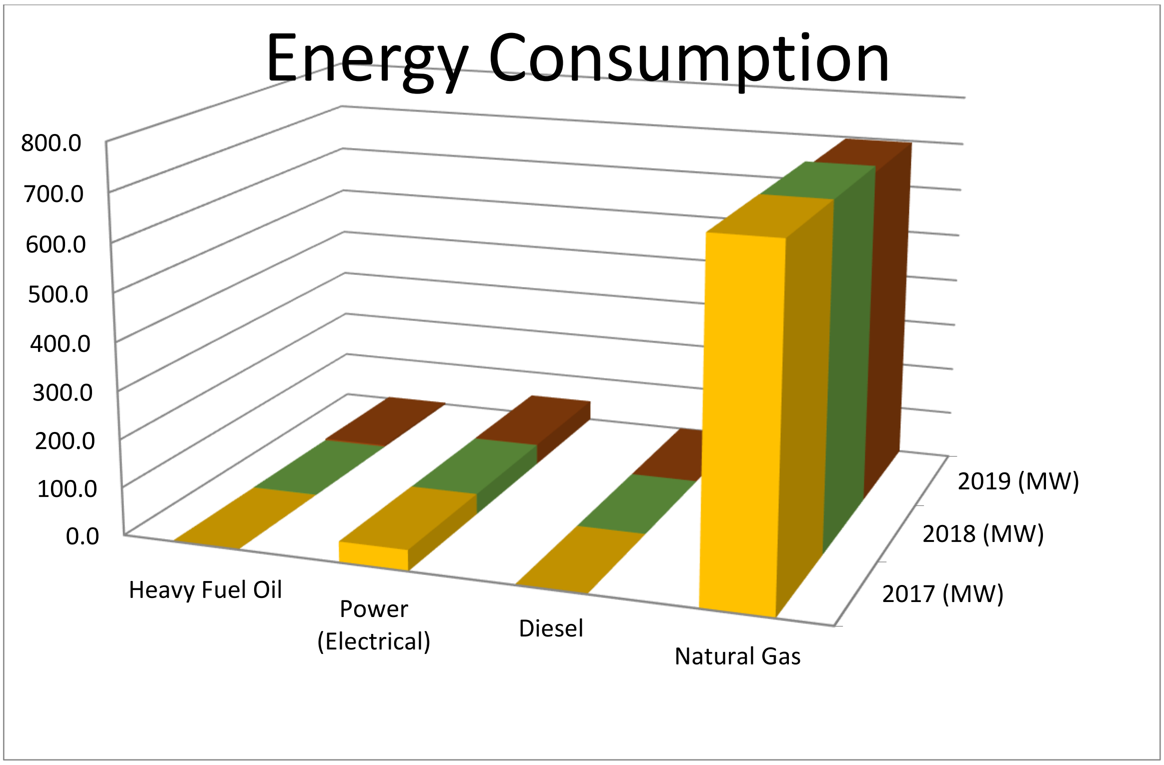


Figure 7 Energy Consumption 2017 – 2019

5.1.1 Energy Efficiency Report 2019

The 2019 energy efficiency report is provided as ***Attachment 3***.

- An ISO 50001 recertification audit was successfully completed in February 2019.
- The 2019 steam efficiency performance was 6.02 GJ/t.
- The 2019 power efficiency performance was 0.727 GJ/t.

5.2 Water Consumption

AAL receives potable water from Limerick City & County Council for process and domestic uses.

The bulk of the potable water is demineralised in the AAL water treatment plant for use in boiler steam generation. The balance of the potable water is used for process make-up, where process condensate (re-condensed water from the process) supply is not available, and also as domestic water.

AAL does not abstract groundwater for process or domestic purposes.

Table 24 Water Consumption 2016 - 2019

Year	Total (m^3)	Relative Consumption (m^3/tonne product)
2019	5,288,763	2.82
2018	5,425,257	2.88
2017	5,268,776	2.73
2016	5,121,103	2.59

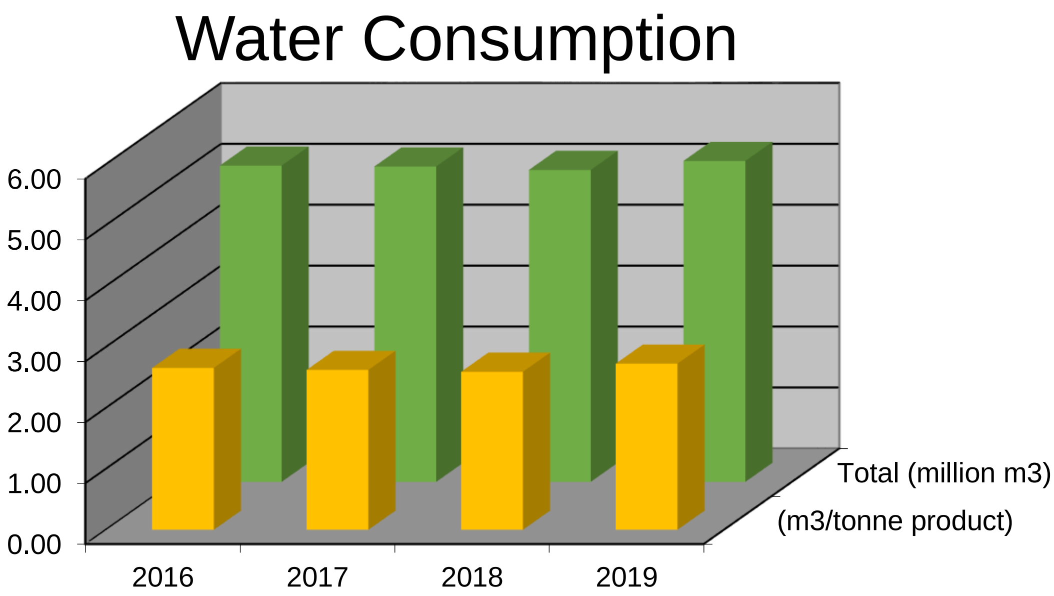


Figure 8 Water Consumption 2016 – 2019

5.3 Progress on Minimising Water Demand and Volume of Trade Effluent Discharges

AAL continually strives to improve the efficiency of its processes in order to reduce both the quantity of raw water consumed and waste effluent produced.

5.4 Raw Materials Efficiency and Waste Reduction

AAL continually strives to improve the efficiency of its processes in order to reduce the raw materials consumed and the waste produced.

Table 25 shows the volumes of raw materials consumed and waste produced for 2018 and 2019. The relative consumption for each parameter is calculated as the volume consumed per tonne of alumina hydrate produced.

Table 25 Raw Material Efficiency & Waste Reduction

Material	2018 Consumption	Relative Consumption (Volume/tonne alumina)	2019 Consumption	Relative Consumption (Volume/tonne alumina)
Alumina Produced (tonnes)	1,885,160	N/A	1,875,265	N/A
Bauxite Ore Consumed (tonnes)	4,590,186	2.4	4,549,956	2.4
Sodium Hydroxide (tonnes)	128,292	0.07	117,615	0.07
Sulphuric Acid (tonnes)	18,893	0.01	17,362	0.01
Heavy Fuel Oil (tonnes)	1,056	0.0002	3,309	0.0006
Water (m^3)	5,425,257	2.7	5,288,763	2.9
Waste (tonnes)	1,495,596	0.8	1,548,585	0.8
Energy (GJ)	754	12.3	744	12.6

6. Environmental Incidents and Complaints

AAL has a procedure in place for classification and reporting of environmental incidents. As part of the requirements of the IE Licence, AAL operates, through the plant Environmental Management System, a procedure for logging and responding to any complaints received from the public.

6.1 Category 1 Incidents

There was one Category 1 (minor) incident notified to the EPA during 2019:

- Minor damage to cladding on the alumina air slide gallery tower which have since been repaired.

An investigation was completed, root causes identified and measures agreed to prevent recurrence of the incident.

6.2 Category 2 – 5 Incidents

There were no Category 2, 3, 4 or 5 (Limited, Serious, Very Serious or Catastrophic) environmental incidents during 2019.

6.3 Complaints

Nine complaints were received during 2019 related to odour, dust and air emissions.

Detailed investigations were conducted into all of these complaints. A screening fence is to be trialled in the BRDA, with all other actions raised by the EPA in relation to these complaints completed and closed.

7. Environmental Management Programme

This section contains summary information on the AAL Environmental Management Programme (EMP).

A revised Schedule of Objectives and Targets for 2020 is presented in Section 7.2 for Agency approval.

Both the EMP and Schedule of Objectives and Targets fall under the site ISO 14001 Environmental Management System. Accordingly, they are included within a structured system of management review and periodic auditing by both internal auditors and independent third party auditors Det Norske Veritas (DNV UK).

The Environmental Performance Reporting (EPR), previously known as the Pollutant Release and Transfer Register (PRTR), which is a requirement of Condition 6.17 of the IE Licence, has been updated to reflect emissions during the 2019 monitoring period.

7.1 Environmental Management Programme (EMP) Report 2019

The AAL Environmental Management Programme (EMP) is a continuously updated plan showing the status of key environmental improvement programmes being undertaken within the plant and is reviewed as part of the ISO 14001 Environmental Management System (EMS).

Progress in achieving planned objectives and targets during 2019 is summarised in Table 26. It sets out the objectives, associated targets and a comment on progress in meeting those targets.

Table 26 EMP 2019 Report

No.	Objective	Target	Progress
1	**Conformance to Industrial Emissions Licence**	Update assessment of Best Available Techniques once issued in the Journal of the European Union	Completed in Q2 as part of licence review.
		Submit Licence review application for operation of a borrow pit	Licence review submitted on 30th April 2019.
2	**Design & operate the BRDA to best practice**	Implement 2019 BRDA vegetation programme	Completed.
		Implement 2019 BRDA screening programme	Completed.
		Complete development of new demonstration area for direct remediation of farmed bauxite residue	Construction phase in progress.
		Continue Wetlands study for treatment of BRDA runoff and develop additional wetland trial area.	On schedule. New wetlands area is under construction since Q3 2019.
		Complete SEED audit	SEED audit complete.
		Further develop Air Dispersion Model	Submitted to EPA in Q3 2019.
3	**Quality assurance for monitoring of industrial air emissions**	Conduct 'Annual Surveillance Testing' as required under EN14181 on GTs, and D gas boilers	Completed.
		Conduct QAL 2 calibration for E gas boiler	Completed.
4	**Continual improvement of ambient air emissions**	Trial directional dust gauge as an additional monitoring technique.	Installed in Q4 2019.

5	**Continual improvement program for groundwater and surface water**	Implement structural integrity programme for 2019	Programme of integrity testing (220 structures) 100% completed in 2019.
		Implement planned programme of concrete upgrade works.	CAPEX program 2019 completed.
		Close the process caustic balance for 2019.	Complete.
6	**Continual improvement of Environment Management System**	Achieve compliant surveillance audit for ISO14001:2015 in Q4	Certification retained.
		Develop internal auditor pool further.	Training and audits completed by relevant auditors to develop competence.
7	**Resource Efficiencies**	Complete enhanced caustic recovery studies	Studies ongoing, at preliminary engineering stage.

7.2 Environmental Objectives and Targets 2020

AAL reviews the plant Environmental Management System on an on-going basis with the aim of updating and refining the Environmental Management Programme (EMP) to take account of progress in meeting objectives and targets.

In addition, new targets are added on the basis of achievement of existing targets and where issues have been identified as requiring a formal and structured EMP approach to drive their implementation.

New targets, which have been added for 2020 are summarised in Table 27. This list highlights only those targets added to the EMP and excludes the significant work involved in on-going programmes and projects to achieve existing targets, the detail of which is set out in the EMP for 2020.

Table 27 EMP Objectives and Targets 2020

Objective	Target
Conformance to Industrial Emissions Licence	Update assessment of Best Available Techniques once issued in the Journal of the European Union
Design & operate the BRDA to best practice	Implement 2020 BRDA vegetation programme
	Implement 2020 BRDA screening programme
	Complete development of new demonstration area for direct remediation of farmed bauxite residue and commence monitoring
	Continue Wetlands study for treatment of BRDA runoff and develop additional wetland trial area.
	Install trial paraweb fence
Quality assurance for monitoring of industrial air emissions	Conduct 'Annual Surveillance Testing' as required under EN14181 on E gas boiler
	Conduct QAL 2 calibration on GTs and D gas boiler
	Commission new chemiluminescence gas analyser for in house air monitoring.
Continual improvement of ambient air emissions	Upgrade continuous particulate monitoring stations at 2 monitoring locations.
	Implement planned programme of works for dust management plan.
Continual improvement program for groundwater and surface water	Implement structural integrity programme for 2020
	Implement planned programme of groundwater improvement works.
	Close the process caustic balance for 2020.
Continual improvement of Environment Management System	Achieve compliant surveillance audit for ISO14001:2015 and ISO9001:2015 in Q4
	Develop internal auditor pool further.
	Develop environment focused week for all personnel on site
	Develop bio diversity management plan
Resource Efficiencies	Complete preliminary engineering for enhanced caustic recovery project.
	Implement programme for reduction of single use plastics

7.3 Environmental Performance Reporting (EPR)

The Environmental Performance Reporting (EPR), previously known as the Pollutant Release and Transfer Register (PRTR) has been updated to provide further data for the calendar year 2019.

In line with EPA correspondence, the PRTR is now submitted to the Agency via the Environmental Performance Reporting (EPR) online application that is accessed through the EDEN portal. As per agency guidelines, there is no requirement to include a copy of the PRTR in the AER.

AAL proposes to monitor and report the same parameters for the 2019 PRTR.

7.3.1 Caustic Mass Balance

The mass balance undertaken during 2019, and tabulated below in Table 28, has closed off the input-output cycle and resolved caustic consumption at the plant to 3.37kg caustic (sodium hydroxide) per tonne of alumina hydrate produced. This is likely to be due to slight margins of error in sampling and measurement of caustic concentrations of minor streams, which are based on periodic grab samples.

Table 28 Caustic Mass Balance 2019

Element	Units (kg/tH)
Input	
Total Caustic Consumption	62.72
Outputs	
Caustic in Mud	52.64
Caustic in Alumina	5.51
Caustic in Alumina Hydrate Ships	0.08
Caustic in Sand to BRDA	0.47
Caustic in Saltcake to BRDA	2.81
Caustic in process scale from Tank Turnarounds shipped to BRDA	1.36
Caustic in West pond disposal to the BRDA (Storm Water Pond)	1.83
Caustic in treated (neutralized & clarified) industrial effluents to the river	1.58
Caustic recovery to process from the BRDA	-0.19
Total Output	**66.09**
Unaccounted	-3.37

8. Other Reports

This section contains additional information required under the various conditions of the IE Licence.

Monitoring data from annual surveys (noise) together with results from ambient air quality, dust deposition and groundwater monitoring are summarised.

Updates regarding the facility Closure, Restoration and Aftercare Management Plan (CRAMP), the Environmental Liabilities Risk Assessment (ELRA) and the costings and financial provisions associated with both are provided.

The BRDA Status Report in Section 8.10 contains details of the quantities of waste deposited and development works undertaken in the BRDA during the 2019 calendar year.

8.1 Noise Monitoring Programme

AAL is required to carry out an annual noise survey in accordance with IE Licence Conditions 4.5 and 6.16. Schedule B.4 sets out the relevant noise limits at off-site noise sensitive locations (NSL) as:

- Day-time: 55 dB (A) L_{eq}
- Evening-time: 50 dB (A) L_{eq}
- Night-time: 45 dB (A) L_{eq}

A survey of noise levels at boundary and off-site noise sensitive locations was carried out in August 2019. At each monitoring location, day-time, evening-time and night-time measurements were made for the following measurement parameters: LA_{eq}, LA_{max}, LA_{min}, LA_{90} and LA_{10}. Monitoring was undertaken in accordance with the EPA *Guidance Note for Noise: Licence Applications, Surveys and Assessments in Relation to Scheduled Activities (NG4)*.

As agreed with the EPA, the night time survey for NSL1 was not undertaken in 2019. This is mainly because this is an amenity area used during the day and evening times, with no residences present that can be affected at night time. A further consideration was due to health and safety concerns, relating to the remoteness of this location, along with unsocial activities recorded in this location in the past.

The monitoring results are summarised on Table 29 and 30.

Table 29 Noise Survey Results – Noise Sensitive Locations

Location	Day-time				Evening				Night-time		
	L_{Aeq}	L_{A90}	L_{A10}	L_{Ar}	L_{Aeq}	L_{A90}	L_{A10}	L_{Ar}	L_{Aeq}	L_{A90}	L_{A10}
NSL 1	42	38	43	42	47	37	44	47	N/A	N/A	N/A
NSL 2	49	32	44	49	48	36	46	48	33	27	36
NSL 3	42	32	41	42	45	37	47	45	37	20	41
NSL 4	54	40	51	49	35	26	36	35	37	31	40
NSL 5	58	32	55	32	55	34	50	34	45	21	38

Table 30 Noise Survey Results – Boundary Locations

Location	Day-time			Night-time		
	L_{Aeq}	L_{A90}	L_{A10}	L_{Aeq}	L_{A90}	L_{A10}
B 1	62	55	64	64	61	66
B 2	56	54	57	60	59	62
B 3	59	57	60	60	59	60
B 4	49	36	51	42	36	43
B 5	49	40	50	37	33	40
B 6	58	55	59	53	51	55
B 7	50	38	48	32	28	33
B 8	41	30	38	31	25	32
B 9	45	36	49	36	30	35

2019 Noise Survey Report Conclusions

Noise monitoring was conducted in August 2019 at NSLs and boundary locations associated with the Aughinish Alumina Ltd. facility as per IE Licence.

Day-time monitoring results at NSLs were compliant with the IE Licence specified limits of L_{Ar} (30 minute) 55dB.

Evening-time monitoring results at NSLs were compliant with the IE Licence specified limits of L_{Ar} (30 minute) 50dB.

Night-time monitoring results at NSLs were compliant with the IE Licence specified limits of L_{Aeq} (30 minute) 45dB.

No tones or impulsive noise was recorded during the survey periods at NSLs associated with activities at the facility.

Boundary monitoring locations were in line with both historic day and night-time monitoring results and were in summary at the lower end of the range. Some variability is recorded at NSL locations, however it is noted that results continue to remain in line with both historic day and night-time monitoring results.

Based upon the monitoring conducted in 2019, the Aughinish Alumina Ltd. facility is compliant with the requirements of the IE Licence for noise at NSLs.

The full noise survey report is included as ***Attachment 4***.

8.2 Groundwater Monitoring

AAL undertakes an extensive groundwater monitoring programme. Overall, 87 groundwater monitoring locations have been established with the agreement of the Agency and are routinely monitored in accordance with Schedule C.8 of the IE Licence. The current IE Licence does not specify limit values for groundwater quality.

Monitoring locations can be categorised into the following:

(i) **Estuarine Springs (ES)** are foreshore springs which discharge from the limestone bedrock at the foreshore (ES1 - 16)

(ii) **Plant Observation Wells (POW)** around the process plant (POW1 - 33); the area around the south pond (SPW1 - 6) and the north pond (NPW1 - 3) and the boreholes (BH1 - 4) in the fuel storage tank area.

(iii) **Observation Wells (OW)** around the perimeter of the Phase 1 and Phase 2 BRDA (OW1-45) installed within estuarine alluvium, glacial till and limestone bedrock.

To meet the requirement of Condition 6.15.2 of the IE Licence, an independent groundwater risk screening and technical assessment was undertaken and a report was submitted to the Agency in 2015. The actions/measures outlined in the report were agreed by the Agency. A technical memorandum providing an update to the baseline soil and groundwater report has been submitted to the Agency as part of the licence review submission in April 2019.

The EPA have also requested that AAL submit each year, via licensee return, a report which analyses and interprets the groundwater monitoring results for the previous calendar year.

8.2.1 Estuarine Springs

Estuarine springs (referred to as ES's) are locations where the water table level intersects ground level to allow groundwater to directly discharge to the surface. The ES's are therefore accepted as the main indicators of groundwater quality beneath the plant area. Sixteen individual estuarine springs (ES1 - 16) have been identified and are routinely monitored when there is flow. It is noted that ESs 4, 5, 6, 8, and 15 had no flow in 2019.

Table 31 contains a summary of monitoring results for the 2019 reporting period.

Reporting is as per Schedule C.6 of the IE Licence.

Table 31 Estuarine Spring Monitoring Results 2019

Emission Point Reference	pH*	Conductivity (µS/cm)*	Soda (g/l)*
ES 1**	8.8	2104	0.6
ES 2	8.0	20425	3.4
ES 3	8.1	6788	2.3
ES 7**	7.6	1033	0.2
ES 9	8.0	11025	2.6
ES 10	7.8	1110	0.2
ES 11	8.2	2189	0.5
ES 12**	10.0	1859	0.7
ES 13	8.4	442	0.1
ES 14	8.1	638	0.1
ES 16**	7.9	792	0.2

*Numerical average of the data for the reporting period
**Spring recovered for treatment - no direct discharge to estuary

The results show that there has been a gradual and sustained improvement in the quality of the spring discharges.

There has been an improvement in pH at ES 1, down from 10.9 in 2015 to 8.8 in 2019. An improvement has also been seen in pH at ES 12, down from 12.3 in 2015 to 10.0 in 2019.

It should be noted that there is no direct discharge to surface water from ES1, ES7, ES12 and ES16 as these streams are intercepted and recovered to the effluent plant for treatment.

8.2.2 Plant Observation Wells (POW)

Table 32 contains a summary of plant observation well (POW) groundwater monitoring results for 2019. The table also includes data for those wells located around the north containment pond (NPW) and the south containment pond (SPW).

Monitoring results are reported to the Agency in the quarterly monitoring reports. The values reported here are the average of analytical results returned during the 2019 monitoring period.

Table 32 POW Monitoring Results 2019

Analytical Parameter																			
POW	**pH**	**Conductivity**	**Total Alkalinity**	**Chloride**	**Fluoride**	**Soda**	**Al**	**As**	**Cd**	**Cr**	**Cu**	**Fe**	**Pb**	**Mg**	**Hg**	**Ni**	**Sulphate**	**Ti**	**Zn**
Ref:		**µS/cm**	**mg/l $CaCO_3$**	**mg/l**	**mg/l**	**g/l**	**µg/l**	**µg/l**	**µg/l**	**µg/l**	**µg/l**	**µg/l**	**µg/l**	**mg/l**	**µg/l**	**µg/l**	**mg/l SO_4**	**µg/l**	**µg/l**
POW 1	12.5	19035	8241	462	11.7	6.9	80685	130.5	0.5	19.0	40	439	2.3	1	0.7	43.5	739	19.5	52
POW 2	8.6	1583	115	110	0.1	0.4	211	1.0	0.3	2.0	24	170	1.1	10	0.2	6.0	439	5.0	100
POW 3	10.2	2117	227	130	0.5	0.7	335	7.9	0.3	0.7	20	113	0.7	3	0.2	1.5	516	5.0	25
POW 5	11.9	6450	2736	69	3.7	2.1	68557	114.0	0.7	1.4	35	85	0.9	1	0.3	15.5	113	8.0	59
POW 6	9.0	325	86	12	0.1	0.1	251	1.0	0.4	1.4	20	185	1.3	5	0.2	1.5	10	15.0	43
POW 7	12.7	28587	13861	191	7.7	9.1	186304	379.4	1.7	4.0	106	642	4.4	2	0.7	19.5	133	8.0	37
POW 8	8.1	633	114	48	0.1	0.1	28	0.7	0.3	0.9	22	1176	0.7	12	0.2	1.5	118	5.0	25
POW 9	7.9	576	226	35	0.2	0.1	53	0.7	0.4	0.9	18	41	0.3	5	0.2	4.0	13	5.0	22
POW 10	7.8	360	145	21	0.0	0.0	90	0.7	0.4	0.7	19	67	0.8	2	0.2	1.0	5	5.0	27
POW 11	12.2	5037	2210	49	2.6	1.1	113064	100.9	0.3	1.8	31	49	3.7	1	0.7	3.0	36	5.0	107
POW 12	10.8	1847	875	36	0.6	0.6	25044	34.7	1.0	0.9	56	81	3.1	1	0.2	2.2	25	5.0	125
POW 13	7.4	761	359	23	0.1	0.2	262	1.0	1.2	1.9	32	1277	1.7	7	0.2	6.0	4	5.0	104
POW 14	7.3	769	336	18	0.2	0.0	38	0.7	0.3	0.7	20	3973	1.1	8	0.2	2.5	16	5.0	26
POW 15	7.1	1111	520	65	0.1	0.2	55	1.0	0.3	0.7	18	2094	0.3	17	0.2	2.0	1	5.0	39
POW 16	10.4	2364	1286	43	1.9	0.8	40112	50.9	0.4	1.5	46	238	4.6	1	0.2	2.5	21	5.0	94
POW 17	12.7	17985	7292	136	12.8	4.3	100661	19.4	0.7	4.4	14	27	3.9	1	0.2	3.0	139	5.0	73
POW 18	11.7	4157	2193	51	2.7	1.2	80511	83.3	0.8	0.9	25	75	1.3	1	0.2	1.2	28	5.0	85
POW 19	11.5	2660	1305	40	1.3	0.8	49879	37.6	0.5	2.4	29	88	1.0	1	0.2	6.0	22	5.0	87
POW 20	10.9	2174	1007	38	1.1	0.7	36008	24.6	0.3	0.8	27	207	1.0	1	0.2	4.0	23	5.0	82
POW 21	8.6	464	181	24	0.1	0.1	103	0.7	0.3	0.9	22	67	0.7	9	0.2	1.0	14	5.0	22

Alk. = Alkalinity
Cl = Chloride
Fl = Fluoride

Analytical Parameter																			
POW	**pH**	**Conductivity**	**Total Alkalinity**	**Chloride**	**Fluoride**	**Soda**	**Al**	**As**	**Cd**	**Cr**	**Cu**	**Fe**	**Pb**	**Mg**	**Hg**	**Ni**	**Sulphate**	**Ti**	**Zn**
Ref:		**µS/cm**	**mg/l $CaCO_3$**	**mg/l**	**mg/l**	**g/l**	**µg/l**	**µg/l**	**µg/l**	**µg/l**	**µg/l**	**µg/l**	**µg/l**	**mg/l**	**µg/l**	**µg/l**	**mg/l SO_4**	**µg/l**	**µg/l**
POW 22	9.4	728	268	21	0.6	0.3	22201	1.0	0.4	0.7	19	150	0.8	6	0.2	1.5	16	5.0	28
POW 23	8.3	488	159	31	0.3	0.1	217	3.0	0.3	1.0	20	57	0.4	6	0.2	1.0	28	5.0	27
POW 24	8.0	536	209	34	0.1	0.1	74	0.7	0.3	0.9	18	47	0.4	10	0.2	1.0	17	5.0	24
POW 25	7.7	330	86	38	0.1	0.0	84	0.7	0.3	0.8	21	96	0.4	1	0.2	1.0	9	27.5	26
POW 28	12.1	7299	3501	68	3.3	1.8	189640	74.8	0.3	1.4	27	500	0.7	4	0.2	4.5	44	5.0	110
POW 29	7.7	1347	319	73	0.1	0.2	30969	28.5	0.3	1.5	27	216	0.7	6	1.0	9.0	244	5.0	101
POW 30	7.6	976	236	58	0.1	0.1	192	1.0	1.1	1.5	22	589	0.8	11	1.1	1.2	169	5.0	109
POW 31	7.6	544	207	31	0.1	0.1	44	1.0	0.3	0.8	20	184	0.7	6	0.2	1.0	22	5.0	30
POW 32	8.3	570	222	36	0.1	0.1	422	2.0	0.4	0.8	21	157	0.7	4	0.2	1.5	21	5.0	24
POW 33	7.7	1091	359	121	0.2	0.2	25	0.7	0.4	0.8	19	805	0.4	10	0.2	1.5	33	5.0	19
SPW 1	8.9	4532	563	80	2.4	1.5	1267	30.7	0.3	1.4	19	59	0.2	7	0.2	1.7	1569	5.0	23
SPW 2	8.8	649	190	22	0.7	0.2	430	2.0	0.3	6.5	20	33	1.5	5	0.2	0.7	63	5.0	67
SPW 3	7.5	455	199	18	0.1	0.0	18	0.7	0.3	0.8	21	21	0.3	6	0.2	1.0	6	5.0	21
SPW 4	8.1	302	115	17	0.1	0.0	182	0.7	0.3	2.0	19	81	0.8	3	0.2	3.5	9	5.0	108
SPW 5	8.3	2030	273	38	0.3	0.6	109	1.5	0.4	1.5	21	27	0.7	12	0.3	0.7	654	5.0	29
SPW 6	8.7	515	144	18	0.5	0.0	2137	0.7	0.3	0.8	22	44	0.8	2	0.2	1.5	69	8.0	30
NPW 1	9.7	919	288	34	0.1	0.3	205	1.0	0.3	1.4	18	147	0.4	3	0.2	1.0	107	5.0	28
NPW 2	8.7	2173	278	126	0.3	0.5	2603	14.0	0.5	2.0	25	2091	1.1	3	0.2	4.0	564	5.0	79
NPW 3	7.7	398	136	24	0.1	0.0	100	0.7	0.3	1.0	18	175	0.7	5	0.2	1.5	13	5.0	24

Alk. = Alkalinity
Cl = Chloride
Fl = Fluoride

*POW 4, 26 and 27 have been decommissioned

8.2.3 BRDA Observation Wells (OW)

Table 33 contains a summary of BRDA Observation Well (OW) groundwater monitoring results for 2019 as per Schedule C.8 of the IE Licence. The current licence does not set out limit values for groundwater quality.

Monitoring results are reported to the Agency in the quarterly monitoring reports. The values reported here are the average of analytical results returned during the 2019 monitoring period.

In 1997, OW's 3, 4, 5 and 6 were capped as part of an extension of the original BRDA. OW's 7, 8, 16, 17, 18, 19 and 23 were decommissioned during 2010 as part of the Phase 2 BRDA extension.

Due to the tidal nature of the surrounding environment, a number of the wells are subject to saline intrusion and accordingly, the measured electrical conductivity, chloride and soda (Na_2O) values are subject to interference.

A review of the monitoring results for pH in 2019 indicate that pH is below 9 in all BRDA observation wells.

Table 33 BRDA OW Monitoring Results 2019

	Analytical Parameter																		
OW Ref.	pH	Conduct-ivity	Total Alkalinity	Chloride	Fluoride	Soda	Al	As	Cd	Cr	Cu	Fe	Pb	Mg	Hg	Ni	Sulphate	Ti	Zn
		µS/cm	mg/l $CaCO_3$	mg/l	mg/l	g/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	mg/l	µg/l	µg/l	mg/l SO_4	µg/l	µg/l
OW 1	7.6	2601	460	101	0.3	0.6	32	2.6	0.4	0.7	27	121	3.1	19	0.2	2.0	746	5.5	123
OW 2	8.0	2264	408	141	0.9	0.6	228	2.9	0.3	0.7	23	123	1.5	22	0.2	2.5	502	5.0	430
OW 9	6.9	14283	716	3216	0.2	3.4	40	8.6	0.3	0.7	24	2657	1.4	370	0.2	10.0	549	5.0	34
OW 10	7.2	29588	256	7286	0.3	6.4	65	1.0	0.4	0.7	24	576	0.9	817	0.2	14.5	838	5.0	11970
OW 11	7.0	29145	1572	6260	0.1	7.6	71	1.0	0.3	2.5	18	62	0.8	689	0.2	1.5	397	18.0	35
OW 12	7.4	29365	1496	6297	0.1	7.6	66	1.0	0.3	1.5	18	155	0.8	698	0.2	1.0	417	13.0	26
OW 13	7.5	551	213	22	0.1	0.0	13	0.7	0.3	0.7	22	66	0.7	7	0.2	1.0	6	5.0	18
OW 14	7.1	679	301	25	0.1	0.0	13	1.0	0.3	0.7	19	1018	0.7	7	0.2	2.0	4	5.0	19
OW 15	7.2	657	303	18	0.1	0.0	12	1.0	0.3	0.7	24	281	0.7	9	0.2	2.0	9	5.0	25
OW 20	7.5	3183	547	823	1.2	0.8	21	4.1	0.3	0.7	31	144	0.9	60	0.2	7.0	379	5.0	45
OW 21	7.0	24478	1635	4802	0.1	6.1	17	1.8	0.3	1.0	21	1982	0.8	663	0.2	1.5	11	19.5	23
OW 22	6.9	4613	597	928	0.3	0.9	14	2.0	0.3	0.7	26	167	0.8	73	0.2	7.5	245	5.0	40
OW 24	7.1	14165	752	2028	0.1	3.4	17	12.6	0.3	0.7	25	2209	0.7	300	0.2	17.0	703	5.5	38
OW 25	6.8	15285	758	2066	0.3	4.4	155	2.3	0.3	2.0	24	4778	0.8	309	0.2	2.5	971	8.0	48
OW 26	7.3	7933	637	1479	0.9	2.0	47	3.2	0.3	0.7	26	169	0.7	161	0.2	3.0	401	7.0	35
OW 27	7.1	9753	735	2151	0.7	2.5	19	8.6	0.3	0.7	21	1814	0.8	234	0.2	7.0	518	5.0	101
OW 28	7.0	17423	718	2574	0.3	4.6	54	6.1	0.3	0.8	21	3085	0.7	395	0.2	10.5	774	6.5	26
OW 29	7.3	17668	837	2584	0.2	4.9	23	11.7	0.3	0.8	25	3341	0.7	440	0.2	10.5	788	6.5	31
OW 30	6.9	2679	636	250	0.4	0.3	32	1.0	0.4	0.9	22	159	0.7	76	0.2	3.0	293	5.5	29
OW 31	6.9	10848	627	2538	0.1	2.5	44	3.4	0.3	1.4	21	1260	0.8	287	0.2	8.0	420	6.0	27

Analytical Parameter																			
OW Ref.	**pH**	**Conduct-ivity**	**Total Alkalinity**	**Chloride**	**Fluoride**	**Soda**	**Al**	**As**	**Cd**	**Cr**	**Cu**	**Fe**	**Pb**	**Mg**	**Hg**	**Ni**	**Sulphate**	**Ti**	**Zn**
		µS/cm	**mg/l $CaCO_3$**	**mg/l**	**mg/l**	**g/l**	**µg/l**	**µg/l**	**µg/l**	**µg/l**	**µg/l**	**µg/l**	**µg/l**	**mg/l**	**µg/l**	**µg/l**	**mg/l SO_4**	**µg/l**	**µg/l**
OW 32	6.6	19590	612	3421	0.1	4.7	45	9.2	0.4	5.0	17	41396	0.7	647	0.2	9.0	2087	20.0	294
OW 33	6.9	17873	644	2479	0.1	4.2	564	3.7	0.3	6.0	26	8399	3.2	551	0.2	5.5	2507	49.5	70
OW 34	7.6	948	282	49	0.1	0.1	46	1.0	0.3	1.4	15	704	1.6	31	0.2	1.2	48	5.0	30
OW 35	6.9	17693	564	4086	0.1	4.3	68	38.3	0.3	3.0	22	37713	1.8	344	0.2	7.5	292	12.0	856
OW 36	7.3	13480	538	2044	0.1	2.8	46	7.6	0.3	1.9	17	5180	0.6	306	0.2	6.5	460	6.5	81
OW 37	7.3	861	259	45	0.1	0.0	37	1.0	0.3	0.9	11	167	0.6	16	0.2	1.0	54	5.0	23
OW 38	7.4	593	245	23	0.1	0.0	28	0.7	0.3	0.9	15	27	0.6	7	0.2	1.0	12	5.0	25
OW 39	7.5	574	183	22	0.1	0.0	150	8.5	0.2	0.8	3	37	15.2	5	5.1	0.2	81	3.0	23
OW 40	7.4	671	264	34	0.2	0.0	20	0.7	0.3	1.4	15	16	0.7	19	0.2	1.0	32	5.0	28
OW 41	7.3	652	254	33	0.1	0.0	20	1.0	0.3	0.9	14	199	0.6	11	0.2	1.0	11	5.0	23
OW 42	7.1	856	320	42	0.0	0.0	49	0.7	0.3	1.4	17	35	0.7	9	0.2	1.0	19	5.0	25
OW 43	7.7	1945	232	422	0.0	0.3	33	1.0	0.3	0.9	14	45	0.7	34	0.2	1.7	66	5.0	21
OW 44	7.1	868	332	45	0.1	0.0	112	1.0	0.3	0.8	17	1804	3.2	19	0.2	1.7	27	5.0	40
OW 45	7.1	1025	318	55	0.1	0.1	309	1.5	0.4	1.0	22	579	5.5	19	0.2	2.5	111	20.5	91

8.3 Leak Detection Monitoring System

In accordance with the IE Licence conditions, AAL is required to undertake annual groundwater monitoring for hydrocarbons in four monitoring boreholes (BH1- BH4) located in the underground fuel storage area.

The fuel storage area comprise three steel underground storage tanks (UST's), two of which were used for diesel and one for petrol. The two diesel UST's were decommissioned in 2005. The petrol UST was decommissioned in Q4 2019.

The results of groundwater monitoring carried out in 2019 are tabulated in Table 34 below.

Table 34 Borehole Groundwater Monitoring Results 2019

Borehole Ref.	Date	DRO* (μg/l)	PAH* (μg/l)
BH 1	16/10/19	<1	<0.01
BH 2	16/10/19	<1	<0.01
BH 3	16/10/19	<1	<0.01
BH 4	16/10/19	<1	<0.01

**DRO – Diesel Range Organic hydrocarbons; PAH - Polycyclic Aromatic Hydrocarbons.*

8.4 Fugitive Emissions in the AAL Plant Area

AAL undertakes monitoring for fugitive dust emissions at thirty locations within the site perimeter.

The dust deposition gauges (labelled DG 1–28, 34 and 35) measure deposited particulate material, collected over a 30 - day period in accordance with VDI Guidelines 4320 Part 2. In total, there are 21 deposition gauges located around the BRDA. The remainder are in the plant area.

Dust deposition measures the daily quantity of dust settling over a specified area (m^2) and is expressed as milligrams per square metre per day ($mg/m^2/day$).

Average results for 2019 are summarised in Table 35. Results are presented as mean annual rates for each location, together with the range of monthly data recorded throughout the year.

Table 35 Dust Deposition Rates (mg/m²/day) in 2019

Deposition Gauge No.	Average Deposition Rate (mg/m2/day)	Range (Min - Max) (mg/m²/day)	TA Luft Guideline Limit mg/m²/day
D.G. 1	57	19 - 99	350
D.G. 2	39	10 - 77	350
D.G. 3	20	2 - 31	350
D.G. 4	24	10 - 83	350
D.G. 5	18	2 - 32	350
D.G. 6	25	12 - 65	350
D.G. 7	21	9 - 40	350
D.G. 8	22	4 - 75	350
D.G. 9	18	5 - 60	350
D.G. 10	20	7 - 79	350
D.G. 11	23	4 - 44	350
D.G. 12	22	7 - 86	350
D.G. 13	9	3 - 21	350
D.G. 14	13	3 - 48	350
D.G. 15	16	5 - 31	350
D.G. 16	36	1 - 169	350
D.G. 17	37	5 - 106	350
D.G. 18	39	3 - 75	350
D.G. 19	69	16 - 120	350
D.G. 20	41	2 - 123	350
D.G. 21	28	8 - 60	350
D.G. 22	21	5 - 64	350
D.G. 23	13	3 - 38	350
D.G. 24	16	1 - 41	350
D.G. 25	20	1 - 58	350
D.G. 26	16	4 - 35	350
D.G. 27	19	2 - 57	350
D.G. 28	17	2 - 47	350
D.G. 34	30	2 - 137	350
D.G. 35	20	4 - 77	350

8.5 Ambient Air Quality Monitoring

A programme of ambient air quality monitoring (both on-site and off-site) is carried out by AAL in accordance with Conditions 5.8 and 6.18 of the IE Licence.

The parameters monitored as part of the ambient air quality monitoring programme are:

- Sulphur Dioxide
- Deposited Dust
- Particulate Matter below 10 µm (PM_{10})
- Particulate Matter below 2.5 µm ($PM_{2.5}$)

Results from the off-site ambient air quality monitoring programme are reviewed against the Ambient Air Quality and Cleaner Air for Europe (CAFE) Directive 2008/50/EC as transposed into Irish legislation by the Air Quality Standard Regulations 2011 (SI 180/2011). On-site ambient air quality monitoring are also reviewed.

8.5.1 Ambient Air Sulphur Dioxide Monitoring

As agreed with the EPA in 2016 all but two of the diffusion tube monitoring locations (locations 1 and 9) were removed from the scope of the ambient SO_2 monitoring requirements. A summary of the ambient sulphur dioxide diffusion tubes results are tabulated in Table 36, along with a description of their locations.

All passive sulphur dioxide (SO_2) monitoring data was within AQS limits for 2019.

Table 36 Ambient Air SO_2 Diffusion Tubes Monthly Results (µg/m^3)

Monitoring Location	Annual Mean (µg/m^3)	Min Result (µg/m^3)	Max Result (µg/m^3)	National Air Quality Standard Lower Assessment Threshold
Residential property (1)	1.26	0.40	1.77	<50µg/m^3 (Not to be exceeded more than 3 times per year)
Foynes Reservoir (9A)	0.91	0.03	1.76	

* Locations shown on ***Attachment 5*** Ambient Air Monitoring Locations Map
**CAFE threshold shown is lower assessment threshold for SO_2 (40% of 24-hour limit value)

8.5.2 Ambient Air Particulate Deposition

Particulate deposition is normally monitored at two off-site locations as part of the ambient air quality monitoring programme. Since 2014, three additional locations have been monitored. Table 37 below shows a summary of the results for these monitoring locations during 2019.

All values were within the TA Luft guideline limit of 350mg/m^2/day.

Table 37 Ambient Air Mean Monthly Particulate Deposition Rates

Site No.	Dust Gauge Ref.	Average Deposition Rate (mg/m2/day)	Range (Min - Max) (mg/m²/day)	TA Luft Guideline Limit mg/m²/day
3*	29	14	1 - 46	350
7	30	22	2 - 52	350
11	31	15	1 - 35	350
12**	32	10	1 - 39	350
13	33	14	1 - 64	350

*Relocated in 2015 away from farmyard roadway to eliminate interference to adjacent field
**Relocated in 2015 out of residents garden to adjacent field (at request of resident)

8.5.3 Ambient Air $PM_{2.5}$ & PM_{10} Monitoring Ambient Air Particulate Deposition

Monitoring of particulate matter below 2.5µm ($PM_{2.5}$) and below 10µm (PM_{10}) is carried out at 5 locations (2 on-site and 3 off-site) by AAL. The monitoring is carried out using Osiris Continuous Air Sampling Monitors. Table 38 (external) and Table 39 (internal) below show a summary of the results obtained for the 2019 monitoring.

Table 38 External Ambient Air Daily $PM_{2.5}$ & PM_{10} Monitoring Results 2019

Monitoring Location	Foynes	Ballysteen	LCC WTP	CAFE Directive Limits
$PM_{2.5}$ Annual Mean µg/m³	4.9	4.4	7.1	25 µg/m³
PM_{10} Annual Mean µg/m³	6.0	5.7	10.1	40 µg/m³

Table 39 Internal Ambient Air Daily $PM_{2.5}$ & PM_{10} Monitoring Results 2019

Monitoring Location	SW of Plant	NE of Plant
$PM_{2.5}$ Annual Mean µg/m³	6.5	8.1
PM_{10} Annual Mean µg/m³	10.6	13.9

With reference to Schedule 3 of Air Quality Standard Regulations 2011 regarding location of sampling points, the AQS regulations do not apply to on-site ambient air monitoring.

In summary, the results of the off-site monitoring indicate the ambient air quality at off-site monitoring points is good (as defined by EPA ambient air monitoring programme) with all parameters monitored falling within the relevant targets/limits for those parameters.

8.6 Bund, Tank and Pipeline Integrity Testing

Condition 6 of the IE Licence (Control and Monitoring) states the requirements for the protection of groundwater from spills, leaks and improper storage. Specifically, Conditions 6.10 and 6.11 deal with the inspection and testing of bunding structures, tanks, underground pipelines and open drains carrying caustic effluent.

8.6.1 Bunds and Tanks

The site has a number of integrity testing and repair programmes.

The integrity testing of all bunding structures and tanks is carried out on an on-going three-year cycle. In total, there are 396 separate items requiring integrity testing at AAL and in 2019 the integrity of 220 bunds, sumps, tanks, underground pipelines and drains was confirmed.

Over the past number of years, substantial sections of the drainage network have been upgraded with a steel or stainless steel liner to minimise the risk of groundwater contamination.

8.6.2 Underground Pipelines

Structural integrity of all underground sanitary pipelines were inspected in 2019. A total of 64 separate sections of sewer lines were inspected and passed in 2019.

8.6.3 Process Drains

AAL carried out a detailed risk assessment of open process drains during 2014. The assessment identified a total of 34 sections of open drain that require integrity testing which was approved by the Agency. Tests are being completed on a 3-yearly schedule.

In 2019, 12 process drains were tested and passed.

8.7 Decommissioning and Residuals Management Plan (DRMP)

Condition 10 of the IE Licence requires that AAL maintains a detailed and fully costed Decommissioning and Residuals Management Plan (DRMP), also referred to as a Closure Restoration and Aftercare Plan (CRAMP) which is adequate to assure the Agency that AAL is at all times capable of financing the environmental decommissioning and restoration of the AAL site after closure. The plan must be reviewed annually.

8.7.1 Update of DRMP/CRAMP

A revision of the CRAMP was conducted by independent consultants PM Group and submitted to the EPA in 2018. A total estimated cost of €24,635,776 was formally approved by the Agency in 2018. No changes were required to the CRAMP in 2019.

8.7.2 Financial Provision

In 2018, AAL agreed an updated Financial Provision with the Agency.

8.8 Environmental Liabilities Risk Assessment (ELRA) Review

8.8.1 Update of ELRA

A revised ELRA was conducted by independent consultants PM Group and submitted to the EPA in 2018. The cost, calculated in accordance with the EPA Guidance, for unknown liabilities associated with the operational and closure phases of the AAL facility was calculated at €1,226,078. This is associated with the potential for a spill or leak from a mobile tanker delivering diesel to the plant.

The ELRA was approved by the Agency in 2018. The Financial Provision for the ELRA was put in place in 2019.

No changes to the Financial Provision were required in 2019.

8.8.2 Statement of Measures in Relation to Prevention of Environmental Damage

The measures currently undertaken by AAL in relation to the prevention of environmental damage and possible remedial actions were detailed in the revised CRAMP and ELRA submitted to the EPA.

8.9 Public Information Programme

In accordance with IE Licence Condition 2.2.2.7, AAL maintains a public awareness and information programme. Copies of quarterly monitoring reports and annual environmental reports are retained at the main Reception/Security building at AAL. This documentation can be reviewed by any member of the public at all reasonable times.

AAL held a public meeting with its neighbours on the 05th December 2019. The agenda included:

- Overview of Aughinish and the business
- Key projects around the site
- Environmental performance and regulatory visits
- BRDA operation and associated landscaping updates
- A pictorial seasonal review of community events and flora and fauna in Aughinish in 2019

8.10 Annual BRDA (Landfill) Status Report

The Bauxite Residue Disposal Area (BRDA) has been classified as a Category A facility under the Extractive Waste Directive. The basis for this classification is the environmental sensitivity of the Special Area of Conservation lands and estuarine habitats adjacent to the BRDA. Operational information required under Schedule D of the IE Licence in respect of the BRDA is tabulated in Table 40 below. All areas are currently operational within the BRDA.

Table 40 BRDA Operational Status

Parameter	Details
BRDA name & Licence number	Aughinish Alumina Ltd. (BRDA) IE Licence Reg. P0035-06
BRDA location	Aughinish Island (National Grid Ref. 127300E, 152200N)
Reporting period	Jan 01 – Dec 31 2019
Owner and/or operator	Aughinish Alumina Ltd.
Area occupied by waste	168.5 hectares (94.5 ha Phase 1 BRDA, 74 ha Phase 2 BRDA)
Tonnage and composition of waste deposited in the preceding year	1,546,213 tonnes (See Table 41)
Methods of depositing	Pumping/Trucking
Time and duration of depositing	24 hours per day, 365 days per year
Total accumulated quantities of waste deposited	34,501,766 tonnes (Table 42)
Calculated remaining capacity	18,606,293 tonnes (Table 43)
Calculated final capacity of site	53,108,059 tonnes
Year in which final capacity of site is expected to be reached	2031
Stability checks undertaken	See Section 8.10.3
Results of monitoring programme	See Section 8.10.3
Summary of any monitoring non-compliances and corrective actions taken	No non-compliances in 2019
Summary of any development/remedial works carried out in the preceding year	See Section 8.10.8
Revisions to BRDA Operational Plan	Minor operational changes
Progress on restoration of cells	In 2019 the program of amending and vegetating the wide stage 5 - 6 plateau of the North East sides of BRDA Phase 1 continued

8.10.1 BRDA Waste Composition and Tonnage Data

Information on current and projected waste disposal rates, together with a breakdown of waste types is tabulated below.

Table 41 BRDA Waste Composition & Tonnage 2019

Waste Stream	LoW Code	Jan – Dec 2019 Total (t)	As % of total waste landfilled
Red Mud (dry)	01 03 09	1,400,137	90.55%
Sand	01 03 99	106,471	6.89%
Salt Cake (wet)	01 03 07	16,224	1.05%
Process Waste (wet)	01 03 99	16,399	1.06%
Lime Grits (wet)	01 03 99	6,902	0.45%
Fluestack Residues (dry) 2017 data	16 11 04	80	0.01%
Total Waste		**1,546,213**	**100.00%**

Table 42 Accumulated Quantities of Waste to BRDA

Waste Stream	LoW Code	1983 – Dec 2019 (t)	As % of total waste landfilled
Red Mud (dry)	01 03 09	30,763,723	89.17%
Salt Cake (wet)	01 03 07	481,667	1.40%
Process Waste (wet) (includes sand)	01 03 99	3,082,570	8.93%
Lime Grits (wet)	01 03 99	164,165	0.48%
Fluestack Residues (dry)	16 11 04	5,261	0.02%
Effluent Sludge A34 Clarifier (dry)*	06 05 03	4,380	0.01%
Total Waste		**34,501,766**	**100%**

(Note1: The data for all residues for 1983 - 1997 other than red mud are estimated based on pro-rata tonnages for the period 1997 to 2000)

* Material no longer generated.

Engineering estimates of the total occupied and remaining capacity of the BRDA have been updated to reflect recorded quantities of waste deposited at the facility during 2019 and take into account the residue deposited in both the Phase 1 BRDA and the Phase 2 BRDA commissioned since 2011 and are tabulated below.

Table 43 Estimated Capacity of BRDA

Period	MOM Note 1	Waste during period (t)	Accumulated waste (t)	Remaining capacity of BRDA (t)
1983 - 2014	R	26,868,179	26,868,179	27,475,746
2015	R	1,507,468	28,375,647	25,968,278
2016	R	1,514,519	29,890,166	24,269,311
2017	R	1,571,677	31,461,843	22,697,634
2018	R	1,493,710	32,955,553	21,203,924
2019	R	1,546,213	34,501,766	18,606,293 Note 2
2020	E	1,546,213	36,047,979	17,060,080

[1] MOM – Method of Measurement; R = Recorded (Measured); E = Engineering Estimate
[2] The remaining capacity based on topographical survey by drone in May 2019

8.10.2 BRDA Containment Capacity

Containment capacity within the BRDA is developed by rockfill embankments constructed upstream on the hardened residue inside the BRDA perimeter. These embankments are constructed in stages, each stage increasing the elevation of the BRDA by 2 metres.

For Phase 1 BRDA, 75% of the perimeter is currently at Stage 10 and 25% is currently at Stage 9.

For Phase 2 BRDA, 93% of the perimeter is at Stage 3 and 7% of the perimeter at Stage 4.

The current IE Licence and planning permission permits the entire existing Phase 1 and Phase 2 BRDA perimeters to be raised to Stage 10, equivalent to a lifetime of to 2031 at planned production rates.

8.10.3 BRDA Monitoring Programme

The 2019 Report on the BRDA stability monitoring programme is reported in the Golder Associates 2019 Annual (Stability) Review, in compliance with Schedule C.7. Monitoring of the BRDA geotechnical instrumentation continued in 2019.

Monitoring of environmental conditions at the BRDA is undertaken on a routine basis through the collection of samples of groundwater from observation wells (OW's) and surface waters for analysis. Monitoring results for the 2019 reporting period are detailed in Section 2.2.7 (Surface Waters) and 8.2.3 (Groundwater) of this AER.

There are 30 dust deposition gauges at various locations around the site with a number of gauges at the perimeter of the BRDA to determine the rates of dusting from the BRDA. Monitoring results for the 2019 reporting period have been detailed in Section 8.4 (Fugitive Emissions in the AAL Plant Area).

8.10.4 Implementation of Golder Breakout Study Recommendations

In accordance with Condition 8.4.16, further progress for 2019 is listed as follows:

1. To control pore pressure dissipation in the bauxite residue while perimeter stage raises are being constructed;
    - The stage raise is constructed in 2 x 1 m depth lifts a minimum of 3 weeks apart,
    - No bauxite residue is placed behind the new stage raise for a minimum period of 3 weeks following the construction of the upper 1m depth lift.
    - The excavation of the collector drain at the downstream toe of the newly constructed stage raise is not undertaken until placement of bauxite residue commences and not before a minimum of 3 weeks following construction of the upper 1m depth lift.

2. Ensure that the undrained shear strength of the red mud forming the foundations for the upstream raise of the BRDA is monitored in accordance with the design criteria adopted;
    - Continuous Penetration Testing (CPT) of bauxite residue around the perimeters of Phase 1 and Phase 2 was undertaken in August 2019 and up to date mud shear strength calculated .

3. Avoid water collecting in the Perimeter Interceptor Channel (PIC) by ensuring sufficient gradient in the channel to allow water to migrate to lower sectors of the Perimeter Interceptor Channel;
    - The base of that PIC was profiled with drainage stone in 2019 to ensure gradient for flow of water.

4. Install and monitor the piezometers, inclinometers and settlement systems in accordance with the Risk Assessment recommendations;
    - A Physical Stability Monitoring Plan for the AAL BRDA was updated by Golder Associates during 2019 following an assessment of the 2018 Best Available Techniques (BAT) Reference Document for the Management of Waste from the Extractive Industries (BREF), in accordance with Directive 2006/21. This Plan consists of scheduled installations and monitoring of geotechnical instruments installed within the facility along with a series of scheduled audits, inspections and conformance checks to assess the performance of the BRDA
    - A repair/replacement programme of standpipe piezometers was undertaken during April 2019 which led to the replacement of 5 No. piezometers: 1APL (9.3m), BGT2A (12.3m), BGT2B (7.3m), BGT2C (15.3m) and BGT15A (8.3m)

8.10.5 Report on Annual BRDA Review

Golder Associates were commissioned by AAL to prepare an annual BRDA review report as required under Schedule C.7 of the IE Licence. This report included a review and assessment of results of monitoring data undertaken by Golder Associates between January and December 2019 and observations made during a site inspection visit in February 2020. A Golder Summary Technical Memorandum of the Annual Inspection is available in ***Attachment 8***.

The stability assessment summarises the monitoring results from the piezometers, the inclinometers / extensometers and visual inspection of the facilities as well as strength of residue and underlying soils and assesses the stability of the BRDA, the inner and outer perimeter walls forming the perimeter interceptor channel, the storm water and liquid waste ponds.

AAL have raised the stack wall for Phase 1 to Stage 9 and Stage 10 in various sectors around the perimeter. For Phase 2, stack walls have been raised to Stage 3 in most sectors and to Stage 4 just locally near the south east side.

The available data from the inclinometers, extensometers, piezometers and geodetic points, together with the 2018 and 2019 CPT data and stability analysis, indicates that the facility is performing in accordance with the design. Visual inspection of the facilities indicates no signs of distress in the walls.

Recommendations from the 2019 Annual BRDA Review are the installation of additional piezometers on Stage 4, 5 and 6 of Phase 1 and at Stage 3 of Phase 2.

8.10.6 Biennial Audit at the BRDA

Golder Associates undertake both the Annual Review and the Biennial Independent Audit in accordance with the scope agreed by the Agency.

8.10.7 Revisions to BRDA Operational Plan

The Operational, Safety and Maintenance (OSM) manual was reviewed in September 2019 to ensure that all relevant information is up to date. The OSM is in compliance with Canadian Dam Association (CDA) guidelines.

8.10.8 BRDA Development/Remedial Works 2019

The notable developments/works in the BRDA during 2019 were:

- The continued raising and profiling of the drainage stone wall elevation along the east side of the Phase 2 BRDA to facilitate drainage.
- The construction of Stage 3 Perimeter Raise on west side of Phase 2 BRDA and the construction of Stage 10 Perimeter Raise along the south west perimeters of the Phase 1 BRDA.
- Continuous penetration testing (CPT) and sampling of the Phase 1 BRDA and Phase 2 BRDA upper perimeter.

There were no remedial works required in the BRDA during 2019.

8.10.9 Progress on Closure Planning and Re-vegetation of BRDA

IE Licence Condition 8.4.17 requires that AAL implements the recommendations in the relevant sub-sections of the Residues Solutions Report submitted to the Agency in July 2007. The subsections to be addressed are:

- Closure Planning
- Closure Re-vegetation
- Post-Closure Management

- Alternative Uses of Residue

Successful employment of the mud farming practice on the BRDA promotes carbonation of the red mud within the BRDA resulting in partial neutralisation to a stable pH of < 11.5.

Rusal Aughinish commenced developing a new 1,625m² closure demonstration cell which is on schedule for completion during 2020. The cell will demonstrate the capping method of the bauxite residue disposal area on carbonated residue as per licence conditions 8.4.21 & 8.4.22. The exposed capping layer upon closure of the BRDA will consist of a seeded amended layer. The demonstration amended layer trials will experiment with various dosages of the proven composite ingredients of neutralised process residue, sand, gypsum and organic material. The trial will also experiment with the composition and depth of the capillary layer including whether its inclusion or exclusion measurably changes upward capillary movement.

The existing established closure demonstration trial cell is self-sustaining.

Attachment 6 contains details of the work conducted by Enrich in 2019 of the restoration works occurring at Stage 5 and 6 of the BRDA.

Since 2014, AAL has been involved in National and European projects to identify and assess potential valorisation options for bauxite residue.

<u>National Level</u>

AAL was involved in project Al-Source, which was funded by the Irish Environment Protection Agency (EPA). The main objective was to demonstrate the value content in Irish bauxite residue via both re-use and recovery techniques. The project ended in 2019. This project highlighted the complexity of recovery techniques that generate no additional waste streams.

<u>European Level</u>

AAL is currently participating in two European projects to develop technology to re-use bauxite residue.

1. AAL is a partner of EIT RawMaterials, which is funded by the EIT (European Institute of Innovation and Technology), a body of the European Union. EIT RawMaterials is a large consortium in the raw materials sector worldwide. Its vision is to develop raw materials into a major strength for Europe. AAL is participating in the RECOVER project initiated in 2016 to develop a new technology to re-use bauxite residue and produce engineered products such as inorganic polymers. A pilot plant is being constructed and a pilot test to demonstrate the technology is planned for 2020 on AAL site. This technology is very energy and operation intensive as well as utilising coke which would produce additional carbon emission.

2. In 2018, AAL started participating in a project funded by Horizon 2020. The RemovAl project will combine, optimize and scale-up developed processing technologies for extracting value from such industrial residues. Aughinish is leading a project work package to develop technology and build a pilot plant to provide treatment of bauxite residue to enable wider opportunities of re-use.

8.10.10 BRDA Constructed Wetland Project

Bauxite residue from the Bayer process contains residual caustic soda with alkaline runoff of pH > 10.5. The DRMP/CRAMP for the BRDA must address the timeframes required for runoff from the BRDA to reduce to ≤ pH 9.0 so it can be discharged to the receiving environment. A novel approach to ensure that BRDA runoff can be passively treated and made suitable for discharge within a short period (months) of BRDA closure is to incorporate constructed wetland(s) into the CRAMP. Constructed wetlands are gaining global acceptance by regulators in mine closure.

In 2012, Aughinish Alumina received funding from its owner Rusal and the International Aluminium Association for a four year study programme investigating the use of a constructed wetland to treat residue runoff. Part one of this study was a two-year (2012-2014) laboratory based investigation of the potential mechanisms that buffer residue pH in wetlands. Parameters included volume and quality of diluting waters, effects of carbonation and soil quality in decreasing pH. Part two of the study is a three year field operation of a constructed wetland within the Aughinish BRDA. An automatic leachate dilution and dosing system feeds the wetland inlet at the target pH and flow-rate. Water inflow and outflow are monitored on a continual basis with soil and herbage analysed seasonally.

In 2013 AAL constructed and commenced operation of a 40 m2 trial constructed wetlands effluent treatment area in collaboration with the University of Limerick and the International Aluminium Institute. The 40 m2 plastic lined reed bed is located within the Aughinish BRDA and contains three types of reeds typically found in wetlands ((Phragmites australis, Typha latifolia and Sparganium erectum). An automatic leachate dilution and dosing system feeds the wetland inlet at the target pH and flow-rate. Within the wetland, microbial activity generates CO2, which carbonates the water and thereby reduces the pH. A discharge pH of < 8.0 has been achieved with efficiency highest in the warmer spring and summer months. This research demonstrates that a constructed wetland would be capable to render BRDA runoff suitable for discharge to the environment. The project continued to be a key research topic in 2019. ***Attachment 7*** contains an overview outlining progress made to date throughout 2019.

8.10.11 BRDA Events 2019

There were zero incidents related to the BRDA which required notification to the Agency during 2019.

8.10.12 Implementation of Extractive Waste Management Plan

AAL is required under Condition 8.3.1 of the IE Licence to maintain an Extractive Waste Management Plan for the minimisation, treatment, recovery and disposal of extractive waste in accordance with Regulation 5 of the Waste Management (Management of Waste from Extractive Industries) Regulations, 2009. An updated Extractive Waste Management Plan was approved by the Agency following submission in 2018.

Extractive waste is treated and disposed to the on-site Bauxite Residue Disposal Area (BRDA) according to the Extractive Waste Management Plan. Waste materials suitable for internal road building within the BRDA are recovered for that purpose. Any other wastes for disposal within the BRDA (such as process contaminated pipes) are disposed following Agency approval on a case by case basis. These arrangements are detailed in the Extractive Waste Management Plan.

8.10.13 Emergency Planning for the BRDA

AAL's internal emergency response plan was updated in January 2019 in accordance with condition 9.4.4.

On 6th March 2019, in accordance with Condition 9.4.5 a successful desk top exercise to review the External Emergency Response Plan took place on-site and was attended by the Principal Response Agencies (LCCC, the HSE, Fire Service, An Garda Siochana) and the EPA as well as all the relevant personnel from AAL. An updated External Emergency Response Plan was subsequently published by LCCC in August 2019.

8.11 Progress on Bauxite Residue Neutralisation

During 2019, the process of industrial residue mud farming continued to be implemented in the BRDA.

As per the requirements of IE Licence Condition 8.4.20, AAL has documented the test method to be utilised to confirm neutralisation of the bauxite residue by mud farming.

The mud is sampled per cell and analysed for pH until target pH of <11.5 is achieved. Three samples per cell are taken and labelled with cell number, date and location. Samples may be taken following amphirolling and if required after harrowing. Once pH < 11.5 is achieved then no further sampling is required.

The quarterly composite analysis on "farmed red mud" as per condition 8.4.20 is listed in the 4 quarterly waste reports located in ***Attachment 2*** Waste Analysis 2019.

Attachment 1
Process Effluent VOC & Toxicity Reports

Fitz scientific
Monitoring and Testing Services

Unit 35,
Boyne Business Park,
Drogheda,
Co. Louth
Ireland
Tel: +353 41 9845440
Fax: +353 41 9846171
Web: www.fitzsci.ie
email info@fitzsci.ie

A copy of this certificate is available on www.fitzsci.ie

Customer	Sean O' Sullivan Aughinish Alumina Ltd Auginish Island Askeaton Co Limerick Ireland	*Lab Report Ref. No.*	3120/643/02
		Date of Receipt	29/01/2019
		Sampled On	29/01/2019
		Date Testing Commenced	29/01/2019
		Received or Collected	Courier
		Condition on Receipt	Acceptable
Customer PO	4631883	*Date of Report*	01/02/2019
Customer Ref	W1-1 29/01/2019	*Sample Type*	Effluent
Ref 2			
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
1,1,1,2-Tetrachloroethane (Industrial	154	GCMS	<1	ug/L	UKAS
1,1,1-Trichloroethane (Industrial Eff.)	154	GCMS	<1	ug/L	UKAS
1,1,2,2-Tetrachloroethane (Industrial	154	GCMS	<5.0	ug/L	
1,1,2-Trichloroethane (Industrial Eff.)	154	GCMS	<2	ug/L	UKAS
1,1-Dichloroethane (Industrial Eff.)	154	GCMS	<1	ug/L	UKAS
1,1-Dichloroethene (Industrial Eff.)	154	GCMS	<1	ug/L	UKAS
1,1-Dichloropropene (Industrial Eff.)	154	GCMS	<1	ug/L	UKAS
1,2,3-Trichlorobenzene (Industrial Eff	154	GCMS	<1	ug/L	UKAS
1,2,3-Trichloropropane (Industrial Eff.	154	GCMS	<2	ug/L	UKAS
1,2,4-Trichlorobenzene (Industrial Eff	154	GCMS	<1	ug/L	UKAS
1,2,4-Trimethylbenzene (Industrial Ef	154	GCMS	<1	ug/L	UKAS
1,2-Dibromo-3-chloropropane (Indust	154	GCMS	<5.0	ug/L	
1,2-Dibromoethane (Industrial Eff.)	154	GCMS	<2	ug/L	UKAS
1,2-Dichlorobenzene (Industrial Eff.)	154	GCMS	<1	ug/L	UKAS
1,2-Dichloroethane (Industrial Eff.)	154	GCMS	<1	ug/L	UKAS
1,2-Dichloropropane (Industrial Eff.)	154	GCMS	<1	ug/L	UKAS
1,3,5-Trimethylbenzene (Industrial Ef	154	GCMS	<1	ug/L	UKAS
1,3-Dichlorobenzene (Industrial Eff.)	154	GCMS	<1	ug/L	UKAS
1,3-Dichloropropane (Industrial Eff.)	154	GCMS	<1	ug/L	UKAS
1,4-Dichlorobenzene (Industrial Eff.)	154	GCMS	<2	ug/L	UKAS
2,2-Dichloropropane (Industrial Eff)	154	GCMS	<5.0	ug/L	
2-Chlorotoluene (Industrial Eff.)	154	GCMS	<1	ug/L	UKAS
4-Chlorotoluene (Industrial Eff.)	154	GCMS	<1	ug/L	UKAS
Benzene (Industrial Eff.)	154	GCMS	<1	ug/L	UKAS

Signed : A Harmon

Date : 01/02/2019

Aoife Harmon - Technical Supervisor

UKAS TESTING 2802

Acc. : Accredited Parameters by ISO 17025:2005
PVL - Parametric Value Limit as per EU (Drinking water) Regulations (SI 122 2014)
For bacterial analysis a result of 0 means none detected in volume examined
All organic results are analysed as received and all results are corrected for dry weight at 104 C
Results shall not be reproduced, except in full, without the approval of Fitz Scientific
Results contained in this report relate only to the samples tested (P) : Presumptive Results

** : The test result for this parameter may be invalid as it has exceeded the recommended holding time (BS EN ISO 5667-3:2012)

Monitoring and Testing Services

Unit 35,
Boyne Business Park,
Drogheda,
Co. Louth
Ireland

Tel: +353 41 9845440
Fax: +353 41 9846171
Web: www.fitzsci.ie
email info@fitzsci.ie

A copy of this certificate is available on www.fitzsci.ie

Customer	Sean O' Sullivan	*Lab Report Ref. No.*	3120/643/02
	Aughinish Alumina Ltd	*Date of Receipt*	29/01/2019
	Auginish Island	*Sampled On*	29/01/2019
	Askeaton	*Date Testing Commenced*	29/01/2019
	Co Limerick	*Received or Collected*	Courier
	Ireland	*Condition on Receipt*	Acceptable
Customer PO	4631883	*Date of Report*	01/02/2019
Customer Ref	W1-1 29/01/2019	*Sample Type*	Effluent
Ref 2			
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
Bromobenzene (Industrial Eff.)	154	GCMS	<1	ug/L	UKAS
Bromochloromethane (Industrial Eff.)	154	GCMS	<1	ug/L	UKAS
Bromodichloromethane (Industrial Eff	154	GCMS	<1	ug/L	UKAS
Bromoform (Industrial Eff.)	154	GCMS	<1	ug/L	UKAS
Bromomethane (Industrial Eff.)	154	GCMS	<5.0	ug/L	
Carbon tetrachloride (Industrial Eff.)	154	GCMS	<1	ug/L	UKAS
Chlorobenzene (Industrial Eff.)	154	GCMS	<1	ug/L	UKAS
Chloroethane (Industrial Eff.)	154	GCMS	<5.0	ug/L	
Chloroform (Industrial Eff.)	154	GCMS	<1	ug/L	UKAS
Chloromethane (Industrial Eff.)	154	GCMS	<5.0	ug/L	
cis-1,2-Dichloroethene (Industrial Eff.	154	GCMS	<1	ug/L	UKAS
cis-1,3-Dichloropropene (Industrial Ef	154	GCMS	<1	ug/L	UKAS
Dibromochloromethane (Industrial Eff	154	GCMS	<1	ug/L	UKAS
Dibromomethane (Industrial Eff.)	154	GCMS	<1	ug/L	UKAS
Dichlorodifluoromethane (Industrial E	154	GCMS	<5.0	ug/L	
Dichloromethane (Industrial Eff.)	154	GCMS	<5.0	ug/L	
Ethylbenzene (Industrial Eff.)	154	GCMS	<1	ug/L	UKAS
Hexachlorobutadiene (Industrial Eff.)	154	GCMS	<1	ug/L	UKAS
Isopropylbenzene (Industrial Eff.)	154	GCMS	<1	ug/L	UKAS
m- & p-Xylene (Industrial Eff.)	154	GCMS	<1	ug/L	UKAS
Naphthalene (Industrial Eff.)	154	GCMS	<1	ug/L	UKAS
n-Butylbenzene (Industrial Eff.)	154	GCMS	<1	ug/L	UKAS
n-Propylbenzene (Industrial Eff.)	154	GCMS	<1	ug/L	UKAS
o-Xylene (Industrial Eff.)	154	GCMS	<1	ug/L	UKAS

Signed : A Harman

Date : 01/02/2019

Aoife Harmon - Technical Supervisor

Acc. : Accredited Parameters by ISO 17025:2005
PVL - Parametric Value Limit as per EU (Drinking water) Regulations (SI 122 2014)
For bacterial analysis a result of 0 means none detected in volume examined
All organic results are analysed as received and all results are corrected for dry weight at 104 C
Results shall not be reproduced, except in full, without the approval of Fitz Scientific
Results contained in this report relate only to the samples tested (P) : Presumptive Results

UKAS TESTING 2802

** : The test result for this parameter may be invalid as it has exceeded the recommended holding time (BS EN ISO 5667-3:2012)

Fitz scientific
Monitoring and Testing Services

Unit 35,
Boyne Business Park,
Drogheda,
Co. Louth
Ireland
Tel: +353 41 9845440
Fax: +353 41 9846171
Web: www.fitzsci.ie
email info@fitzsci.ie

A copy of this certificate is available on www.fitzsci.ie

Customer	**Sean O' Sullivan** **Aughinish Alumina Ltd** **Auginish Island** **Askeaton** **Co Limerick** **Ireland**	***Lab Report Ref. No.***	**3120/643/02**
		Date of Receipt	**29/01/2019**
		Sampled On	**29/01/2019**
		Date Testing Commenced	**29/01/2019**
		Received or Collected	**Courier**
		Condition on Receipt	**Acceptable**
Customer PO	**4631883**	***Date of Report***	**01/02/2019**
Customer Ref	**W1-1 29/01/2019**	***Sample Type***	**Effluent**
Ref 2			
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
p-Isopropyltoluene (Industrial Eff.)	154	GCMS	<1	ug/L	UKAS
sec-Butylbenzene (Industrial Eff.)	154	GCMS	<1	ug/L	UKAS
Styrene (Industrial Eff)	154	GCMS	<1	ug/L	UKAS
tert-Butylbenzene (Industrial Eff)	154	GCMS	<1	ug/L	UKAS
Tetrachloroethene (Industrial Eff)	154	GCMS	<1	ug/L	UKAS
Toluene (Industrial Eff)	154	GCMS	<1	ug/L	UKAS
trans-1,2-Dichloroethene (Industrial E	154	GCMS	<1	ug/L	UKAS
trans-1,3-Dichloropropene (Industrial	154	GCMS	<2	ug/L	UKAS
Trichloroethene (Industrial Eff)	154	GCMS	<5.0	ug/L	
Trichlorofluoromethane (Industrial Eff	154	GCMS	<5.0	ug/L	
Vinyl chloride (Industrial Eff.)	154	GCMS	<5.0	ug/L	
Volatile Organic Compounds	154	GCMS	<5.0	ug/L	
Xylene Total (Industrial Eff)	154	GCMS	<1	ug/L	UKAS

Signed : A Harmon

Aoife Harmon - Technical Supervisor

Date : 01/02/2019

UKAS TESTING 2802

Acc. : Accredited Parameters by ISO 17025:2005
PVL - Parametric Value Limit as per EU (Drinking water) Regulations (SI 122 2014)
For bacterial analysis a result of 0 means none detected in volume examined
All organic results are analysed as received and all results are corrected for dry weight at 104 C
Results shall not be reproduced, except in full, without the approval of Fitz Scientific
Results contained in this report relate only to the samples tested (P) : Presumptive Results

** : The test result for this parameter may be invalid as it has exceeded the recommended holding time (BS EN ISO 5667-3:2012)

Fitz scientific
Monitoring and Testing Services

Unit 35,
Boyne Business Park,
Drogheda,
Co. Louth
Ireland
Tel: +353 41 9845440
Fax: +353 41 9846171
Web: www.fitzsci.ie
email info@fitzsci.ie

A copy of this certificate is available on www.fitzsci.ie

Customer	**Sean O' Sullivan**	***Lab Report Ref. No.***	**3120/643/01**
	Aughinish Alumina Ltd	***Date of Receipt***	**29/01/2019**
	Auginish Island	***Sampled On***	**29/01/2019**
	Askeaton	***Date Testing Commenced***	**29/01/2019**
	Co Limerick	***Received or Collected***	**Courier**
	Ireland	***Condition on Receipt***	**Acceptable**
Customer PO	**4631883**	***Date of Report***	**05/02/2019**
Customer Ref	**W1-1 29/01/2019**	***Sample Type***	**Effluent**
Ref 2			
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
Acetone	328	GCMS	0.75	mg/L	
Acetonitrile	328	GCMS	<0.33	mg/L	
Ethanol	328	GCMS	<0.35	mg/L	
Isopropyl Alcohol	328	GCMS	<0.34	mg/L	
MEK	328	GC-FID	<0.22	mg/L	
Methanol	328	GC-FID	<0.45	mg/L	

Signed : A Harmon ***Date : 05/02/2019***

Aoife Harmon - Technical Supervisor

Acc. : Accredited Parameters by ISO 17025:2005
PVL - Parametric Value Limit as per EU (Drinking water) Regulations (SI 122 2014)
For bacterial analysis a result of 0 means none detected in volume examined
All organic results are analysed as received and all results are corrected for dry weight at 104 C
Results shall not be reproduced, except in full, without the approval of Fitz Scientific
Results contained in this report relate only to the samples tested (P) : Presumptive Results
** : The test result for this parameter may be invalid as it has exceeded the recommended holding time (BS EN ISO 5667-3:2012)

Fitz scientific

Monitoring and Testing Services

Unit 35,
Boyne Business Park,
Drogheda,
Co. Louth
Ireland

Tel: +353 41 9845440
Fax: +353 41 9846171
Web: www.fitzsci.ie
email info@fitzsci.ie

A copy of this certificate is available on www.fitzsci.ie

Customer	**Sean O' Sullivan**	***Lab Report Ref. No.***	**3120/697/17**
	Aughinish Alumina Ltd	***Date of Receipt***	**31/07/2019**
	Auginish Island	***Sampled On***	**30/07/2019**
	Askeaton	***Date Testing Commenced***	**31/07/2019**
	Co Limerick	***Received or Collected***	**Courier**
	Ireland	***Condition on Receipt***	**Acceptable**
Customer PO	**P4631883**	***Date of Report***	**14/08/2019**
Customer Ref	**W1-1 30/07/2019**	***Sample Type***	**Effluent**
Ref 2			
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
1,1,1,2-Tetrachloroethane (Industrial	154	GCMS	<1	ug/L	UKAS
1,1,1-Trichloroethane (Industrial Eff.)	154	GCMS	<1	ug/L	UKAS
1,1,2,2-Tetrachloroethane (Industrial	154	GCMS	<5.0	ug/L	
1,1,2-Trichloroethane (Industrial Eff.)	154	GCMS	<2	ug/L	UKAS
1,1-Dichloroethane (Industrial Eff.)	154	GCMS	<1	ug/L	UKAS
1,1-Dichloroethene (Industrial Eff.)	154	GCMS	<1	ug/L	UKAS
1,1-Dichloropropene (Industrial Eff.)	154	GCMS	<1	ug/L	UKAS
1,2,3-Trichlorobenzene (Industrial Eff	154	GCMS	<1	ug/L	UKAS
1,2,3-Trichloropropane (Industrial Eff.	154	GCMS	<2	ug/L	UKAS
1,2,4-Trichlorobenzene (Industrial Eff	154	GCMS	<1	ug/L	UKAS
1,2,4-Trimethylbenzene (Industrial Ef	154	GCMS	<1	ug/L	UKAS
1,2-Dibromo-3-chloropropane (Indust	154	GCMS	<5.0	ug/L	
1,2-Dibromoethane (Industrial Eff.)	154	GCMS	<2	ug/L	UKAS
1,2-Dichlorobenzene (Industrial Eff.)	154	GCMS	<1	ug/L	UKAS
1,2-Dichloroethane (Industrial Eff.)	154	GCMS	<1	ug/L	UKAS
1,2-Dichloropropane (Industrial Eff.)	154	GCMS	<1	ug/L	UKAS
1,3,5-Trimethylbenzene (Industrial Ef	154	GCMS	<1	ug/L	UKAS
1,3-Dichlorobenzene (Industrial Eff.)	154	GCMS	<1	ug/L	UKAS
1,3-Dichloropropane (Industrial Eff.)	154	GCMS	<1	ug/L	UKAS
1,4-Dichlorobenzene (Industrial Eff.)	154	GCMS	<2	ug/L	UKAS
2,2-Dichloropropane (Industrial Eff)	154	GCMS	<5.0	ug/L	
2-Chlorotoluene (Industrial Eff.)	154	GCMS	<1	ug/L	UKAS
4-Chlorotoluene (Industrial Eff.)	154	GCMS	<1	ug/L	UKAS
Acetone	328	GCMS	<0.22	mg/L	

Signed : A Harmon ***Date : 14/08/2019***

Aoife Harmon - Laboratory Supervisor

Acc. : Accredited Parameters by ISO 17025:2005
PVL - Parametric Value Limit as per EU (Drinking water) Regulations (SI 122 2014)
For bacterial analysis a result of 0 means none detected in volume examined
All organic results are analysed as received and all results are corrected for dry weight at 104 C
Results shall not be reproduced, except in full, without the approval of Fitz Scientific
Results contained in this report relate only to the samples tested (P) : Presumptive Results

ilac-MRA UKAS TESTING 2802

** : The test result for this parameter may be invalid as it has exceeded the recommended holding time (BS EN ISO 5667-3:2018)

Fitz scientific

Monitoring and Testing Services

Unit 35,
Boyne Business Park,
Drogheda,
Co. Louth
Ireland

Tel: +353 41 9845440
Fax: +353 41 9846171
Web: www.fitzsci.ie
email info@fitzsci.ie

A copy of this certificate is available on www.fitzsci.ie

Customer	Sean O' Sullivan Aughinish Alumina Ltd Auginish Island Askeaton Co Limerick Ireland	*Lab Report Ref. No.*	3120/697/17
		Date of Receipt	31/07/2019
		Sampled On	30/07/2019
		Date Testing Commenced	31/07/2019
		Received or Collected	Courier
		Condition on Receipt	Acceptable
Customer PO	P4631883	*Date of Report*	14/08/2019
Customer Ref	W1-1 30/07/2019	*Sample Type*	Effluent
Ref 2			
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
Acetonitrile	328	GCMS	<0.33	mg/L	
Benzene (Industrial Eff.)	154	GCMS	<1	ug/L	UKAS
Bromobenzene (Industrial Eff.)	154	GCMS	<1	ug/L	UKAS
Bromochloromethane (Industrial Eff.)	154	GCMS	<1	ug/L	UKAS
Bromodichloromethane (Industrial Eff	154	GCMS	<1	ug/L	UKAS
Bromoform (Industrial Eff.)	154	GCMS	<1	ug/L	UKAS
Bromomethane (Industrial Eff.)	154	GCMS	<5.0	ug/L	
Carbon tetrachloride (Industrial Eff.)	154	GCMS	<1	ug/L	UKAS
Chlorobenzene (Industrial Eff.)	154	GCMS	<1	ug/L	UKAS
Chloroethane (Industrial Eff.)	154	GCMS	<5.0	ug/L	
Chloroform (Industrial Eff.)	154	GCMS	3	ug/L	UKAS
Chloromethane (Industrial Eff.)	154	GCMS	<5.0	ug/L	
cis-1,2-Dichloroethene (Industrial Eff.	154	GCMS	<1	ug/L	UKAS
cis-1,3-Dichloropropene (Industrial Ef	154	GCMS	<1	ug/L	UKAS
Dibromochloromethane (Industrial Eff	154	GCMS	1	ug/L	UKAS
Dibromomethane (Industrial Eff.)	154	GCMS	<1	ug/L	UKAS
Dichlorodifluoromethane (Industrial E	154	GCMS	<5.0	ug/L	
Dichloromethane (Industrial Eff.)	154	GCMS	<5.0	ug/L	
Ethanol	328	GCMS	<0.35	mg/L	
Ethylbenzene (Industrial Eff.)	154	GCMS	<1	ug/L	UKAS
Hexachlorobutadiene (Industrial Eff.)	154	GCMS	<1	ug/L	UKAS
Isopropyl Alcohol	328	GCMS	<0.34	mg/L	
Isopropylbenzene (Industrial Eff.)	154	GCMS	<1	ug/L	UKAS
m- & p-Xylene (Industrial Eff.)	154	GCMS	<1	ug/L	UKAS

Signed : A Harmon

Date : 14/08/2019

Aoife Harmon - Laboratory Supervisor

Acc. : Accredited Parameters by ISO 17025:2005
PVL - Parametric Value Limit as per EU (Drinking water) Regulations (SI 122 2014)
For bacterial analysis a result of 0 means none detected in volume examined
All organic results are analysed as received and all results are corrected for dry weight at 104 C
Results shall not be reproduced, except in full, without the approval of Fitz Scientific
Results contained in this report relate only to the samples tested (P) : Presumptive Results

ilac-MRA UKAS TESTING 2802

** : The test result for this parameter may be invalid as it has exceeded the recommended holding time (BS EN ISO 5667-3:2018)

Fitz scientific

Monitoring and Testing Services

Unit 35,
Boyne Business Park,
Drogheda,
Co. Louth
Ireland

Tel: +353 41 9845440
Fax: +353 41 9846171
Web: www.fitzsci.ie
email info@fitzsci.ie

A copy of this certificate is available on www.fitzsci.ie

Customer	Sean O' Sullivan	*Lab Report Ref. No.*	3120/697/17
	Aughinish Alumina Ltd	*Date of Receipt*	31/07/2019
	Auginish Island	*Sampled On*	30/07/2019
	Askeaton	*Date Testing Commenced*	31/07/2019
	Co Limerick	*Received or Collected*	Courier
	Ireland	*Condition on Receipt*	Acceptable
Customer PO	P4631883	*Date of Report*	14/08/2019
Customer Ref	W1-1 30/07/2019	*Sample Type*	Effluent
Ref 2			
Ref 3			

CERTIFICATE OF ANALYSIS

Test Parameter	SOP	Analytical Technique	Result	Units	Acc.
MEK	328	GC-FID	<0.22	mg/L	
Methanol	328	GC-FID	<0.45	mg/L	
Naphthalene (Industrial Eff.)	154	GCMS	<1	ug/L	UKAS
n-Butylbenzene (Industrial Eff.)	154	GCMS	<1	ug/L	UKAS
n-Propylbenzene (Industrial Eff.)	154	GCMS	<1	ug/L	UKAS
o-Xylene (Industrial Eff.)	154	GCMS	<1	ug/L	UKAS
p-Isopropyltoluene (Industrial Eff.)	154	GCMS	<1	ug/L	UKAS
sec-Butylbenzene (Industrial Eff.)	154	GCMS	<1	ug/L	UKAS
Styrene (Industrial Eff)	154	GCMS	<1	ug/L	UKAS
tert-Butylbenzene (Industrial Eff)	154	GCMS	<1	ug/L	UKAS
Tetrachloroethene (Industrial Eff)	154	GCMS	<1	ug/L	UKAS
Toluene (Industrial Eff)	154	GCMS	<1	ug/L	UKAS
trans-1,2-Dichloroethene (Industrial E	154	GCMS	<1	ug/L	UKAS
trans-1,3-Dichloropropene (Industrial	154	GCMS	<2	ug/L	
Trichloroethene (Industrial Eff)	154	GCMS	<5.0	ug/L	
Trichlorofluoromethane (Industrial Eff	154	GCMS	<5.0	ug/L	
Vinyl chloride (Industrial Eff.)	154	GCMS	<5.0	ug/L	
Volatile Organic Compounds	154	GCMS	<5.0	ug/L	
Xylene Total (Industrial Eff)	154	GCMS	<1	ug/L	UKAS

Signed : A Harmon

Date : 14/08/2019

Aoife Harmon - Laboratory Supervisor

Acc. : Accredited Parameters by ISO 17025:2005
PVL - Parametric Value Limit as per EU (Drinking water) Regulations (SI 122 2014)
For bacterial analysis a result of 0 means none detected in volume examined
All organic results are analysed as received and all results are corrected for dry weight at 104 C
Results shall not be reproduced, except in full, without the approval of Fitz Scientific
Results contained in this report relate only to the samples tested (P) : Presumptive Results

ilac-MRA UKAS TESTING 2802

** : The test result for this parameter may be invalid as it has exceeded the recommended holding time (BS EN ISO 5667-3:2018)

**Report on the Industrial Emissions Licencing (IEL) Testing of the Aughinish W1-1B final effluent
on behalf of
Aughinish Alumina
May 2019**

Report prepared by

Aquatic Services Unit,
Environmental Research Institute.
Lee Road.
Cork

Introduction

Toxicity testing was requested by for the final effluent sample at the Aughinish Alumina facility as part of their Industrial Emissions licensing requirements. The sample code for the Aughinish effluent is W1-1 and the IE License number for the effluent is P0035-06. Two aquatic species from different trophic levels were selected for the testing namely the marine copepod (*Tisbe battagliai*) and the bacteria (*Vibrio fischeri*). Testing commenced on April 10th, 2019 and finished on April 12th, 2019.

Methodology

The W1-1B effluent sample was collected on April 8th, 2019 by Aughinish Alumina personnel and transported by courier service to the Aquatic Services Unit (ASU) laboratory. The effluent sample arrived to the ASU laboratory on April 9th, 2019 and was placed immediately in a refrigerator at 4 ºC until required for testing. Initial sample chemistries were recorded on April 10th, 2019 and the sample had a temperature of 5.4º C.

Tisbe battagliai Bioassay

The *Tisbe* bioassay was carried out following standard methods as described in Environment Agency's Methods for the Examination of Waters and Associated Materials (Environment Agency, 2007). The effluent was tested for toxicity at the following concentrations 4, 8, 16, 32, and 64% effluent. The salinity of the effluent was adjusted to 28 parts per thousand (ppt) using hypersaline brine to make the sample suitable for testing. Twenty *Tisbe* isolates (animals 6 days old) were tested for each concentration. These animals were added into 4 replicates of five animals per test chamber for each concentration. Testing was carried out in a constant temperature room at a temperature of 20 ºC ± 2 throughout the test. A light regime of 16 hours light/8 hours dark was used throughout the testing period. The test duration was 48 hours. Filtered seawater adjusted to 28 ppt by the addition of distilled water was used as control and dilution water. An additional salt water control comprising of distilled water and hypersaline brine was also tested. A concurrent reference toxicant using zinc sulphate was conducted to assess the sensitivity of the test organisms. The *T. battagliai* were obtained from in house cultures at the ASU.

Vibrio fischeri bacteria bioassay using Microtox system.

The luminescent bacteria *Vibrio fischeri* are used exclusively in the Microtox system. Testing was carried out following the ISO 11348-3 guidelines (ISO, 2007). The concentrations of effluent tested ranged from 6.25% to 80%. Two replicates were used for each concentration tested. A concurrent reference toxicant bioassay was also carried out to determine the health and suitability of the bacteria.

Statistical Analyses

Statistical analyses to generate LC_{50} (Lethal Concentration to cause 50 percent mortality) or EC_{50} (Effective Concentration to cause 50 percent effect) data were performed using the ToxCalc v5.0.32 Environmental Toxicity Data Analysis System, (Tidepool Scientific, 2007). Microtox statistical analyses were carried out using the manufacturers software programme MicrotoxOmni.(Azur Environmental Ltd., 1995)

Results and Discussion

<u>*Tisbe battagliai* Bioassay</u>

This test was deemed to be valid given that there was greater than 90% survival in the controls indicating that the animals and testing conditions were satisfactory (Environment Agency, 2007). A LC_{50} value of 24.8 % effluent was calculated for this bioassay. This would correspond to a Toxicity Unit (TU) value of 4 for the effluent. Results of this bioassay are displayed in Figure 1. A concurrent reference toxicant bioassay using zinc sulphate was carried out alongside the effluent bioassay. This bioassay produced an EC_{50} of 0.52 mg/L of Zinc sulphate, this EC_{50} value is in agreement with previously published data for *Tisbe sp.* (US EPA, 2007) and with ongoing toxicity testing at the ASU. This indicates that the animals were of suitable sensitivity to be used for toxicity testing. Water quality measurements in the test chambers remained within normal limits for the duration of the bioassay. These data are presented in Appendix 2.

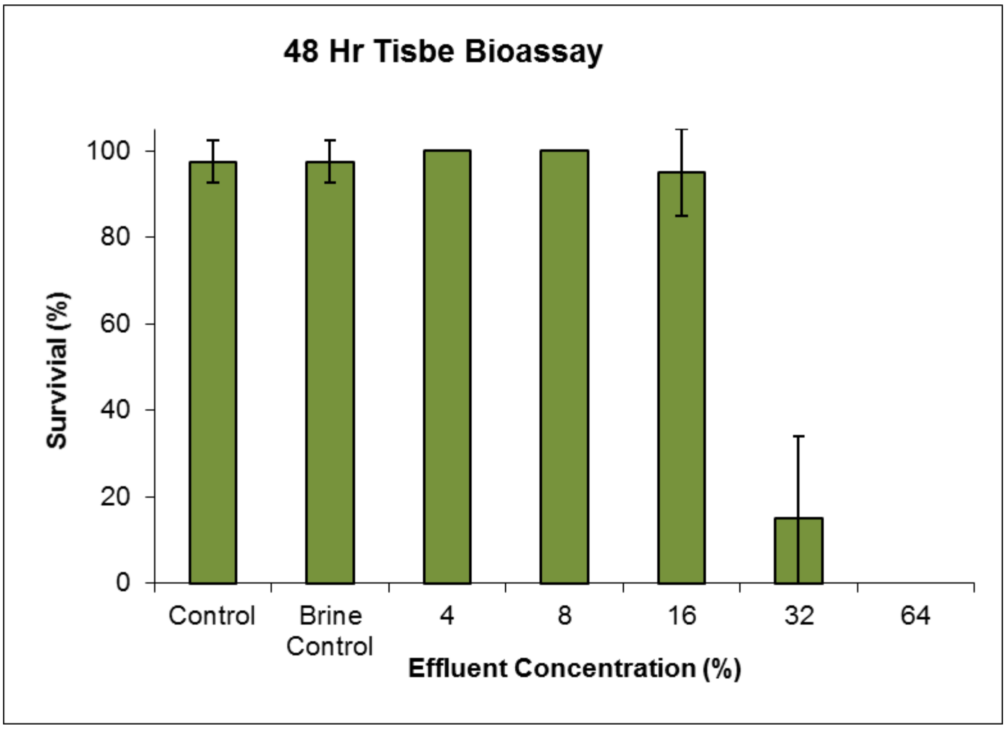


Figure 1 Average survival of *Tisbe battagliai* after 48 hours in a concentration series of the Aughinish Alumina effluent.

Microtox results.

The Microtox bioassay carried out on April 11th, 2019 was deemed to be valid. A reference toxicant test was carried out before actual testing of samples took place to ensure that the bacterium and reagents were suitable for testing. The reference toxicant using $Zinc^{++}$ ion determined an EC_{50} of 1.34 mg/L after 15 minutes exposure. This is within the guideline range of 0.6-2.2 mg $Zinc^{++}$/L as specified by the Microtox manufacturer (Azur Environmental, 1995). These data are presented in Appendix 2.

A G_L value of 2 was generated for this test. The G_L value is the dilution level at which a waste water effluent causes less than 20% inhibition to the species. Effluent samples with G_L values ranging from 1-10 are considered to have low toxicity, G_L values of 10-100 are considered to be moderate toxicity and G_L values greater than 100 are considered to have high toxicity. This G_L ranking system is based on research carried out on selected effluents (Wang et al., 2002). The Microtox test generated an EC^{50} of greater than 54.3% effluent, this would equate to a TU value of 1.8 The data for the Microtox effluent test are presented in Figure 2.

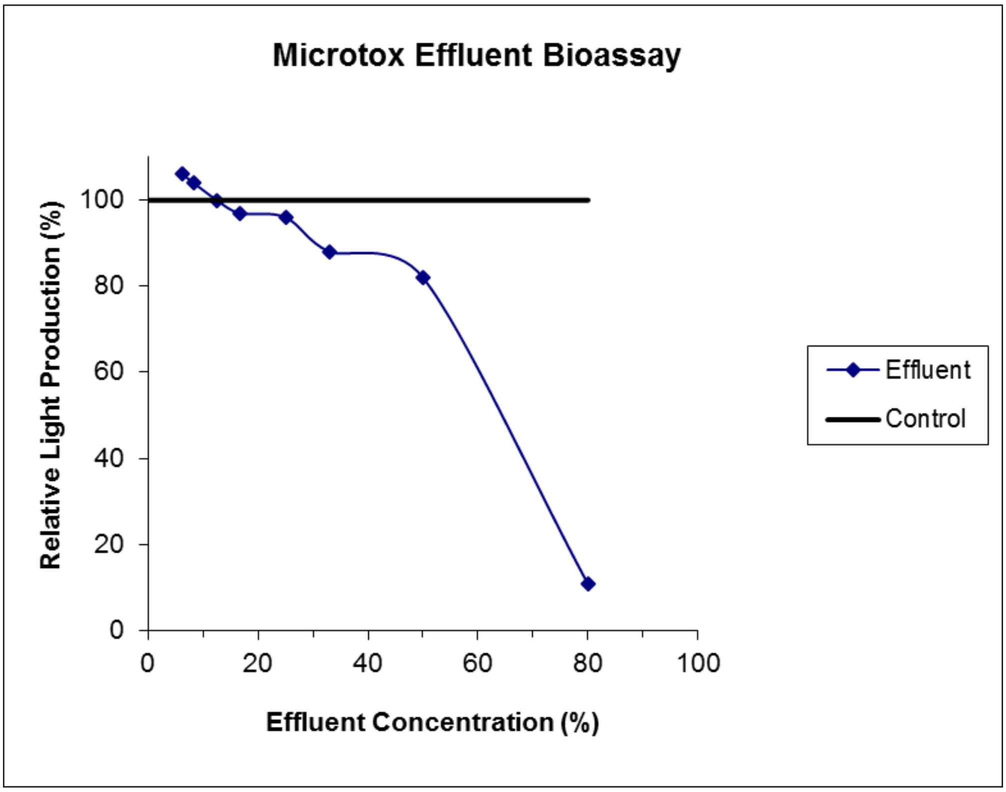


Figure 2 Plot of the Microtox results for the W1-1 effluent sample. Values represent light production relative to the controls. The highest concentration of effluent tested was 80%.

Summary and Conclusions

The marine copepod, *Tisbe battagliai,* was more sensitive to the effluent during this round of testing. The *Tisbe* bioassay produced a TU value of 4. In the Microtox bioassay, a dose dependent decrease in light production was observed across the concentration series. The Microtox bioassay was less sensitive to the effluent and a TU value of 1.8 was determined during this round of testing. The toxicity of effluents has been classified based on their TU values using the following scale TU<1 (relatively not acutely toxic), TU between 1 and 10 (minor acutely toxic), TU between 10 and 100 (moderately acutely toxic) and TU>100 (very acutely toxic) (Tonkes et al., 1999). Based on this scale, the results from the bioassays performed on the Aughinish Alumina W1-1 final effluent sampled on April 8th, 2019 indicate that the sample is minor acutely toxic. All of the bioassays performed in the current round of testing were deemed to be valid as they meet all of the criteria as specified in the guidelines.

References

Azur Environmental, 1995. Microtox Acute Basic Test Procedures. Azur Environmental ,. Carlsbad, California, USA.

Environment Agency, 2007. The direct toxicity assessment of aqueous environmental samples using the marine copepod *Tisbe battagliai* lethality test. Methods for the Examination of Waters and Associated Materials. http://www.environment-agency.gov.uk/nls

ISO 11348-3:2007. Water quality-Determination of the inhibitory effect of water samples on the light emission of Vibrio fischeri (Luminescent bacteria test)—Part 3: method using freeze dried bacteria. International Standards Organisation.

Tonkes, M. Graaf, P.J.F., and Jannes, G.,1999. Assessment of Complex Industrial Effluents in the Netherlands using a Whole Effluent Toxicity (or WET) Approach. Water Science and Technology, Vol. 39, No. 10-11, pp 55-61.

U.S EPA, 2007. ECOTOX User Guide: ECOTOXicology Database System. Version 4. http:/www.epa.gov/ecotox.

Wang, C., Yediler, A., Lienert, D., Wang, Z., and Kettrup, A., 2002. Toxicity evaluation of reactive dyestuffs , auxiliaries and selected effluents in the textile finishing industry to luminescent bacteria *Vibrio fischeri*. Chemosphere, 46, pp 339-344

..

Appendix 1- Water Quality Measurements for *Tisbe battagliai* Bioassay

48 Hour Tisbe Bioassay
Augh W1-1 Effluent 10/04/19

Concentration (%)	Survival			D.O (mg/L)			pH			Salinity (ppt)			Temp (ºC)		
	0hrs	24hrs	48hrs	0hrs	24hrs	48hrs	0hrs	24hrs	48hrs	0hrs	24hrs	48hrs	0hrs	24hrs	48hrs
Control A	5	5	5	7.6		7.6	8.32		8.02	28		28	19.7	20.4	20.3
Control B	5	5	5												
Control C	5	5	5												
Control D	5	5	5												
Control 2A	5	5	5	7.6		7.6	8.32		8.02	28		28	19.7	20.4	20.3
Control 2B	5	5	4												
Control 2C	5	5	5												
Control 2D	5	5	5												
Brine Control A	5	5	5	7.0		7.5	8.32		8.00	27		28	19.0	20.4	20.3
Brine Control B	5	5	5												
Brine Control C	5	5	5												
Brine Control D	5	5	5												
Brine Control 2A	5	5	4	7.0		7.5	8.32		8.00	27		28	19.0	20.4	20.3
Brine Control 2B	5	5	5												
Brine Control 2C	5	5	5												
Brine Control 2D	5	5	5												
4A	5	5	5	7.0		7.1	8.33		8.12	27		28	19.2	20.4	20.3
4B	5	5	5												
4C	5	5	5												
4D	5	5	5												
8A	5	5	5	7.6		7.4	8.28		8.17	28		29	19.0	20.4	20.3
8B	5	5	5												
8C	5	5	5												
8D	5	5	5												
16A	5	5	4	7.6		7.6	8.25		8.25	28		29	19.4	20.4	20.3
16B	5	5	5												
16C	5	5	5												
16D	5	5	5												
32A	5	5	0	7.8		7.7	8.09		8.35	27		29	19.2	20.4	20.3
32B	5	5	2												
32C	5	5	1												
32D	5	5	0												
64A	5	3	0	8.2		7.0	7.95		8.44	27		28	19.0	20.4	20.3
64B	5	2	0												
64C	5	2	0												
64D	5	1	0												

Notes

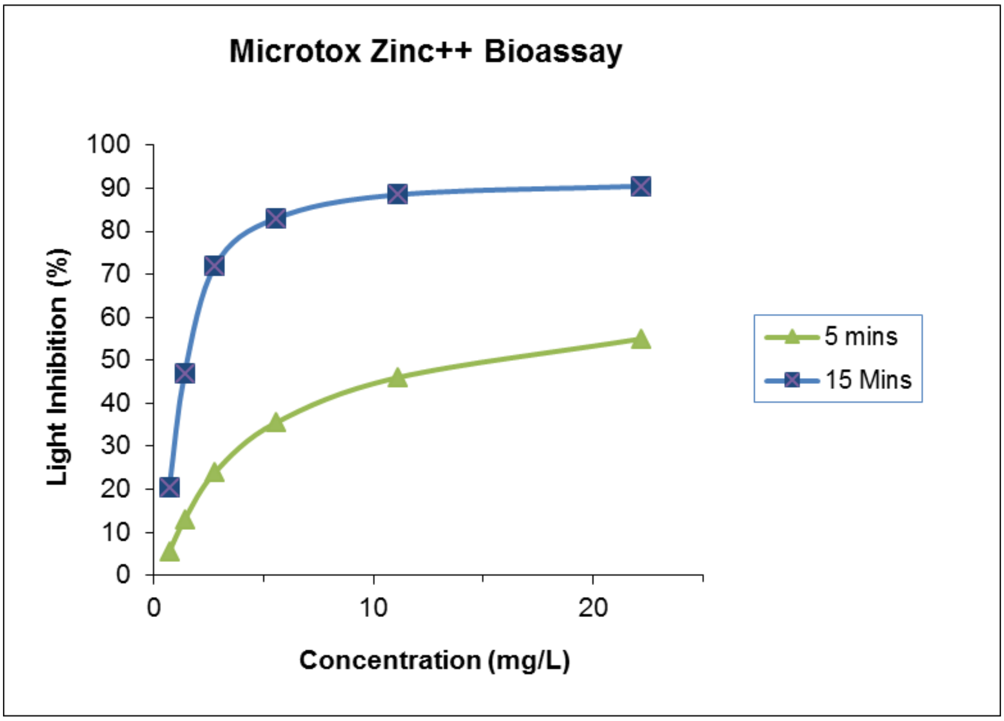
Day 0 Initiated at 16.00 , Animals 6 days old at initiation

24hrs 10.15

48hrs Terminated at 14.00

Testing performed by Aquatic Services Unit, ERI Building, Lee Rd., Cork

Appendix 2- Microtox Reference Toxicant Bioassay



Plot of light inhibition relative to the controls versus Zinc^{++} concentration after 5 and 15 minutes exposure.

The toxicity testing carried out for this report complies with internationally accepted guidelines. The results of these toxicity tests contained in this report are deemed valid under these guidelines.

Signed: David Gillespie ______________________________

David Gillespie MSc (Toxicology)

City Analysts Limited,
Pigeon House Road,
Ringsend,
Dublin 4.

Tel: (01) 613 6003
Fax: (01) 613 6008

Email:
reports@cityanalysts.ie

www.cityanalysts.ie

Customer

Louise Clune

Aughinish Alumina
Aughinish
Limerick

Certificate Of Analysis

Job Number: 19-60798

Issue Number: 1

Report Date: 2 September 2019

Site: Not Applicable

PO Number: Not Supplied

Date Samples Received: 27/08/2019

Please find attached the results for the samples received at our laboratory on 27/08/2019.

Should you have any queries regarding the report or require any further services, we would be happy to discuss your requirements. For additional information about the company please log-on to our website at the above address.

Thank you for choosing City Analysts Limited. We look forward to assisting you again.

Authorised By:

Linda Hanrahan

Sent By: **Sent Date:** 2 September 2019

Shane Reynolds
Laboratory Manager

Notes:

Results relate only to the items tested.
Information on methods of analysis and performance characteristics is available on request.
Any opinions or interpretations indicated are outside the scope of our INAB accreditation.
This test report shall not be reproduced except in full or with written approval of City Analysts Limited.

City Analysts Limited
Environmental Laboratories

City Analysts Limited,
Pigeon House Road,
Ringsend,
Dublin 4.

Tel: (01) 613 6003
Fax: (01) 613 6008

Email:
reports@cityanalysts.ie

www.cityanalysts.ie

ISO 17025 INAB ACCREDITED TESTING
DETAILED IN SCOPE REG NO.138T

Certificate Of Analysis

Customer

Louise Clune

Aughinish Alumina
Aughinish
Limerick

Report Reference: 19-60798

Report Version: 1

Site: Not Applicable

Sample Description: W1-1 27/8/19

Sample Type: Effluent (Final)

Lab Reference Number: 452870

Date of Sampling: 27/08/2019

Time of Sampling: 00:00

Date Sample Received: 27/08/2019

Site / Method Ref.	Analysis Start Date	Parameter	Result	Units
S/S3239#	02/09/2019	Inhibitory effect to Vibrio fischeri	>45% giving <2.2 toxic units.	%vol/vol
S/S3238#	02/09/2019	48 h LC50 to Tisbe battagliai	>32% giving <3.1 toxic units.	%vol/vol
Toxicity Chemistry Suite				
S/S3011#	27/08/2019	Conductivity @ 20℃	7150.0	uS/cm @20℃
S/S1003#	29/08/2019	Dissolved Oxygen	8.31	mg/l O2
S/S1041#	27/08/2019	PH	7.69	pH Unit
S/S3011	27/08/2019	Salinity	3.6	ppt

= INAB Accredited, U = UKAS Accredited, * = Subcontracted

Note:
PV Value is the parametric value, taken from European Communities, (Drinking Water) Regulations, 2014. S.I. No. 122 of 2014 and relates only to drinking water samples.
For queries on results, please contact us within two weeks of the report date to ensure that we can accommodate your query as samples cannot be stored indefinitely.
NAC & ATC - No abnormal change and acceptable to customers.
TVC - Total viable count
Site D = Analysed at City Analysts Dublin. Site S = Analysed at City Analysts Shannon

City Analysts Limited
Environmental Laboratories

City Analysts Limited,
Pigeon House Road,
Ringsend,
Dublin 4.

Tel: (01) 613 6003
Fax: (01) 613 6008

Email:
reports@cityanalysts.ie

www.cityanalysts.ie

ISO 17025 INAB ACCREDITED TESTING DETAILED IN SCOPE REG NO.138T

Certificate Of Analysis

Customer

Louise Clune

Aughinish Alumina
Aughinish
Limerick

Report Reference: 19-60798

Report Version: 1

Site: Not Applicable

Sample Description: W1-1 27/8/19

Sample Type: Effluent (Final)

Lab Reference Number: 452870

Date of Sampling: 27/08/2019

Time of Sampling: 00:00

Date Sample Received: 27/08/2019

Test Parameter	Concentration % vol. / vol.	Toxic Units	95% Confidence Limits % vol./vol.	Method of Calculation
Marine Bacterium	>45	<2.2	45.05-116.	Microtox
Marine Copepod	>32	<3.1		Tox calc

Comments

Marine Bacterium
30 min EC50 to Vibrio fischeri
39.33% Light inhibition occurred at 45% vol/vol.
-Compared to the control.

Marine Copepod
48 hr Tisbe battagliai
No Tisbe were immobilised @ 100% vol/vol
-compared to control

Test Method(s): (see Appendix 1)

Method 2: Marine Bacterium
Method 3: Marine Copepod
Method 10: Sampling

= INAB Accredited, U = UKAS Accredited, * = Subcontracted

Note:
PV Value is the parametric value, taken from European Communities, (Drinking Water) Regulations, 2014. S.I. No. 122 of 2014 and relates only to drinking water samples.
For queries on results, please contact us within two weeks of the report date to ensure that we can accommodate your query as samples cannot be stored indefinitely.
NAC & ATC - No abnormal change and acceptable to customers.
TVC - Total viable count
Site D = Analysed at City Analysts Dublin. Site S = Analysed at City Analysts Shannon

Appendix 1

Toxicity Test Methods and Procedures

1. Freshwater Crustacean

Method 3235 based on ISO 6341:2012: ‘Water quality – Determination of the inhibition of the mobility of Daphnia magna Straus (Cladocera, Crustacea)

3. Marine Copepod

Method 3238 based on ISO 14669:1999: ‘Water quality – Determination of acute lethal toxicity to marine copepods (Copepoda, Crustacea)’

2. Marine Bacterium

Method 3239 based on ISO 11348-3:2007: ‘Water quality - Determination of the inhibitory effect of water samples on the light emission of Vibrio fischeri (Luminescent bacteria test) – Part 3: Method using freeze-dried bacteria’

4. Marine Algae

Method 3237 based on ISO 10253:2006: ‘Water quality - Marine algal growth inhibition test with Skeletonema costatum and Phaeodactylum tricornutum’

5. Freshwater Algae

Method 3236 based on ISO 8692:2012: ‘Water quality – Freshwater algal growth inhibition test with unicellular green algae’

6. Freshwater Plant

Based on ISO 20079:2005: ‘Water quality – Determination of the toxic effect of water constituents and waste water to duckweed (Lemna minor) – Duckweed growth inhibition test’

7. Marine Fish

Method based on OECD 1992: Guideline 203: - ‘Fish, acute toxicity test’

8. Freshwater Fish

Based on OECD 1992: Guideline 203: - ‘Fish, acute toxicity test’

9. Estuarine Crustacean

Based on MAFF SOP No. BEG/030:1996: ‘Brown Shrimp (Crangon crangon) 96 h acute toxicity for liquid effluents and wastes’

10. Sampling

Based on ISO 5667-16:2017: ‘Water quality – Sampling - Part 16: Guidance on biotesting of samples’

11. Eluate Generation

Based on DIN 38 414 part 4, 1984: – ‘Sludge and Sediments (Group S) – Determination of leachability by water (S4)

Attachment 2
Waste Analysis

Waste Monitoring Results
Quarterly Report

Quarter 1 2019

Emission Point Reference	Description	Date	IEL	pH	Dry matter	Chloride	Fluoride	Soda	Total Alkalinity	Al*	As*	Cd*	Cr*	Cu*	Fe*	Pb*	Mg*	Hg*	Ni*	Ti*	Zn*
			Limits		%	mg/Kg	mg/Kg	mg/Kg	mg/Kg $CaCO_3$	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg
C.4 Waste Monitoring	**Red Mud****	28/02/19	N/A	11.21	76	42	87.00	2346	3913	22304	2.726	0.802	168	9.075	6127	15.902	189.3	<.0025	1.258	4100	3.202
	Sand	28/02/19	N/A	11.8	83	24	25	2109	4124	10682	3.487	<.01	303	10.932	57894	17.145	140.2	<.0025	2.16	1655	23.419
	Salt Cake	28/02/19	N/A	13.2	56	5870	2386	209740	444385	44639	73.432	0.075	0.037	1.253	20.752	<.01	22.6	<.0025	1.109	1.149	2.046
				pH	**--**	**Chloride**	**Fluoride**	**Soda**	**Total Alkalinity**	**Al***	**As***	**Cd***	**Cr***	**Cu***	**Fe***	**Pb***	**Mg***	**Hg***	**Ni***	**Ti***	**Zn***
						mg/l	**mg/l**	**mg/l**	**mg/l $CaCO_3$**	**mg/l**	**µg/l**	**µg/l**	**µg/l**	**µg/l**	**µg/l**	**µg/l**	**mg/l**	**µg/l**	**µg/l**	**µg/l**	**µg/l**
	Red Mud stack Leachate	28/02/19		11.7		49.61	14.13	1840	2698	66.9	180.8	1.400	17.000	22	57	0.2	0.17	4	7	7	109
				pH	**Dry matter**	**Organic matter**	**N**	**P**	**--**	**Al***	**As***	**Cd***	**Cr***	**Cu***	**Fe***	**Pb***	**Mg***	**Hg***	**Ni***	**Ti***	**Zn***
					%	**%**	**mg/l**	**mg/l**		**µg/l**	**µg/l**	**µg/l**	**µg/l**	**µg/l**	**µg/l**	**µg/l**	**mg/l**	**µg/l**	**µg/l**	**µg/l**	**µg/l**
	Sanitary Sludge	29/01/19		7.0	0.53	99.9	346.4	382.0		28816	<10	<10	<10	4686.8	########	27.400	13.3	<2.5	335.72	56.9	2658.9

***Metal analysis & Sanitary Sludge analysis : Fitz Scientific**
**** Farmed red mud**

Waste Monitoring Results
Quarterly Report

Quarter 2 2019

Emission Point Reference	Description	Date	IEL	pH	Dry matter	Chloride	Fluoride	Soda	Total Alkalinity	Al*	As*	Cd*	Cr*	Cu*	Fe*	Pb*	Mg*	Hg*	Ni*	Ti*	Zn*
			Limits		%	mg/Kg	mg/Kg	mg/Kg	mg/Kg $CaCO_3$	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg
C.4 Waste Monitoring	Red Mud**		N/A	11.01	72	95	50.50	3428	4881	28869	<.01	<.01	179.66	6.96	8995	15.46	195.9	<.0025	0.18	9287	6.15
	Sand		N/A	11.7	81	46	23	2624	4843	13257	<.01	<.01	312.50	8.687	53806	17.12	91.9	<.0025	1.10	2354	21.08
	Salt Cake		N/A	12.9	56	6274	7943	229972	441381	33395	43.02	<.01	<.01	1.183	22.932	<.01	17.1	<.0025	1.450	2.223	3.680
				pH	--	Chloride	Fluoride	Soda	Total Alkalinity	Al*	As*	Cd*	Cr*	Cu*	Fe*	Pb*	Mg*	Hg*	Ni*	Ti*	Zn*
						mg/l	mg/l	mg/l	mg/l $CaCO_3$	mg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	mg/l	µg/l	µg/l	µg/l	µg/l
	Red Mud stack Leachate			12.3		176.60	28.20	5390	9011	50.33	160.0	1.900	60.00	41	200	<.173	0.2	<,2	6	21	19
				pH	Dry matter	Organic matter	N	P	--	Al*	As*	Cd*	Cr*	Cu*	Fe*	Pb*	Mg*	Hg*	Ni*	Ti*	Zn*
					%	%	mg/l	mg/l		µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	mg/l	µg/l	µg/l	µg/l	µg/l
	Sanitary Sludge			7.1	0.90	75.0	588.3	86.6		13629.90	<10	<10	<10	1772	11033	<10	25	15	13	74.62	1036

***Metal analysis & Sanitary Sludge analysis : Fitz Scientific**
**** Farmed red mud**

Quarter 3 2019

Emission Point Reference	Description	Date	IEL	pH	Dry matter	Chloride	Fluoride	Soda	Total Alkalinity	Al*	As*	Cd*	Cr*	Cu*	Fe*	Pb*	Mg*	Hg*	Ni*	Ti*	Zn*
			Limits		%	mg/Kg	mg/Kg	mg/Kg	mg/Kg $CaCO_3$	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg
C.4 Waste Monitoring	**Red Mud****		N/A	11.16	78	147	70.35	4741.72	5271	28127	5.154	1.367	157.09	10.763	10716	17.04	186.2	<.0025	3.36	7433	57.62
	Sand		N/A	12.2	83	11	31	2502	4975	11551	3.83	0.951	207.38	8.064	46068	17.03	99.5	<.0025	3.32	2421	102.66
	Salt Cake		N/A	13.7	55	6205	1067	218171	438066	32440	27.13	0.173	0.206	2.344	9.027	<.01	12.5	<.0025	3.021	0.807	69.614
				pH	**--**	**Chloride**	**Fluoride**	**Soda**	**Total Alkalinity**	**Al***	**As***	**Cd***	**Cr***	**Cu***	**Fe***	**Pb***	**Mg***	**Hg***	**Ni***	**Ti***	**Zn***
						mg/l	**mg/l**	**mg/l**	**mg/l $CaCO_3$**	**mg/l**	**µg/l**	**µg/l**	**µg/l**	**µg/l**	**µg/l**	**µg/l**	**mg/l**	**µg/l**	**µg/l**	**µg/l**	**µg/l**
	Red Mud stack Leachate			10.7		289.40	26.50	6590	5293	139.3	0.516	0.002	0.038	0.033	0.021	<.005	2.1	0.0015	0.0096	0.039	0.0093
				pH	**Dry matter**	**Organic matter**	**N**	**P**	**--**	**Al***	**As***	**Cd***	**Cr***	**Cu***	**Fe***	**Pb***	**Mg***	**Hg***	**Ni***	**Ti***	**Zn***
					%	**%**	**mg/l**	**mg/l**		**µg/l**	**µg/l**	**µg/l**	**µg/l**	**µg/l**	**µg/l**	**µg/l**	**mg/l**	**µg/l**	**µg/l**	**µg/l**	**µg/l**
	Sanitary Sludge			7.2	0.40	72.4	242.5	56.2		25711.0	<10	<10	48	5208	22064	47.0	19	27	73	83.48	3059

***Metal analysis & Sanitary Sludge analysis : Fitz Scientific**
**** Farmed red mud**

Quarter 4 2019

Emission Point Reference	Description	Date	IEL	pH	Dry matter	Chloride	Fluoride	Soda	Total Alkalinity	Al*	As*	Cd*	Cr*	Cu*	Fe*	Pb*	Mg*	Hg*	Ni*	Ti*	Zn*
			Limits		%	mg/Kg	mg/Kg	mg/Kg	mg/Kg $CaCO_3$	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg
C.4 Waste Monitoring	Red Mud**		N/A	11.1	77	64	37.3	2784	4571	299883	1.151	<0.01	159.77	10.106	12000	16.17	200.0	<0.0025	1.95	10600	56.63
	Sand		N/A	11.6	83	42	26	3072	5421	4901	3.38	<0.01	88.91	4.780	20892	5.81	59.0	<0.0025	<0.010	1402	24.57
	Salt Cake		N/A	13.2	55	6817	715	215599	442759	43044	24.98	0.012	0.07	1.889	7.887	<0.010	17.0	<0.0025	2.675	1.146	2.469
				pH	--	Chloride	Fluoride	Soda	Total Alkalinity	Al*	As*	Cd*	Cr*	Cu*	Fe*	Pb*	Mg*	Hg*	Ni*	Ti*	Zn*
						mg/l	mg/l	mg/l	mg/l $CaCO_3$	mg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	mg/l	µg/l	µg/l	µg/l	µg/l
	Red Mud stack Leachate			12.0		58.57	16.00	5.87	2569	103	0.221	<.0005	0.032	0.031	0.134	0.0012	<1	<.0001	<.0004	0.171	0.0041
				pH	Dry matter	Organic matter	N	P	--	Al*	As*	Cd*	Cr*	Cu*	Fe*	Pb*	Mg*	Hg*	Ni*	Ti*	Zn*
					%	%	mg/l	mg/l		µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	mg/l	µg/l	µg/l	µg/l	µg/l
	Sanitary Sludge			7.3	0.60	99.9	254.7	1.8		84889	<10.0	<10.0	298	7021	55886	237.0	30	23	<10	947.82	5399

***Metal analysis & Sanitary Sludge analysis : Fitz Scientific**
**** Farmed red mud**

Attachment 3
Energy Efficiency Report

ENERGY EFFICIENCY REPORT 2019

RUSAL AUGHINISH

1. Table of Contents

1. Background

This report summarises the 2019 energy performance for inclusion in the Annual Environmental Report for RUSAL Aughinish. Reports for earlier years were included in previous Environmental Reports.

2. Energy Management System

An ISO 50001 recertification audit was successfully completed in February 2019.

In addition, the plant again qualified as a high quality CHP site under the UK CHPQA self-assessment scheme. The plant is also certified as high efficiency CHP through the commission for Energy Regulation's scheme.

3. Steam Efficiency

Steam efficiency is reported as the energy in the total steam produced by the plant divided by the hydrate production; GJ/t. The chart below shows steam efficiency data for each year since 2013.

The steam efficiency in 2019 shows a slight improvement over the previous year. This was primarily due to investment in the heater refurbishment programme.

Significant investment in the heat recovery equipment will result in improved energy efficiency in 2020 and the programme is scheduled to continue throughout 2020.

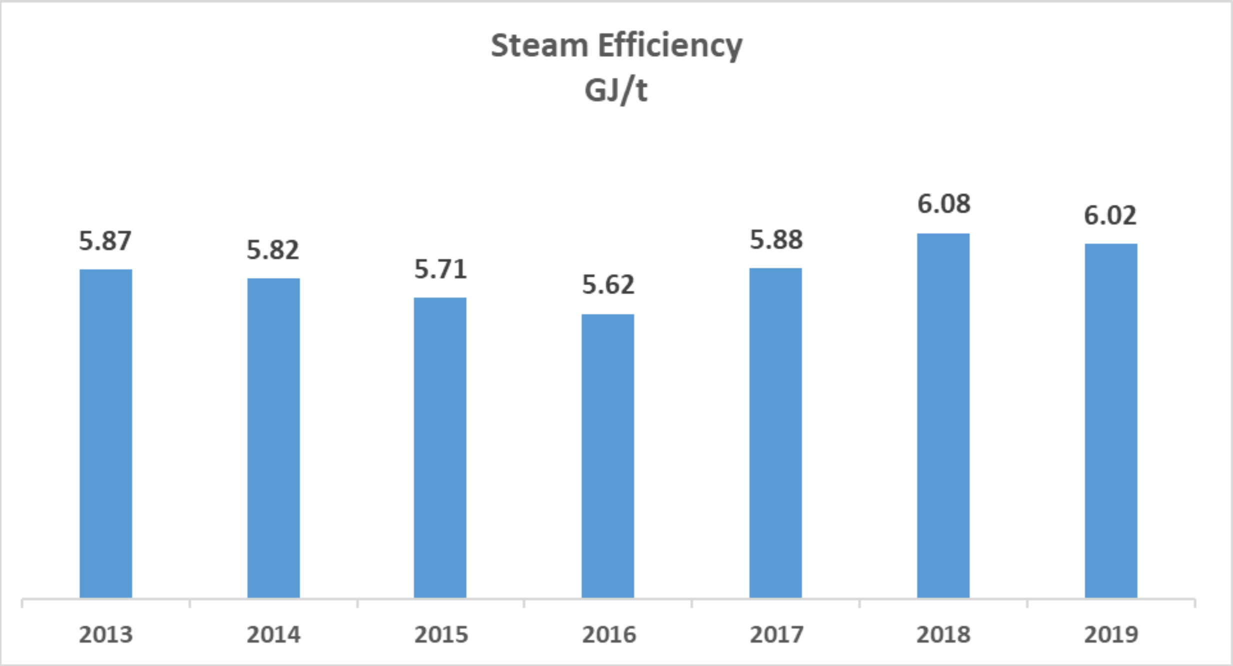


Figure 1 Steam efficiency (GJ/t) from 2013 to 2019

4. Power Efficiency

Power efficiency is reported as the electrical energy used divided by the hydrate production; GJ/t. The chart below shows the power efficiency performance for each year since 2013. The 2019 result of 0.727GJ/t.

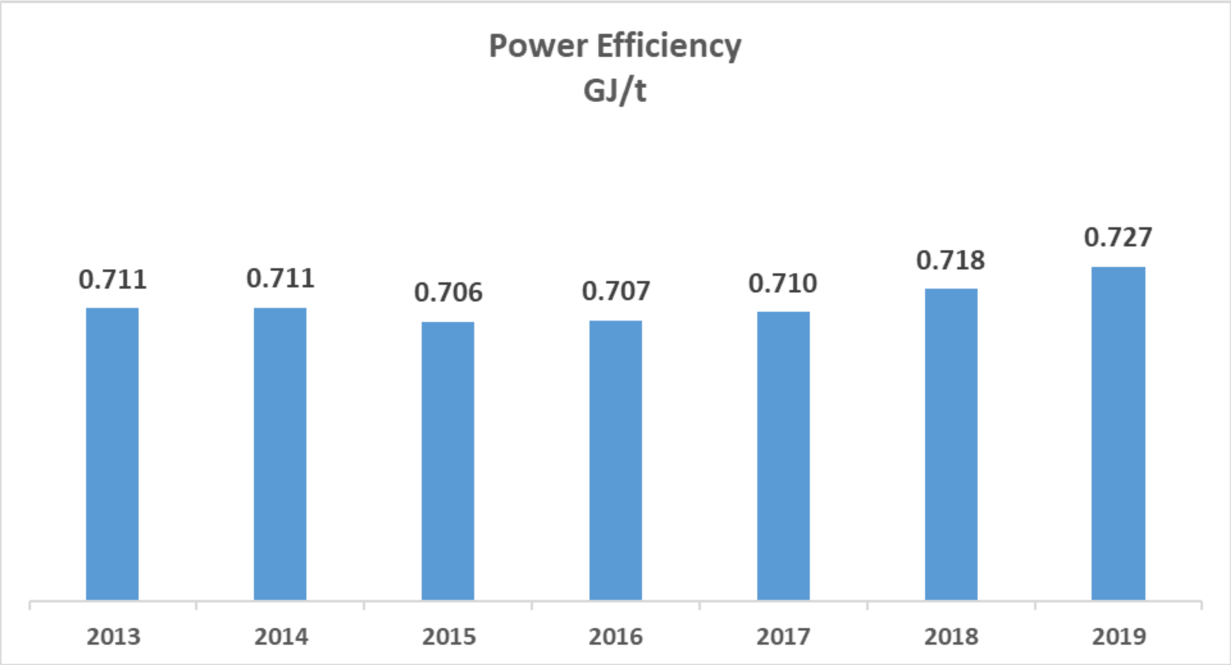


Figure 2 Power Efficiency (GJ/t) from 2013 to 2019

5. Calcination

The overall calcination efficiency performance for 2019 was in line with the 2018 performance. The plant continues to monitor and optimise the air to fuel ratio, which is one of the main drivers for calcination efficiency outside of the production rate.

6. Energy Programme for 2020

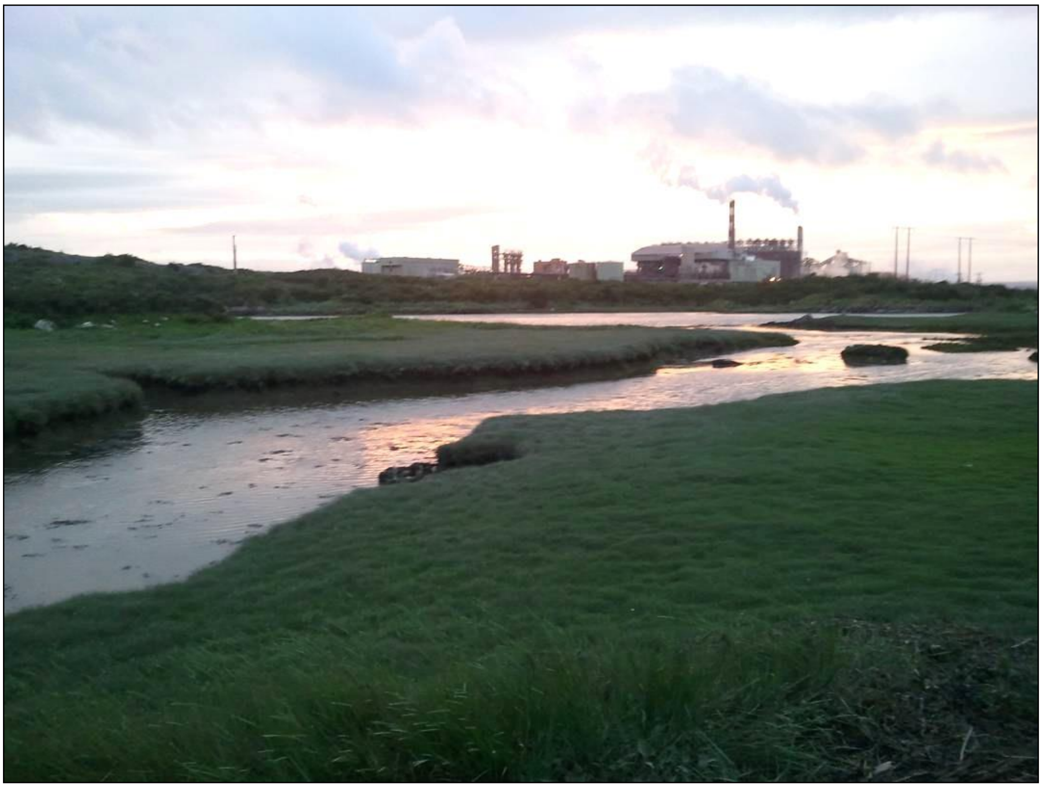
The main projects affecting heat recovery are:

- Manual descale of poorly performing digestion heaters
- Continue re-tube programme of digestion heaters
- Descale of heaters in the vacuum flash area

Attachment 4
Noise Survey Report

Aughinish Alumina Ltd.

Aughinish Island, Askeaton, Co. Limerick.
Industrial Emissions Licence Reg No. P0035-06



Report on

Annual Environmental Noise Survey 2019

October 2019

ENVIRONMENT ISO 14001:2004 NSAI Certified
HEALTH & SAFETY OHSAS 18001:2007 NSAI Certified
QUALITY ISO 9001:2008 NSAI Certified

Control Sheet

Document Title:	Report on Annual Environmental Noise Survey 2019		Document No.	R1_1017_44	
Rev	**Description**	**Originator**	**Reviewer**	**Change**	**Date**
00	Draft	SM	BT	Draft	2/9/2019
01	Final	SM	BT	Client Comments	08/10/2019

This report is produced solely for the benefit of Aughinish Alumina Ltd. and no liability is accepted for any reliance placed on it by any other party unless specifically agreed in writing otherwise. This report refers, within the limitations stated, to the condition of the normal operating conditions of the site at the time of the noise compliance site survey. No warranty is given as to the possibility of future changes in the condition of the normal operating conditions of the site.

OES Consulting
Dublin | Newry | Tralee

Head Office : +353 1 690 97 90
LoCall: 1890 130 007
Email: info@oes.ie
Web: oes.ie

Office Locations:
Anfield House, Baldonnell Business Park, Naas Road, Dublin 22, D22 N2N4
Office 13, Linenhall House, WIN Business Park, Canal Quay, Newry, Co. Down, BT35 6FP
Unit 2 E, Liber House, Monavalley, Tralee, Co. Kerry, V92 NN80

Aughinish Alumina Ltd.
Aughinish Island, Askeaton, Co. Limerick

Annual Environmental Noise Survey 2019

Contents

Attachments

1 Introduction

OES Consulting (OES) was commissioned by Aughinish Alumina Ltd. (AAL) to undertake its annual environmental noise survey at its facility on Aughinish Island, Askeaton, Co. Limerick.

The noise assessment was undertaken in accordance with Conditions and Schedules set out in the Industrial Emissions Licence (IEL) registration number P0035-06. The relevant Conditions and Schedules of the Licence are as follows:

- In accordance with Condition 4.5 of the licence ''*noise from the installation shall not give rise to sound pressure levels ($L_{Aeq,T}$) measured at the specified noise sensitive locations (including those specified in Schedule C.5 Noise Monitoring Locations, of this licence) which exceed the limit value(s).*''

- In accordance with Condition 6.16 of the licence ''*the licensee shall carry out a noise survey of the site operations annually. The survey programme shall be undertaken in accordance with the methodology specified in the 'Guidance Note for Noise: Licence Applications, Surveys and Assessments in Relation to Scheduled Activities (NG4)', as published by the Agency.*''

- In accordance with Schedule B.4 of the licence daytime limits of $L_{Ar\ (30\ minutes)}$ of 55 dB(A), Evening time limits of $L_{Ar(30\ minutes)}$ of 50 dB(A) and Night-time $L_{Aeq\ (15\text{-}30\ minutes)}$ of 45 dB(A) apply. In addition, Schedule B.4 states that "*there shall be no clearly audible tonal component or impulsive component in the noise emission from the activity at any noise sensitive location.*''

- Schedule C.5 *Noise Monitoring* sets out the monitoring locations, parameters to be measured, measurement frequency, measurement periods, and minimum survey duration as tabulated below:

Location	**Measurement**	**Frequency**
NSL1-NSL5 (incl.) B1-B9 Any other NSL which the Agency deems appropriate.	LAeq(15minute) / LAeq(30 minute) LAr,T (30 minute)	Annually
Period	**Minimum Survey Duration**	
Daytime	4 hour survey with a minimum of 3 sampling periods at each monitoring location. **Note2**	
Evening Time	2 hours survey with a minimum of 1 sampling period at each noise monitoring location.	
Night-Time**Note1**	3 hour survey with a minimum of 2 sampling periods at each noise monitoring location.	
Note1: Night-time measurements should be made between 2300hrs and 0400hrs, Sunday to Thursday, with 2300hrs being the preferred start time. Note 2: Sampling period is to be the time period T stated within the relevant licence. Typically this will be either 15 minutes or 30 minutes in duration. This applies to day, evening and night time periods.		

2 Methodology

The noise survey was undertaken in accordance with the 'Guidance Note for Noise: Licence Applications, Surveys and Assessments in Relation to Scheduled Activities (NG4)' as revised and published by the Environmental Protection Agency in January 2016 and in accordance with the Conditions and Schedules of IEL P0035-06.

The survey was carried out on Thursday 1st, Friday 2nd, Monday 26th, Tuesday 27th and Wednesday 28th, August, 2019. The noise survey and report were undertaken by Ms. Siobhan Maher who is a Member of the Institute of Acoustics (MIOA).

2.1 Measurement Locations

The noise survey was conducted at 9 Boundary Locations (B1 to B9) and 5 Noise Sensitive Locations (NSL1 to NSL5) as shown in Figure 1, Attachment 1 and described in Table 1 below. The night time survey for NSL1 was not undertaken in 2019 (or 2017 and 2018) as agreed with the EPA primarily due to the fact that this is an amenity area used during the day and evening times with no residences present that can be affected at night time and secondly due to safety concerns relating to the remoteness of location and unsocial activities recorded there in the past at night. B5 was moved approx. 75m east due to construction/earthmoving activities close to the normal position.

Table 1: Noise Monitoring Locations

Monitoring location	GPS Cordinates	Location type	Location relative to Aughinish Alumina Ltd. installation
B1	528276 655432	Boundary	Located on the North-West corner of the jetty where ships are unloaded and loaded.
B2	528807 653808	Boundary	Located at the North East of the facility, close to the cooling towers.
B3	528676 652702	Boundary	Located towards the North side of the main access road.
B4	528153 651916	Boundary	Located to the South of the facility, close to the Nature Trail car-park.
B5	526797 652555	Boundary	Located to the Western corner of the site in the vicinity of the Bauxite Residue Disposal Area (BRDA). Moved approx. 100m east due to earthworks and HGVs operating close to normal location.
B6	528002 653635	Boundary	Located on the Shore Road providing access to the Southwest of the main facility.

Monitoring location	GPS Cordinates	Location type	Location relative to Aughinish Alumina Ltd. installation
B7	526713 652467	Boundary	Located in the BRDA to the Southwest of the site.
B8	527668 650952	Boundary	Located to the South of the BRDA Phase II.
B9	528780 651096	Boundary	Located to the Southeast of the BRDA Phase II.
NSL1	529168 652761	Noise sensitive location	Located approximately 600m South East of the facility adjacent to Poulaweela Creek.
NSL2	529000 651731	Noise sensitive location	Located approximately 1,200m to the South East of the facility in the vicinity of a residential dwelling.
NSL3	527720 649969	Noise sensitive location	Located approximately 3km to the South of the facility in the townland of Oola.
NSL4	526069 652096	Noise sensitive location	Located approximately 2.6km to the South West. Located at the eastern end of Foynes Port.
NSL5	528805 651209	Noise sensitive location	Located 1.9km directly South of the facility in the vicinity of a residential building at a crossroads.

2.2 Survey Periods

In accordance with IEL P0035-06 and the NG4 Guidelines, three sampling periods are required at each noise monitoring location during the daytime, one sampling period is required during the evening period and two sampling periods are required during the night-time surveys.

Sample periods were 15 minutes for Boundary Locations and 30 minutes for NSLs during the daytime, evening and night-time surveys.

The survey was undertaken during a typical operational production period as required for compliance evaluation.

In total, 54 boundary and 28 NSL measurements were completed. The survey period covered a total of 34 hours including set-up time.

2.3 Weather

Weather conditions were mostly favourable for monitoring of environmental noise during all periods when the survey was carried out. General weather information was sourced from the Met Eireann Shannon Airport Observatory automatic synoptic station. This is shown in Attachment 2.

The weather during the NSL survey on 1st - 2nd August 2019, was warm with temperatures up to 22^{0}C during the daytime dropping to approx. 13^{0}C during the night-time survey. Wind direction varied throughout during the first survey from north/north-easterly in the early morning to north-westerly in the afternoon and south, south-easterly in the evening and night into the early hours of 2nd August 2019. Wind speeds were generally low with calm conditions <0.5 m/sec in the morning and during the evening and night-time periods. Wind speed varied during the afternoon with average speeds up to 1.5m/sec and occasional gusts up to 4m/sec. Conditions were dry.

The boundary survey was undertaken on the 26th, 27th and 28th August 2019. Daytime temperatures on the 26th August were up to 19^{0}C during the day and evening measurement periods. Wind direction was from the south/southwest throughout the day and evening of 26th August with max. speeds recorded in the afternoon of up to 3m/sec however overall conditions were calm and wind speeds were <1 m/sec. Conditions were dry up to approx. 23.30 hrs when light drizzle developed. The survey was halted on 00.15 hrs on 27th August as precipitation became heavier. The night-time survey recommenced on the 27th August at 23.00 hrs until 04.05 hrs on 28th August 2019. Locations B1 – B6 and B9 were monitored during this period. B1 (jetty), B2 (east shoreline) and B6 (west shoreline) were affected by breezy conditions due to their more exposed location in the estuary. The effects in terms of uncertainty on results are discussed in Sections 4.2 and 4.3 of this report. The wind direction was west-south-westerly. Occasional spits of very light drizzle occurred however this did not result in extraneous noise on the microphone.

2.4 Instrumentation

All measurements were undertaken using Type 1 Precision Integrating Sound Level Meters and associated hardware (calibrators, tripod) and type approved software. Calibration certificates for the noise meters and calibrators are presented in Attachment 3.

Details of the monitoring equipment used are provided in Table 2.

Table 2: Monitoring Equipment

Instrument Type	Manufacturer	Model Number	Serial Number
Sound Level Meter	NTi	XL2	A2A-08898-E0
Acoustic Calibrator	Larson Davis	CAL200	11728
Preamplifier & Microphone	NTi	MA2230	8694 & 5062
Sound Level Meter	NTi	XL2	A2A-16311-E0
Acoustic Calibrator	Larson Davis	CAL200	16757
Preamplifier & Microphone	NTi	MA230	8567&A17383

The SLMs including the microphones and the calibrators have been externally calibrated in accordance with standard procedures. All tests are traceable in accordance with ISO/IEC 17025. Attachment 4 contains the calibration certs for the equipment used.

A Testo 410-1 (Serial No. 38463402/711 with manuf. calibration cert) Digital Wind Speed Scale Gauge Meter Anemometer with a range from 0.4 – 20m/s and a temperature range from -10 – 50°C was used on-site to measure wind speeds and temperature.

Data was post analysed using Nti Explorer Software Version 1.85.

2.5 Procedure

The monitoring kit was positioned at each monitoring location. Refer to Attachment 4 for Photolog showing meter locations. Care was taken to ensure that the meters were a minimum distance of 3.5m from any reflective surface other than the ground, and placed upon a tripod with a microphone height of 1.2-1.5m off the ground as per the requirements of NG4. The sound level meters (SLM) was set to record over 15 or 30 minutes as appropriate.

The results were saved to instrument memory for later analysis. Survey personnel noted all primary noise sources contributing to noise measurements. The noise meters were attended. The survey results were noted into Field Notebooks immediately following each measurement.

The meters were calibrated before and at the end of each survey period at a minimum with calibration regularly conducted during the surveys. The drift between calibrations was <0.1 dB for all measurements.

2.6 Measurement Parameters

The survey results are presented in terms of the following parameters:

L_{Aeq} is the A-weighted equivalent continuous sound level. It is a type of average and is used to describe a fluctuating noise in terms of a single noise level (or steady sound) over the sample period.

L_{Amax} is the A-weighted instantaneous maximum sound level measured during the sample period.

L_{A10} is the A-weighted sound level that is exceeded for 10% of the sample period time. It is typically used as a descriptor for intermittent high noise level features during a monitoring event such as road traffic.

L_{A90} is the A-weighted sound level that is exceeded for 90% of the sample period. It is typically used as a descriptor for background noise.

In addition to the above, the following definitions may also apply to the report discussion:

$L_{Ar,T}$ The Rated Noise Level is equal to the L_{Aeq} during a specified time interval (T), plus specified adjustments for tonal character and/or impulsiveness of the sound.

The "A" suffix denotes sound levels that have been "A-weighted" in order to account for the non-linear nature of human hearing to sounds of different frequencies.

Tonal sounds are defined as sounds which cover a range of only a few Hz which contains a clearly audible tone, i.e. distinguishable, discrete or continuous noise (whine, hiss, screech, or hum etc.) are referred to as being 'tonal'.

A simplified objective method for determining if tones are present is set out in Section 5.1 of NG4 and BS4142:2014: Annex C (normative): Objective Method for assessing the audibility of tones in sound: One-third octave method.

According to the simplified method, an audible tone is normally defined as being greater than or equal to the following values in both adjacent one third octave bands:

- 15dB in low frequency one third octave bands (25Hz to 125Hz);
- 8dB in middle frequency bands (160Hz to 400Hz), and;
- 5dB in high frequency bands (500Hz to 10,000Hz).

1/3 Octave Analysis is defined as frequency analysis of sound such that the frequency spectrum is subdivided into narrower bands of one–third of an octave each in order to objectively determine if a sound is tonal or not.

All sound levels in this report are expressed in terms of decibels (dB) relative to $2x10^{-5}$ Pa.

3 Noise Monitoring Results

Detailed noise monitoring summary sheets for all noise monitoring locations are appended as Attachment 5 of this report. These sheets contain the logged values for the main parameters measured over time and the overall spectrum recorded at each location for each individual measurement. Attachment 6 contains the tabulated 1/3 octave band spectral data as required under the revised NG4 Guidelines, 2016.

A summary of the overall main parameters $L_{Aeq,t}$, L_{Amax}, $L_{A90,t}$, $L_{A10,t}$ measured at each location and findings of tonal analysis in accordance with BS4142:2014: Annex C for day, evening and night time measurements are outlined in Tables 3 to 5 overleaf respectively.

A summary assessment of compliance with the limit values and conditions at NSLs is also presented in Tables 3 to 5. Where an $L_{Aeq't}$ value is below the required limit value for NSLs with no tones or impulsive sound present, then no further detailed analysis of the logged data has been conducted and the L_{Aeq} is listed as the $L_{Ar,T}$ even though the facility related sound may actually be lower as the L_{Aeq} may have been influenced by extraneous sources. Where the $L_{Aeq,t}$ exceeds the limit value then further detailed analysis is conducted and commentary provided to determine an appropriate $L_{Ar,t}$.

Boundary locations are not NSLs and therefore the limit values have not been applied to these measurements as indicated in the tables overleaf.

Table 3: Daytime Noise Monitoring Results Summary

Noise location	Date Time	L_{Aeq}	L_{Amax}	L_{A10}	L_{A90}	Tonal or Impulsive noise* (Y/N)	L_{AR}	Comments (ex. main noise sources on site, & extraneous noise ex. road traffic)	IEL Limit	Is L_{Ar} compliant with noise limit?
Noise Sensitive Locations - Monitoring Results										
NSL1	2019-08-01 08.21	42	55	43	39	No	42	**Facility**. Steady broadband sound predominant from the facility. Intermittent off-loading of material audible; - non-impulsive. Facility was quieter during #3. Potential tone associated with the facility investigated at 250Hz but does not satisfy criteria. Both unweighted L_{eq}, and L_{90} spectra evaluated. Potential tones at high frequencies are due to birds. **Other.** Song birds and gulls cackling at times. Airplanes overhead; - low flying during #3 resulting in slight increase in L_{Aeq}.	55	Yes
	2019-08-01 08.51	41	57	42	38	No	41		55	Yes
	2019-08-01 09.24	43	61	44	36	No	43		55	Yes
NSL2	2019-08-01 15.37	46	71	43	32	No	46	**Facility**. Main sound from facility is slightly audible and broadband with just discernible mid-frequency underlying sound. No sound from BRDA. **Other.** Birds tweeting. Strimmer on at times to east. Distant traffic on N69 was not particularly audible as location was upwind during survey. Occasional passing traffic on local road increasing L_{Aeq} above L_{A10}. Airplanes pass overhead. Alarm type noise during #3. Not from facility.	55	Yes
	2019-08-01 16.07	48	74	41	32	No	48		55	Yes
	2019-08-01 16.37	52	81	47	31	No	52		55	Yes

Noise location	Date Time	L_{Aeq}	L_{Amax}	L_{A10}	L_{A90}	Tonal or Impulsive noise* (Y/N)	L_{AR}	Comments (ex. main noise sources on site, & extraneous noise ex. road traffic)	IEL Limit	Is L_{Ar} compliant with noise limit?
NSL3	2019-08-01 13.49	38	60	39	31	No	38	**Facility.** Facility very faintly audible at times as location was downwind but not always audible. **Other**. Frequent traffic on the N69 predominant constant noise source. Occasional passing cars on local access road during #2 increasing L_{Aeq} above L_{A10}. Airplanes pass overhead during all measurements.	55	Yes
	2019-08-01 14.22	47	74	41	32	No	47		55	Yes
	2019-08-01 14.53	40	61	42	32	No	40		55	Yes
NSL4	2019-08-01 12.02	56	81	57	42	No	42	**Facility**: Facility inaudible. Wind direction NNW therefore location is cross wind. **Other.** Port activities predominant. Crane engines on and truck engines idling nearby at times. Traffic on port spine road. Continuous pump-like source associated with the port bulk tanks to southwest and premises to south of monitoring location. Occasional planes overhead. As port noise was predominant and the facility was inaudible, the L_{A90} value is stated as the $L_{AR,t}$ for #1 where the L_{Aeq} is above the daytime limit.	55	Yes
	2019-08-01 12.36	53	76	48	40	No	53		55	Yes
	2019-08-01 13.07	53	79	48	38	No	53		55	Yes
NSL5	2019-08-01 10.02	57	80	56	33	No	33	**Facility.** No sound from the BRDA. Main facility is barely audible to inaudible.	55	Yes

Noise location	Date Time	L_{Aeq}	L_{Amax}	L_{A10}	L_{A90}	Tonal or Impulsive noise* (Y/N)	L_{AR}	Comments (ex. main noise sources on site, & extraneous noise ex. road traffic)	IEL Limit	Is L_{Ar} compliant with noise limit?
	2019-08-01 10.32	58	81	55	32	No	32	**Other**. Traffic on the local access road increased the L_{Aeq} values. Refer to logging in Attachment 5 showing peaks. N69 continuous and distant traffic influencing L_{A90} values. Large trucks passing resulted in L_{Amax} values recorded. Planes overhead. The rating value is set at the L_{A90} due to the predominance of extraneous sources affecting the L_{Aeq} and the faint audibility of the facility.	55	Yes
	2019-08-01 11.06	58	81	55	32	No	32		55	Yes
Boundary Location - Noise Monitoring Results										
B1	2019-08-26 09.13	67	88	71	57	N/A	N/A	Minor construction works including the erection of scaffolding occurring during #1 close to the meter. Low-flying overhead plane at 9.19. Low frequency continuous hum from jetty process area. Reverse beepers and grinding intermittent. Occasional parking vans close to meter. Much less activity on wharf during #3.	N/A	N/A
	2019-08-26 09.29	61	86	62	55	N/A	N/A		N/A	N/A
	2019-08-26 09.44	58	78	60	54	N/A	N/A		N/A	N/A
B2	2019-08-26 10.30	56	73	55	53	N/A	N/A	Facility sources predominant. Internal vehicles and overhead planes caused peaks.	N/A	N/A
	2019-08-26 10.30	56	70	59	54	N/A	N/A		N/A	N/A
	2019-08-26 11.04	56	73	57	54	N/A	N/A		N/A	N/A
B3	2019-08-26 13.47	60	80	62	57	N/A	N/A	Facility sources predominant both fixed and mobile. Cars, vans and trucks drive out from the facility entrance past the meter.	N/A	N/A
	2019-08-26 14.04	57	67	58	57	N/A	N/A		N/A	N/A
	2019-08-26 14.19	59	76	60	57	N/A	N/A		N/A	N/A

Noise location	Date Time	L_{Aeq}	L_{Amax}	L_{A10}	L_{A90}	Tonal or Impulsive noise* (Y/N)	L_{AR}	Comments (ex. main noise sources on site, & extraneous noise ex. road traffic)	IEL Limit	Is L_{Ar} compliant with noise limit?
B4	2019-08-26 14.53	49	70	49	37	N/A	N/A	BRDA sources audible throughout intermittently but 3 cars passed right by the meter during #1. Birds tweeting. Passing cars on access road to AAL also intermittent. Clanking and squeaking sounds from the BRDA in close proximity to B4 during #3.	N/A	N/A
	2019-08-26 15.08	48	68	50	35	N/A	N/A		N/A	N/A
	2019-08-26 15.23	49	66	53	36	N/A	N/A		N/A	N/A
B5	2019-08-26 11.38	56	82	55	46	N/A	N/A	Meter moved slightly due to earthworks and heavy facility access at usual location causing safety concerns for monitoring. Meter moved to beside Observation wells 11,12,22, approx. 100m east. JCB and passing vehicles affecting measurements.	N/A	N/A
	2019-08-26 11.57	49	68	52	37	N/A	N/A		N/A	N/A
	2019-08-26 12.15	41	65	42	37	N/A	N/A		N/A	N/A
B6	2019-08-26 10.17	58	67	60	56	N/A	N/A	Sound from main facility predominant. Some birds tweeting. Wind speed 1.7 – 3.0 m/sec from south. Overhead plane during #3. Some passing vehicles on Shore Road.	N/A	N/A
	2019-08-26 10.39	58	65	59	54	N/A	N/A		N/A	N/A
	2019-08-26 10.58	57	80	59	54	N/A	N/A		N/A	N/A
B7	2019-08-26 11.49	54	83	51	37	N/A	N/A	Location beside electrical facility in BRDA. Some passing HGVs carrying stone to works near B5 during #1 and #2. Emergency alarm check was completed at 12.00 hrs and audible during #1. Some facility occasionally audible on BRDA to south. Quiet otherwise.	N/A	N/A
	2019-08-26 12.04	55	81	49	38	N/A	N/A		N/A	N/A
	2019-08-26 12.19	42	59	44	38	N/A	N/A		N/A	N/A
B8	2019-08-26 12.43	40	61	39	30	N/A	N/A		N/A	N/A

Noise location	Date Time	L_{Aeq}	L_{Amax}	L_{A10}	L_{A90}	Tonal or Impulsive noise* (Y/N)	L_{AR}	Comments (ex. main noise sources on site, & extraneous noise ex. road traffic)	IEL Limit	Is L_{Ar} compliant with noise limit?
	2019-08-26 12.59	34	52	37	31	N/A	N/A	Works on BRDA stopped. Car pass by, overhead plane during #1. 13.21 passing dumper truck during #3. Birds tweeting and cattle lowing. N69 traffic main continuous background source.	N/A	N/A
	2019-08-26 13.14	50	74	38	30	N/A	N/A		N/A	N/A
B9	2019-08-26 13.56	47	65	50	36	N/A	N/A	N69 and local traffic predominant. Barking dog in distance. No sound from BRDA.	N/A	N/A
	2019-08-26 14.14	44	59	47	35	N/A	N/A		N/A	N/A
	2019-08-26 14.30	45	62	49	36	N/A	N/A		N/A	N/A

**Only tones or impulsive sounds associated with the AAL operations are considered.*

Table 4: Evening Noise Monitoring Results Summary

Noise location	Date / Time	L_{Aeq}	L_{Amax}	L_{A10}	L_{A90}	Tonal or Impulsive noise* (Y/N)	$L_{Ar,}$	Comments (ex. main noise sources on site, & extraneous noise ex. road traffic)	IEL Limit	Is L_{Ar} compliant with noise limit?
Noise Sensitive Locations - Monitoring Results										
NSL1	2018-09-01 19.47	47	68	44	37	No	47	**Facility**. Steady broadband facility noise audible. **Other**. Car turning close to meter. L_{A10} therefore less than L_{Aeq}. Low flying overhead plane.	50	Yes
NSL2	2018-08-01 20.24	48	73	46	36	No	48	**Facility**: Faint facility noise (broadband) just audible. **Other.** Birdsong. Occasional passing traffic on local road increasing L_{Aeq} above L_{A10}. Distant traffic on N69 is the main source audible. A lawnmower was audible in the distance.	50	Yes
NSL3	2019-08-01 21.34	45	62	47	37	No	45	**Facility**: Facility not audible. **Other.** Traffic on the N69 is steady and dominant. Airplane overhead.	50	Yes
NSL4	2019-08-01 22.22	35	56	36	26	No	35	**Facility.** Facility not audible. Wind direction SSW. **Other.** N69 traffic noise audible. Tonal sound from pumps in adjoining port bulk tanks.	50	Yes

Noise location	Date / Time	L_{Aeq}	L_{Amax}	L_{A10}	L_{A90}	Tonal or Impulsive noise* (Y/N)	$L_{Ar,}$	Comments (ex. main noise sources on site, & extraneous noise ex. road traffic)	IEL Limit	Is L_{Ar} compliant with noise limit?
NSL5	2019-08-01 20.58	55	77	50	34	No	34	**Facility.** Faint facility noise only barely audible during times of very low local noise. Individual sources not distinctive. **Other**. Traffic on the N69 and traffic on local roads the primary sources of noise, as cars pass by close to meter raising the L_{Aeq} to above the evening time limit. The rating value is set at the L_{A90} due to the predominance of extraneous sources affecting the L_{Aeq}.	50	Yes
Boundary Monitoring Location Results.										
B1	2019-08-26 20.39	65	85	68	62	N/A	N/A	Ship unloading in process increased noise levels compared to daytime. Rumbling and gantry alarm.	N/A	N/A
B2	2019-08-26 20.07	56	66	56	55	N/A	N/A	Facility sound predominant. One passing vehicle.	N/A	N/A
B3	2019-08-26 19.44	60	64	61	60	N/A	N/A	Facility sound predominant. Plane overhead 19.51hrs	N/A	N/A
B4	2019-08-26 19.22	47	64	52	30	N/A	N/A	Most sound from GAA and Nature Park leisure users with cars arriving and departing. No sound from BRDA or main facility.	N/A	N/A
B5	2019-08-26 21.32	47	67	36	30	N/A	N/A	Very calm. Main facility and N69 barely audible. A loud low flying plane passed overhead at 21.40 resulting in increase in $L_{Aeq,t}$.	N/A	N/A

Noise location	Date / Time	L_{Aeq}	L_{Amax}	L_{A10}	L_{A90}	Tonal or Impulsive noise* (Y/N)	$L_{Ar,}$	Comments (ex. main noise sources on site, & extraneous noise ex. road traffic)	IEL Limit	Is L_{Ar} compliant with noise limit?
B6	2019-08-26 21.07	57	65	59	55	N/A	N/A	Facility sound predominant.	N/A	N/A
B7	2019-08-26 21.58	31	52	32	29	N/A	N/A	Predominant noise was hum from electricity plant. Other noises were from water trickling from outfall pipe and Birds tweeting.	N/A	N/A
B8	2019-08-26 22.26	31	60	35	23	N/A	N/A	N69 traffic noise predominant. Quiet otherwise.	N/A	N/A
B9	2019-08-26 19.07	46	61	51	36	N/A	N/A	Facility inaudible. No sound from BRDA. Passing vehicles on local access road and N69 traffic predominant noise sources.	N/A	N/A

**Only tones or impulsive sounds associated with the AAL operations are considered.*

Table 5: Night-Time Noise Monitoring Results Summary

Noise location	Date/ Time	L_{Aeq}	L_{Amax}	L_{A10}	L_{A90}	Tonal or Impulsive noise* (Y/N)	Comments (ex. main noise sources on site, & extraneous noise ex. road traffic)	IEL Limit	Is the L_{Aeq} compliant with noise limit?
Noise Sensitive Locations - Monitoring Results									
NSL2	2019-08-02 02.34	32	56	36	24	No	**Facility**: Facility audible as a broadband source. Individual sources were not distinct. **Other:** Distant traffic on N69 occasionally audible.	45	Yes
	2019-08-02 03.05	33	57	36	30	No		45	Yes
NSL3	2019-08-02 00.13	35	55	39	19	No	**Facility**. Facility inaudible. **Other.** Traffic on N69, predominant but reduced and intermittent.	45	Yes
	2019-08-02 00.44	38	61	43	20	No		45	Yes
NSL4	2019-08-01 23.00	37	55	40	30	No	**Facility.** Facility inaudible. **Other.** Port bulk tank pumps on with steady tone at 80Hz and intermittent tone at 160Hz.	45	Yes
	2019-08-01 23.32	37	55	40	32	No		45	Yes
NSL5	2019-08-02 01.25	48	75	41	21	No	**Facility.** Facility faintly audible. **Other**. Occasional traffic passing on the local access road and the N69. Not much distant traffic. Very calm; - no breeze. Occasional fast passing traffic on local road increasing L_{Aeq} above L_{A10}. The L_{A90} represents facility noise due to the predominance of extraneous sources affecting the L_{Aeq}.	45	Yes
	2019-08-02 01.55	42	73	34	21	No		45	Yes

Noise location	Date/ Time	L_{Aeq}	L_{Amax}	L_{A10}	L_{A90}	Tonal or Impulsive noise* (Y/N)	Comments (ex. main noise sources on site, & extraneous noise ex. road traffic)	IEL Limit	Is the L_{Aeq} compliant with noise limit?
Boundary Location - Noise Monitoring Results									
B1	2019-08-28 01.30	65	74	67	64	N/A	Ship engine running and tugs moving around likely preparing for ship departure. Ship or tug engine was loud. At 01.54 during #2 the engine reduced down to a “stand-by” level; - refer to logging in Attachment 5 illustrating effect. Wind was up to 8m/sec at times however the ship noise was predominant as evidenced by effect of engine switching off (refer to logging Attachment 5).	N/A	N/A
	2019-08-28 01.46	63	70	65	58	N/A		N/A	N/A
B2	2019-08-28 00.43	60	66	61	59	N/A	Main adjacent facility predominant. Low hum from jetty was also audible. Breeze was up to 6 m/sec occasionally during #1 but then died down. Average was 2.7m/sec. Location screened from main effects of wind as a source from west as at lower ground level.	N/A	N/A
	2019-08-28 00.58	60	70	62	59	N/A		N/A	N/A
B3	2019-08-28 02.39	59	61	60	59	N/A	Facility sound predominant.	N/A	N/A
	2019-09-28 02.56	60	68	60	59	N/A		N/A	N/A
B4	2019-08-28 02.45	43	66	45	38	N/A	Main facility audible as a continuous source. Continuous leaves rustling during #1 increased all parameters compared to #2. Passing cars on AAL access road.	N/A	N/A
	2019-09-28 03.02	41	60	40	33	N/A		N/A	N/A
B5	2019-08-27 22.59	37	58	40	32	N/A	Overhead plane 23.06; water trickling sound but adjoining Foynes port noise was clearly audible. N69 traffic occasionally audible. Wind speeds varied between 0.8 – 1.4m/sec but increased at times up to 4.5m/sec during #2. Westerly direction. Location downwind of Foynes port.	N/A	N/A
	2019-08-27 23.14	36	55	39	33	N/A		N/A	N/A

Noise location	Date/ Time	L_{Aeq}	L_{Amax}	L_{A10}	L_{A90}	Tonal or Impulsive noise* (Y/N)	Comments (ex. main noise sources on site, & extraneous noise ex. road traffic)	IEL Limit	Is the L_{Aeq} compliant with noise limit?
B6	2019-08-27 23.39	54	61	56	52	N/A	Facility sound predominant. Breeze was up to 7m/sec at times during #1. Location was upwind of prevailing wind. Difference between measurements is due to wind as it has reduced during #2.	N/A	N/A
	2019-08-27 02.15	51	62	53	50	N/A		N/A	N/A
B7	2019-08-26 23.36	31	55	31	28	N/A	Predominant noise was hum from electricity plant. Other noises from water flowing from outfall pipe.	N/A	N/A
	2019-08-26 23.56	32	55	35	28	N/A		N/A	N/A
B8	2019-08-26 23.00	29	55	30	24	N/A	N69 distant traffic noise predominant with occasional bird calls.	N/A	N/A
	2019-08-26 23.15	32	60	34	26	N/A		N/A	N/A
B9	2019-08-28 03.32	31	46	33	30	N/A	Facility slightly audible as broadband source. No traffic on the N69 except one off vehicles in distance. One jeep turned at crossroads. 2 passing cars on local road during #2.	N/A	N/A
	2019-08-28 03.50	40	60	37	30	N/A		N/A	N/A

Only tones or impulsive sounds associated with the AAL operations are considered.

4 Discussion of Results

In addition to the summary tables presented in Section 3, a further brief discussion of the monitoring results recorded at the NSLs and boundary locations is presented below. Results for 2019 are compared to historical values since 2010 onwards for both NSLs and boundary locations. The effects of location, terrain and meteorological conditions are considered below where necessary. Section 4.3 presents a Statement of Uncertainty as required under the NG4 revised Guidelines, 2016.

4.1 Noise Sensitive Locations (NSLs)

4.1.1 NSL Daytime Results

The daytime $L_{Ar(30\ min)}$ 55 dB was not exceeded at any of the NSLs due to facility related sound. Facility related sound was mostly faint to inaudible at all NSLs with the exception of NSL1 where it was clearly audible. The $L_{Aeq,30min}$ values recorded were below the daytime limit value at NSL1, 2 and 3 but above it at NSL 4 (one of three measurements only) and 5. Both of these locations were dominated by extraneous sources. The facility noise was either inaudible at NSL4 (Foynes Port) or low to faint at NSL5. NSL5 is dominated by traffic noise. The L_{AF} values observed during lulls in traffic noise were noted to be < 45 dB. Accordingly, the daytime limit was complied with at NSL5.

The daytime values recorded at the NSLs are within the range typically recorded historically. In general, extraneous sources are responsible for differences that occur with the exception of NSL1 which is the closest to the facility.

4.1.2 NSL Evening Time Results

The evening time $L_{Ar(30\ minute)}$ 50dB was not exceeded at any of the NSLs due to facility related sound. As during the day, facility related sound was mostly faint to inaudible with the exception of NSL1 where it was clearly audible. The $L_{Aeq(30\ minute)}$ values recorded were below the evening time limit value at all NSLs with the exception of NSL5. The elevation of the $L_{Aeq(30\ minute)}$ value at NSL5 during the evening was due extraneous sources; mainly passing traffic. The facility sound is therefore best represented by the $L_{A90(30\ minute)}$ value at this location. Accordingly, the evening time limit was complied with at NSL5.

Evening time monitoring originally commenced in 2013 in accordance with the latest license conditions. Variations between day and evening, within the evening period and between years is due to variations in extraneous sources.

4.1.3 NSL Night-Time Results

The night time $L_{Aeq(30\ minute)}$ 45dB was not exceeded at any of the NSLs due to facility related sound. Facility related sound was inaudible at NSL3 and NSL4 although it was audible and faintly audible at NSL2 and NSL5 respectively. The $L_{Aeq,30min}$ values recorded were below the night-time limit value at all NSLs with the exception of measurement #1 at NSL5. This location is beside the AAL access road and the $L_{Aeq,30min}$ value recorded was due to individual fast passing vehicles on the local access road and the N69. The $L_{A90(30\ minute)}$ value is considered to be more representative of facility related sound.

Overall the night-time values were within the range typically recorded at NSLs since 2010.

4.2 Boundary Locations

There are nine boundary locations varying in proximity to the main facility sources.

B1 is located on the jetty approx. 1km out into the estuary and noise levels recorded at this point were significantly influenced by a number of different activities occurring during the day, evening and night-time periods. During the 2019 survey, some scaffolding was being erected at the jetty offices close to B1. When this ceased daytime $L_{Aeq,15min}$ values reduced. A ship was being unloaded during the evening time survey, while ship/tug engines predominated during the night-time survey. When the engine(s) went to stand-by during the second night-time measurement, noise levels significantly dropped on the jetty compared to 1st measurement as shown in the logging for B1 in Attachment 5. Breezy conditions above recommended wind speeds for monitoring prevailed on the jetty during the night-time survey however the ship/tug engine noise was loud and predominant over this. Values recorded are within the range historically recorded for this location; albeit at the upper end of the range due to the type of activities taking place during the 2019 survey.

As in previous years, B2, B3 and B6 were dominated by (day, evening and night) facility related noise sources as they are located in close proximity to the main facility.

Noise levels at B2 were within the historical range with the exception of the night-time survey. This location was downwind of the facility during the night-time and it is considered that the facility related sound levels recorded increased by approx. 3 decibels due to wind conditions present. Notwithstanding this, the AAL port activities were also audible at B2 during the night-time even though the port was cross-wind of B2.

Levels recorded at B3 were within the range typically recorded for this location.

Noise levels at B6 were higher than previously recorded during the daytime period at this location and were at the upper end of the range for the evening time. However, the levels recorded were within the overall range independent of survey period time.

By contrast, B4 and B9 are located further away from the main facility and are also screened from the BRDA by mounding created along the boundary. Sounds emanating from the BRDA were audible at B4 during the daytime survey but not at B9. Both locations were more significantly influenced by extraneous sources which can vary considerably during the day, evening and night. For example, B4 is close to a Nature Trail which can be busier in the evening compared to the daytime. Noise levels recorded at B4 and B9 were within the historical range recorded.

B5, B7 and B8 are within the BRDA. B7 and B8 and, to a lesser extent B5, are not particularly influenced by the main facility noise sources. Sources causing variability at B5, B7, and B8 between day evening and night time and also between years include site specific sources such as the operation of the sprinkler system and tractors in the BRDA as well as the presence of extraneous sources;- e.g. depending on wind direction, the N69 can influence $L_{A90,15min}$ values, especially at B8. B5 was moved approx. 100m east during the current survey for safety reasons as there were a number of HGVs operating intermittently in close proximity to the normal location during the daytime period. Foynes Port sources (bulk tank pumps) to the west were audible at B5 during the night-time survey. In summary, it is noted that the day, evening and night-time results for B5, B7 and B8 boundary locations are within the range recorded historically.

4.3 Statement of Uncertainty

As required under the 2016 NG4 Guidelines, the level of uncertainty in the measurement data is considered below.

Weather conditions can affect the results of noise monitoring. Aughinish Island covers a wide area and, although the general forecast for the area can be for suitable wind speeds it is possible, at times, that locations B1, B2 and B6 which are at sea or on the western and eastern shore roads can be affected by gusts above favourable levels for noise monitoring. These locations are however dominated by facility noise and activities and the level of noise from activities is generally higher than wind induced effects. Very breezy conditions occurred at B1 during the 2019 night-time survey however a ship and/or tug engines were on which were significant and therefore it is not considered that the wind caused significant deviations from noise levels that would otherwise have been recorded at this location. B2 was likely to have been affected by wind carry over of process related sound by approx. 3 decibels during the night-time. The prevailing wind was westerly and therefore B2 was downwind of facility sources. B6 was upwind during the night-time monitoring period and therefore may be slightly under-estimated based on the day and evening time measurements when calmer conditions prevailed.

Drift on the meter between calibrations was <0.1 dB and therefore well within acceptable levels.

Post - processing rounding of values was only completed on final results.

Type 1 meters were used. The degree of tolerance for a Type 1 meter is +/- 0.7 dB.

Detailed notes were taken during the measurements and the L_{AF} values observed during lulls in extraneous noise to assist in assessing compliance levels.

Repeat measurements correlated well during the 2019 survey. 2019 results were within the range historically recorded.

5 Conclusions and Recommendations

Noise monitoring was conducted in August 2019 at boundary locations and NSLs associated with the Aughinish Alumina Ltd. facility.

Day-time, evening and night time monitoring results for facility related sound were compliant with the daytime, evening and night time specified limits of $L_{Ar(30\ minute)}$ 55 dB, $L_{Ar(30\ minute)}$ 50 dB and $L_{Aeq(30\ minute)}$ 45 dB respectively at all NSLs.

No tones or impulsive noise associated with the activities at the facility were recorded during the survey periods at any NSLs during all monitoring periods.

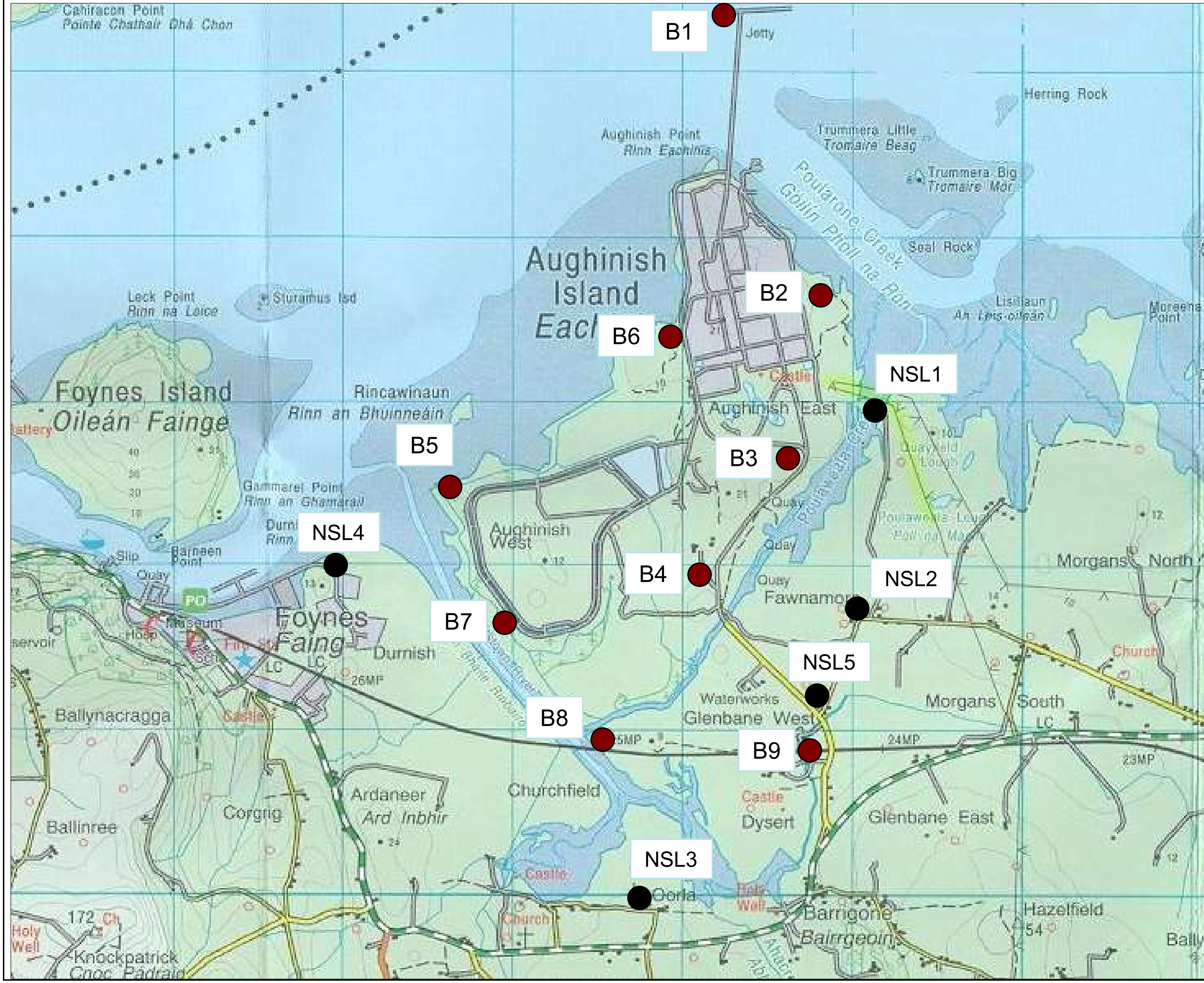
The results for boundary monitoring locations were within the range recorded historically for day, evening and night-time periods.

6 References

'Guidance Note for Noise: Licence Applications, Surveys and Assessments in Relation to Scheduled Activities (NG4)' as revised and published by the Environmental Protection Agency in January 2016.

Attachment 1 - Site Location Map

Committed to **your** success



Legend

Boundary Monitoring Locations (B)

Noise Sensitive Locations (NSL)

RUSAL

OES Consulting 2nd Floor, FBD House, Fels Point, Tralee, Kerry
T: (066) 7128321 F: (066) 7180061 E: info@oes.ie

Client: Aughinish Alumina Ltd (Rusal)

Project: Environmental Noise Survey

Title: Noise Monitoring Locations

Scale	1:30,303
Ref.	11/08/2014
OES Ref.	F1_1017_30
Revision	01
Document Control	By: KG
	Chkd By: TQ
	App. By: TQ

Attachment 2 - Met Data

Committed to **your** success

DAILY DATA

Weather station Data is available from 16/10/2015 to 26/08/2019

Select Station & Date:

Station

Shannon Airport ▼

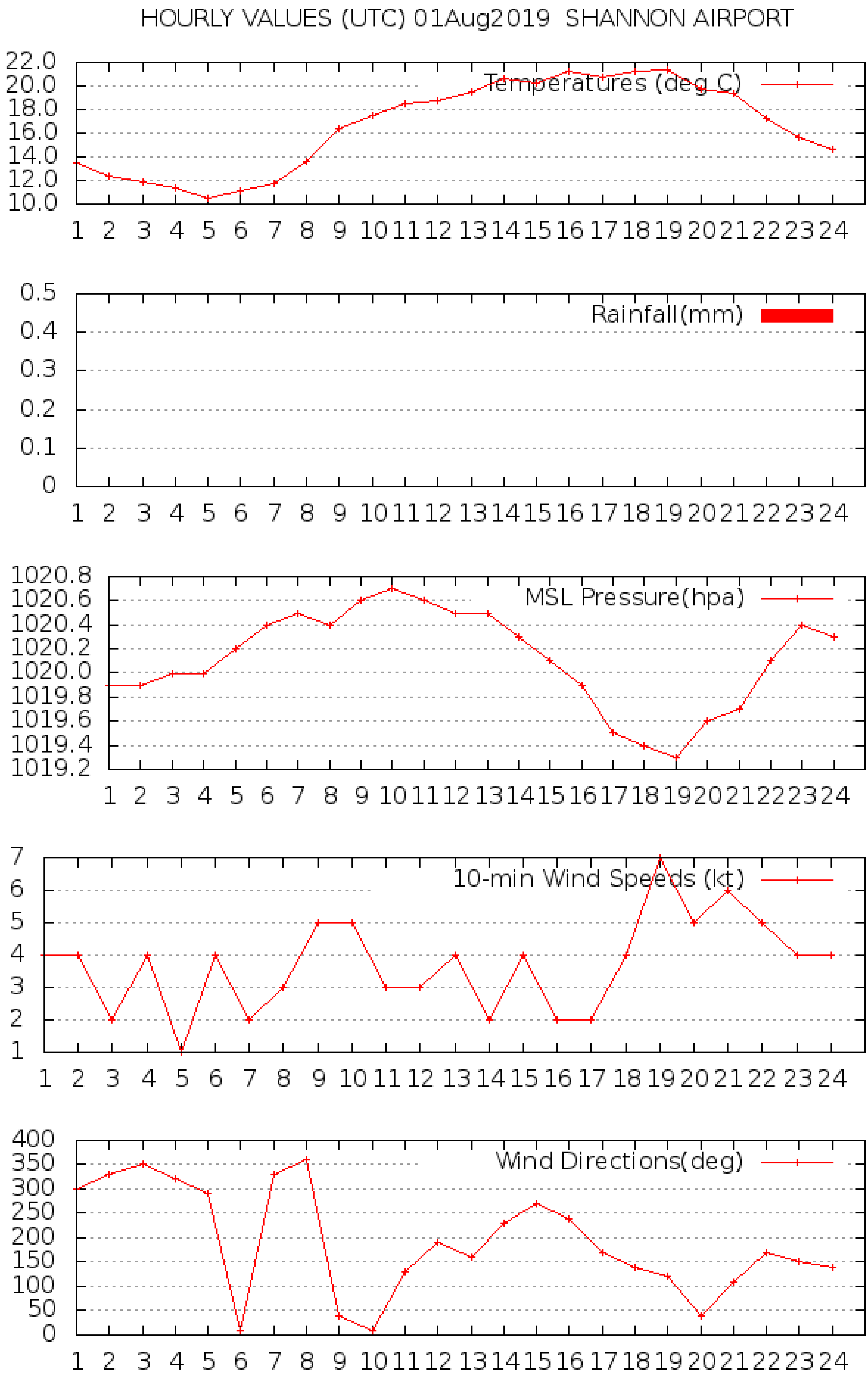
Date

01/08/2019 ▼

GO

WEATHER STATION REPORTS FROM SHANNON AIRPORT

Date	**Rainfall** (mm)	**Max Temp** (°C)	**Min Temp** (°C)	**Grass Min Temp** (°C)	**Mean Wind Speed** (knots)	**Max Gust** (>= 34 knots)	**Sunshine** (hours)
01/08/2019	tr	21.8	10.4	7.5	3.7		9.2



(https://www.met.ie)

DAILY DATA

Weather station Data is available from 16/10/2015 to 26/08/2019

Select Station & Date:

Station

Shannon Airport ▼

Date

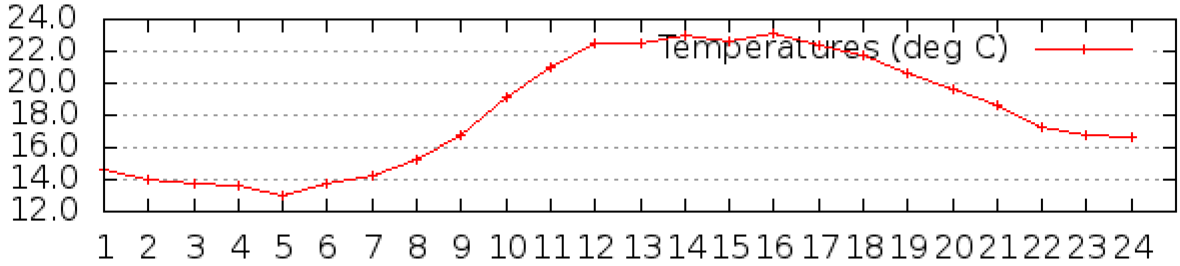
02/08/2019 ▼

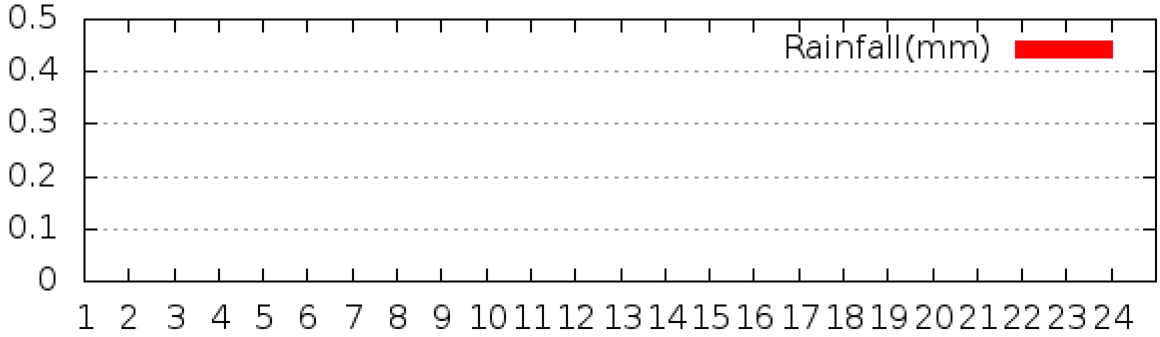
GO

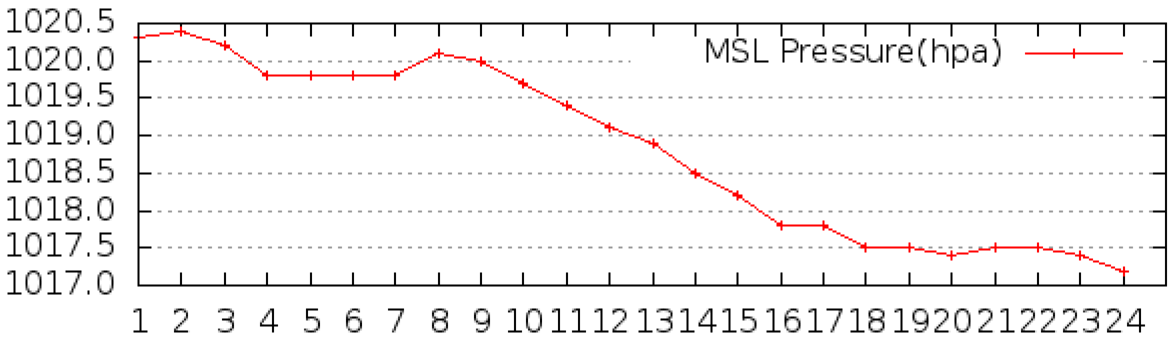
WEATHER STATION REPORTS FROM SHANNON AIRPORT

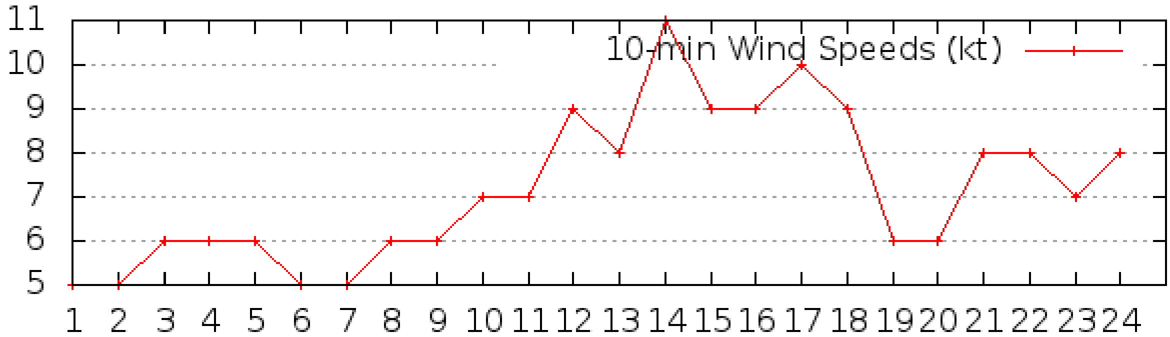
Date	**Rainfall** (mm)	**Max Temp** (°C)	**Min Temp** (°C)	**Grass Min Temp** (°C)	**Mean Wind Speed** (knots)	**Max Gust** (>= 34 knots)	**Sunshine** (hours)
02/08/2019	tr	23.6	13.0	10.9	7.2		8.5

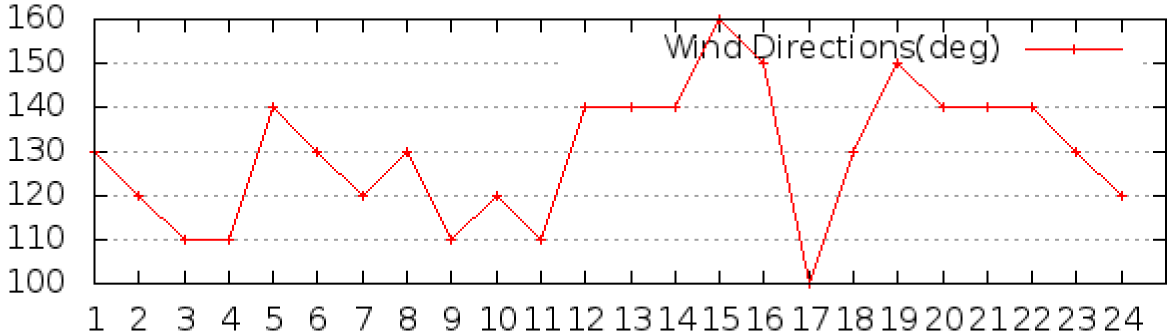
HOURLY VALUES (UTC) 02Aug2019 SHANNON AIRPORT











(https://www.met.ie)

DAILY DATA

Weather station Data is available from 16/10/2015 to 28/08/2019

Select Station & Date:

Station

Shannon Airport ▼

Date

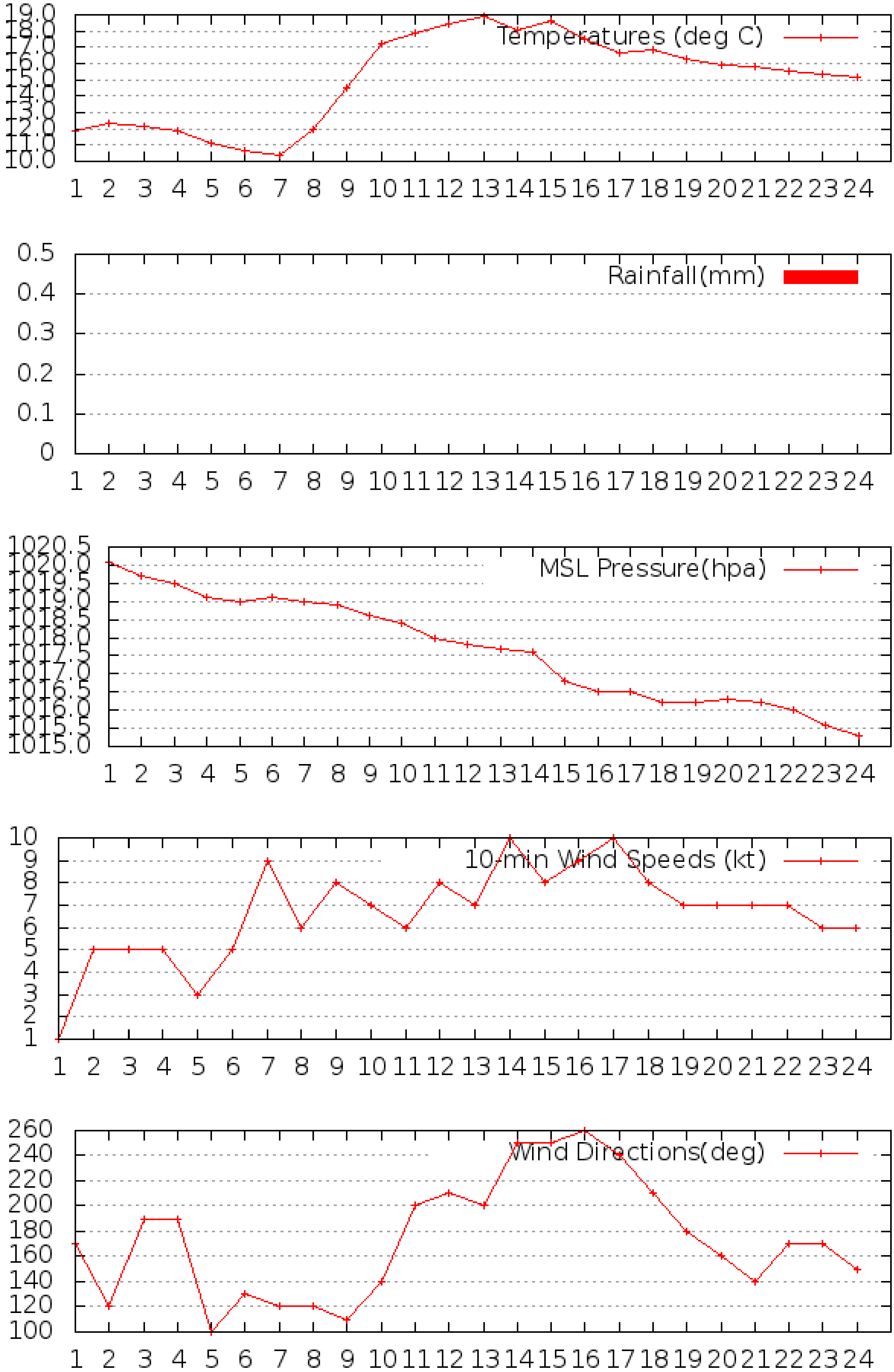
26/08/2019 ▼

GO

WEATHER STATION REPORTS FROM SHANNON AIRPORT

Date	**Rainfall** (mm)	**Max Temp** (°C)	**Min Temp** (°C)	**Grass Min Temp** (°C)	**Mean Wind Speed** (knots)	**Max Gust** (>= 34 knots)	**Sunshine** (hours)
26/08/2019	tr	19.1	10.3	7.4	6.7		6.0

HOURLY VALUES (UTC) 26 Aug 2019 SHANNON AIRPORT



(https://www.met.ie)

DAILY DATA

Weather station Data is available from 16/10/2015 to 28/08/2019

Select Station & Date:

Station

Shannon Airport ▼

Date

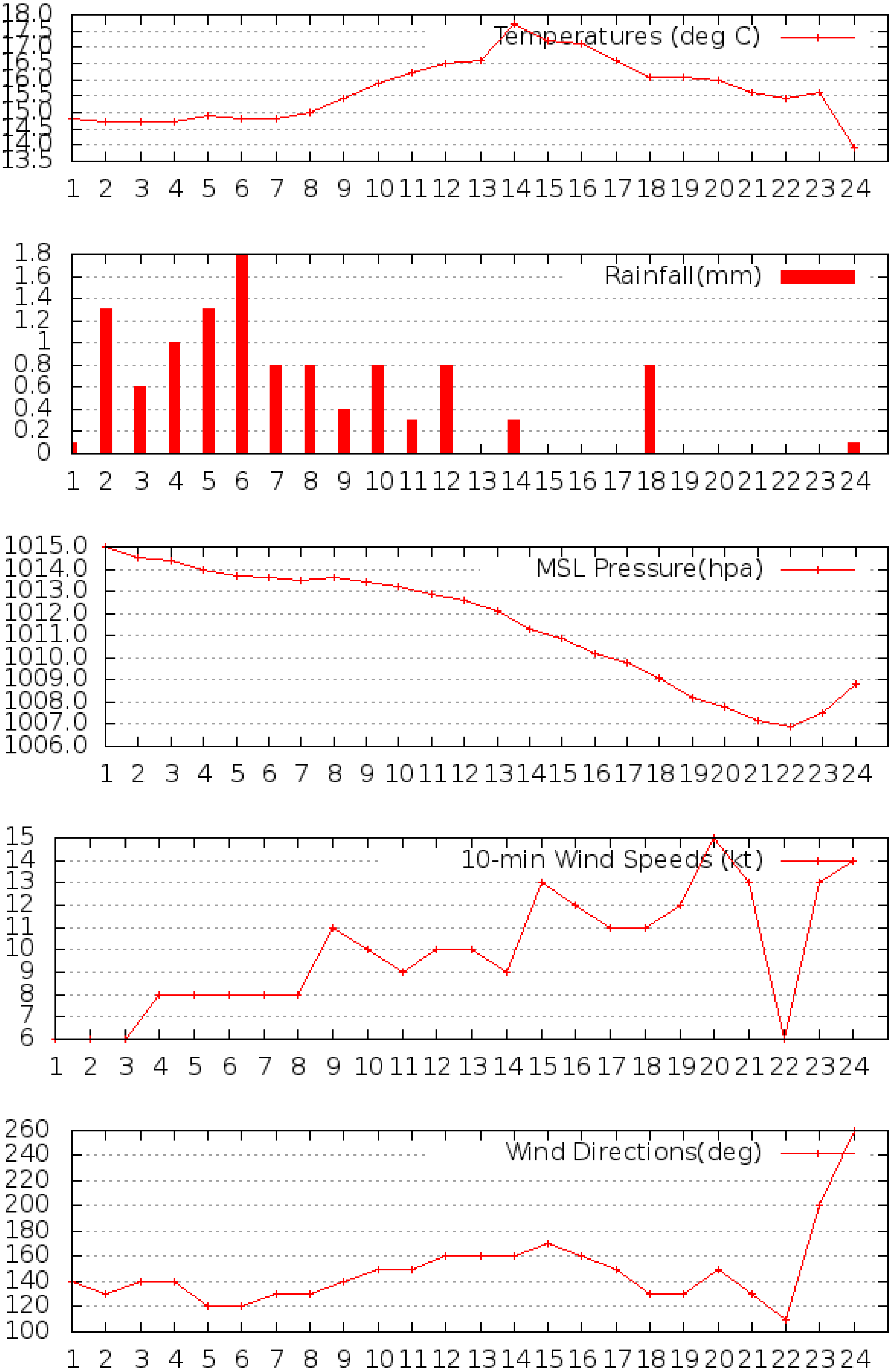
27/08/2019 ▼

GO

WEATHER STATION REPORTS FROM SHANNON AIRPORT

Date	**Rainfall** (mm)	**Max Temp** (°C)	**Min Temp** (°C)	**Grass Min Temp** (°C)	**Mean Wind Speed** (knots)	**Max Gust** (>= 34 knots)	**Sunshine** (hours)
27/08/2019	12.5	17.7	13.8	13.4	9.9		0.0

HOURLY VALUES (UTC) 27Aug2019 SHANNON AIRPORT



(https://www.met.ie)

DAILY DATA

Weather station Data is available from 16/10/2015 to 28/08/2019

Select Station & Date:

Station

Shannon Airport ▼

Date

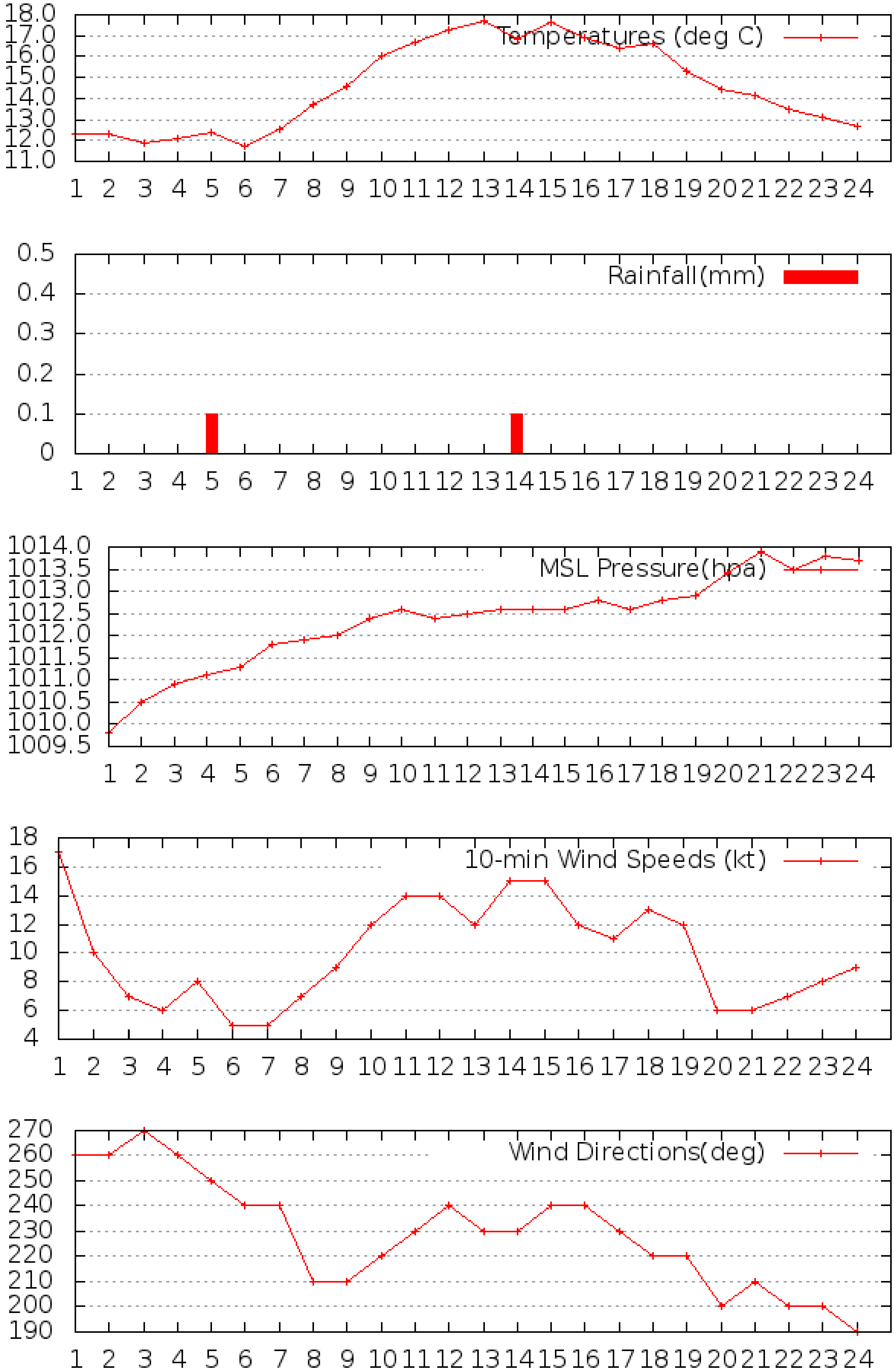
28/08/2019 ▼

GO

WEATHER STATION REPORTS FROM SHANNON AIRPORT

Date	**Rainfall** (mm)	**Max Temp** (°C)	**Min Temp** (°C)	**Grass Min Temp** (°C)	**Mean Wind Speed** (knots)	**Max Gust** (>= 34 knots)	**Sunshine** (hours)
28/08/2019	0.2	18.3	11.6	9.2	10.0		7.4

HOURLY VALUES (UTC) 28Aug2019 SHANNON AIRPORT



(https://www.met.ie)

Attachment 3 - Certificates of Calibration

Committed to **your** success

Campbell Associates Ltd
5b Chelmsford Road Industrial Estate
GREAT DUNMOW, Essex, GB-CM6 1HD
www.campbell-associates.co.uk
Phone 01371 871030 Facsimile 01371879106

Certificate of Calibration and Conformance

CALIBRATION

0789

Certificate No.: U29202

Test object:	**Sound Level Meter, BS EN IEC 61672-1:2003 Class 1 (Precision)**
Manufacturer:	**NTi Audio**
Type:	**XL2-TA**
Serial no:	**A2A-08898-E0**

Customer:	**Redkite Environmental Ltd**
Address:	**Hunter's Moon, Ballykeane Road, Redcross, Co. Wicklow. Ireland.**
Contact Person:	**Siobhan Maher**
Order No:	**P009/01**

Method :
Calibration has been performed as set out in CA Technical Procedures TP01 & 02 as appropriate. These are based on the procedures for periodic verification set out in BS EN IEC 61672-3:2006. Results and conformance statement are overleaf and detailed results are in the attached Test Report.

	Producer:	Type:	Serial No:	Certificate number
Microphone	NTi Audio	MC230	8694	29201
Calibrator*	Larson Davis	CAL200	11728	U29200
Preamplifier	NTi Audio	MA220	5062	Included

Additional items that also have been submitted for verification

Wind shield	None
Attenuator	None
Extension cable	None

These items have been taken into account wherever appropriate.

Environmental conditions:	Pressure:	Temperature:	Relative humidity:
Reference conditions:	101.325 kPa	23.0 °C	50 %RH
Measurement conditions:	101.73 ± 0.01kPa	21.5 ± 0.2°C	42.3 ± 2%RH

Date received :	30/07/2018
Date of calibration:	02/08/2018
Date of issue:	02/08/2018

Engineer

M-Planivel

Palanivel Marappan B.Eng (Hons), M.Sc

Supervisor

Michael Tickner

Certificate of Calibration and Conformance

UKAS Laboratory Number 0789

Certificate No.: U29202

Conformance

From markings on the sound level meter or by reference to the manufacturer's published literature it has been determined that the instrument submitted for verification was originally manufactured to BS EN IEC 61672-1:2002 and similarly that the associated sound calibrator conforms to BS EN IEC 60942.

Statement of conformance

The sound level meter submitted for testing has successfully completed the class 1 periodic tests of BS EN IEC 61672-3:2006, for the environmental conditions under which the tests were performed. As public evidence was available[1], from an independent testing organisation responsible for approving the results of pattern evaluation tests performed in accordance with BS EN IEC 61672-2:2003, to demonstrate that the model of sound level meter fully conformed to the requirements in BS EN IEC 61672-1:2002, and that the sound level meter submitted for testing conforms to the class 1 requirements of BS EN IEC 61672-1:2003.

[1] This evidence is held on file at the calibration laboratory

Measurement Results:

Indication at the calibration check frequency - IEC61672-3 Ed.1 #9	Passed
Self-generated noise - IEC 61672-3 Ed.1 #10	Passed
Acoustical signal tests of a frequency weighting - IEC 61672-3 Ed.1 #11	Passed
Frequency weightings: A Network - IEC 61672-3 Ed.1 #12.3	Passed
Frequency weightings: C Network - IEC 61672-3 Ed.1 #12.3	Passed
Frequency weightings: Z Network - IEC 61672-3 Ed.1 #12.3	Passed
Frequency and time weightings at 1 kHz IEC 61672-3 Ed.1 #13	Passed
Level linearity on the reference level range - IEC 61672-3 Ed.1 #14	Passed
Level linearity including the level range control - IEC 61672-3 Ed.1 #15	Passed
Toneburst response - IEC 61672-3 Ed.1 #16	Passed
Peak C sound level - IEC 61672-3 Ed.1 #17	Passed
Overload indication - IEC 61672-3 Ed.1 #18	Passed
Electrical signal tests of frequency weightings - IEC 61672-3 Ed.1 #12	Passed

Comment

Correct level with associated calibrator is 113.9dB(A).

Observations

No information on the uncertainty of measurement, required by 11.7 of BS EN IEC 61672-3:2006 of the adjustment data given in the instruction manual or obtained from the manufacturer or supplier of the sound level meter, or the manufacturer of the microphone, or the manufacture of the electrostatic actuator was published in the instruction manual or made available by the manufacturer or supplier. The uncertainty of measurement of the adjustment data has therefore been assumed to be numerically zero for the purposes of this periodic test. If these uncertainties are not actually zero, there is a possibility that the frequency response of the sound level meter may not conform to the requirements of BS EN IEC 61672-1:2003.

No adjustment data have been published in the instruction manual or made available by the manufacturer or supplier of the sound level meter to account for the average effects of reflections from the case of the sound level meter and diffraction of sound around the microphone as required by sub-clause 11.4 and 12.6 of BS EN IEC 61672-3:2006. The average effects of reflections from the case of the sound level meter and diffraction of sound around the microphone have therefore been assumed to be numerically zero for the purposes of this periodic test. If these adjustment data are not actually zero, there is a possibility that the frequency response of the sound level meter may not meet the requirements of BS EN IEC 61672-1:2003.

The details of the uncertainty for each measurement is available from the Calibration Laboratory on request and is based on the standard uncertainty multiplied by a coverage factor K=2, providing a level of confidence of approximately 95%. The uncertainty evaluation has been carried out in accordance with UKAS requirements. Details on the sources of corrections and their associated uncertainties that relate to this verification are contained the detailed test report accompanying this certificate.

Calibration Report

Certificate No.:29201

Manufacturer: NTi Audio
Type: MC230
Serial no: 8694

Customer:	**Redkite Environmental Ltd**
Address:	**Hunter's Moon, Ballykeane Road, Redcross, Co. Wicklow. Ireland.**
Order No:	**P009/01**
Contact Person:	**Siobhan Maher**

Measurement Results:

	Sensitivity: (dB re 1V/Pa)	Capacitance: (pF)
1:	-26.51	17.8
2:	-26.51	17.7
3:	-26.52	17.7
Result (Average):	**-26.51**	**17.7**
Expanded Uncertainty:	0.10	2.00
Degree of Freedom:	>100	>100
Coverage Factor:	2.00	2.00

The following correction factors have been applied during the measurement:
Pressure:-0.005 dB/kPa Temperature:-0.010 dB/°C Relative humidity:0.000 dB/%RH

Reference Calibrator: WSC2 - GRAS42AA-18277 Volume correction: 0.000 dB
Records:K:\C A\Calibration\Nor-1504\Nor-1017 MicCal\2018\MC230_8694_M1.nmf
Measurement procedure: TP05
All results quoted are directly traceable to National Physical Laboratory, London

The reported expanded uncertainty of measurement is stated as the standard uncertainty of measurement multiplied by the coverage factor k = 2, which for a normal distribution corresponds to coverage probability of approximately 95%. The standard uncertainty of measurement has been determined in accordance with EA publication EA-4/02.

Comment:

Environmental conditions:

Pressure:	Temperature:	Relative humidity:
101.720 ± 0.041 kPa	21.1 ± 0.1 °C	47.1 ± 0.9 %RH

Date of calibration: 02/08/2018
Date of issue: 02/08/2018

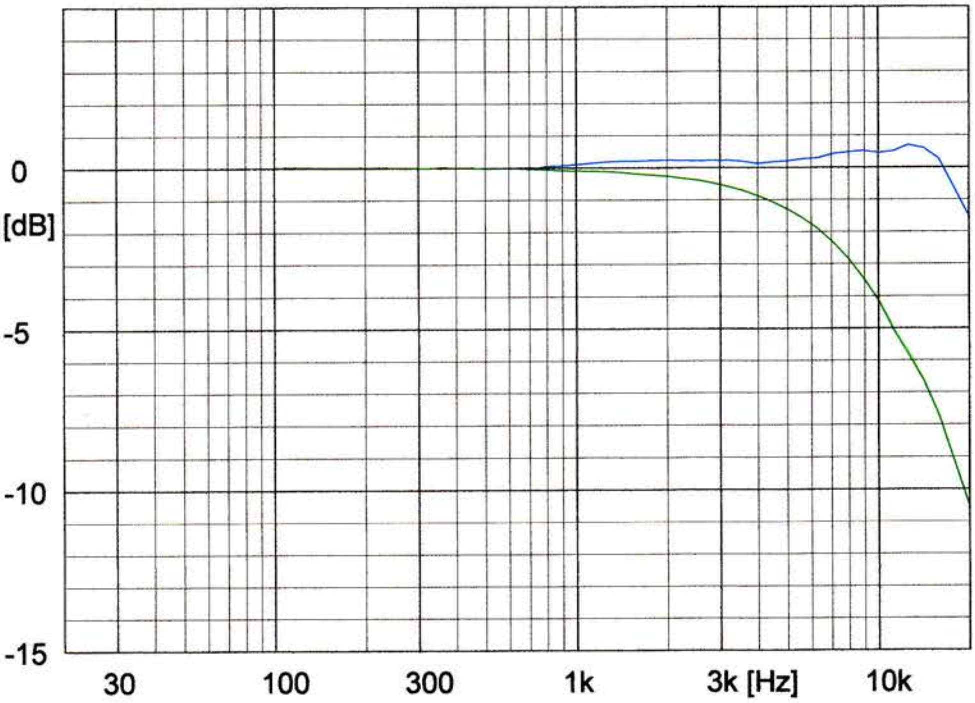
Supervisor : Darren Batten TechIOA
Engineer :

M. Planivel

Palanivel Marappan B.Eng (Hons), M.Sc
Software version: 6.0h

Campbell Associates
www.campbell-associates.co.uk

Microphone Calibration Certificate



NTi Audio
Type: MC230

Serial no: 8694

Sensitivity: 47.24 mV/Pa
-26.51 ±0.10 dB re. 1 V/Pa
Capacitance: 17.7 ±2.0 pF
Date: 02/08/2018

Signature: M. Hanivel

Measurement conditions:

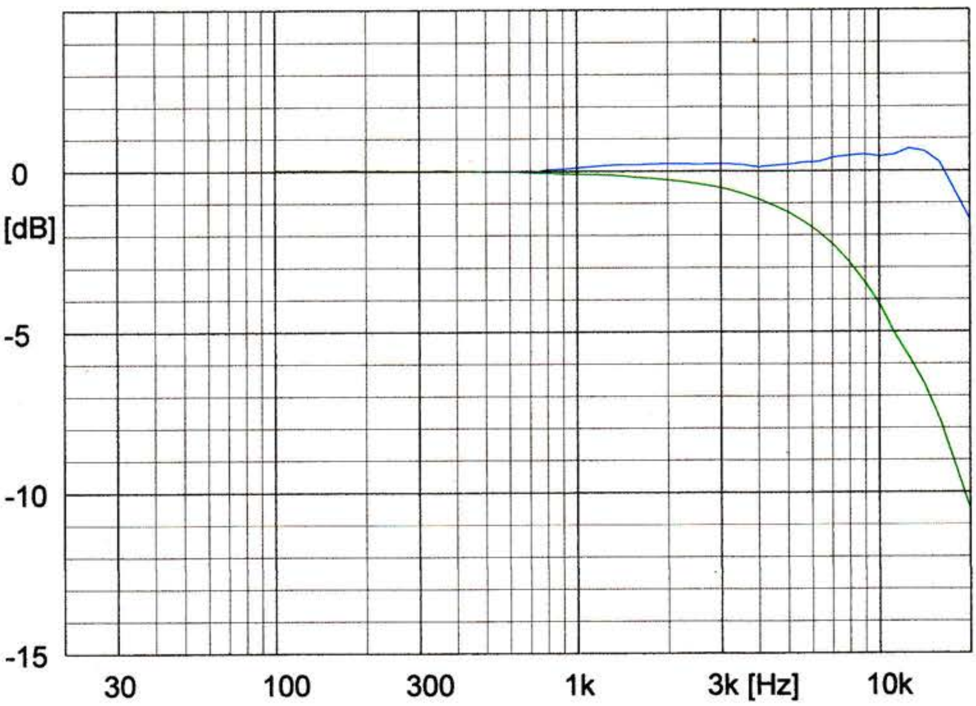
Polarisation voltage:	0.0 V
Pressure:	101.72 ±0.04 kPa
Temperature:	21.1 ±0.1 °C
Relative humidity:	47.1 ±0.9 %RH

Results are normalized to the reference conditions.

Free field response
Pressure (Actuator) response

Campbell Associates
www.campbell-associates.co.uk

Microphone Calibration Certificate



NTi Audio
Type: MC230

Serial no: 8694

Sensitivity: 47.24 mV/Pa
-26.51 ±0.10 dB re. 1 V/Pa
Capacitance: 17.7 ±2.0 pF
Date: 02/08/2018

Signature: M. Hanivel

Measurement conditions:

Polarisation voltage:	0.0 V
Pressure:	101.72 ±0.04 kPa
Temperature:	21.1 ±0.1 °C
Relative humidity:	47.1 ±0.9 %RH

Results are normalized to the reference conditions.

Free field response
Pressure (Actuator) response

Campbell Associates
www.campbell-associates.co.uk

Comment:

Certificate of Calibration

Issued to:	Certificate Number
Redkite Environmental Huntersmoon Ballykeane Road Redcross Co. Wicklow	AC190065

Test Date: 26/07/2019

Equipment Information

Item Calibrated:	Acoustic Calibrator	**Model:**	CAL200
Make:	Larson Davis	**Serial Number:**	11728

Calibration Procedure

The above calibrator was verified in line with the requirements of BS EN 60942:2003. The calibrator was allowed to stablize for a suitable period, as described in the manufacturer's instruction manual, in laboratory conditions. The sound pressure level in the cavity (half-inch). The operating frequency and signal distortion were also measured.

Calibration Standards

Description	Serial Number
National Instruments PXI-4461	19C91D2
GRAS 42AA Pistonphone	227947
GRAS 46A0 Pressure Field Microphone	228216

The standards used in this calibration are traceable to NIST and/or other National Measurement Institutes (NMI's) that are signatories of the International Committee of Weights and Measures (CIPM) mutual recognition agreement (MRA).

Signed on behalf of Sonitus Systems:

Calibration Report

Equipment Information

Model: CAL200
Serial Number: 11728

Ambient Conditions

Measurement conditions were within the tolerances defined in BS EN 60942.

Barometric Pressure: 1045 hPa
Temperature: 26.0 °C
Relative Humidity: 43 %

Results

Calibrator Setting	Measured Parameter	Measured Value	Tolerance +/-	Uncertainty +/-
94 dB, 1KHz	Sound pressure level (dB)	94.26	0.40	0.14 dB
	Frequency (Hz)	1000.44	10 Hz	0.25 Hz
	Distortion (%)	0.19	3.0	0.3
94 dB, 1KHz	Sound pressure level (dB)	114.24	0.40	0.14 dB
	Frequency (Hz)	1000.42	10 Hz	0.25 Hz
	Distortion (%)	0.28	3.0	0.3

RESULT: PASS

As public evidence was available, from a testing organization responsible for approving the results of pattern evaluation tests, to demonstrate that the model of sound calibrator fully conformed to the requirements for pattern evaluation described in Annex A of IEC 60942:2003, the sound calibrator tested is considered to conform to all the Class 1 requirements of IEC 60942:2003

The manufacturer's guidelines concerning free-field correction should be observed.

Notes
1. All measurements were made with the half-inch configuration of the calibrator in place.
2. The measurement uncertainty is reported as a standard uncertainty multiplied by a coverage factor k=2 which, for a normal probability distribution, corresponds to a coverage probability of approximately 95%.
3. The given uncertainty corresponds to measured values only and does not relate to the long term stability of the device under test.

Manufacturer Calibration Certificate

The sound level meter submitted for testing successfully completed the periodic tests of IEC 61672-3. All tests are traceable in accordance with ISO/IEC 17025.

No pattern approval is available for this sound level meter configuration.

Sound Level Meter

Manufacturer	NTi Audio		
Type	XL2	S/N	A2A-16311-E0
Firmware	V4.20		
Reference Level Range	mid		
Microphone Model	M2230		
Preamplifier	MA220	S/N	8567
Microphone Capsule	MC230A	S/N	A17383
Performance class	Class 1		
Customer Inventory Nr.			

Customer

Date 31 July 2019

Certificate FL-19-193

Results **PASSED**
(for detailed report see next pages)

Operator

Markus Frick

NTi Audio AG • Im alten Riet 102, 9494 Schaan • Liechtenstein
info@nti-audio.com • www.nti-audio.com

Measurement equipment

Test System

Model	NTi Audio FX100, S/No. 11094
Last Calibration	16 July 2019
Cal Certificate	NTI Cal #3393
Next Calibration	15 July 2020

Reference Microphone

Model	MTG MV203 S/N #630, Mic Capsule, MK221 S/N #16502
Last Calibration	08 December 2017
Cal Certificate	METAS #259-16159
Next Calibration	08 December 2019

Sound Calibrator

Model	Norsonic 1251 S/N #30930
Reference Level	114 dB
Calibration Frequency	1000 Hz
Last Calibration	06 December 2018
Cal Certificate	METAS #259-17305
Next Calibration	05 December 2020

Environmental conditions

Temperature	24.7 °C
Humidity	39 %
Pressure	968 hPa

Notes

- This calibration certificate documents the traceability to national standards, which realize the units of measurement according to the international Systems of Units (SI).
- The user is obliged to have the object recalibrated at appropriate intervals.
- This calibration certificate may not be reproduced other than in full except with the permission of the issuing laboratory. Calibration certificates without signature are not valid.
- All limits listed in this report are acceptance limits in accordance with IEC61672.
- The reported expanded uncertainty is based on a standard uncertainty multiplied by a coverage factor k=2, providing a level of confidence of approximately 95%. The uncertainty evaluation has been carried out in accordance with the regulations of the GUM.

NTi AUDIO

1. Indication at the calibration check frequency

The indication of the sound level meter at the calibration check frequency is checked by application of the sound calibrator and adjusted, if necessary, to indicate the required sound level for the environmental conditions under which the tests are performed. All levels in [dB].

Sensitivity before calibration	Sensitivity after calibration	Meas level	Limit -	Limit +	Uncert.	Status
41.8 mV/Pa	42.2 mV/Pa	114	113	115	0.2	Passed

2. Self-generated noise

2.1 Microphone cartridge installed

The self-generated noise is measured in the most-sensitive level range as a time-averaged sound pressure level with frequency-weighting A and an averaging time of 30 seconds. All levels in [dB].

Weight-ing	Meas level	Limit +	Uncert.	Status
A	16.8	18.0	0.1	Passed

2.2 Microphone cartridge replaced by the capsule replacement NTI-K65-15

The self-generated noise is measured in the most-sensitive level range as a time-averaged sound pressure level for all frequency-weightings and an averaging time of 30 seconds. All levels in [dB] referenced to S = 42 mV/Pa.

Weight-ing	Meas level	Limit +	Uncert.	Status
A	10.8	13.0	0.1	Passed
C	13.6	16.0	0.1	Passed
Z	18.7	24.0	0.1	Passed

3. Acoustic signal tests of a frequency weighting

The frequency weighting is tested for frequency-weighting A, using an acoustic test facility. The sound level meter is set to a fast time-weighted sound level in the reference level range. All levels in [dB].

Freq. [Hz]	Gen. level	Meas level	Dev	Limit -	Limit +	Uncert.	Status
125	78.0	78.2	0.2	-1.0	1.0	0.4	Passed
250	85.3	85.6	0.3	-1.0	1.0	0.4	Passed
500	90.8	91.0	0.2	-1.0	1.0	0.4	Passed
1000	94.0	94.1	0.1	-0.7	0.7	0.4	Passed
2000	95.2	95.2	0.0	-1.0	1.0	0.4	Passed
4000	95.0	95.2	0.2	-1.0	1.0	0.4	Passed
8000	92.8	93.2	0.4	-2.5	1.5	0.4	Passed

NTi AUDIO

4. Electric signal tests of frequency weightings

Frequency weightings are determined relative to the response at 1 kHz using steady sinusoidal electrical input signals. The sound level meter is set to display F-time-weighted sound level in the reference level range. All available frequency weightings provided in the sound level meter are verified. All levels in [dB].

4.1 A-Weighting

Freq. [Hz]	Gen. level	Meas level	Dev	Limit -	Limit +	Uncert.	Status
1000	80.0	80.0	0.0	-0.7	0.7	0.1	Passed
63	106.2	79.9	-0.1	-1.0	1.0	0.1	Passed
125	96.1	79.9	-0.1	-1.0	1.0	0.1	Passed
250	88.6	79.9	-0.1	-1.0	1.0	0.1	Passed
500	83.2	80.0	0.0	-1.0	1.0	0.1	Passed
2000	78.8	80.0	0.0	-1.0	1.0	0.1	Passed
4000	79.0	80.0	0.0	-1.0	1.0	0.1	Passed
8000	81.1	79.9	-0.1	-2.5	1.5	0.1	Passed
12500	84.3	80.0	0.0	-2.5	1.5	0.1	Passed
16000	86.6	79.9	-0.1	-2.5	1.5	0.1	Passed

4.2 C-Weighting

Freq. [Hz]	Gen. level	Meas level	Dev	Limit -	Limit +	Uncert.	Status
1000	80.0	80.0	0.0	-0.7	0.7	0.1	Passed
63	80.8	79.9	-0.1	-1.0	1.0	0.1	Passed
125	80.2	80.1	0.1	-1.0	1.0	0.1	Passed
250	80.0	80.0	0.0	-1.0	1.0	0.1	Passed
500	80.0	80.1	0.1	-1.0	1.0	0.1	Passed
2000	80.2	80.1	0.1	-1.0	1.0	0.1	Passed
4000	80.8	80.0	0.0	-1.0	1.0	0.1	Passed
8000	83.0	79.9	-0.1	-2.5	1.5	0.1	Passed
12500	86.2	79.9	-0.1	-2.5	1.5	0.1	Passed
16000	88.5	79.8	-0.2	-2.5	1.5	0.1	Passed

4.3 Z-Weighting

Freq. [Hz]	Gen. level	Meas level	Dev	Limit -	Limit +	Uncert.	Status
1000	80.0	80.0	0.0	-0.7	0.7	0.1	Passed
63	80.0	79.9	-0.1	-1.0	1.0	0.1	Passed
125	80.0	80.0	0.0	-1.0	1.0	0.1	Passed
250	80.0	80.0	0.0	-1.0	1.0	0.1	Passed
500	80.0	80.0	0.0	-1.0	1.0	0.1	Passed
2000	80.0	80.0	0.0	-1.0	1.0	0.1	Passed
4000	80.0	80.0	0.0	-1.0	1.0	0.1	Passed
8000	80.0	80.0	0.0	-2.5	1.5	0.1	Passed
12500	80.0	80.0	0.0	-2.5	1.5	0.1	Passed
16000	80.0	80.1	0.1	-2.5	1.5	0.1	Passed

NTi AUDIO

5. Frequency and time weightings at 1kHz

While injecting a constant steady signal at the reference frequency of 1 kHz the F-time-weighted sound level, S-time-weighted sound level and time-averaged sound level are verified with frequency weighting A. Additionally the F-time-weighted sound level for frequency weightings C and Z is measured. The first measurement serves as reference and differences in the reading with respect to this first one are determined. All levels in [dB].

Level	Exp level	Meas level	Dev	Limit -	Limit +	Uncert.	Status
LAF	114.0	114.0	0.0	-0.7	0.7	0.1	Passed
LAS	114.0	113.8	-0.2	-0.7	0.7	0.1	Passed
LAeq	114.0	114.0	0.0	-0.7	0.7	0.1	Passed
LCF	114.0	114.0	0.0	-0.7	0.7	0.1	Passed
LCeq	114.0	114.0	0.0	-0.7	0.7	0.1	Passed
LZF	114.0	114.0	0.0	-0.7	0.7	0.1	Passed
LZeq	114.0	114.0	0.0	-0.7	0.7	0.1	Passed

6. Level linearity on the reference level range

The level linearity on the reference level range is determined by applying steady sinusoidal electrical signals at a frequency of 8 kHz with the sound level meter set for frequency-weighting A and fast time-weighting. All levels in [dB].

Exp abs level	Meas. level	Abs dev	Abs Limit -	Abs Limit +	Exp rel level	Rel dev	Rel Limit -	Rel Limit +	Uncert.	Status
114.0	114.0	0.0	-0.8	0.8	0.0	0.0	-0.3	0.3	0.1	Passed
119.0	119.0	0.0	-0.8	0.8	119.0	0.0	-0.3	0.3	0.1	Passed
124.0	124.0	0.0	-0.8	0.8	124.0	0.0	-0.3	0.3	0.1	Passed
125.0	125.0	0.0	-0.8	0.8	125.0	0.0	-0.3	0.3	0.1	Passed
114.0	114.0	0.0	-0.8	0.8	0.0	0.0	-0.3	0.3	0.1	Passed
109.0	109.0	0.0	-0.8	0.8	109.0	0.0	-0.3	0.3	0.1	Passed
104.0	104.0	0.0	-0.8	0.8	104.0	0.0	-0.3	0.3	0.1	Passed
99.0	99.0	0.0	-0.8	0.8	99.0	0.0	-0.3	0.3	0.1	Passed
94.0	94.0	0.0	-0.8	0.8	94.0	0.0	-0.3	0.3	0.1	Passed
89.0	89.0	0.0	-0.8	0.8	89.0	0.0	-0.3	0.3	0.1	Passed
84.0	84.0	0.0	-0.8	0.8	84.0	0.0	-0.3	0.3	0.1	Passed
79.0	79.0	0.0	-0.8	0.8	79.0	0.0	-0.3	0.3	0.1	Passed
74.0	74.0	0.0	-0.8	0.8	74.0	0.0	-0.3	0.3	0.1	Passed
69.0	69.0	0.0	-0.8	0.8	69.0	0.0	-0.3	0.3	0.1	Passed
64.0	64.0	0.0	-0.8	0.8	64.0	0.0	-0.3	0.3	0.1	Passed
59.0	59.0	0.0	-0.8	0.8	59.0	0.0	-0.3	0.3	0.1	Passed
54.0	54.0	0.0	-0.8	0.8	54.0	0.0	-0.3	0.3	0.1	Passed
49.0	49.0	0.0	-0.8	0.8	49.0	0.0	-0.3	0.3	0.1	Passed
44.0	44.0	0.0	-0.8	0.8	44.0	0.0	-0.3	0.3	0.1	Passed
39.0	39.1	0.1	-0.8	0.8	39.0	0.1	-0.3	0.3	0.1	Passed
34.0	34.2	0.2	-0.8	0.8	34.1	0.1	-0.3	0.3	0.1	Passed
33.0	33.2	0.2	-0.8	0.8	33.2	0.0	-0.3	0.3	0.1	Passed
32.0	32.2	0.2	-0.8	0.8	32.2	0.0	-0.3	0.3	0.1	Passed
31.0	31.3	0.3	-0.8	0.8	31.2	0.1	-0.3	0.3	0.1	Passed
30.0	30.4	0.4	-0.8	0.8	30.3	0.1	-0.3	0.3	0.1	Passed

NTi AUDIO

7. Level linearity including the level range control

The test is performed with steady sinusoidal electrical input signals at a frequency of 1 kHz and with the sound level meter set for frequency weighting A and fast time weighting. With the input signal level kept constant, the indicated signal level is recorded for all level ranges where the applied signal level is displayed. All levels in [dB].

		Low Range		Mid Range		High Range			
Starting Range	Source level	Dev	Limit +/-	Dev	Limit +/-	Dev	Limit +/-	Uncert.	Status
Low	94	0.0	0.40	0.0	0.15	0.0	0.15	0.1	Passed
Mid	114			0.0	0.30	0.0	0.55	0.1	Passed
High	134					0.0	0.30	0.1	Passed
Low	29	0.1	0.30					0.1	Passed
Mid	36			0.1	0.30			0.1	Passed
High	58					0.1	0.30	0.1	Passed

8. Toneburst response

The response of the sound level meter to short-duration signals is tested on the reference level range with 4 kHz tonebursts that start and stop at zero crossings and are extracted from steady 4 kHz sinusoidal electrical input signals. The sound level meter is set for frequency weighting A. All levels in [dB].

The continuous signal level is 123 dB.

Burst signal	Burst duration [ms]	Exp level	Meas level	Dev	Limit -	Limit +	Uncert.	Status
LAF	200	122.0	121.9	-0.1	-0.5	0.5	0.2	Passed
LAF	2	105.0	104.9	-0.1	-1.5	1.0	0.2	Passed
LAF	0.25	96.0	95.8	-0.2	-3.0	1.0	0.2	Passed
LAS	200	115.6	115.5	-0.1	-0.5	0.5	0.2	Passed
LAS	2	96.0	95.9	-0.1	-3.0	1.0	0.2	Passed
LAeq10s	200	106.0	105.9	-0.1	-0.5	0.5	0.2	Passed
LAeq10s	2	86.0	85.8	-0.2	-0.5	0.5	0.2	Passed
LAeq10s	0.25	77.0	76.8	-0.2	-0.5	0.5	0.2	Passed

9. C-weighted peak sound level

The sound level meter is tested on the least-sensitive level range with fast time weighting and C frequency weighting. The test signals are a single complete cycle of an 8 kHz sinusoid starting and stopping at zero crossings and positive and negative half cycles of a 500 Hz sinusoid that also start and stop at zero crossings. All levels in [dB].

Burst signal	Source level	Exp LCp-LCF	Meas LCp-LCF	Dev	Limit -	Limit +	Uncert.	Status
8kHz	129.0	3.4	3.1	-0.3	-2.0	2.0	0.2	Passed
500Hz +	132.0	2.4	2.2	-0.2	-1.0	1.0	0.2	Passed
500Hz -	132.0	2.4	2.2	-0.2	-1.0	1.0	0.2	Passed

10. Overload Indication

Overload indication is tested on the least-sensitive level range with the sound level meter set to A-weighted, time-averaged sound level. Positive and negative one-half-cycle sinusoidal electrical signals at a frequency of 4 kHz are used. All levels in [dB].

Start level	OV +	OV -	Dev	Limit -	Limit +	Uncert.	Status
137.0	139.1	139.1	0.0	-1.5	1.5	0.3	Passed

AUDIO

LESS NOISE . MORE SOUND

Manufacturer Calibration Certificate

The following instrument has been tested and calibrated to the manufacturer specifications.
The calibration is traceable in accordance with ISO/IEC 17025 covering all instrument functions.

- Device Type: **Class 1 Sound Calibrator CAL200**
- Serial Number: **16757**

- Certificate Issued: **23 July 2019**
- Certificate Number: **43669-16757-CAL200**
- Results: **PASSED**
(for detailed report see next page)

Tested by: M. Frick

Signature:

Stamp: NTi Audio AG
Im alten Riet 102
LI - 9494 Schaan
www.nti-audio.com

Calibration of:	Class 1 Sound Calibrator CAL200
Serial Number:	16757
Date:	23 July 2019

- Detailed Calibration Test Results:

	actual	actual error	max. tolerance	calibration uncertainty[1]
Measured Level @ 94 dBSPL	**93.88 dBSPL**	-0.1%	±0.2 dB	0.25 dB
Measured Level @ 114 dBSPL	**113.90 dBSPL**	-0.1%	±0.2 dB	0.25 dB
Measured Frequency	**1000 Hz**	≤0.1%	±1 %	0.1 Hz

- Test Conditions:

Temperature:	**26 °C**
Relative Humidity:	**36 %**

- Calibration Equipment Used:

- Norsonic Sound Calibrator, Type 1251, S/No. 30930
  Last Calibration: 05.12.2018, Next Calibration: 05.12.2020
  Calibrated by Metas, Switzerland

- NTi Audio FX100, S/No. 11094
  Last Calibration: 14.08.2018, Next Calibration: 14.08.2019
  Manufacturer calibration based on Agilent 34410, Serial No. MY47014254,
  Last Calibration: 14.05.2019, Next Calibration: 14.05.2020
  which is calibrated by ELCAL to national standards maintained
  at Swiss Federal Office of Metrology. SCS 0002

[1] The reported expanded uncertainty is based on a standard uncertainty multiplied by a coverage factor k=2, providing a level of confidence of approximately 95%. The uncertainty evaluation has been carried out in accordance with the regulations of the GUM.

Attachment 4 - Photo Log

Committed to **your** success

Plate 01: NSL1

Plate 02: NSL2

Plate 03: NSL3

Plate 04: NSL4

Plate 05: NSL5

Plate 06: B1

Plate 07: B2

Plate 08: B3

Plate 09: B4

Plate 10: B5

Plate 11: B6

Plate 12: B7

Plate 13: B8

Plate 14: B9

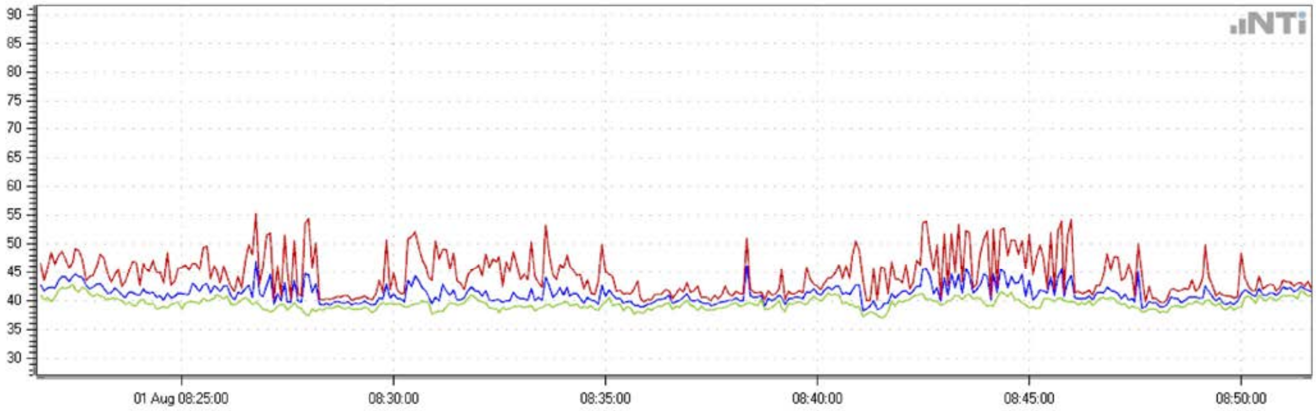
Attachment 5 - Noise Monitoring Report Sheets

Committed to **your** success

NSL1 Daytime #1

Start: 2019-08-01 08:21:36

End: 2019-08-01 08:51:36



LAFmax_dt LAFmin_dt LAeq_dt

Configuration

Device Info: XL2, SNo. A2A-08898-E0, FW3.11 Type Approved

Mic Type: NTi Audio M2230, SNo. 5062, User calibrated 2019-08-01 08:10

Mic Sensitivity: 43.3 mV/Pa

Range: 20 - 120 dB

Ln based on: LAeq_dt

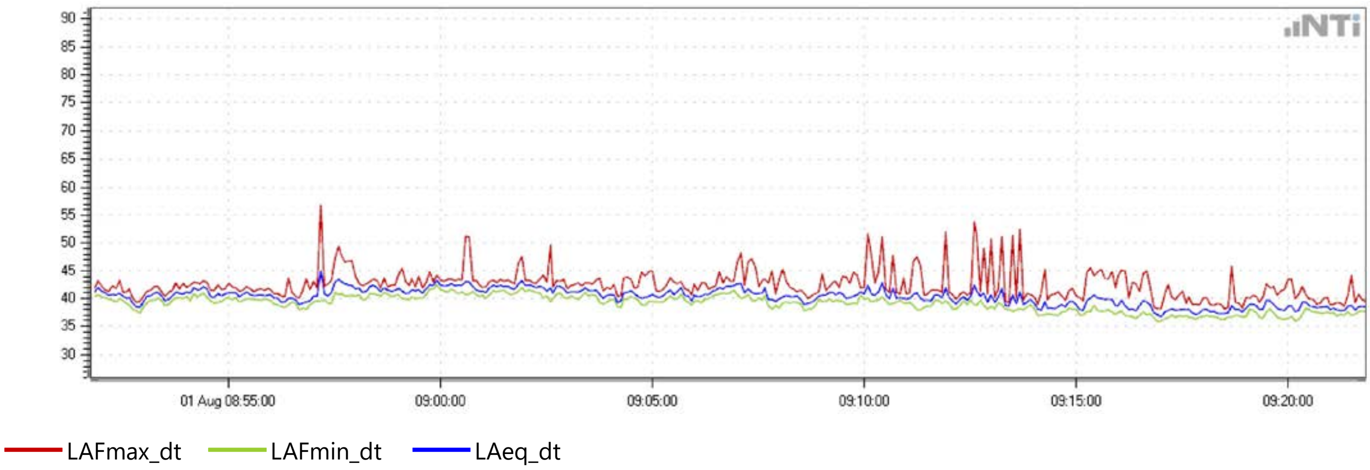
Results

Type	Start Date and Time	Duration	LAFmax [dB]	LAFmin [dB]	LAeq [dB]	L 10.0 % [dB]	L 90.0 % [dB]
Recorded		**00:30:00**	**55.3**	**37.1**	**41.6**		
Project Result		**00:30:00**	**55.3**	**37.1**	**41.6**	**43.2**	**39.4**

NSL1 Daytime #2

Start: 2019-08-01 08:51:46

End: 2019-08-01 09:21:46



Configuration

Device Info: XL2, SNo. A2A-08898-E0, FW3.11 Type Approved

Mic Type: NTi Audio M2230, SNo. 5062, User calibrated 2019-08-01 08:10

Mic Sensitivity: 43.3 mV/Pa

Range: 20 - 120 dB

Ln based on: LAeq_dt

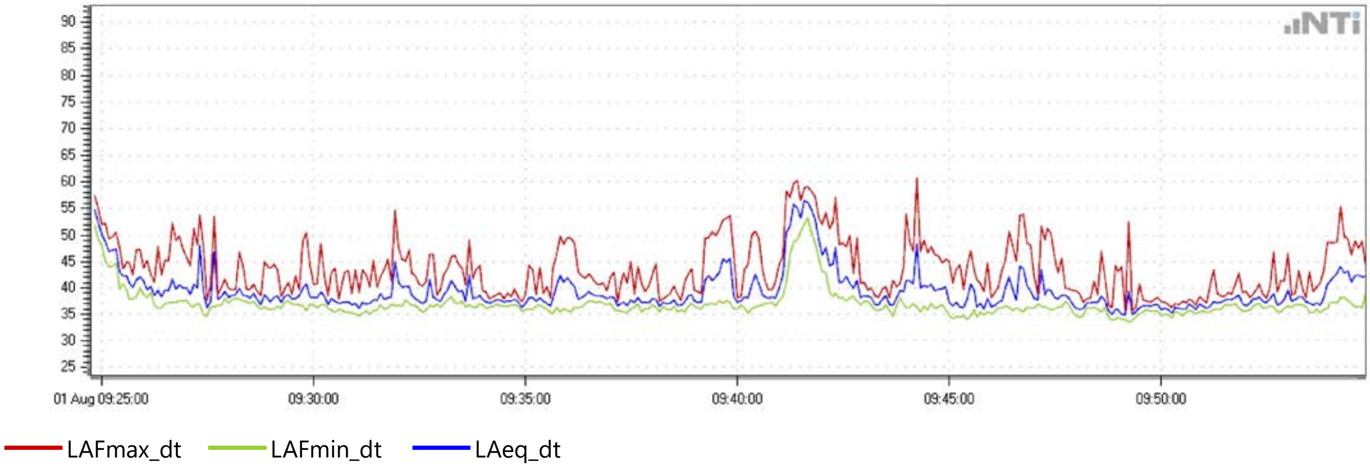
Results

Type	Start Date and Time	Duration	LAFmax [dB]	LAFmin [dB]	LAeq [dB]	L 10.0 % [dB]	L 90.0 % [dB]
Recorded		**00:30:00**	**56.8**	**35.9**	**40.5**		
Project Result		**00:30:00**	**56.8**	**35.9**	**40.5**	**42.3**	**38.1**

NSL1 Daytime #3

Start: 2019-08-01 09:24:46

End: 2019-08-01 09:54:46



Configuration

Device Info: XL2, SNo. A2A-08898-E0, FW3.11 Type Approved

Mic Type: NTi Audio M2230, SNo. 5062, User calibrated 2019-08-01 08:10

Mic Sensitivity: 43.3 mV/Pa

Range: 20 - 120 dB

Ln based on: LAeq_dt

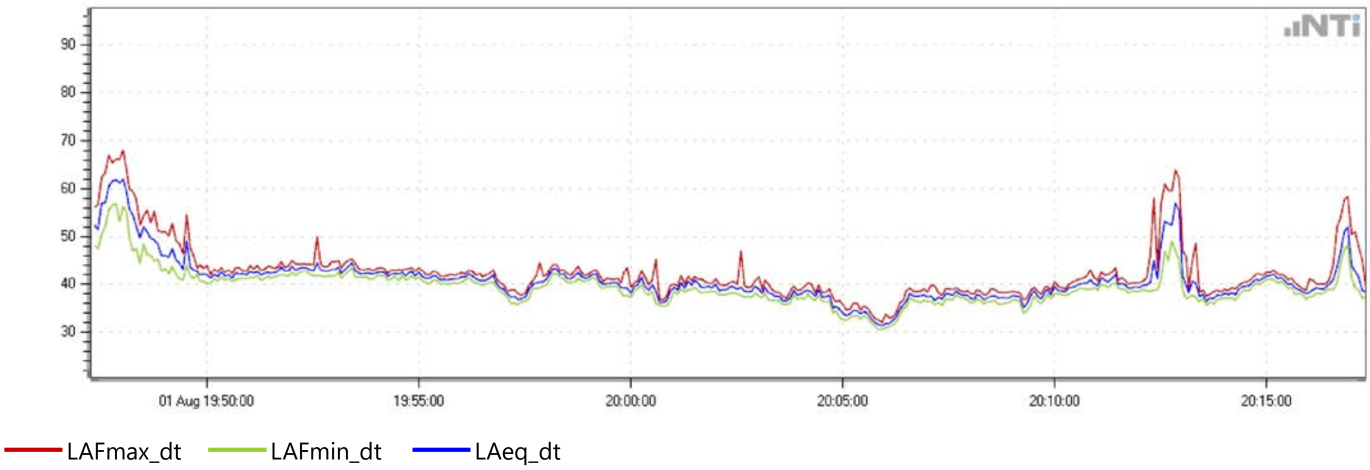
Results

Type	Start Date and Time	Duration	LAFmax [dB]	LAFmin [dB]	LAeq [dB]	L 10.0 % [dB]	L 90.0 % [dB]
Recorded		**00:30:00**	**60.7**	**33.5**	**42.5**		
Project Result		**00:30:00**	**60.7**	**33.5**	**42.5**	**43.8**	**36.3**

NSL1 Evening #1

Start: 2019-08-01 19:47:16

End: 2019-08-01 20:17:16



Configuration

Device Info: XL2, SNo. A2A-08898-E0, FW3.11 Type Approved

Mic Type: NTi Audio M2230, SNo. 5062, User calibrated 2019-08-01 19:43

Mic Sensitivity: 43.2 mV/Pa

Range: 20 - 120 dB

Ln based on: LAeq_dt

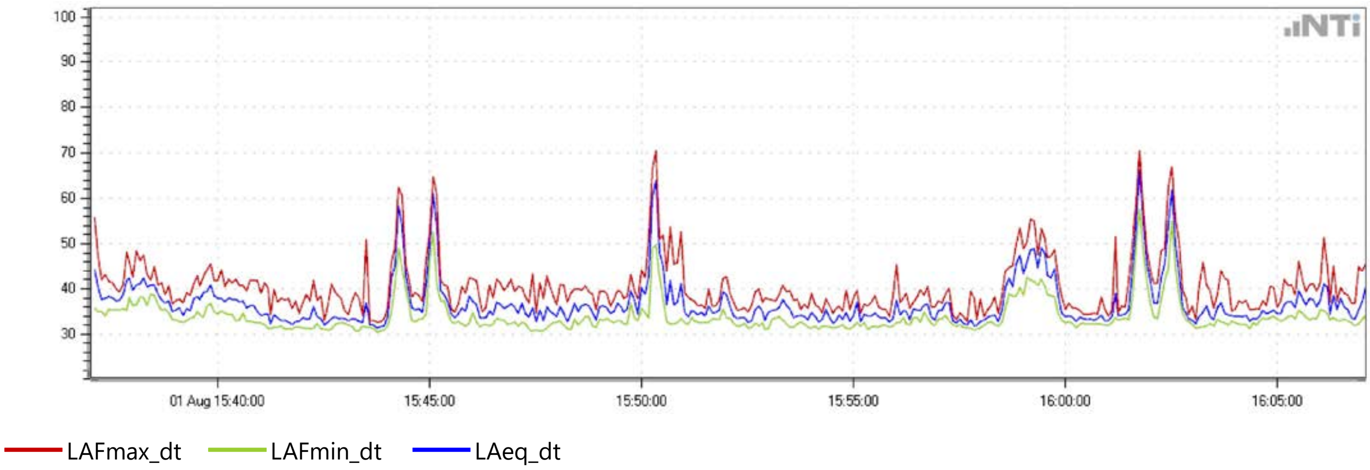
Results

Type	Start Date and Time	Duration	LAFmax [dB]	LAFmin [dB]	LAeq [dB]	L 10.0 % [dB]	L 90.0 % [dB]
Recorded		**00:30:00**	**68.1**	**30.6**	**46.6**		
Project Result		**00:30:00**	**68.1**	**30.6**	**46.6**	**44.4**	**36.9**

NSL2 Daytime #1

Start: 2019-08-01 15:37:02

End: 2019-08-01 16:07:02



Configuration

Device Info: XL2, SNo. A2A-08898-E0, FW3.11 Type Approved

Mic Type: NTi Audio M2230, SNo. 5062, User calibrated 2019-08-01 15:23

Mic Sensitivity: 42.9 mV/Pa

Range: 20 - 120 dB

Ln based on: LAeq_dt

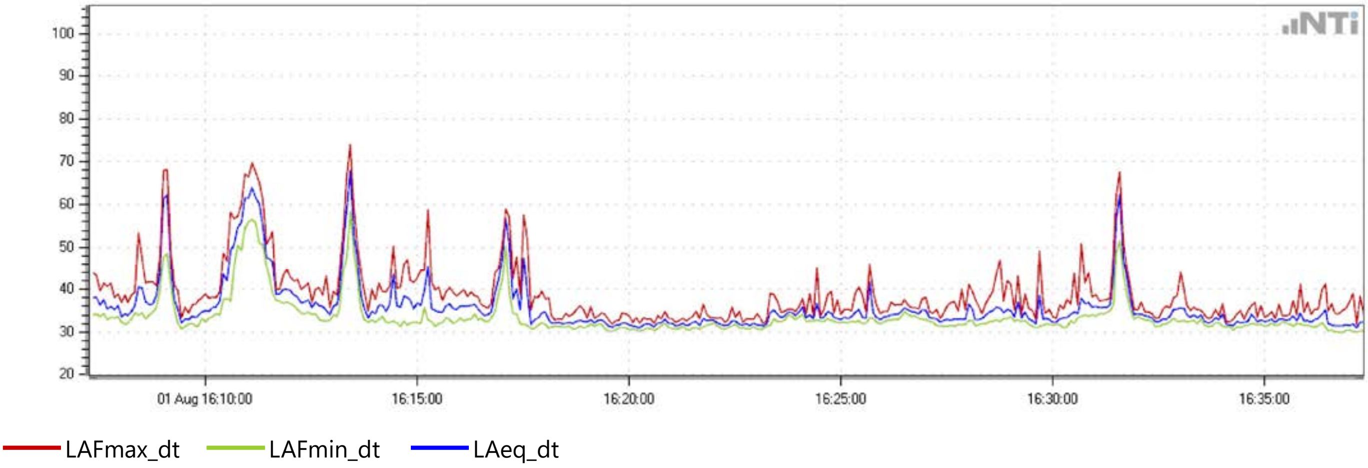
Results

Type	Start Date and Time	Duration	LAFmax [dB]	LAFmin [dB]	LAeq [dB]	L 10.0 % [dB]	L 90.0 % [dB]
Recorded		**00:30:00**	**70.6**	**30.4**	**46.2**		
Project Result		**00:30:00**	**70.6**	**30.4**	**46.2**	**42.1**	**32.6**

NSL2 Daytime #2

Start: 2019-08-01 16:07:16

End: 2019-08-01 16:37:16



Configuration

Device Info: XL2, SNo. A2A-08898-E0, FW3.11 Type Approved

Mic Type: NTi Audio M2230, SNo. 5062, User calibrated 2019-08-01 15:23

Mic Sensitivity: 42.9 mV/Pa

Range: 20 - 120 dB

Ln based on: LAeq_dt

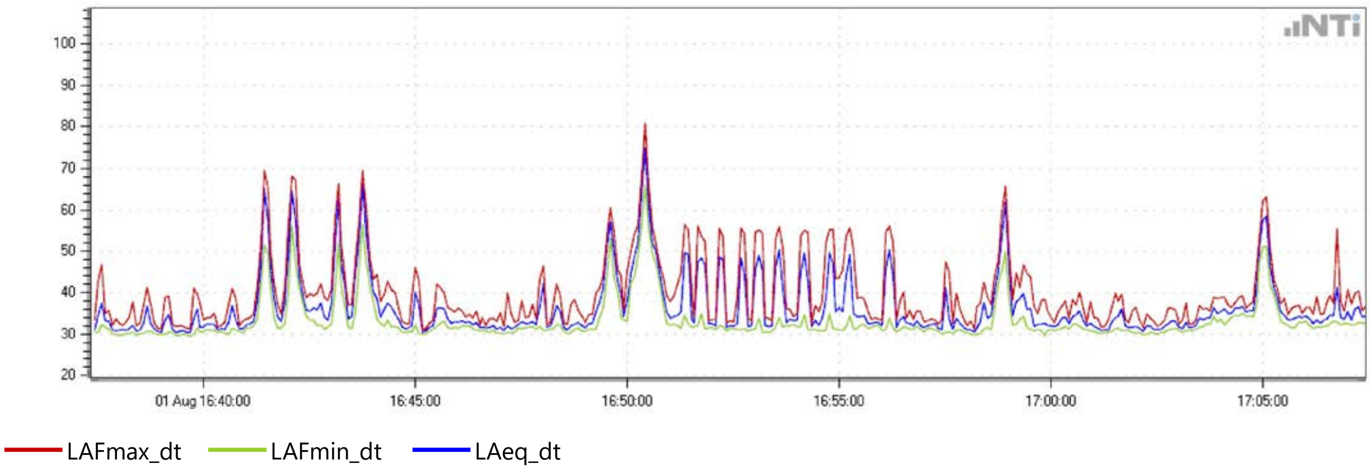
Results

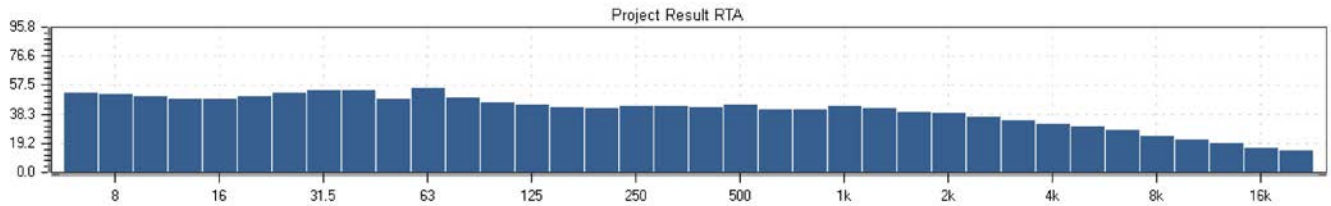
Type	Start Date and Time	Duration	LAFmax [dB]	LAFmin [dB]	LAeq [dB]	L 10.0 % [dB]	L 90.0 % [dB]
Recorded		**00:30:00**	**74.0**	**29.8**	**48.2**		
Project Result		**00:30:00**	**74.0**	**29.8**	**48.2**	**41.0**	**31.9**

NSL2 Daytime #3

Start: 2019-08-01 16:37:24

End: 2019-08-01 17:07:24





Configuration

Device Info: XL2, SNo. A2A-08898-E0, FW3.11 Type Approved

Mic Type: NTi Audio M2230, SNo. 5062, User calibrated 2019-08-01 15:23

Mic Sensitivity: 42.9 mV/Pa

Range: 20 - 120 dB

Ln based on: LAeq_dt

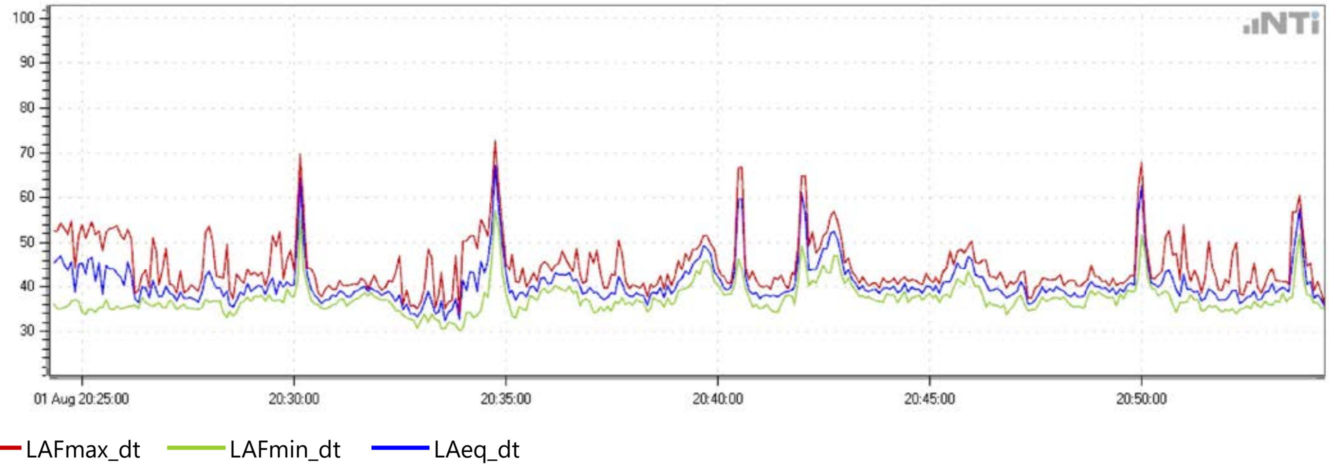
Results

Type	Start Date and Time	Duration	LAFmax [dB]	LAFmin [dB]	LAeq [dB]	L 10.0 % [dB]	L 90.0 % [dB]
Recorded		**00:30:00**	**80.7**	**29.5**	**51.8**		
Project Result		**00:30:00**	**80.7**	**29.5**	**51.8**	**47.3**	**31.2**

NSL2 Evening

Start: 2019-08-01 20:24:16

End: 2019-08-01 20:54:16



Configuration

Device Info: XL2, SNo. A2A-08898-E0, FW3.11 Type Approved

Mic Type: NTi Audio M2230, SNo. 5062, User calibrated 2019-08-01 19:43

Mic Sensitivity: 43.2 mV/Pa

Range: 20 - 120 dB

Ln based on: LAeq_dt

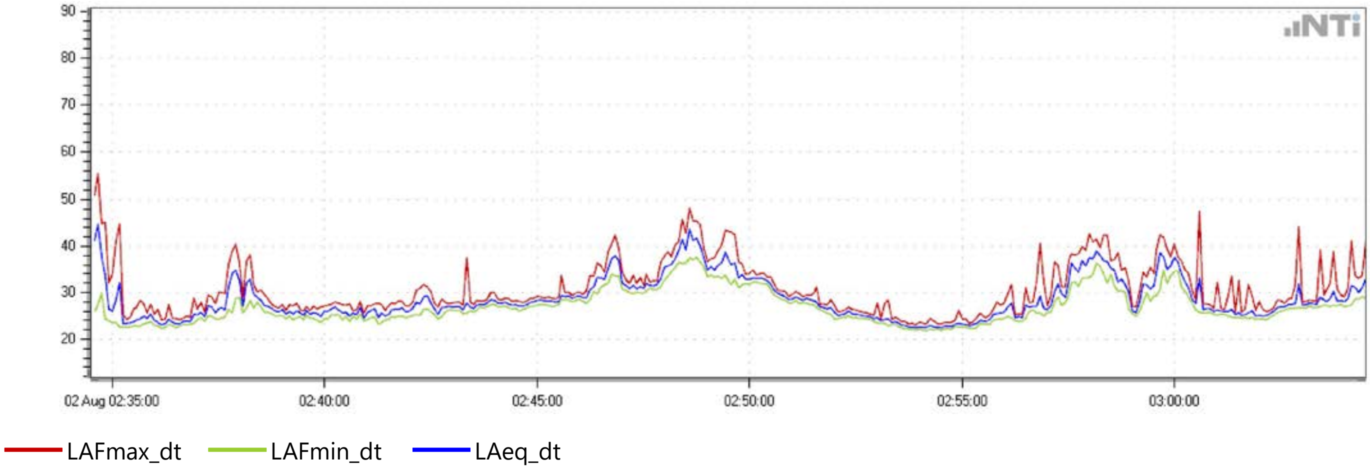
Results

Type	Start Date and Time	Duration	LAFmax [dB]	LAFmin [dB]	LAeq [dB]	L 10.0 % [dB]	L 90.0 % [dB]
Recorded		**00:30:00**	**72.8**	**30.1**	**47.5**		
Project Result		**00:30:00**	**72.8**	**30.1**	**47.5**	**46.3**	**36.3**

NSL2 Night time #1

Start: 2019-08-02 02:34:30

End: 2019-08-02 03:04:30



Configuration

Device Info: XL2, SNo. A2A-08898-E0, FW3.11 Type Approved

Mic Type: NTi Audio M2230, SNo. 5062, User calibrated 2019-08-02 02:28

Mic Sensitivity: 43.0 mV/Pa

Range: 0 - 100 dB

Ln based on: LAeq_dt

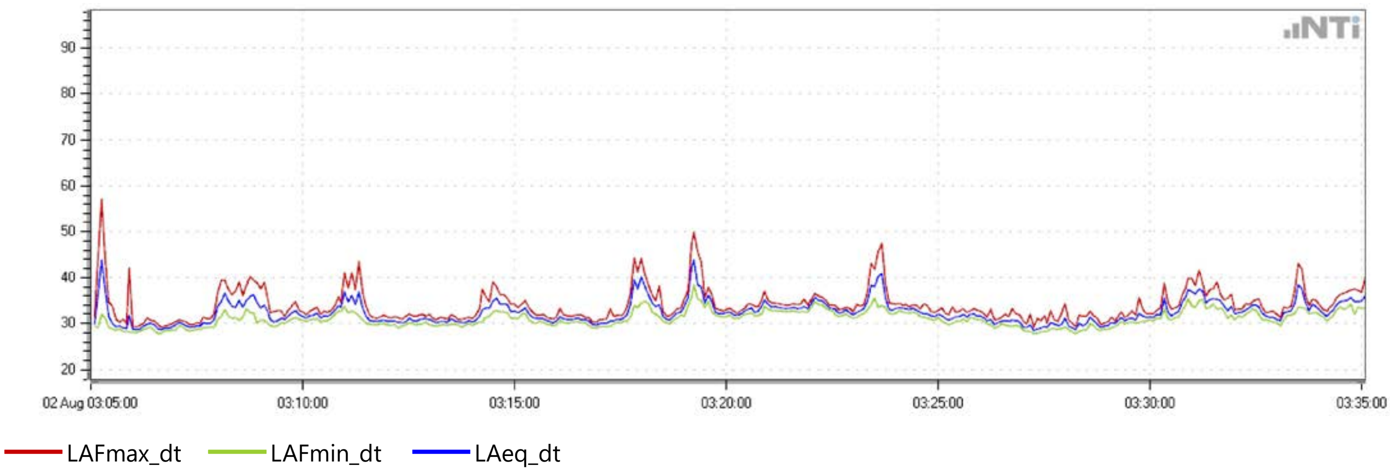
Results

Type	Start Date and Time	Duration	LAFmax [dB]	LAFmin [dB]	LAeq [dB]	L 10.0 % [dB]	L 90.0 % [dB]
Recorded		**00:30:00**	**55.5**	**21.9**	**31.6**		
Project Result		**00:30:00**	**55.5**	**21.9**	**31.6**	**35.5**	**23.9**

NSL2 Night time #2

Start: 2019-08-02 03:05:04

End: 2019-08-02 03:35:04



Configuration

Device Info: XL2, SNo. A2A-08898-E0, FW3.11 Type Approved

Mic Type: NTi Audio M2230, SNo. 5062, User calibrated 2019-08-02 02:28

Mic Sensitivity: 43.0 mV/Pa

Range: 0 - 100 dB

Ln based on: LAeq_dt

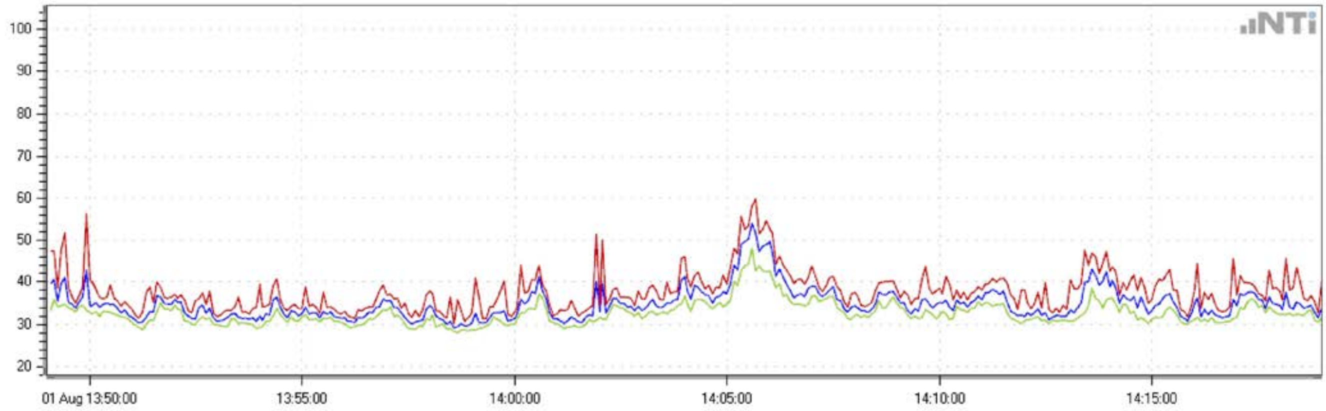
Results

Type	Start Date and Time	Duration	LAFmax [dB]	LAFmin [dB]	LAeq [dB]	L 10.0 % [dB]	L 90.0 % [dB]
Recorded		**00:30:00**	**57.1**	**27.8**	**33.4**		
Project Result		**00:30:00**	**57.1**	**27.8**	**33.4**	**35.5**	**29.7**

NSL3 Daytime #1

Start: 2019-08-01 13:49:00

End: 2019-08-01 14:19:00



LAFmax_dt LAFmin_dt LAeq_dt

Configuration

Device Info: XL2, SNo. A2A-08898-E0, FW3.11 Type Approved

Mic Type: NTi Audio M2230, SNo. 5062, User calibrated 2019-08-01 13:39

Mic Sensitivity: 43.2 mV/Pa

Range: 20 - 120 dB

Ln based on: LAeq_dt

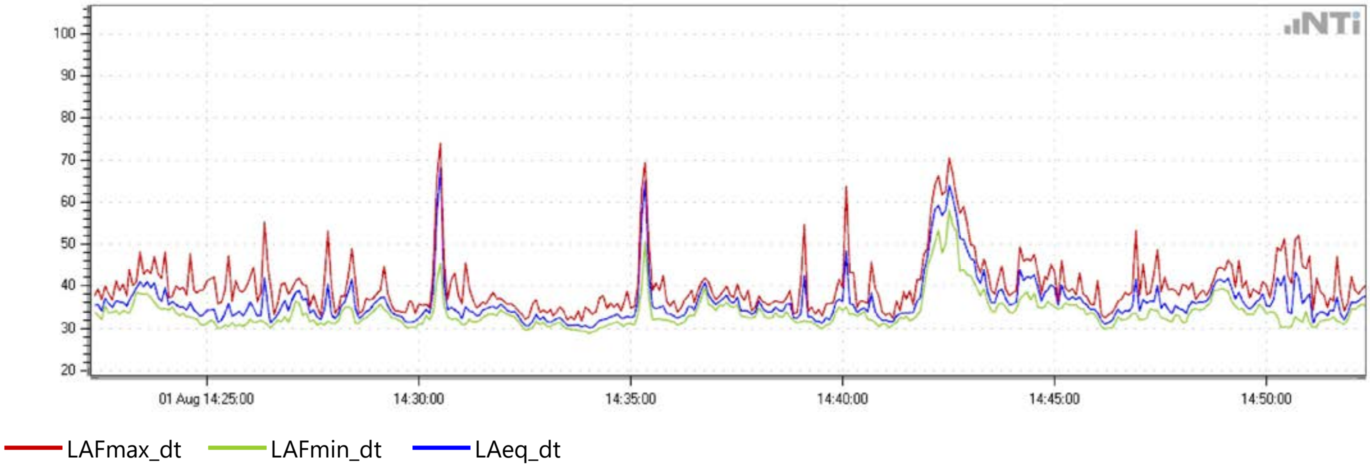
Results

Type	Start Date and Time	Duration	LAFmax [dB]	LAFmin [dB]	LAeq [dB]	L 10.0 % [dB]	L 90.0 % [dB]
Recorded		**00:30:00**	**59.9**	**28.0**	**38.1**		
Project Result		**00:30:00**	**59.9**	**28.0**	**38.1**	**38.9**	**31.1**

NSL3 Daytime #2

Start: 2019-08-01 14:22:18

End: 2019-08-01 14:52:18



Configuration

Device Info: XL2, SNo. A2A-08898-E0, FW3.11 Type Approved

Mic Type: NTi Audio M2230, SNo. 5062, User calibrated 2019-08-01 13:39

Mic Sensitivity: 43.2 mV/Pa

Range: 20 - 120 dB

Ln based on: LAeq_dt

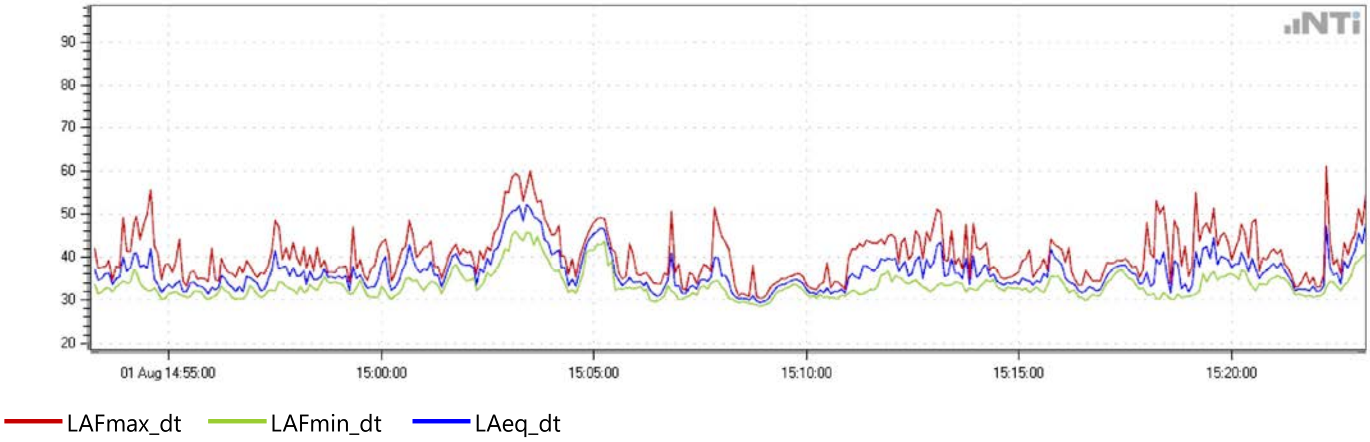
Results

Type	Start Date and Time	Duration	LAFmax [dB]	LAFmin [dB]	LAeq [dB]	L 10.0 % [dB]	L 90.0 % [dB]
Recorded		**00:30:00**	**74.1**	**28.8**	**47.4**		
Project Result		**00:30:00**	**74.1**	**28.8**	**47.4**	**41.1**	**31.9**

NSL Daytime #3

Start: 2019-08-01 14:53:10

End: 2019-08-01 15:23:10



Configuration

Device Info: XL2, SNo. A2A-08898-E0, FW3.11 Type Approved

Mic Type: NTi Audio M2230, SNo. 5062, User calibrated 2019-08-01 13:39

Mic Sensitivity: 43.2 mV/Pa

Range: 20 - 120 dB

Ln based on: LAeq_dt

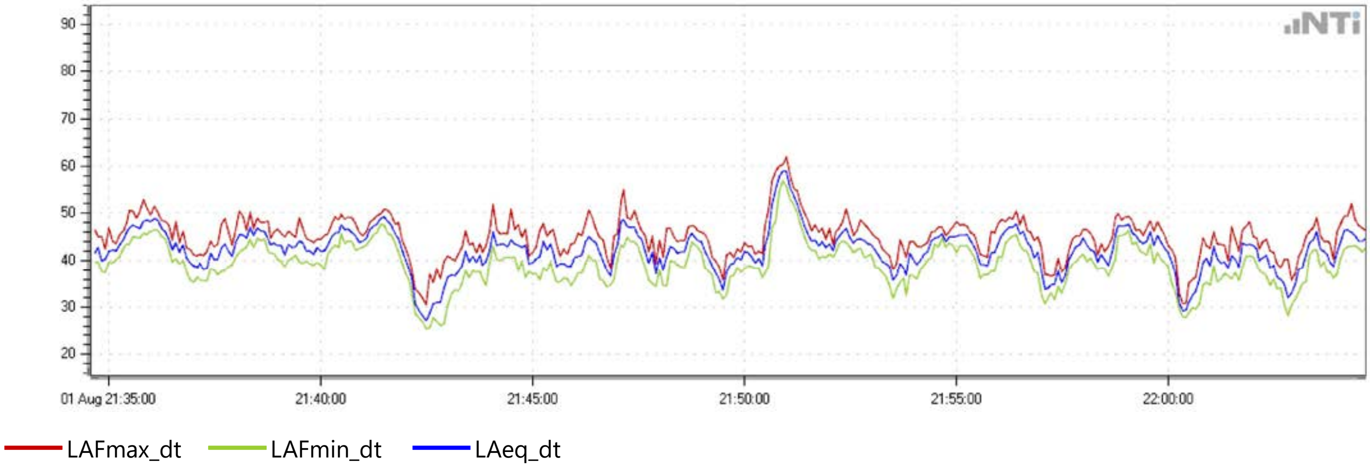
Results

Type	Start Date and Time	Duration	LAFmax [dB]	LAFmin [dB]	LAeq [dB]	L 10.0 % [dB]	L 90.0 % [dB]
Recorded		**00:30:00**	**61.2**	**28.5**	**39.5**		
Project Result		**00:30:00**	**61.2**	**28.5**	**39.5**	**41.9**	**31.8**

NSL3 Evening

Start: 2019-08-01 21:34:38

End: 2019-08-01 22:04:38



Configuration

Device Info: XL2, SNo. A2A-08898-E0, FW3.11 Type Approved

Mic Type: NTi Audio M2230, SNo. 5062, User calibrated 2019-08-01 21:28

Mic Sensitivity: 42.7 mV/Pa

Range: 20 - 120 dB

Ln based on: LAeq_dt

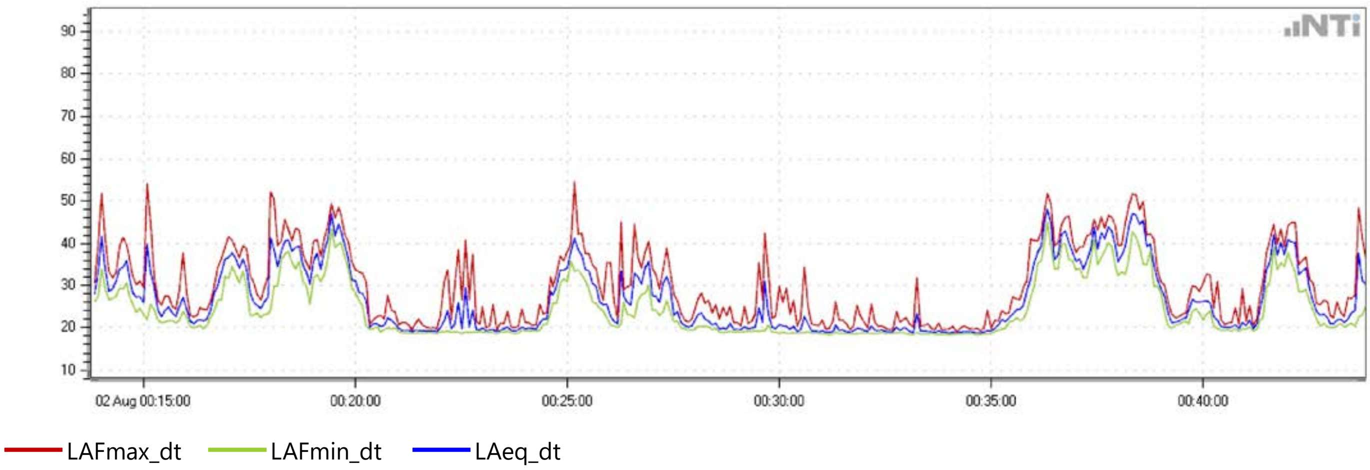
Results

Type	Start Date and Time	Duration	LAFmax [dB]	LAFmin [dB]	LAeq [dB]	L 10.0 % [dB]	L 90.0 % [dB]
Recorded		**00:30:00**	**62.0**	**25.5**	**44.8**		
Project Result		**00:30:00**	**62.0**	**25.5**	**44.8**	**47.1**	**36.5**

NSL3 Night time #1

Start: 2019-08-02 00:13:48

End: 2019-08-02 00:43:48



Configuration

Device Info: XL2, SNo. A2A-08898-E0, FW3.11 Type Approved

Mic Type: NTi Audio M2230, SNo. 5062, User calibrated 2019-08-02 00:03

Mic Sensitivity: 42.9 mV/Pa

Range: 0 - 100 dB

Ln based on: LAeq_dt

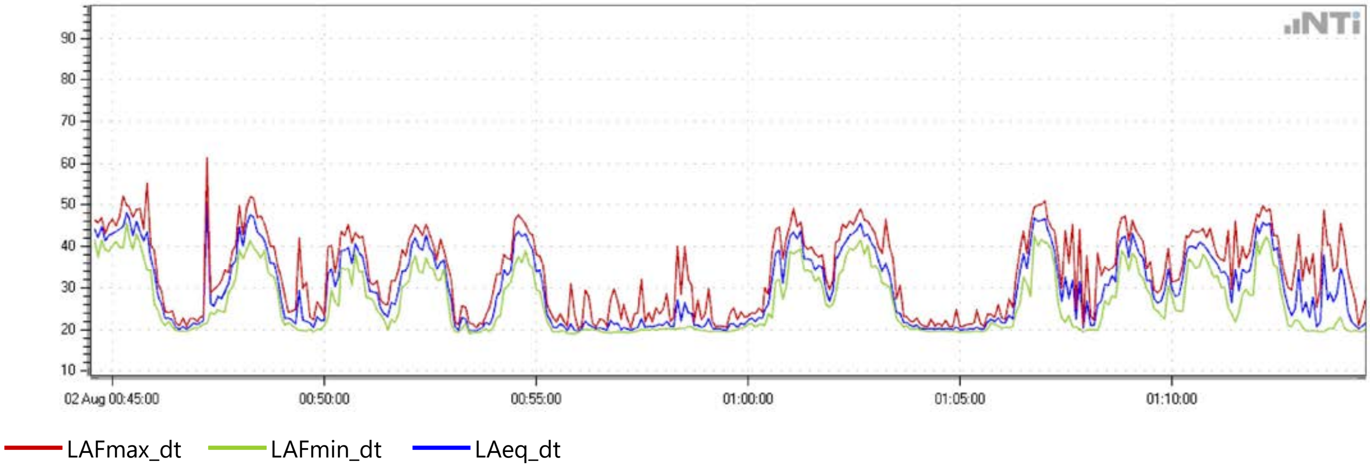
Results

Type	Start Date and Time	Duration	LAFmax [dB]	LAFmin [dB]	LAeq [dB]	L 10.0 % [dB]	L 90.0 % [dB]
Recorded		**00:30:00**	**54.6**	**18.2**	**34.8**		
Project Result		**00:30:00**	**54.6**	**18.2**	**34.8**	**39.1**	**19.2**

NSL3 Night time #2

Start: 2019-08-02 00:44:32

End: 2019-08-02 01:14:32



Configuration

Device Info: XL2, SNo. A2A-08898-E0, FW3.11 Type Approved

Mic Type: NTi Audio M2230, SNo. 5062, User calibrated 2019-08-02 00:03

Mic Sensitivity: 42.9 mV/Pa

Range: 0 - 100 dB

Ln based on: LAeq_dt

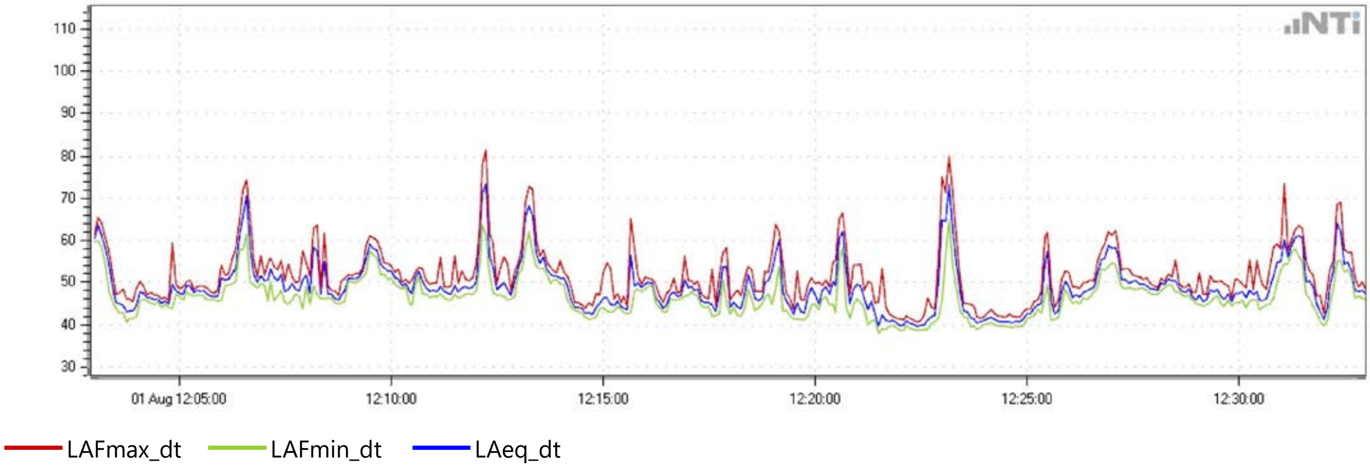
Results

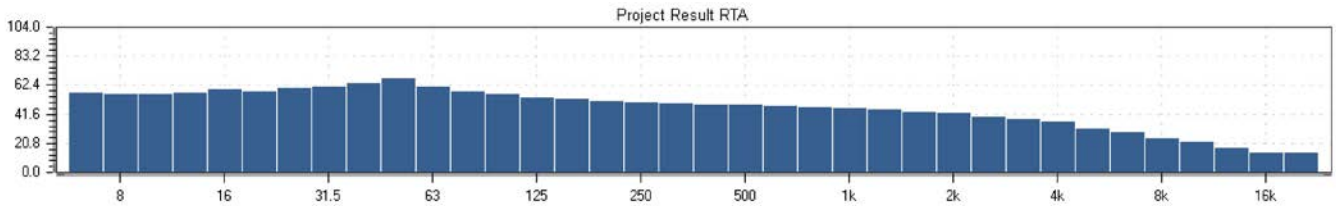
Type	Start Date and Time	Duration	LAFmax [dB]	LAFmin [dB]	LAeq [dB]	L 10.0 % [dB]	L 90.0 % [dB]
Recorded		**00:30:00**	**61.4**	**18.9**	**37.8**		
Project Result		**00:30:00**	**61.4**	**18.9**	**37.8**	**42.8**	**20.2**

NSL4 Daytime #1

Start: 2019-08-01 12:02:58

End: 2019-08-01 12:32:58





Configuration

Device Info: XL2, SNo. A2A-08898-E0, FW3.11 Type Approved

Mic Type: NTi Audio M2230, SNo. 5062, User calibrated 2019-08-01 11:37

Mic Sensitivity: 43.7 mV/Pa

Range: 20 - 120 dB

Ln based on: LAeq_dt

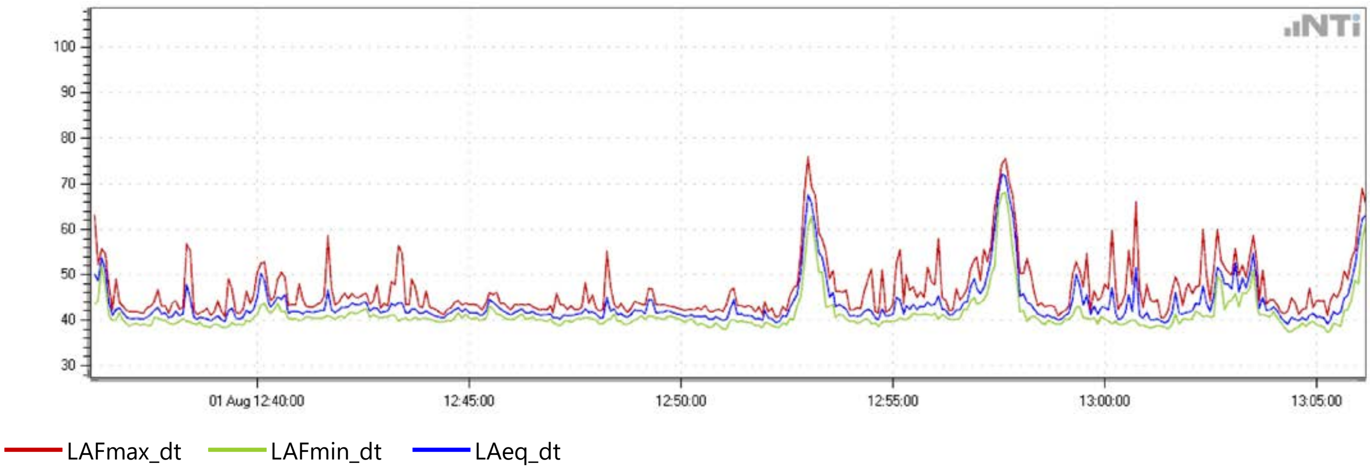
Results

Type	Start Date and Time	Duration	LAFmax [dB]	LAFmin [dB]	LAeq [dB]	L 10.0 % [dB]	L 90.0 % [dB]
Recorded		**00:30:00**	**81.4**	**38.0**	**56.2**		
Project Result		**00:30:00**	**81.4**	**38.0**	**56.2**	**56.9**	**42.3**

NSL4 Daytime #2

Start: 2019-08-01 12:36:06

End: 2019-08-01 13:06:06



Configuration

Device Info: XL2, SNo. A2A-08898-E0, FW3.11 Type Approved

Mic Type: NTi Audio M2230, SNo. 5062, User calibrated 2019-08-01 11:37

Mic Sensitivity: 43.7 mV/Pa

Range: 20 - 120 dB

Ln based on: LAeq_dt

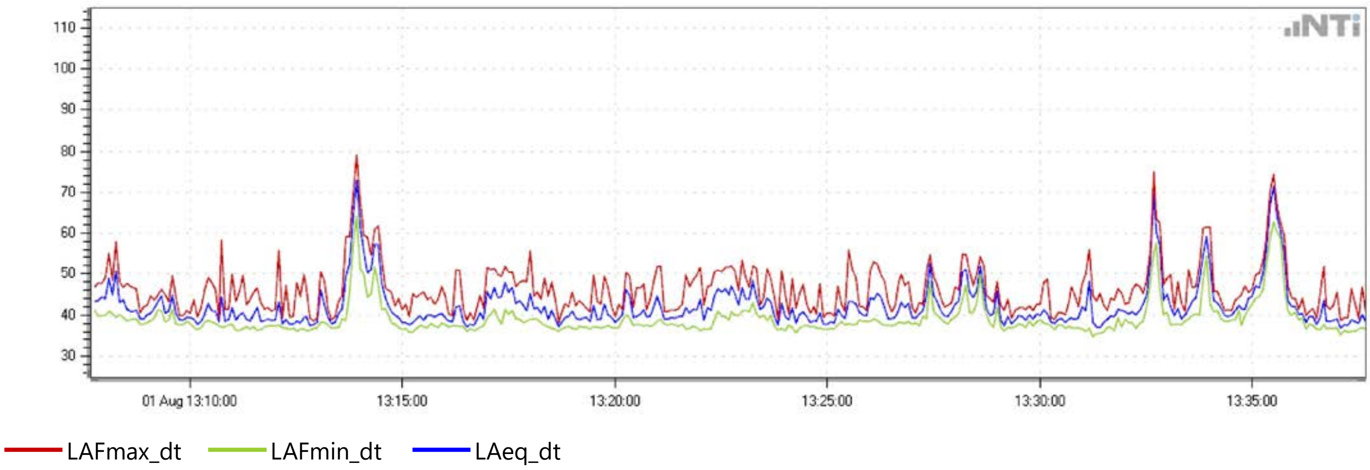
Results

Type	Start Date and Time	Duration	LAFmax [dB]	LAFmin [dB]	LAeq [dB]	L 10.0 % [dB]	L 90.0 % [dB]
Recorded		**00:30:00**	**76.0**	**37.5**	**52.9**		
Project Result		**00:30:00**	**76.0**	**37.5**	**52.9**	**48.1**	**40.4**

NSL4 Daytime #3

Start: 2019-08-01 13:07:40

End: 2019-08-01 13:37:40



Configuration

Device Info: XL2, SNo. A2A-08898-E0, FW3.11 Type Approved

Mic Type: NTi Audio M2230, SNo. 5062, User calibrated 2019-08-01 11:37

Mic Sensitivity: 43.7 mV/Pa

Range: 20 - 120 dB

Ln based on: LAeq_dt

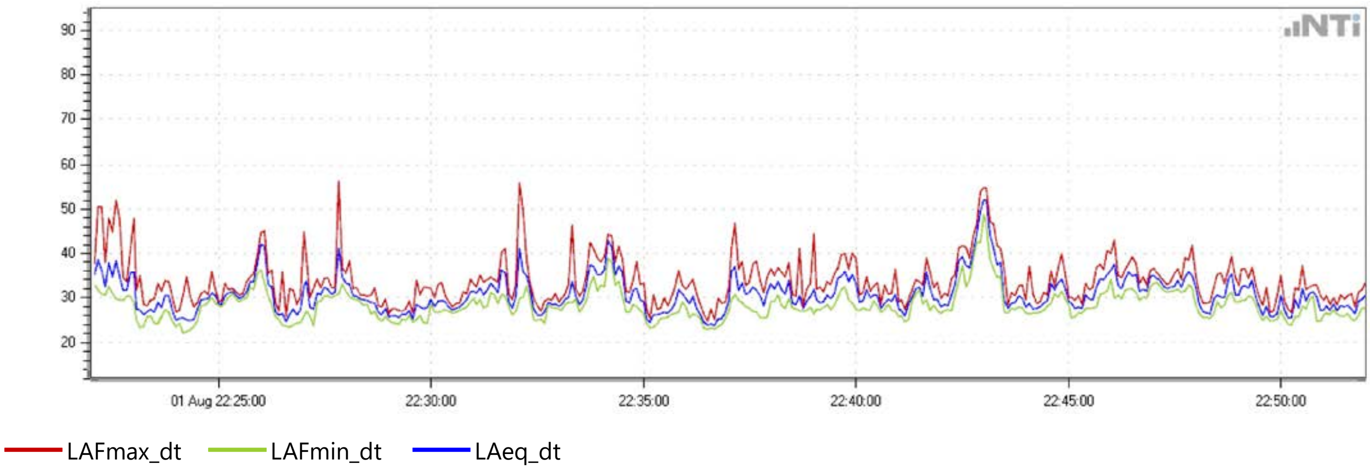
Results

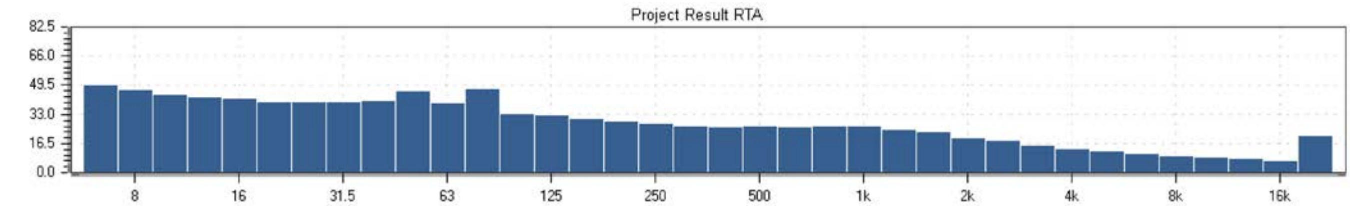
Type	Start Date and Time	Duration	LAFmax [dB]	LAFmin [dB]	LAeq [dB]	L 10.0 % [dB]	L 90.0 % [dB]
Recorded		**00:30:00**	**79.1**	**34.7**	**52.6**		
Project Result		**00:30:00**	**79.1**	**34.7**	**52.6**	**47.8**	**37.9**

NSL4 Evening

Start: 2019-08-01 22:22:00

End: 2019-08-01 22:52:00





Configuration

Device Info: XL2, SNo. A2A-08898-E0, FW3.11 Type Approved

Mic Type: NTi Audio M2230, SNo. 5062, User calibrated 2019-08-01 22:20

Mic Sensitivity: 42.9 mV/Pa

Range: 0 - 100 dB

Ln based on: LAeq_dt

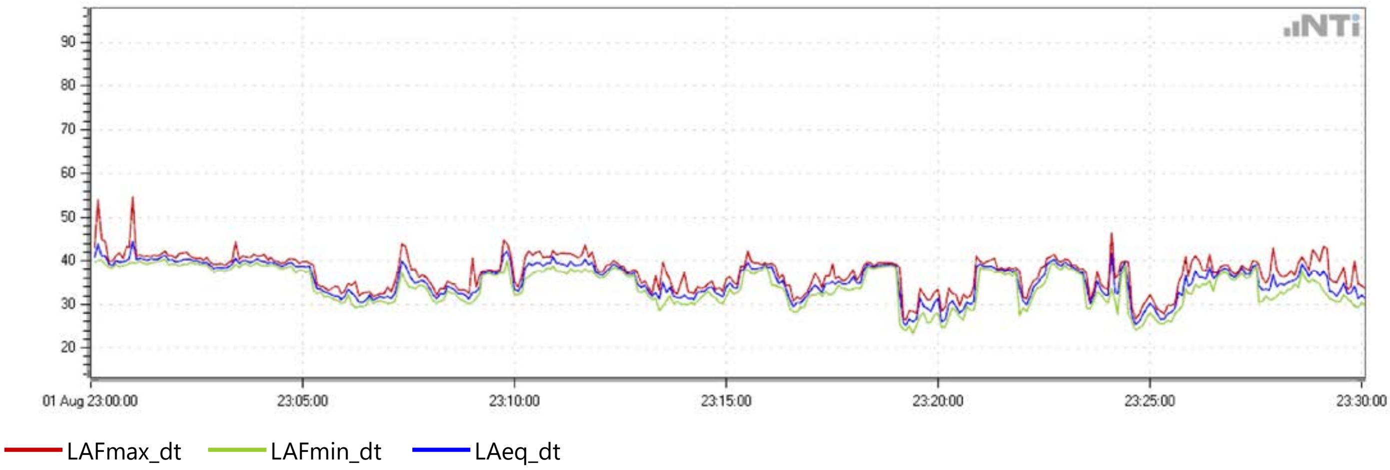
Results

Type	Start Date and Time	Duration	LAFmax [dB]	LAFmin [dB]	LAeq [dB]	L 10.0 % [dB]	L 90.0 % [dB]
Recorded		**00:30:00**	**56.3**	**22.1**	**34.8**		
Project Result		**00:30:00**	**56.3**	**22.1**	**34.8**	**35.8**	**26.2**

NSL4 Night time #1

Start: 2019-08-01 23:00:02

End: 2019-08-01 23:30:02



Configuration

Device Info: XL2, SNo. A2A-08898-E0, FW3.11 Type Approved

Mic Type: NTi Audio M2230, SNo. 5062, User calibrated 2019-08-01 22:20

Mic Sensitivity: 42.9 mV/Pa

Range: 0 - 100 dB

Ln based on: LAeq_dt

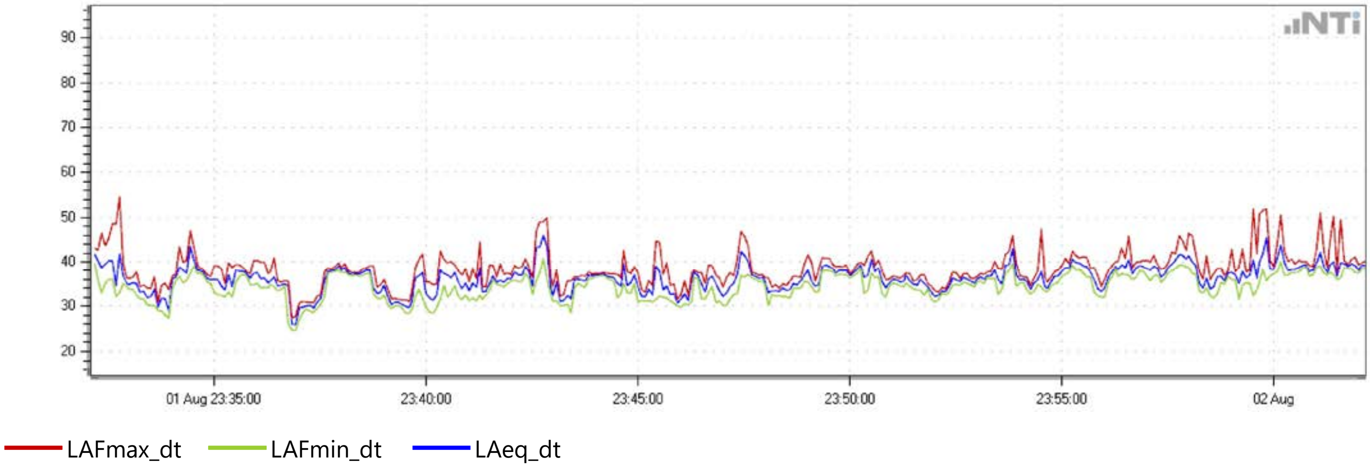
Results

Type	Start Date and Time	Duration	LAFmax [dB]	LAFmin [dB]	LAeq [dB]	L 10.0 % [dB]	L 90.0 % [dB]
Recorded		**00:30:00**	**54.6**	**23.2**	**37.0**		
Project Result		**00:30:00**	**54.6**	**23.2**	**37.0**	**40.1**	**30.2**

NSL4 Night time #2

Start: 2019-08-01 23:32:08

End: 2019-08-02 00:02:08



Configuration

Device Info: XL2, SNo. A2A-08898-E0, FW3.11 Type Approved

Mic Type: NTi Audio M2230, SNo. 5062, User calibrated 2019-08-01 22:20

Mic Sensitivity: 42.9 mV/Pa

Range: 0 - 100 dB

Ln based on: LAeq_dt

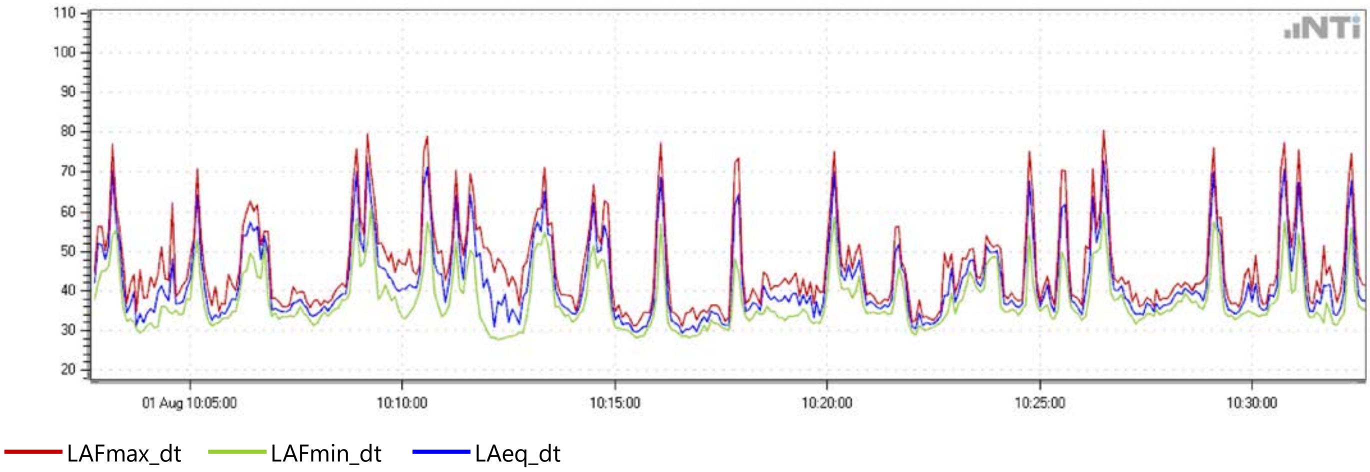
Results

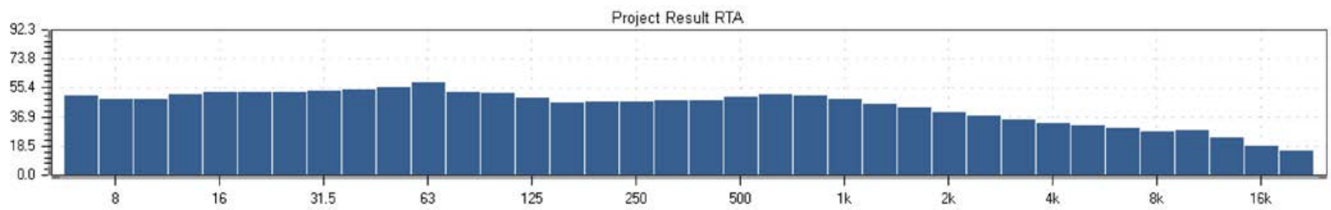
Type	Start Date and Time	Duration	LAFmax [dB]	LAFmin [dB]	LAeq [dB]	L 10.0 % [dB]	L 90.0 % [dB]
Recorded		**00:30:00**	**54.6**	**24.6**	**37.3**		
Project Result		**00:30:00**	**54.6**	**24.6**	**37.3**	**39.7**	**32.3**

NSL5 Daytime #1

Start: 2019-08-01 10:02:40

End: 2019-08-01 10:32:40





Configuration

Device Info: XL2, SNo. A2A-08898-E0, FW3.11 Type Approved

Mic Type: NTi Audio M2230, SNo. 5062, User calibrated 2019-08-01 09:55

Mic Sensitivity: 43.5 mV/Pa

Range: 20 - 120 dB

Ln based on: LAeq_dt

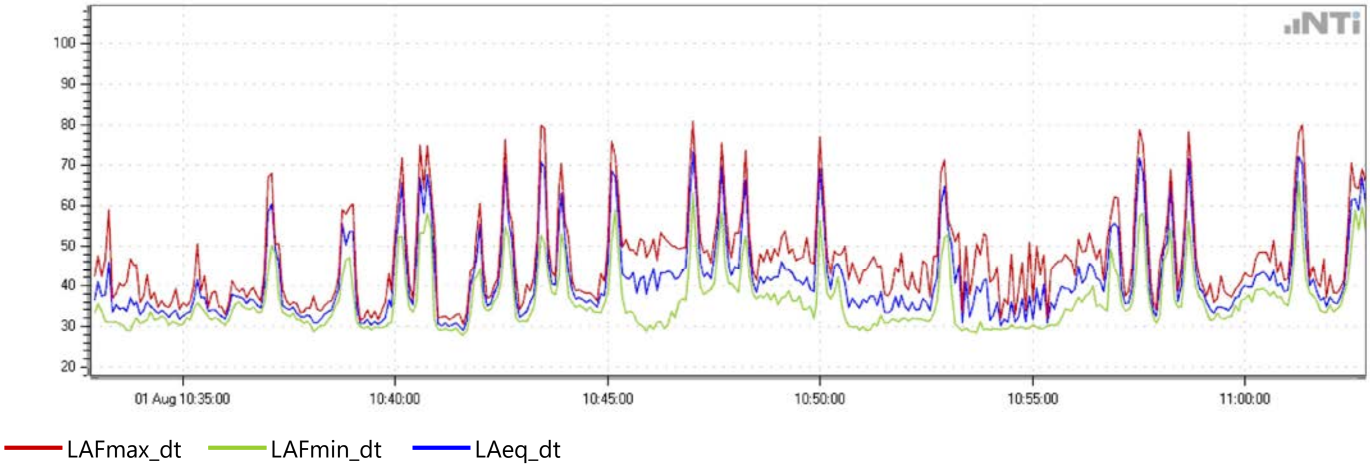
Results

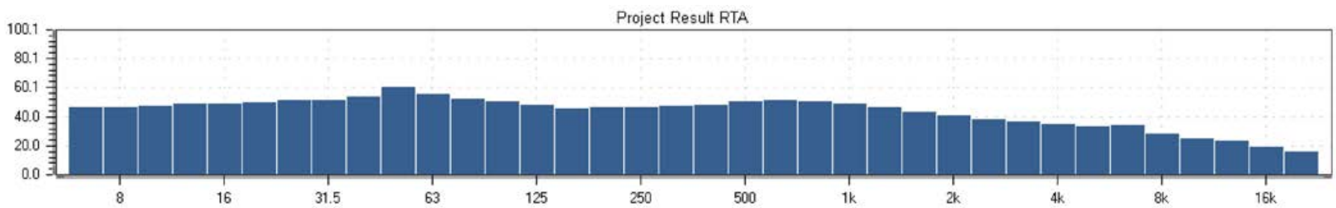
Type	Start Date and Time	Duration	LAFmax [dB]	LAFmin [dB]	LAeq [dB]	L 10.0 % [dB]	L 90.0 % [dB]
Recorded		**00:30:00**	**80.3**	**27.7**	**57.0**		
Project Result		**00:30:00**	**80.3**	**27.7**	**57.0**	**55.5**	**32.6**

NSL5 Daytime #2

Start: 2019-08-01 10:32:50

End: 2019-08-01 11:02:50





Configuration

Device Info: XL2, SNo. A2A-08898-E0, FW3.11 Type Approved

Mic Type: NTi Audio M2230, SNo. 5062, User calibrated 2019-08-01 09:55

Mic Sensitivity: 43.5 mV/Pa

Range: 20 - 120 dB

Ln based on: LAeq_dt

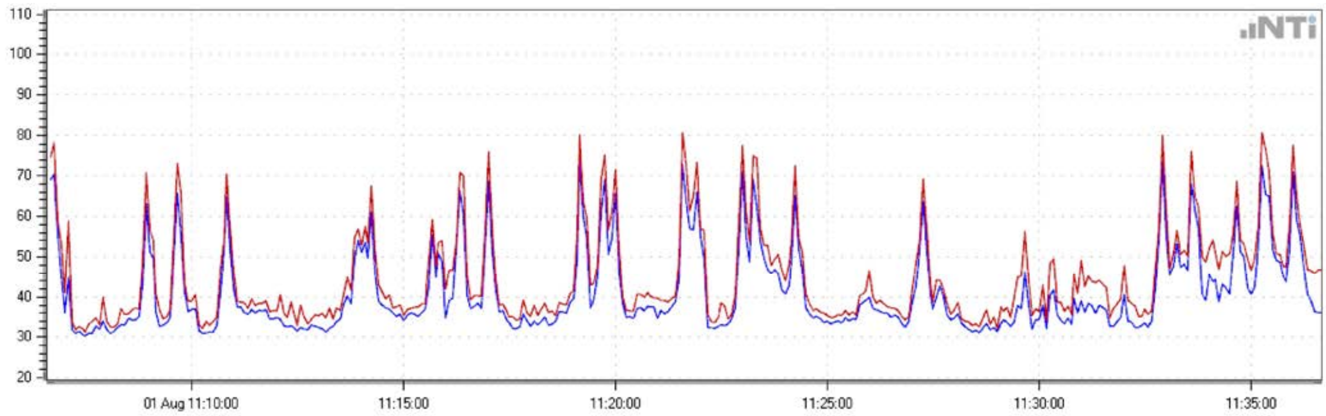
Results

Type	Start Date and Time	Duration	LAFmax [dB]	LAFmin [dB]	LAeq [dB]	L 10.0 % [dB]	L 90.0 % [dB]
Recorded		**00:30:00**	**80.9**	**27.8**	**57.5**		
Project Result		**00:30:00**	**80.9**	**27.8**	**57.5**	**55.1**	**31.6**

NSL5 Daytime #3

Start: 2019-08-01 11:06:38

End: 2019-08-01 11:36:38



LAFmax_dt LAeq_dt

Configuration

Device Info: XL2, SNo. A2A-08898-E0, FW3.11 Type Approved

Mic Type: NTi Audio M2230, SNo. 5062, User calibrated 2019-08-01 09:55

Mic Sensitivity: 43.5 mV/Pa

Range: 20 - 120 dB

Ln based on: LAeq_dt

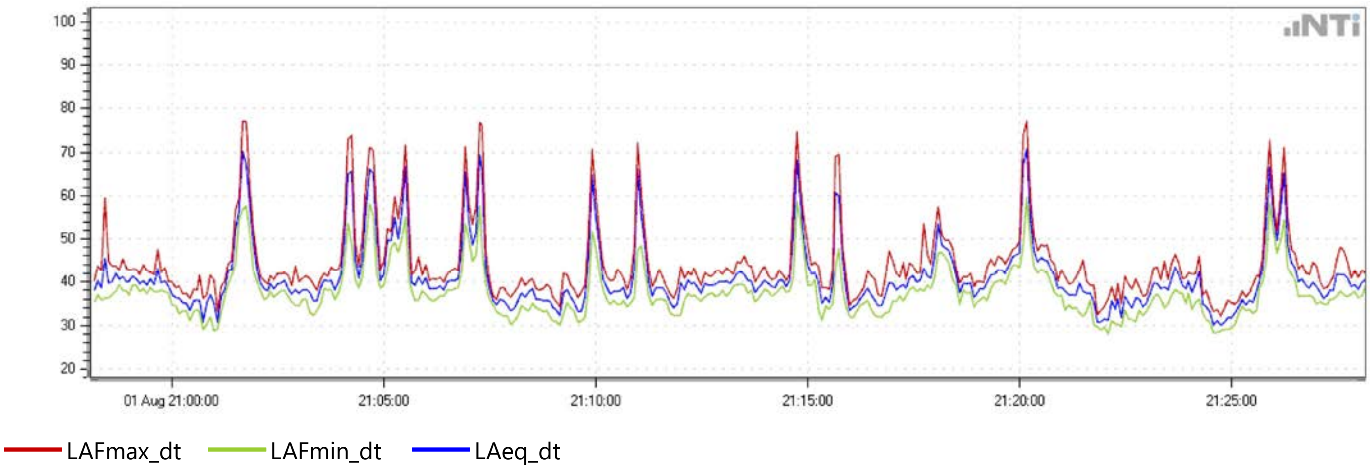
Results

Type	Start Date and Time	Duration	LAFmax [dB]	LAFmin [dB]	LAeq [dB]	L 10.0 % [dB]	L 90.0 % [dB]
Recorded		**00:30:00**	**80.6**	**29.4**	**57.7**		
Project Result		**00:30:00**	**80.6**	**29.4**	**57.7**	**54.8**	**32.1**

NSL5 Evening

Start: 2019-08-01 20:58:08

End: 2019-08-01 21:28:08



Configuration

Device Info: XL2, SNo. A2A-08898-E0, FW3.11 Type Approved

Mic Type: NTi Audio M2230, SNo. 5062, User calibrated 2019-08-01 19:43

Mic Sensitivity: 43.2 mV/Pa

Range: 20 - 120 dB

Ln based on: LAeq_dt

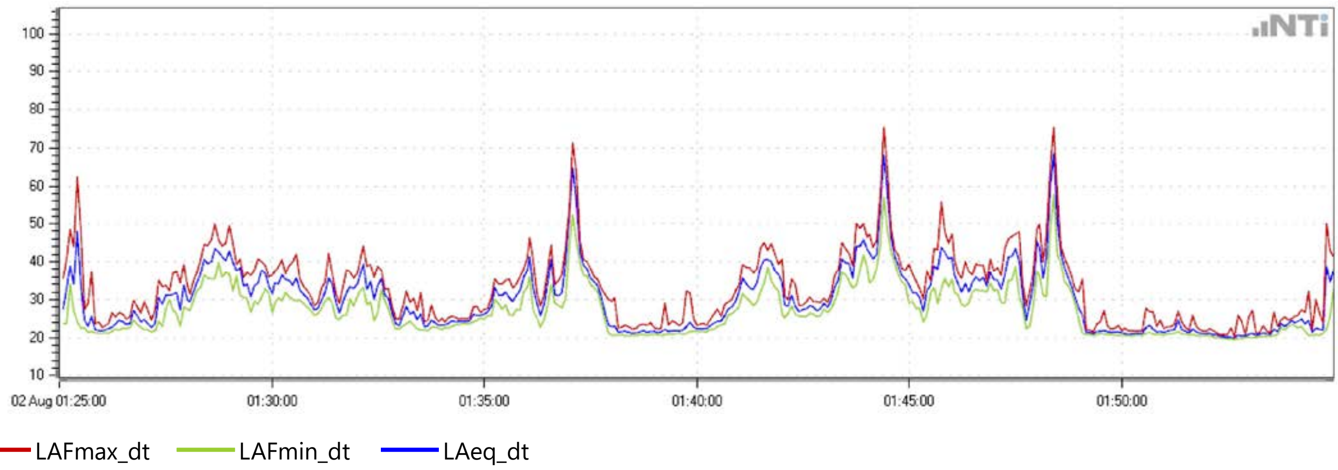
Results

Type	Start Date and Time	Duration	LAFmax [dB]	LAFmin [dB]	LAeq [dB]	L 10.0 % [dB]	L 90.0 % [dB]
Recorded		**00:30:00**	**77.0**	**28.1**	**54.5**		
Project Result		**00:30:00**	**77.0**	**28.1**	**54.5**	**50.3**	**34.4**

NSL5 Night time #1

Start: 2019-08-02 01:25:00

End: 2019-08-02 01:55:00



Configuration

Device Info: XL2, SNo. A2A-08898-E0, FW3.11 Type Approved

Mic Type: NTi Audio M2230, SNo. 5062, User calibrated 2019-08-02 01:23

Mic Sensitivity: 43.2 mV/Pa

Range: 0 - 100 dB

Ln based on: LAeq_dt

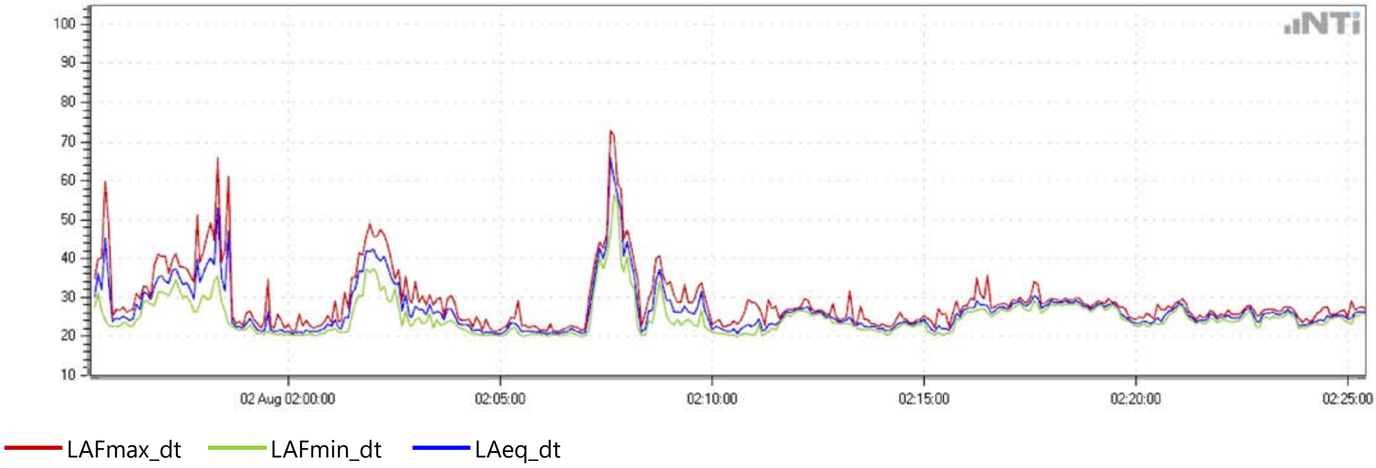
Results

Type	Start Date and Time	Duration	LAFmax [dB]	LAFmin [dB]	LAeq [dB]	L 10.0 % [dB]	L 90.0 % [dB]
Recorded		**00:30:00**	**75.3**	**19.5**	**47.5**		
Project Result		**00:30:00**	**75.3**	**19.5**	**47.5**	**40.6**	**21.4**

NSL5 Night time #2

Start: 2019-08-02 01:55:24

End: 2019-08-02 02:25:24



Configuration

Device Info: XL2, SNo. A2A-08898-E0, FW3.11 Type Approved

Mic Type: NTi Audio M2230, SNo. 5062, User calibrated 2019-08-02 01:23

Mic Sensitivity: 43.2 mV/Pa

Range: 0 - 100 dB

Ln based on: LAeq_dt

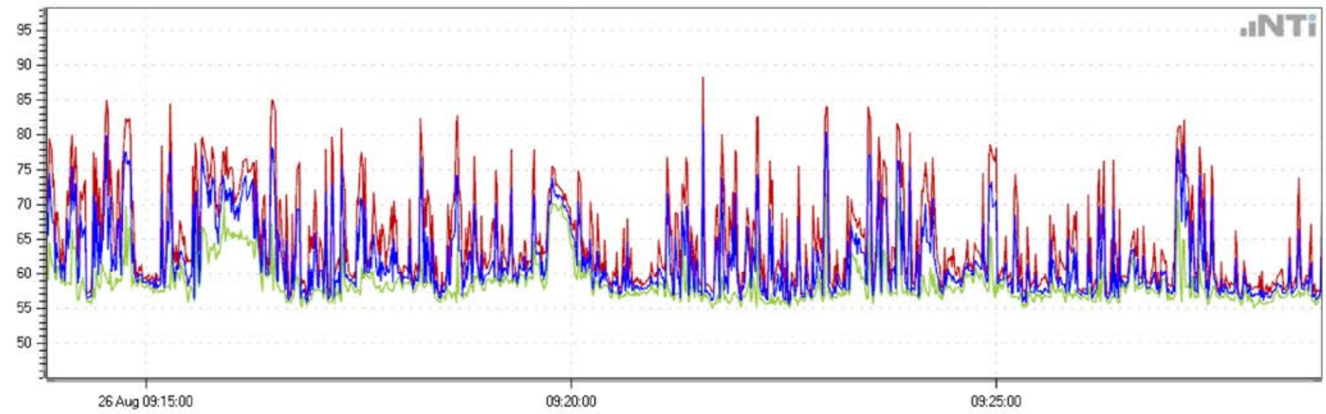
Results

Type	Start Date and Time	Duration	LAFmax [dB]	LAFmin [dB]	LAeq [dB]	L 10.0 % [dB]	L 90.0 % [dB]
Recorded		**00:30:00**	**72.7**	**19.9**	**42.3**		
Project Result		**00:30:00**	**72.7**	**19.9**	**42.3**	**34.3**	**21.3**

B1 Daytime #1

Start: 2019-08-26 09:13:50

End: 2019-08-26 09:28:50



LAeq_dt LAFmax_dt LAFmin_dt

Configuration

Device Info: XL2, SNo. A2A-08898-E0, FW3.11 Type Approved

Mic Type: NTi Audio M2230, SNo. 5062, User calibrated 2019-08-26 09:12

Mic Sensitivity: 43.3 mV/Pa

Range: 20 - 120 dB

Ln based on: LAeq_dt

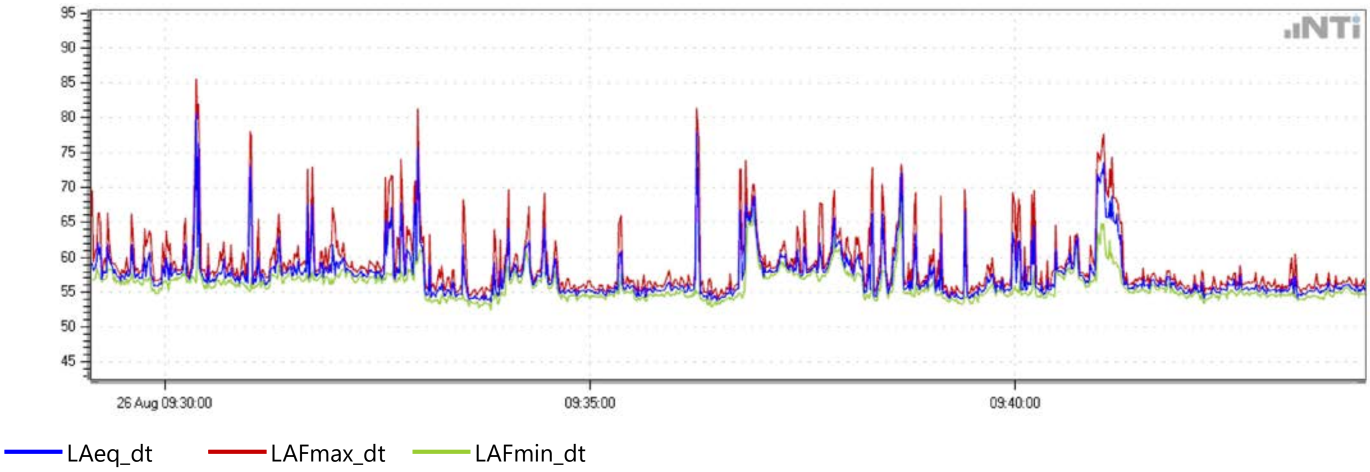
Results

Type	Start Date and Time	Duration	LAeq [dB]	LAFmax [dB]	LAFmin [dB]	L 10.0 % [dB]	L 90.0 % [dB]
Recorded		**00:15:00**	**66.6**	**88.2**	**55.1**		
Project Result		**00:15:00**	**66.6**	**88.2**	**55.1**	**71.0**	**57.2**

B1 Daytime #2

Start: 2019-08-26 09:29:08

End: 2019-08-26 09:44:08



Configuration

Device Info: XL2, SNo. A2A-08898-E0, FW3.11 Type Approved

Mic Type: NTi Audio M2230, SNo. 5062, User calibrated 2019-08-26 09:12

Mic Sensitivity: 43.3 mV/Pa

Range: 20 - 120 dB

Ln based on: LAeq_dt

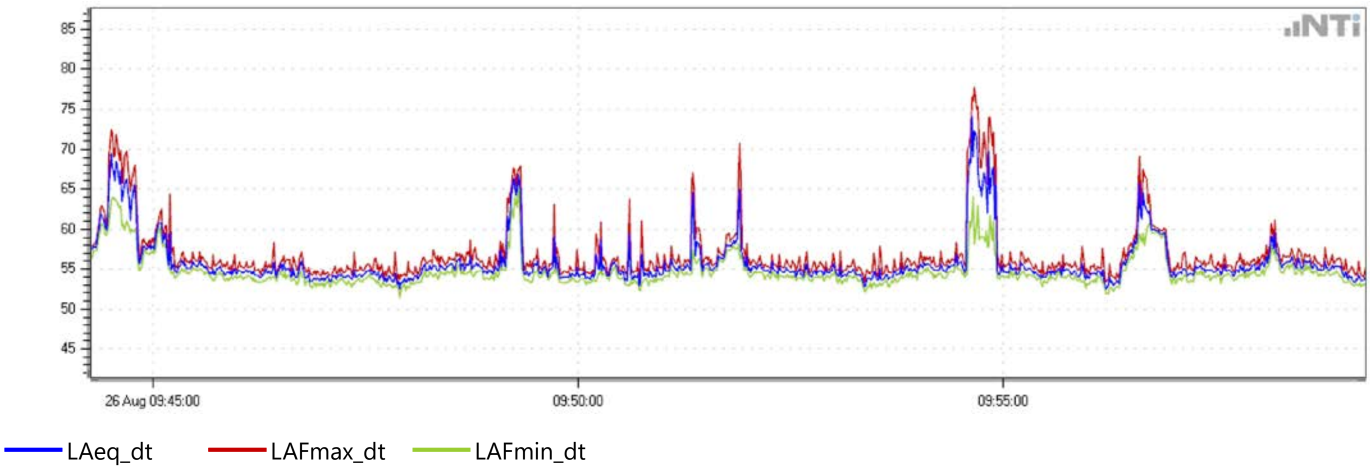
Results

Type	Start Date and Time	Duration	LAeq [dB]	LAFmax [dB]	LAFmin [dB]	L 10.0 % [dB]	L 90.0 % [dB]
Recorded		**00:15:00**	**60.5**	**85.5**	**52.4**		
Project Result		**00:15:00**	**60.5**	**85.5**	**52.4**	**61.5**	**54.8**

B1 Daytime #3

Start: 2019-08-26 09:44:16

End: 2019-08-26 09:59:16



Configuration

Device Info: XL2, SNo. A2A-08898-E0, FW3.11 Type Approved

Mic Type: NTi Audio M2230, SNo. 5062, User calibrated 2019-08-26 09:12

Mic Sensitivity: 43.3 mV/Pa

Range: 20 - 120 dB

Ln based on: LAeq_dt

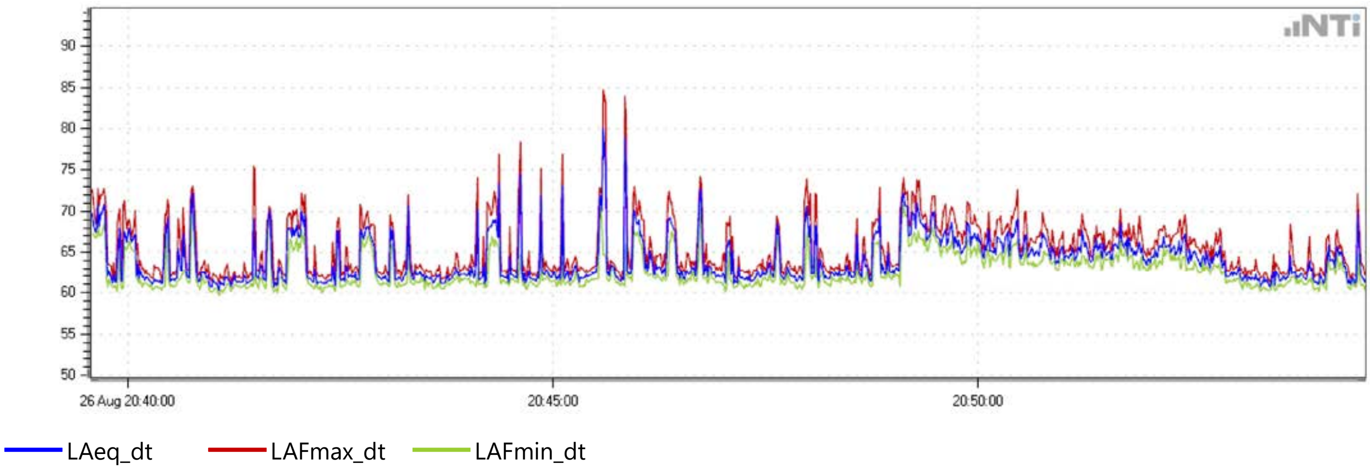
Results

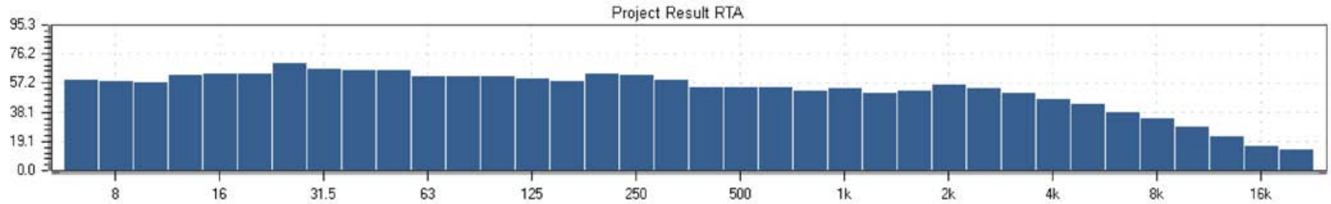
Type	Start Date and Time	Duration	LAeq [dB]	LAFmax [dB]	LAFmin [dB]	L 10.0 % [dB]	L 90.0 % [dB]
Recorded		**00:15:00**	**58.0**	**77.7**	**51.4**		
Project Result		**00:15:00**	**58.0**	**77.7**	**51.4**	**59.5**	**54.0**

B1 Evening

Start: 2019-08-26 20:39:34

End: 2019-08-26 20:54:34





Configuration

Device Info: XL2, SNo. A2A-08898-E0, FW3.11 Type Approved

Mic Type: NTi Audio M2230, SNo. 5062, User calibrated 2019-08-26 18:59

Mic Sensitivity: 43.2 mV/Pa

Range: 20 - 120 dB

Ln based on: LAeq_dt

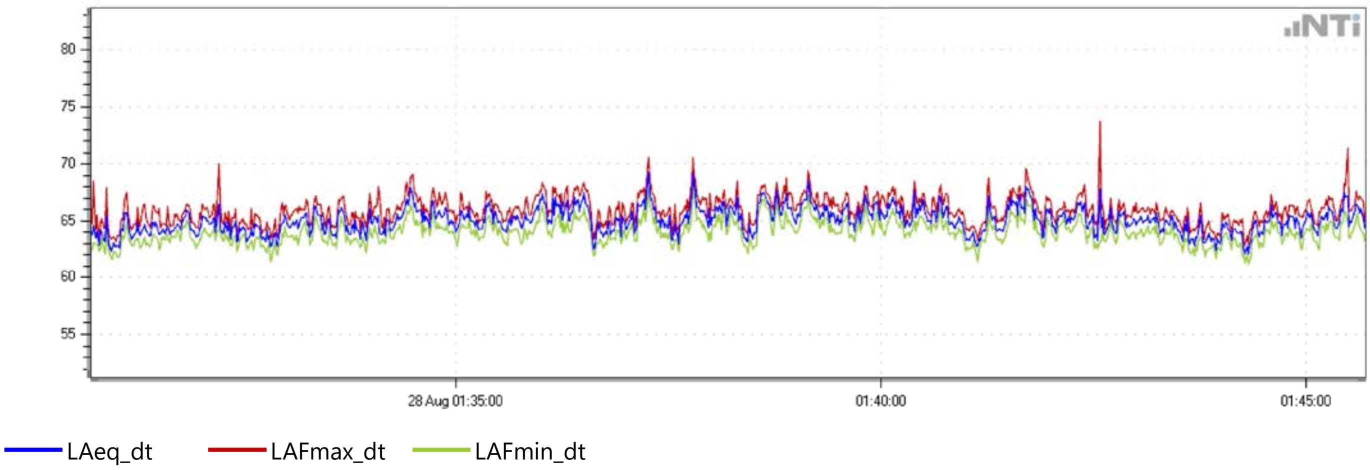
Results

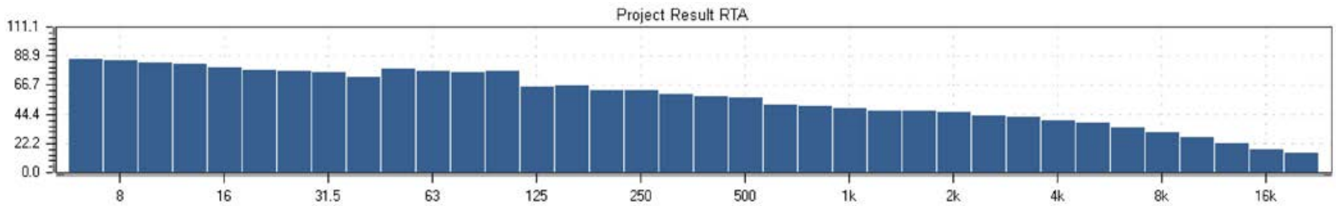
Type	Start Date and Time	Duration	LAeq [dB]	LAFmax [dB]	LAFmin [dB]	L 10.0 % [dB]	L 90.0 % [dB]
Recorded		**00:15:00**	**65.2**	**84.7**	**59.7**		
Project Result		**00:15:00**	**65.2**	**84.7**	**59.7**	**68.1**	**61.5**

B1 Night time #1

Start: 2019-08-28 01:30:42

End: 2019-08-28 01:45:42





Configuration

Device Info: XL2, SNo. A2A-08898-E0, FW3.11 Type Approved

Mic Type: NTi Audio M2230, SNo. 5062, User calibrated 2019-08-28 01:15

Mic Sensitivity: 43.3 mV/Pa

Range: 20 - 120 dB

Ln based on: LAeq_dt

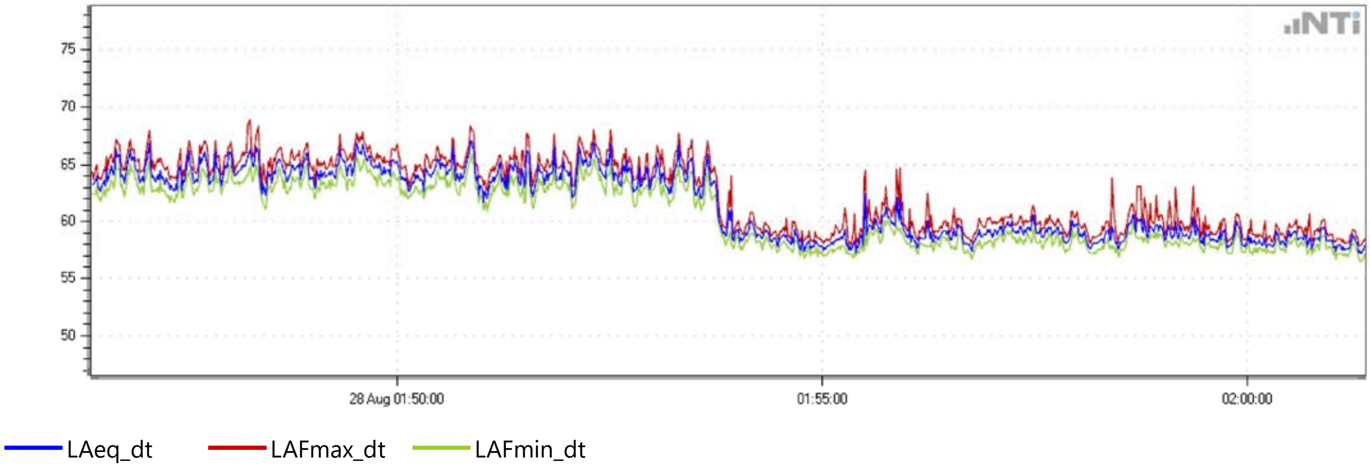
Results

Type	Start Date and Time	Duration	LAeq [dB]	LAFmax [dB]	LAFmin [dB]	L 10.0 % [dB]	L 90.0 % [dB]
Recorded		**00:15:00**	**65.2**	**73.7**	**61.2**		
Project Result		**00:15:00**	**65.2**	**73.7**	**61.2**	**66.6**	**63.7**

B1 Night time #2

Start: 2019-08-28 01:46:24

End: 2019-08-28 02:01:24



Configuration

Device Info: XL2, SNo. A2A-08898-E0, FW3.11 Type Approved

Mic Type: NTi Audio M2230, SNo. 5062, User calibrated 2019-08-28 01:15

Mic Sensitivity: 43.3 mV/Pa

Range: 20 - 120 dB

Ln based on: LAeq_dt

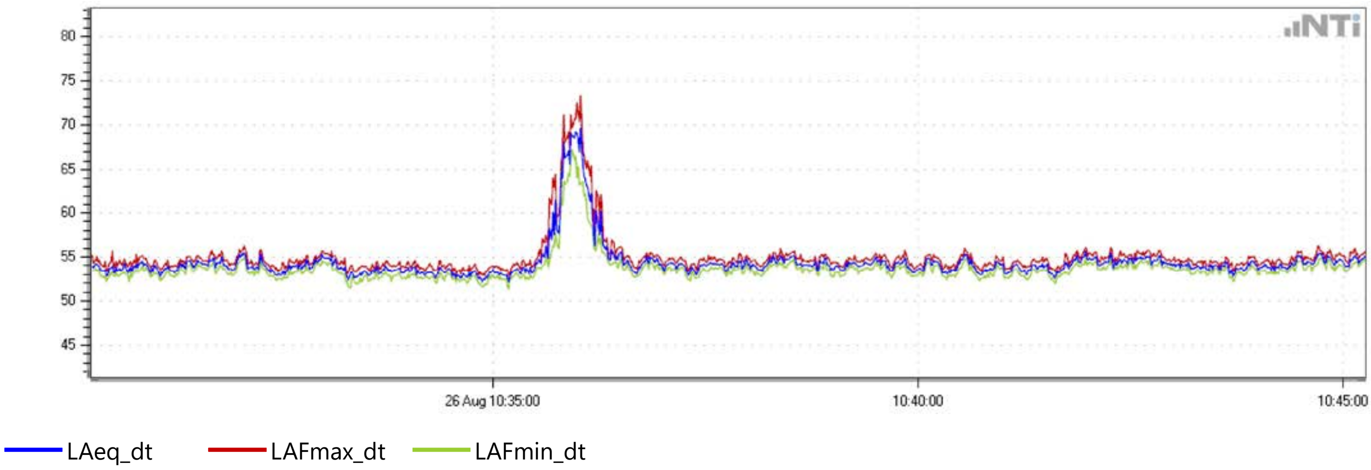
Results

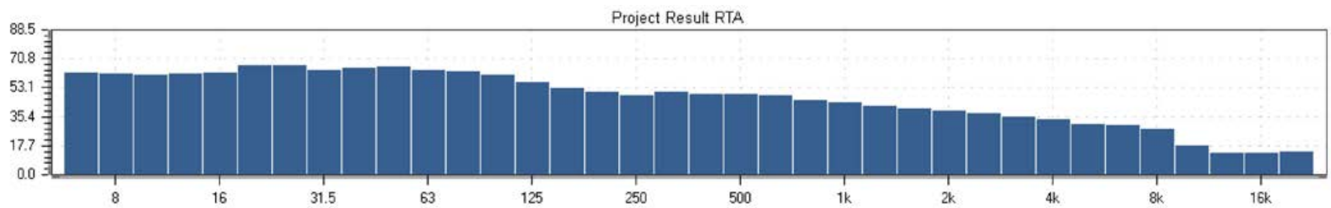
Type	Start Date and Time	Duration	LAeq [dB]	LAFmax [dB]	LAFmin [dB]	L 10.0 % [dB]	L 90.0 % [dB]
Recorded		**00:15:00**	**62.5**	**68.9**	**56.5**		
Project Result		**00:15:00**	**62.5**	**68.9**	**56.5**	**65.3**	**58.2**

B2 Daytime #1

Start: 2019-08-26 10:30:16

End: 2019-08-26 10:45:16





Configuration

Device Info: XL2, SNo. A2A-16311-E0, FW4.20

Mic Type: NTi Audio M2230, SNo. 8567, User calibrated 2019-08-26 10:28

Mic Sensitivity: 41.2 mV/Pa

Range: 20 - 120 dB

Ln based on: LAeq_dt

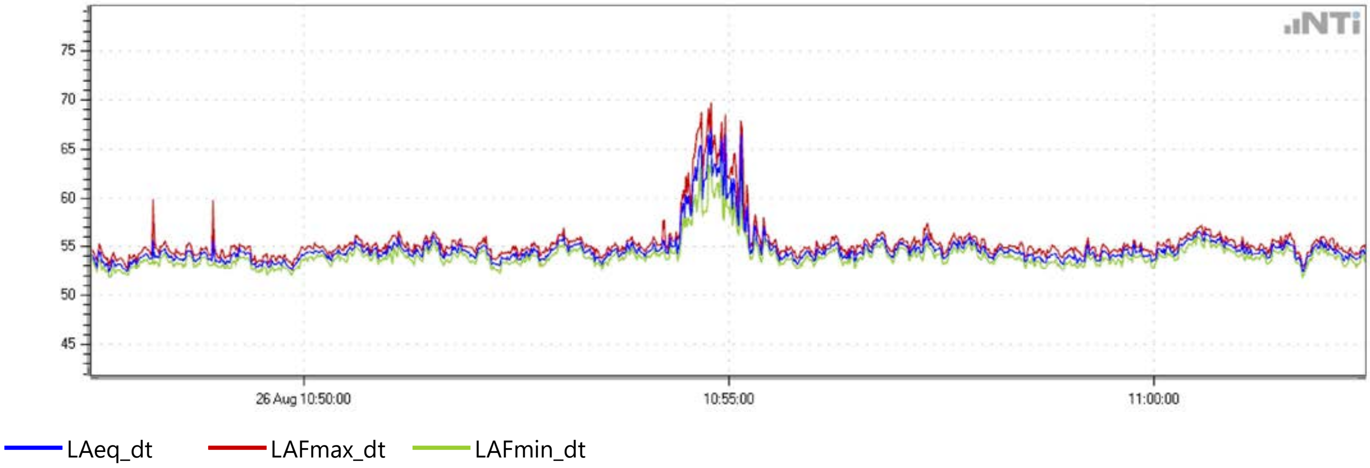
Results

Type	Start Date and Time	Duration	LAeq [dB]	LAFmax [dB]	LAFmin [dB]	L 10.0 % [dB]	L 90.0 % [dB]
Recorded		**00:15:00**	**55.7**	**73.3**	**51.3**		
Project Result		**00:15:00**	**55.7**	**73.3**	**51.3**	**55.1**	**53.3**

B2 Daytime #2

Start: 2019-08-26 10:47:30

End: 2019-08-26 11:02:30



Configuration

Device Info: XL2, SNo. A2A-16311-E0, FW4.20

Mic Type: NTi Audio M2230, SNo. 8567, User calibrated 2019-08-26 10:28

Mic Sensitivity: 41.2 mV/Pa

Range: 20 - 120 dB

Ln based on: LAeq_dt

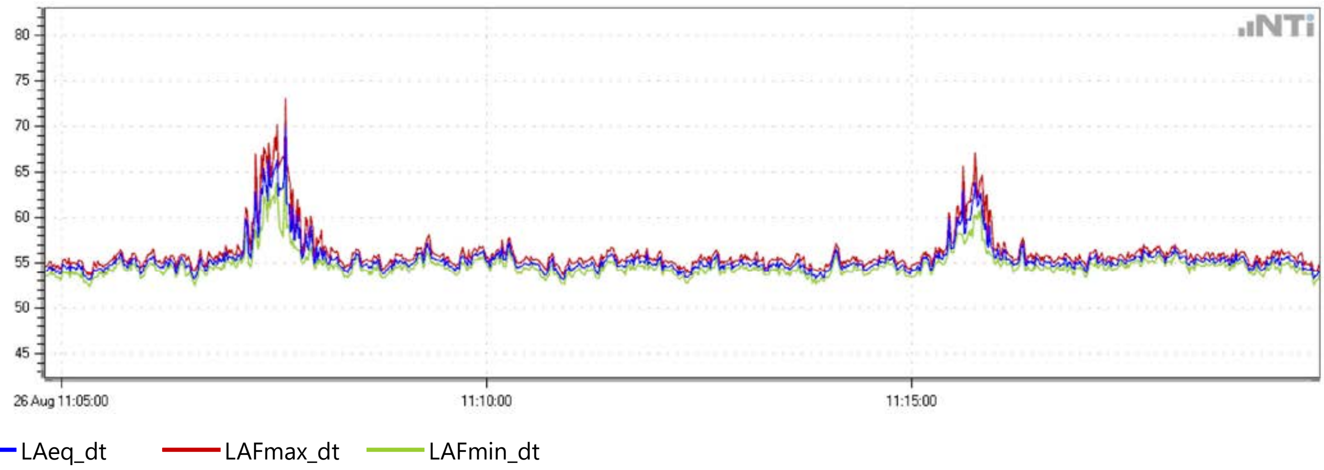
Results

Type	Start Date and Time	Duration	LAeq [dB]	LAFmax [dB]	LAFmin [dB]	L 10.0 % [dB]	L 90.0 % [dB]
Recorded		**00:15:00**	**55.5**	**69.7**	**51.8**		
Project Result		**00:15:00**	**55.5**	**69.7**	**51.8**	**55.8**	**53.6**

B2 Daytime #3

Start: 2019-08-26 11:04:48

End: 2019-08-26 11:19:48



Configuration

Device Info: XL2, SNo. A2A-16311-E0, FW4.20

Mic Type: NTi Audio M2230, SNo. 8567, User calibrated 2019-08-26 10:28

Mic Sensitivity: 41.2 mV/Pa

Range: 20 - 120 dB

Ln based on: LAeq_dt

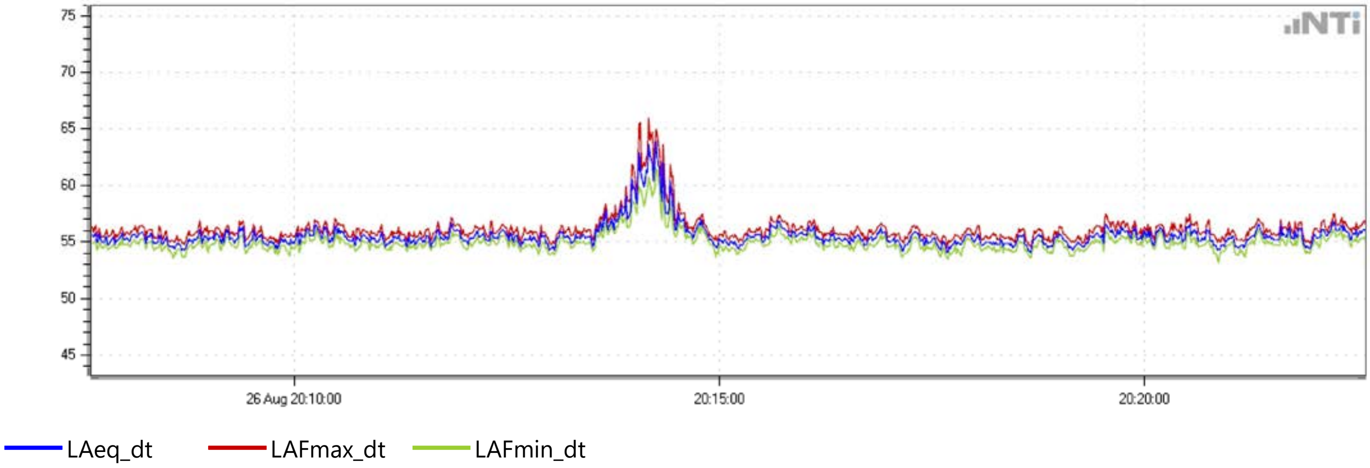
Results

Type	Start Date and Time	Duration	LAeq [dB]	LAFmax [dB]	LAFmin [dB]	L 10.0 % [dB]	L 90.0 % [dB]
Recorded		**00:15:00**	**56.1**	**73.1**	**52.3**		
Project Result		**00:15:00**	**56.1**	**73.1**	**52.3**	**56.5**	**54.2**

B2 Evening

Start: 2019-08-26 20:07:36

End: 2019-08-26 20:22:36



Configuration

Device Info: XL2, SNo. A2A-08898-E0, FW3.11 Type Approved

Mic Type: NTi Audio M2230, SNo. 5062, User calibrated 2019-08-26 18:59

Mic Sensitivity: 43.2 mV/Pa

Range: 20 - 120 dB

Ln based on: LAeq_dt

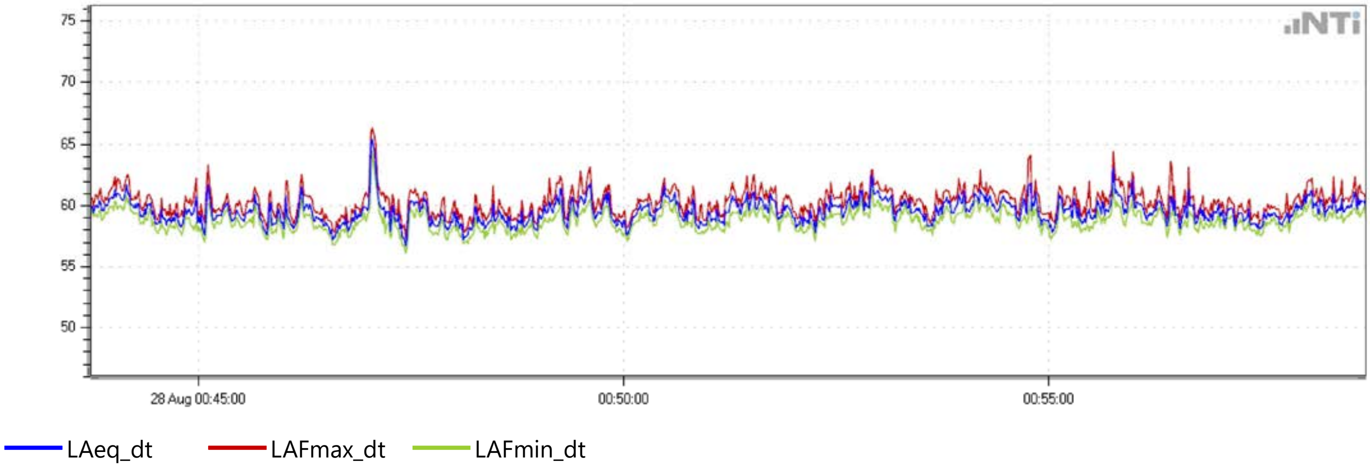
Results

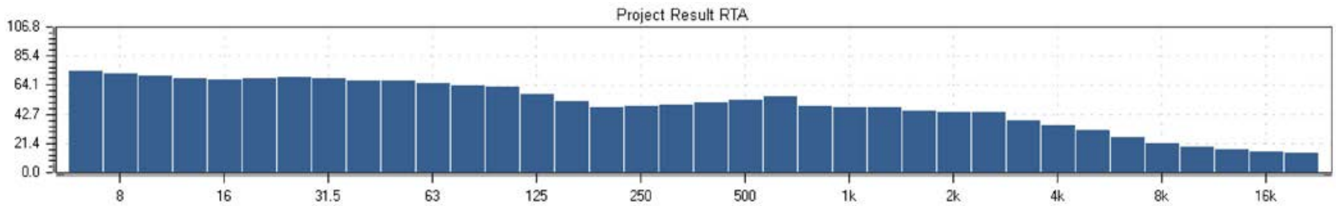
Type	Start Date and Time	Duration	LAeq [dB]	LAFmax [dB]	LAFmin [dB]	L 10.0 % [dB]	L 90.0 % [dB]
Recorded		**00:15:00**	**55.8**	**65.9**	**53.2**		
Project Result		**00:15:00**	**55.8**	**65.9**	**53.2**	**56.4**	**54.8**

B2 Night #1

Start: 2019-08-28 00:43:44

End: 2019-08-28 00:58:44





Configuration

Device Info: XL2, SNo. A2A-08898-E0, FW3.11 Type Approved

Mic Type: NTi Audio M2230, SNo. 5062, User calibrated 2019-08-28 00:09

Mic Sensitivity: 43.4 mV/Pa

Range: 20 - 120 dB

Ln based on: LAeq_dt

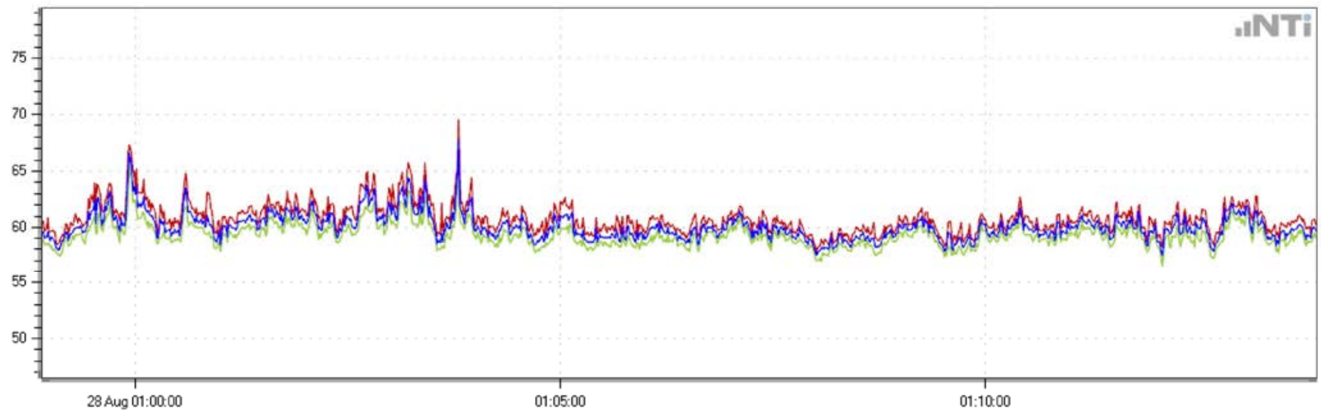
Results

Type	Start Date and Time	Duration	LAeq [dB]	LAFmax [dB]	LAFmin [dB]	L 10.0 % [dB]	L 90.0 % [dB]
Recorded		**00:15:00**	**59.6**	**66.3**	**56.1**		
Project Result		**00:15:00**	**59.6**	**66.3**	**56.1**	**60.8**	**58.5**

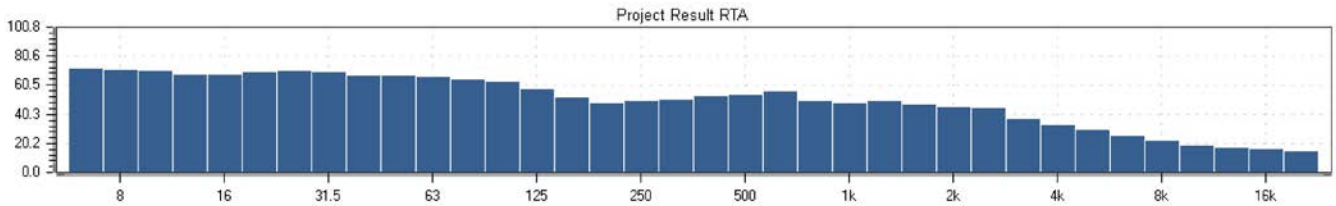
B2 Night #2

Start: 2019-08-28 00:58:54

End: 2019-08-28 01:13:54



LAeq_dt LAFmax_dt LAFmin_dt



Configuration

Device Info: XL2, SNo. A2A-08898-E0, FW3.11 Type Approved

Mic Type: NTi Audio M2230, SNo. 5062, User calibrated 2019-08-28 00:09

Mic Sensitivity: 43.4 mV/Pa

Range: 20 - 120 dB

Ln based on: LAeq_dt

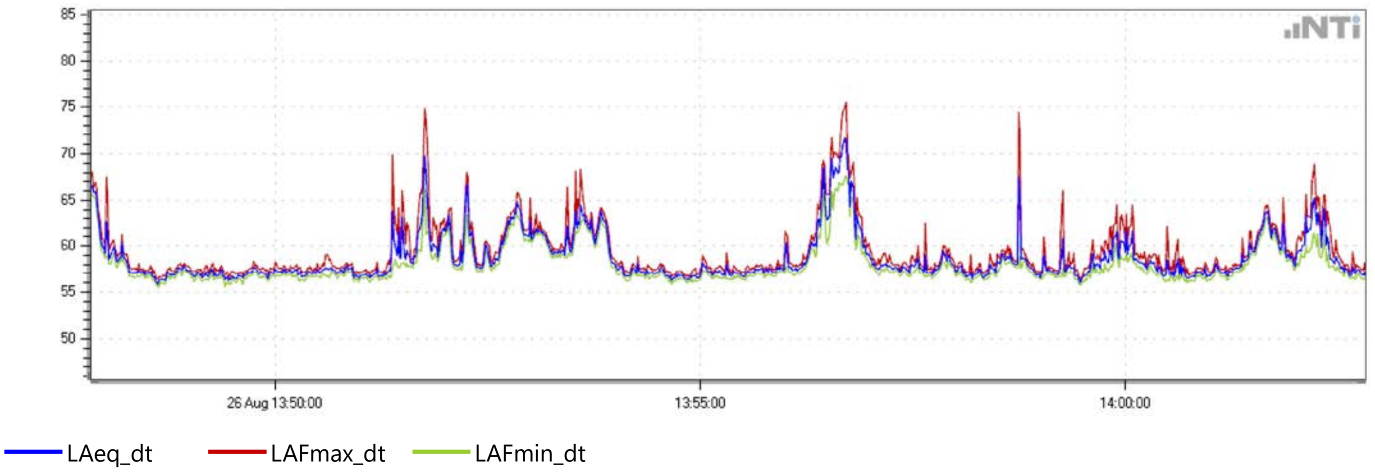
Results

Type	Start Date and Time	Duration	LAeq [dB]	LAFmax [dB]	LAFmin [dB]	L 10.0 % [dB]	L 90.0 % [dB]
Recorded		**00:15:00**	**60.2**	**69.5**	**56.5**		
Project Result		**00:15:00**	**60.2**	**69.5**	**56.5**	**61.6**	**58.8**

B3 Daytime #1

Start: 2019-08-26 13:47:50

End: 2019-08-26 14:02:50



Configuration

Device Info: XL2, SNo. A2A-16311-E0, FW4.20

Mic Type: NTi Audio M2230, SNo. 8567, User calibrated 2019-08-26 12:42

Mic Sensitivity: 40.5 mV/Pa

Range: 20 - 120 dB

Ln based on: LAeq_dt

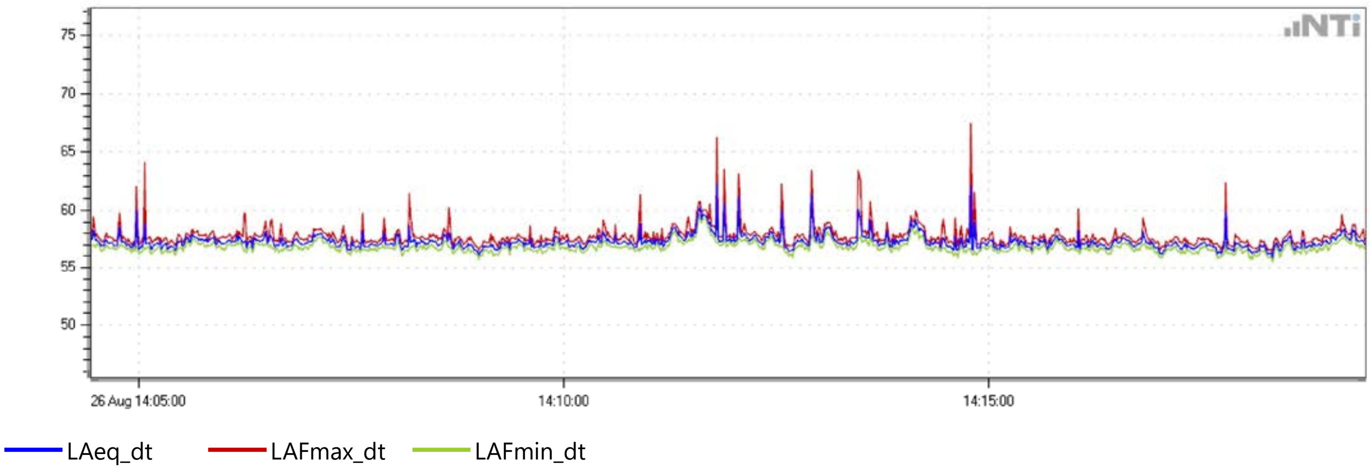
Results

Type	Start Date and Time	Duration	LAeq [dB]	LAFmax [dB]	LAFmin [dB]	L 10.0 % [dB]	L 90.0 % [dB]
Recorded		**00:15:00**	**59.9**	**75.5**	**55.6**		
Project Result		**00:15:00**	**59.9**	**75.5**	**55.6**	**62.3**	**56.9**

B3 Daytime #2

Start: 2019-08-26 14:04:26

End: 2019-08-26 14:19:26



Configuration

Device Info: XL2, SNo. A2A-16311-E0, FW4.20

Mic Type: NTi Audio M2230, SNo. 8567, User calibrated 2019-08-26 12:42

Mic Sensitivity: 40.5 mV/Pa

Range: 20 - 120 dB

Ln based on: LAeq_dt

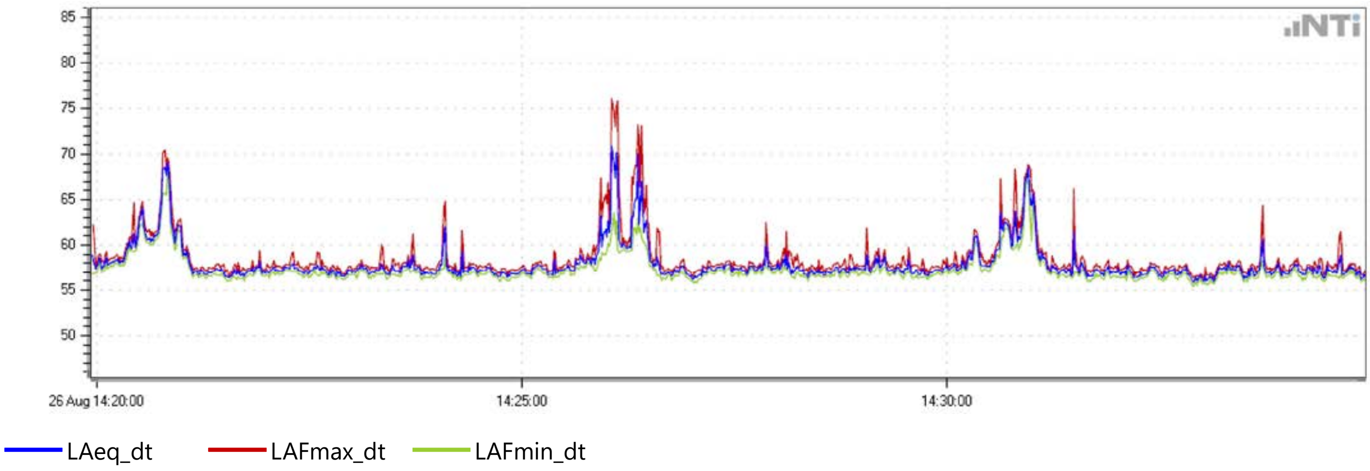
Results

Type	Start Date and Time	Duration	LAeq [dB]	LAFmax [dB]	LAFmin [dB]	L 10.0 % [dB]	L 90.0 % [dB]
Recorded		**00:15:00**	**57.3**	**67.4**	**55.5**		
Project Result		**00:15:00**	**57.3**	**67.4**	**55.5**	**57.9**	**56.8**

B3 Daytime #3

Start: 2019-08-26 14:19:56

End: 2019-08-26 14:34:56



Configuration

Device Info: XL2, SNo. A2A-16311-E0, FW4.20

Mic Type: NTi Audio M2230, SNo. 8567, User calibrated 2019-08-26 12:42

Mic Sensitivity: 40.5 mV/Pa

Range: 20 - 120 dB

Ln based on: LAeq_dt

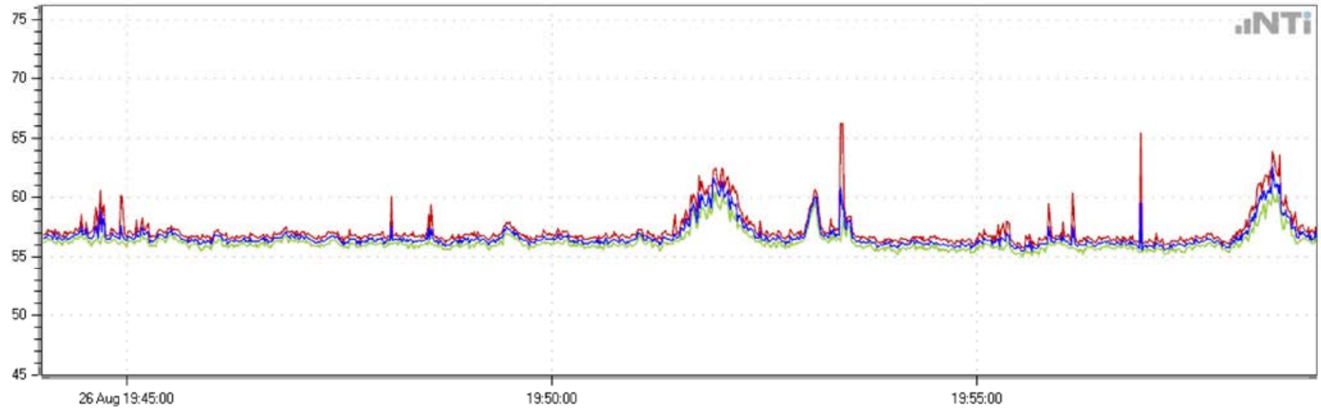
Results

Type	Start Date and Time	Duration	LAeq [dB]	LAFmax [dB]	LAFmin [dB]	L 10.0 % [dB]	L 90.0 % [dB]
Recorded		**00:15:00**	**58.8**	**76.1**	**55.4**		
Project Result		**00:15:00**	**58.8**	**76.1**	**55.4**	**60.4**	**56.8**

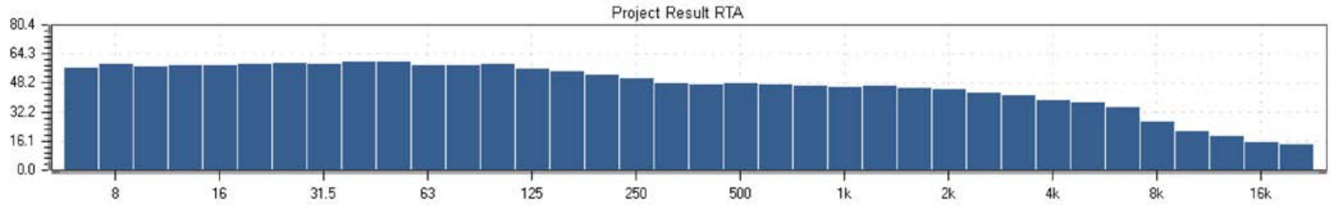
B3 Evening

Start: 2019-08-26 19:44:00

End: 2019-08-26 19:59:00



LAeq_dt LAFmax_dt LAFmin_dt



Configuration

Device Info: XL2, SNo. A2A-08898-E0, FW3.11 Type Approved

Mic Type: NTi Audio M2230, SNo. 5062, User calibrated 2019-08-26 18:59

Mic Sensitivity: 43.2 mV/Pa

Range: 20 - 120 dB

Ln based on: LAeq_dt

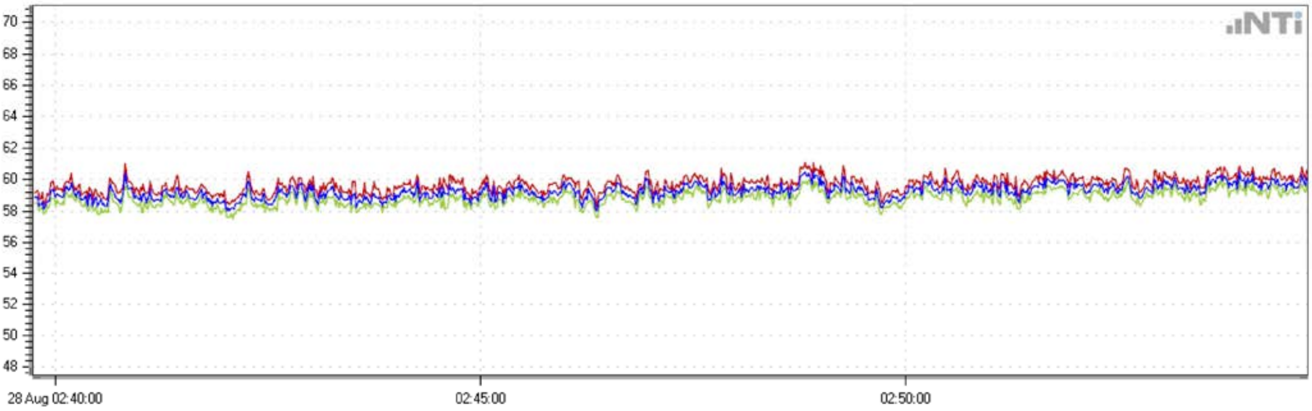
Results

Type	Start Date and Time	Duration	LAeq [dB]	LAFmax [dB]	LAFmin [dB]	L 10.0 % [dB]	L 90.0 % [dB]
Recorded		**00:15:00**	**56.9**	**66.2**	**55.0**		
Project Result		**00:15:00**	**56.9**	**66.2**	**55.0**	**57.7**	**56.1**

B3 Night time #1

Start: 2019-08-28 02:39:44

End: 2019-08-28 02:54:44



LAeq_dt LAFmax_dt LAFmin_dt

Configuration

Device Info: XL2, SNo. A2A-08898-E0, FW3.11 Type Approved

Mic Type: NTi Audio M2230, SNo. 5062, User calibrated 2019-08-28 02:37

Mic Sensitivity: 43.2 mV/Pa

Range: 20 - 120 dB

Ln based on: LAeq_dt

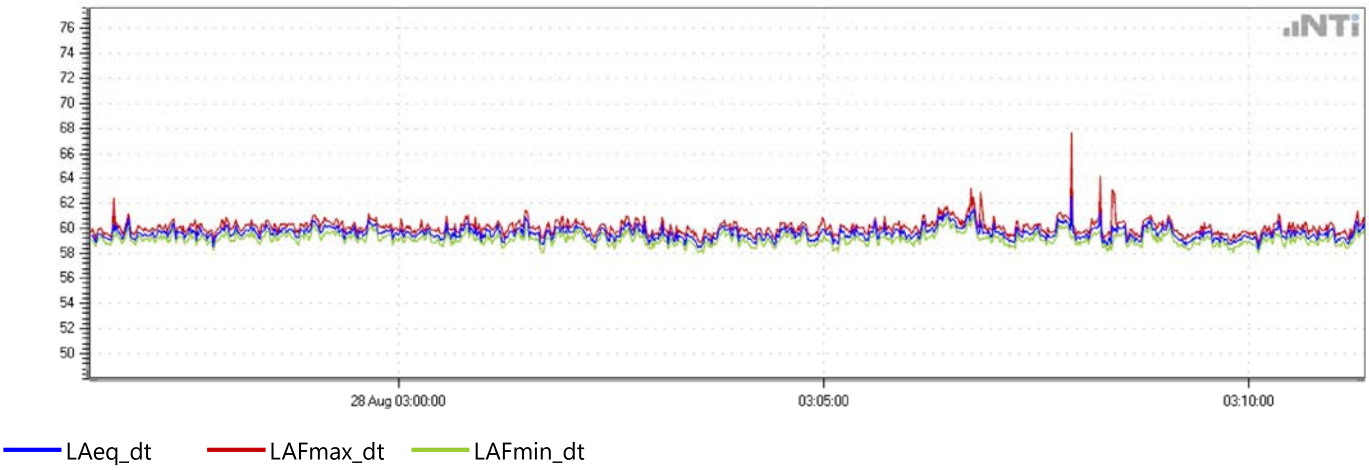
Results

Type	Start Date and Time	Duration	LAeq [dB]	LAFmax [dB]	LAFmin [dB]	L 10.0 % [dB]	L 90.0 % [dB]
Recorded		**00:15:00**	**59.3**	**61.1**	**57.5**		
Project Result		**00:15:00**	**59.3**	**61.1**	**57.5**	**59.9**	**58.7**

B3 Night time #2

Start: 2019-08-28 02:56:22

End: 2019-08-28 03:11:22



Configuration

Device Info: XL2, SNo. A2A-08898-E0, FW3.11 Type Approved

Mic Type: NTi Audio M2230, SNo. 5062, User calibrated 2019-08-28 02:37

Mic Sensitivity: 43.2 mV/Pa

Range: 20 - 120 dB

Ln based on: LAeq_dt

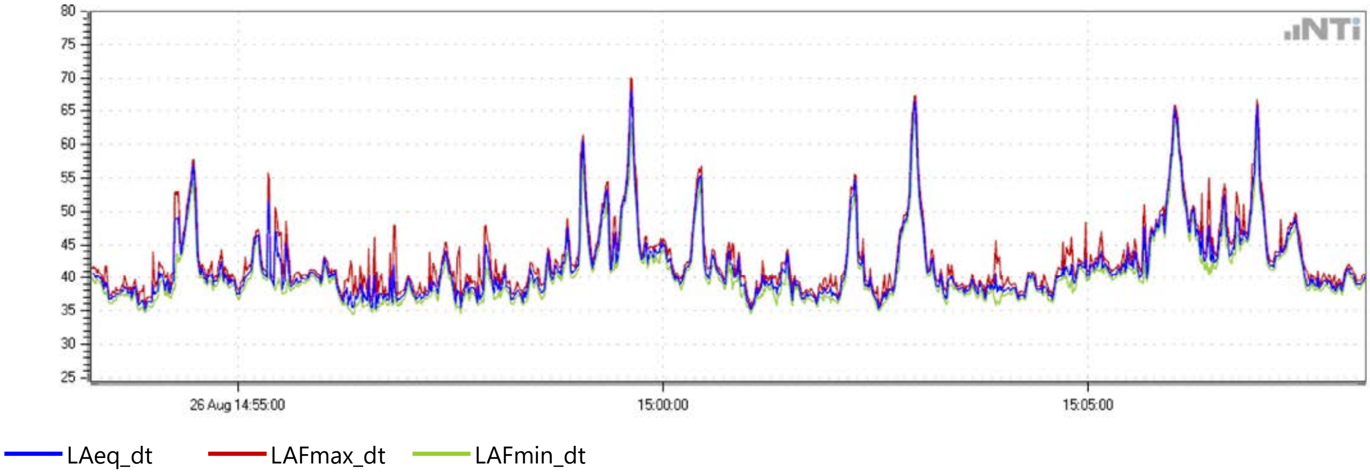
Results

Type	Start Date and Time	Duration	LAeq [dB]	LAFmax [dB]	LAFmin [dB]	L 10.0 % [dB]	L 90.0 % [dB]
Recorded		**00:15:00**	**59.7**	**67.6**	**58.1**		
Project Result		**00:15:00**	**59.7**	**67.6**	**58.1**	**60.3**	**59.2**

B4 Daytime #1

Start: 2019-08-26 14:53:16

End: 2019-08-26 15:08:16



Configuration

Device Info: XL2, SNo. A2A-08898-E0, FW3.11 Type Approved

Mic Type: NTi Audio M2230, SNo. 5062, User calibrated 2019-08-26 13:30

Mic Sensitivity: 43.1 mV/Pa

Range: 20 - 120 dB

Ln based on: LAeq_dt

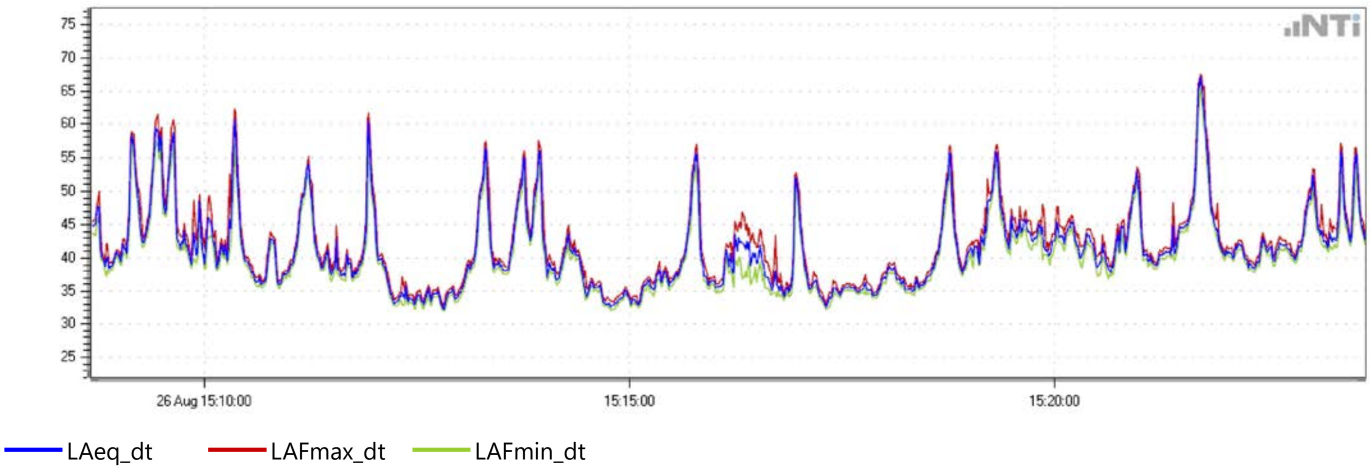
Results

Type	Start Date and Time	Duration	LAeq [dB]	LAFmax [dB]	LAFmin [dB]	L 10.0 % [dB]	L 90.0 % [dB]
Recorded		**00:15:00**	**48.9**	**70.0**	**34.4**		
Project Result		**00:15:00**	**48.9**	**70.0**	**34.4**	**49.0**	**37.3**

B4 Daytime #2

Start: 2019-08-26 15:08:40

End: 2019-08-26 15:23:40



Configuration

Device Info: XL2, SNo. A2A-08898-E0, FW3.11 Type Approved

Mic Type: NTi Audio M2230, SNo. 5062, User calibrated 2019-08-26 13:30

Mic Sensitivity: 43.1 mV/Pa

Range: 20 - 120 dB

Ln based on: LAeq_dt

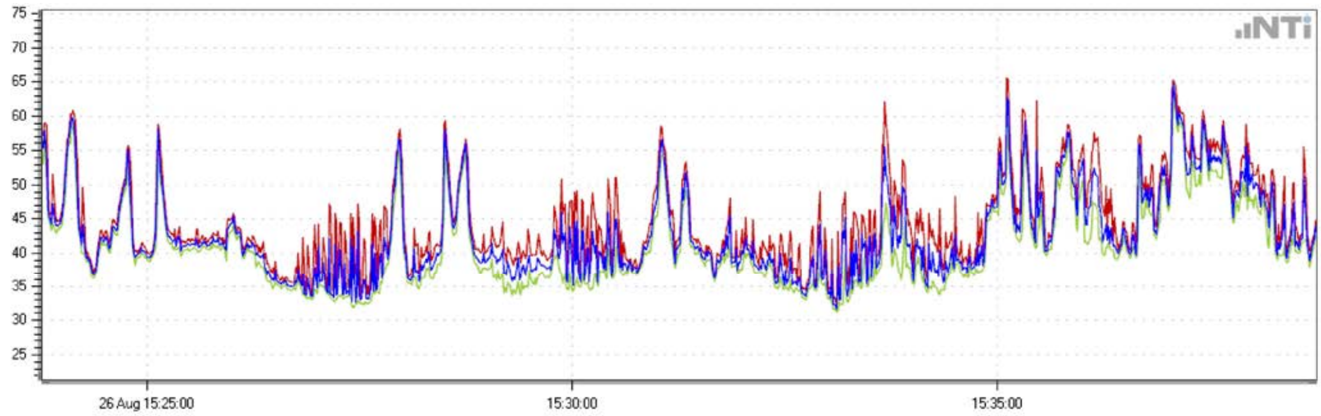
Results

Type	Start Date and Time	Duration	LAeq [dB]	LAFmax [dB]	LAFmin [dB]	L 10.0 % [dB]	L 90.0 % [dB]
Recorded		**00:15:00**	**47.8**	**67.5**	**32.0**		
Project Result		**00:15:00**	**47.8**	**67.5**	**32.0**	**49.9**	**34.9**

B4 Daytime #3

Start: 2019-08-26 15:23:46

End: 2019-08-26 15:38:46



LAeq_dt LAFmax_dt LAFmin_dt

Configuration

Device Info: XL2, SNo. A2A-08898-E0, FW3.11 Type Approved

Mic Type: NTi Audio M2230, SNo. 5062, User calibrated 2019-08-26 13:30

Mic Sensitivity: 43.1 mV/Pa

Range: 20 - 120 dB

Ln based on: LAeq_dt

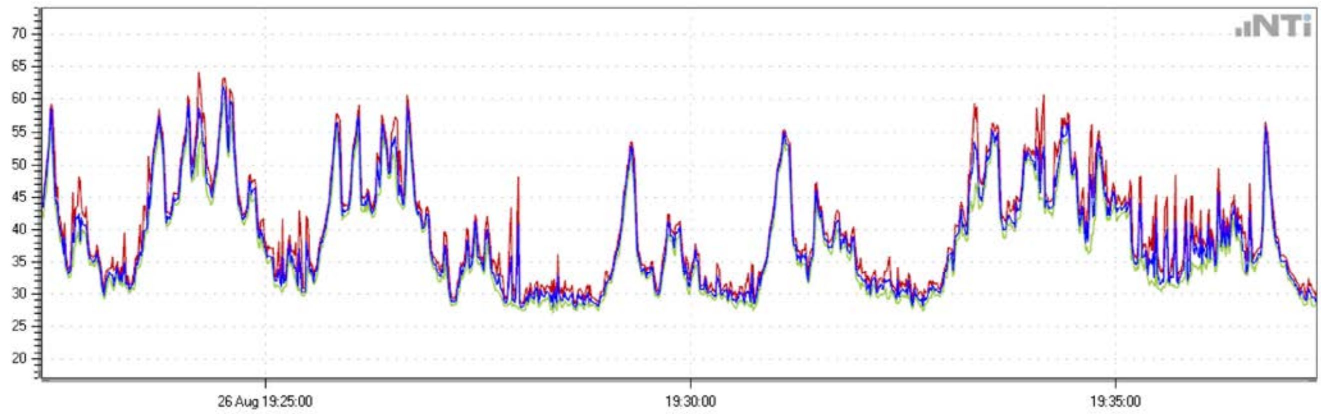
Results

Type	Start Date and Time	Duration	LAeq [dB]	LAFmax [dB]	LAFmin [dB]	L 10.0 % [dB]	L 90.0 % [dB]
Recorded		**00:15:00**	**48.5**	**65.6**	**31.3**		
Project Result		**00:15:00**	**48.5**	**65.6**	**31.3**	**52.7**	**35.8**

B4 Evening

Start: 2019-08-26 19:22:22

End: 2019-08-26 19:37:22



LAeq_dt LAFmax_dt LAFmin_dt

Configuration

Device Info: XL2, SNo. A2A-08898-E0, FW3.11 Type Approved

Mic Type: NTi Audio M2230, SNo. 5062, User calibrated 2019-08-26 18:59

Mic Sensitivity: 43.2 mV/Pa

Range: 20 - 120 dB

Ln based on: LAeq_dt

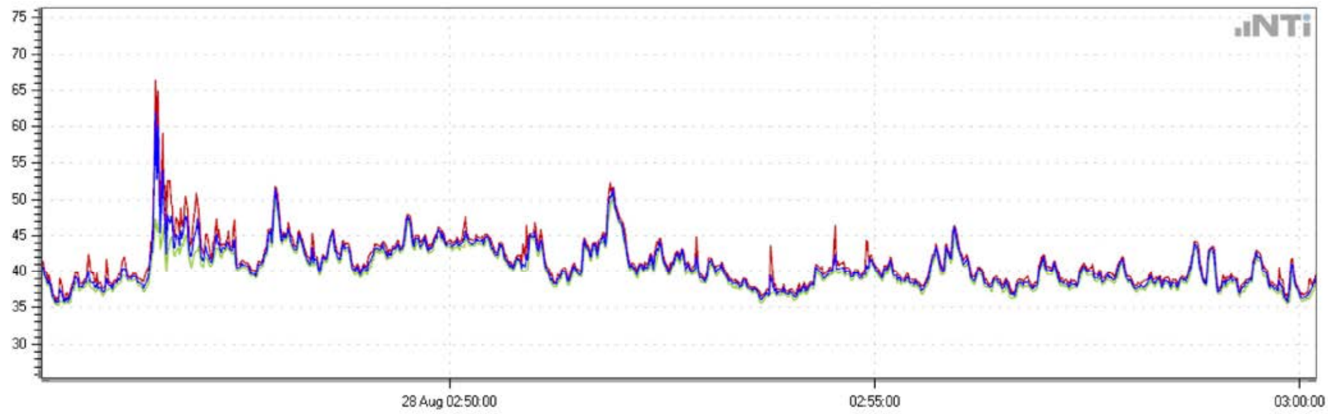
Results

Type	Start Date and Time	Duration	LAeq [dB]	LAFmax [dB]	LAFmin [dB]	L 10.0 % [dB]	L 90.0 % [dB]
Recorded		**00:15:00**	**46.8**	**64.1**	**27.1**		
Project Result		**00:15:00**	**46.8**	**64.1**	**27.1**	**51.8**	**29.9**

B4 Night time #1

Start: 2019-08-28 02:45:12

End: 2019-08-28 03:00:12



LAeq_dt LAFmax_dt LAFmin_dt

Configuration

Device Info: XL2, SNo. A2A-16311-E0, FW4.20

Mic Type: NTi Audio M2230, SNo. 8567, User calibrated 2019-08-28 02:42

Mic Sensitivity: 41.0 mV/Pa

Range: 20 - 120 dB

Ln based on: LAeq_dt

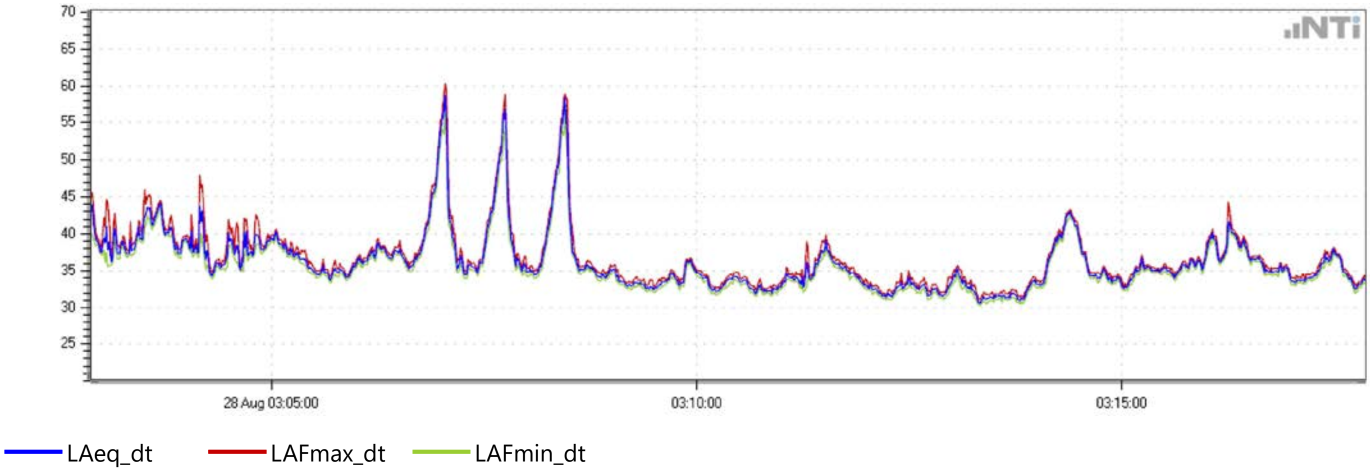
Results

Type	Start Date and Time	Duration	LAeq [dB]	LAFmax [dB]	LAFmin [dB]	L 10.0 % [dB]	L 90.0 % [dB]
Recorded		**00:15:00**	**42.6**	**66.4**	**35.3**		
Project Result		**00:15:00**	**42.6**	**66.4**	**35.3**	**44.5**	**37.7**

B4 Night time #2

Start: 2019-08-28 03:02:52

End: 2019-08-28 03:17:52



Configuration

Device Info: XL2, SNo. A2A-16311-E0, FW4.20

Mic Type: NTi Audio M2230, SNo. 8567, User calibrated 2019-08-28 02:42

Mic Sensitivity: 41.0 mV/Pa

Range: 20 - 120 dB

Ln based on: LAeq_dt

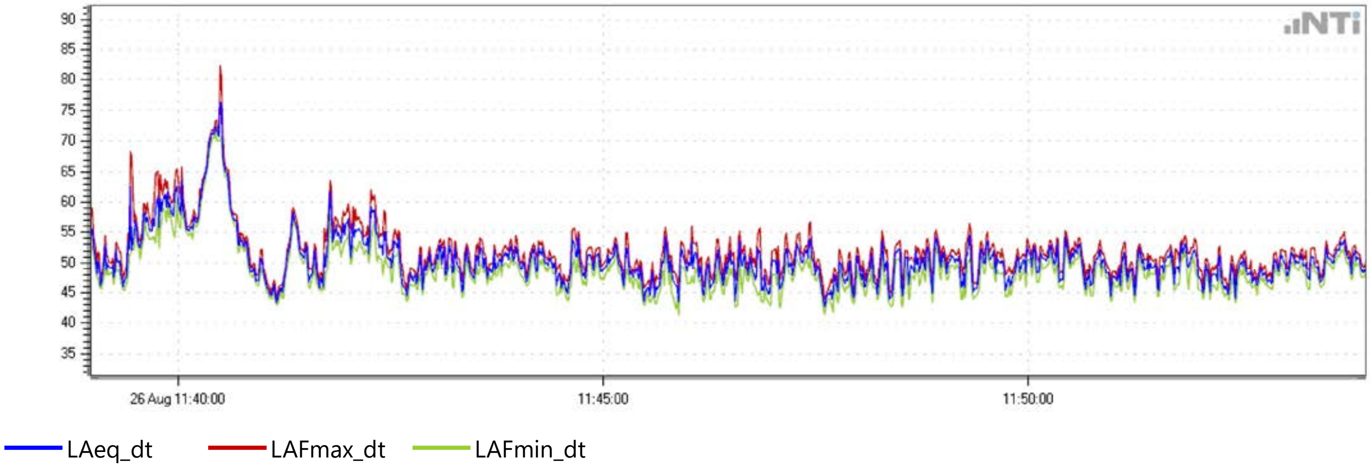
Results

Type	Start Date and Time	Duration	LAeq [dB]	LAFmax [dB]	LAFmin [dB]	L 10.0 % [dB]	L 90.0 % [dB]
Recorded		**00:15:00**	**40.7**	**60.3**	**30.2**		
Project Result		**00:15:00**	**40.7**	**60.3**	**30.2**	**40.4**	**32.5**

B5 Daytime #1

Start: 2019-08-26 11:38:58

End: 2019-08-26 11:53:58



Configuration

Device Info: XL2, SNo. A2A-08898-E0, FW3.11 Type Approved

Mic Type: NTi Audio M2230, SNo. 5062, User calibrated 2019-08-26 11:16

Mic Sensitivity: 43.5 mV/Pa

Range: 20 - 120 dB

Ln based on: LAeq_dt

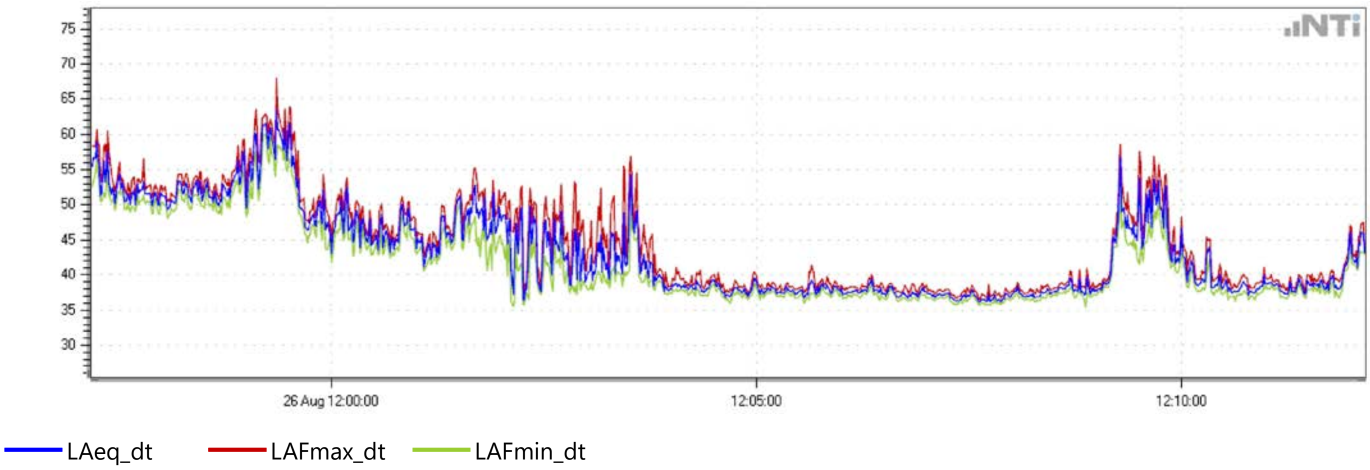
Results

Type	Start Date and Time	Duration	LAeq [dB]	LAFmax [dB]	LAFmin [dB]	L 10.0 % [dB]	L 90.0 % [dB]
Recorded		**00:15:00**	**55.8**	**82.3**	**41.4**		
Project Result		**00:15:00**	**55.8**	**82.3**	**41.4**	**55.3**	**46.2**

B5 Daytime #2

Start: 2019-08-26 11:57:10

End: 2019-08-26 12:12:10



Configuration

Device Info: XL2, SNo. A2A-08898-E0, FW3.11 Type Approved

Mic Type: NTi Audio M2230, SNo. 5062, User calibrated 2019-08-26 11:16

Mic Sensitivity: 43.5 mV/Pa

Range: 20 - 120 dB

Ln based on: LAeq_dt

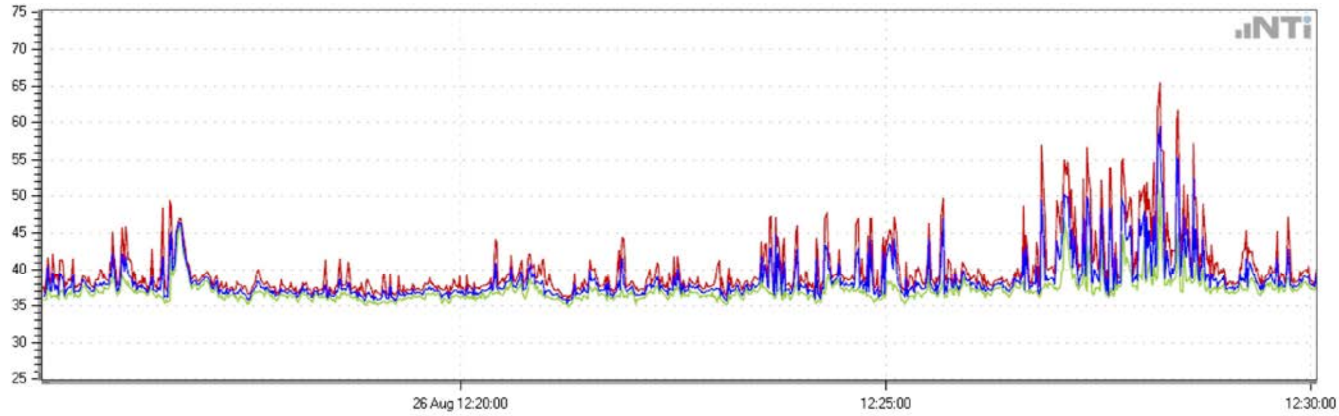
Results

Type	Start Date and Time	Duration	LAeq [dB]	LAFmax [dB]	LAFmin [dB]	L 10.0 % [dB]	L 90.0 % [dB]
Recorded		**00:15:00**	**48.7**	**68.0**	**35.4**		
Project Result		**00:15:00**	**48.7**	**68.0**	**35.4**	**52.3**	**37.3**

B5 Daytime #3

Start: 2019-08-26 12:15:04

End: 2019-08-26 12:30:04



LAeq_dt LAFmax_dt LAFmin_dt

Configuration

Device Info: XL2, SNo. A2A-08898-E0, FW3.11 Type Approved

Mic Type: NTi Audio M2230, SNo. 5062, User calibrated 2019-08-26 11:16

Mic Sensitivity: 43.5 mV/Pa

Range: 20 - 120 dB

Ln based on: LAeq_dt

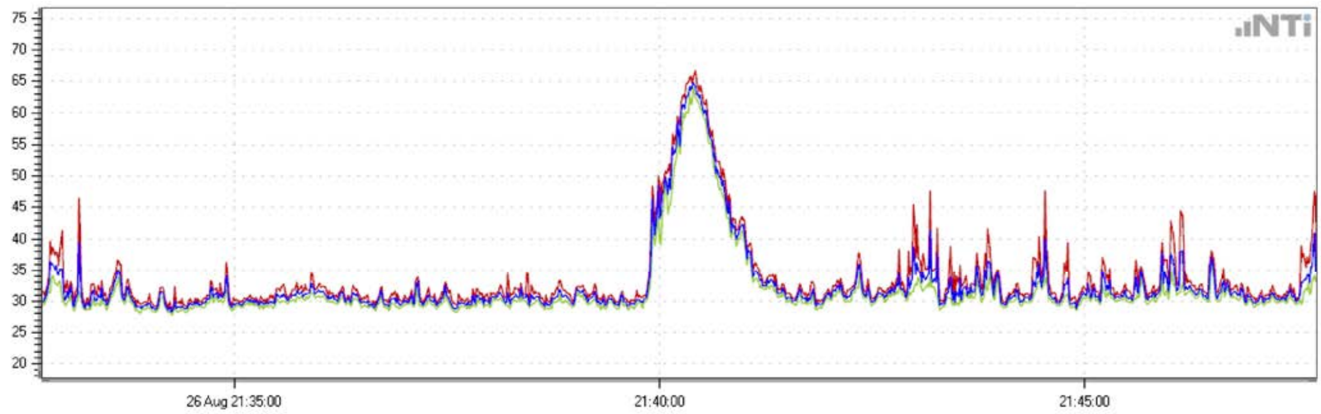
Results

Type	Start Date and Time	Duration	LAeq [dB]	LAFmax [dB]	LAFmin [dB]	L 10.0 % [dB]	L 90.0 % [dB]
Recorded		**00:15:00**	**40.6**	**65.4**	**34.9**		
Project Result		**00:15:00**	**40.6**	**65.4**	**34.9**	**41.8**	**36.6**

B5 Evening

Start: 2019-08-26 21:32:44

End: 2019-08-26 21:47:44



LAeq_dt LAFmax_dt LAFmin_dt

Configuration

Device Info: XL2, SNo. A2A-08898-E0, FW3.11 Type Approved

Mic Type: NTi Audio M2230, SNo. 5062, User calibrated 2019-08-26 18:59

Mic Sensitivity: 43.2 mV/Pa

Range: 20 - 120 dB

Ln based on: LAeq_dt

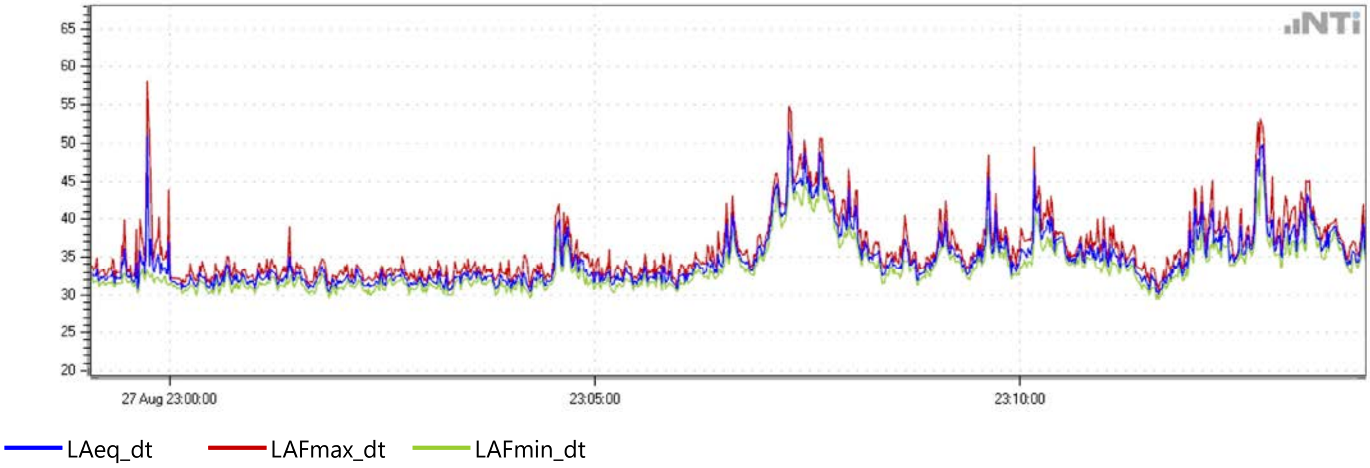
Results

Type	Start Date and Time	Duration	LAeq [dB]	LAFmax [dB]	LAFmin [dB]	L 10.0 % [dB]	L 90.0 % [dB]
Recorded		**00:15:00**	**46.6**	**66.7**	**27.8**		
Project Result		**00:15:00**	**46.6**	**66.7**	**27.8**	**36.1**	**29.6**

B5 Night time #1

Start: 2019-08-27 22:59:04

End: 2019-08-27 23:14:04



Configuration

Device Info: XL2, SNo. A2A-08898-E0, FW3.11 Type Approved

Mic Type: NTi Audio M2230, SNo. 5062, User calibrated 2019-08-27 22:51

Mic Sensitivity: 43.1 mV/Pa

Range: 0 - 100 dB

Ln based on: LAeq_dt

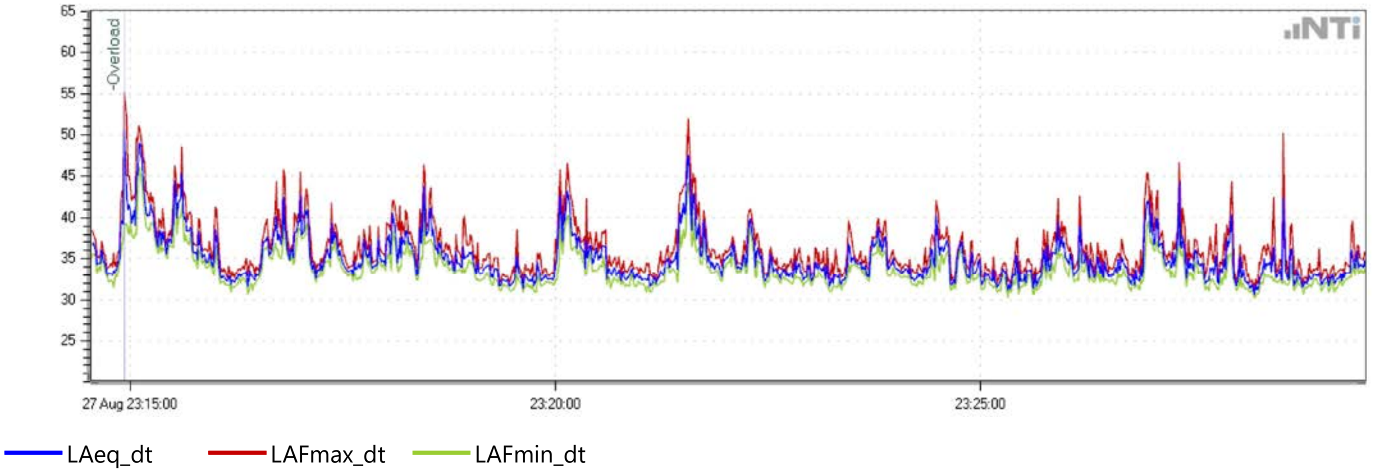
Results

Type	Start Date and Time	Duration	LAeq [dB]	LAFmax [dB]	LAFmin [dB]	L 10.0 % [dB]	L 90.0 % [dB]
Recorded		**00:15:00**	**37.2**	**58.1**	**29.4**		
Project Result		**00:15:00**	**37.2**	**58.1**	**29.4**	**39.7**	**31.6**

B5 Night time #2

Start: 2019-08-27 23:14:32

End: 2019-08-27 23:29:32



Configuration

Device Info: XL2, SNo. A2A-08898-E0, FW3.11 Type Approved

Mic Type: NTi Audio M2230, SNo. 5062, User calibrated 2019-08-27 22:51

Mic Sensitivity: 43.1 mV/Pa

Range: 0 - 100 dB

Ln based on: LAeq_dt

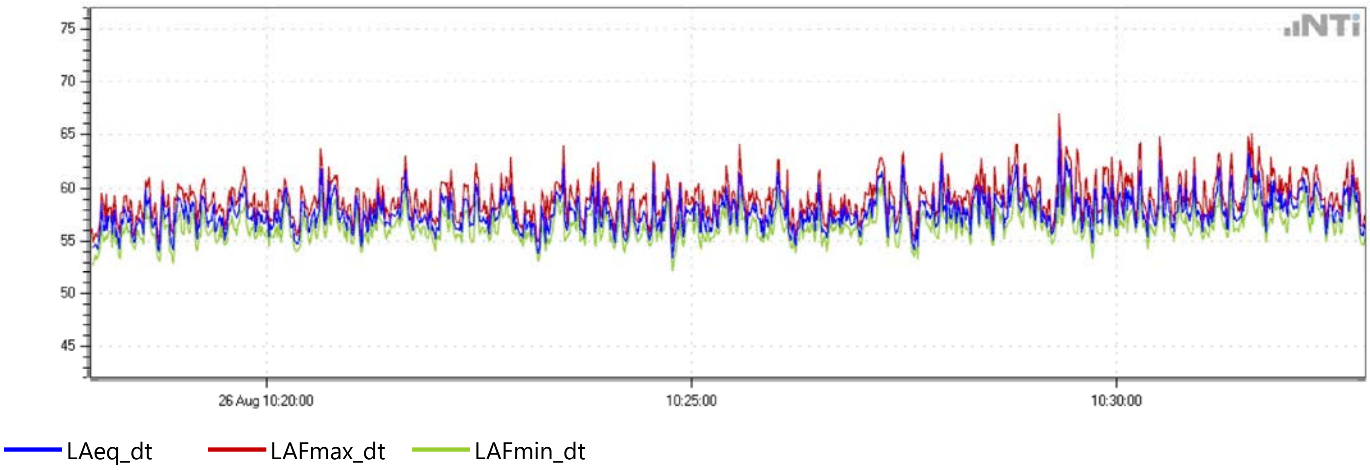
Results

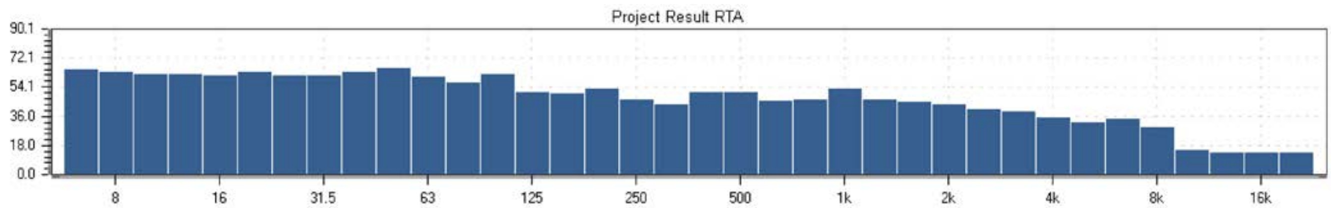
Type	Start Date and Time	Duration	LAeq [dB]	LAFmax [dB]	LAFmin [dB]	L 10.0 % [dB]	L 90.0 % [dB]
Recorded		**00:15:00**	**36.3**	**55.1**	**30.2**		
-Overload (1)		**00:00:01**	**50.5**	**55.1**	**39.2**	**50.6**	**50.6**
Project Result		**00:15:00**	**36.3**	**55.1**	**30.2**	**38.9**	**32.5**

B6 Daytime #1

Start: 2019-08-26 10:17:56

End: 2019-08-26 10:32:56





Configuration

Device Info: XL2, SNo. A2A-08898-E0, FW3.11 Type Approved

Mic Type: NTi Audio M2230, SNo. 5062, User calibrated 2019-08-26 09:12

Mic Sensitivity: 43.3 mV/Pa

Range: 20 - 120 dB

Ln based on: LAeq_dt

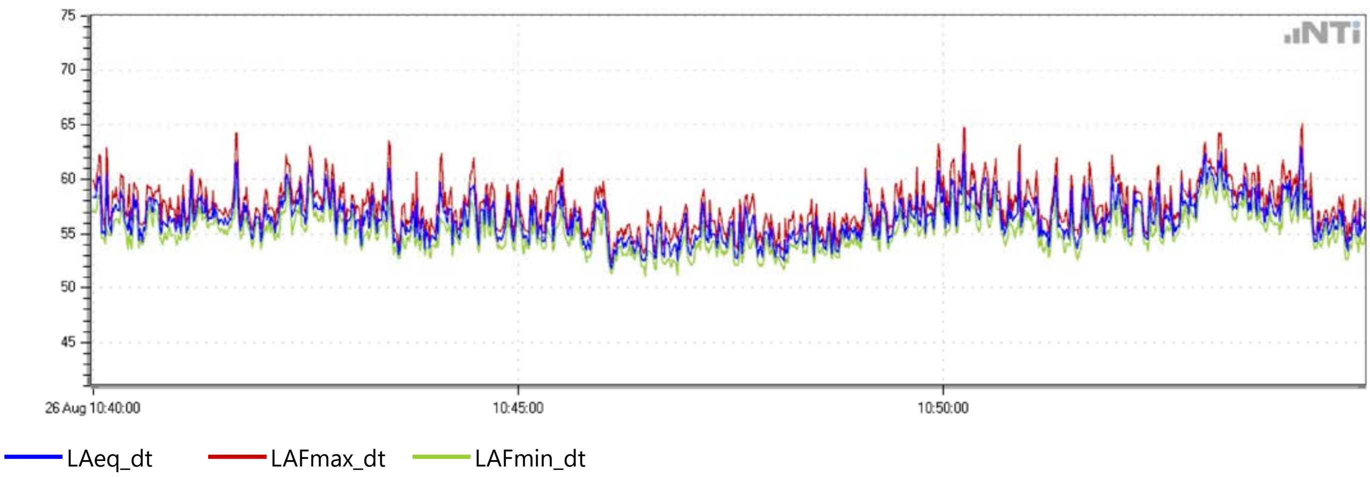
Results

Type	Start Date and Time	Duration	LAeq [dB]	LAFmax [dB]	LAFmin [dB]	L 10.0 % [dB]	L 90.0 % [dB]
Recorded		**00:15:00**	**58.0**	**67.0**	**52.1**		
Project Result		**00:15:00**	**58.0**	**67.0**	**52.1**	**59.9**	**56.0**

B6 Daytime #2

Start: 2019-08-26 10:39:58

End: 2019-08-26 10:54:58



Configuration

Device Info: XL2, SNo. A2A-08898-E0, FW3.11 Type Approved

Mic Type: NTi Audio M2230, SNo. 5062, User calibrated 2019-08-26 09:12

Mic Sensitivity: 43.3 mV/Pa

Range: 20 - 120 dB

Ln based on: LAeq_dt

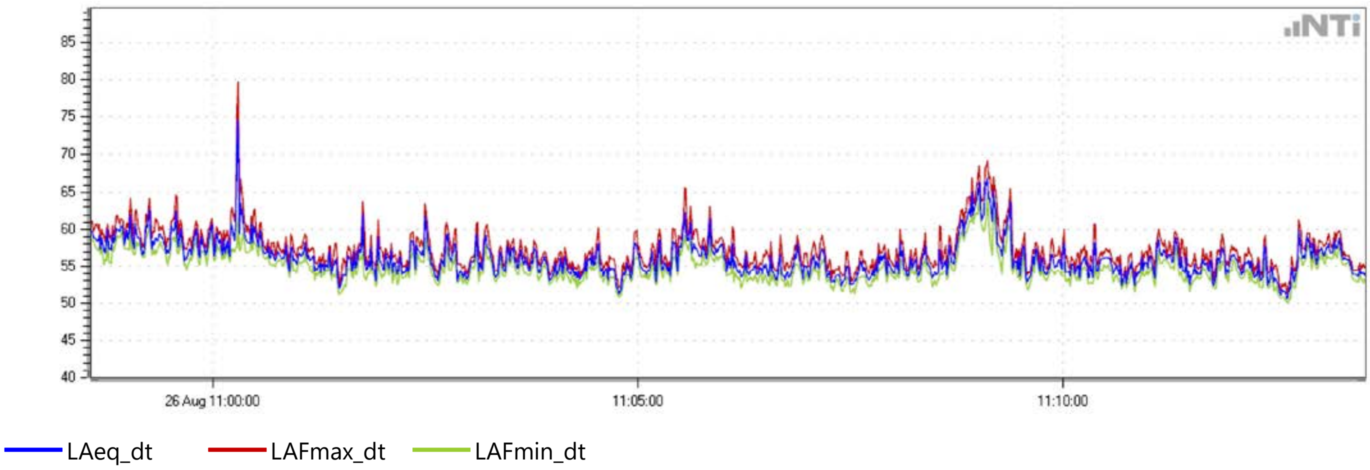
Results

Type	Start Date and Time	Duration	LAeq [dB]	LAFmax [dB]	LAFmin [dB]	L 10.0 % [dB]	L 90.0 % [dB]
Recorded		**00:15:00**	**56.8**	**65.1**	**51.1**		
Project Result		**00:15:00**	**56.8**	**65.1**	**51.1**	**59.0**	**54.3**

B6 Daytime #3

Start: 2019-08-26 10:58:34

End: 2019-08-26 11:13:34



Configuration

Device Info: XL2, SNo. A2A-08898-E0, FW3.11 Type Approved

Mic Type: NTi Audio M2230, SNo. 5062, User calibrated 2019-08-26 09:12

Mic Sensitivity: 43.3 mV/Pa

Range: 20 - 120 dB

Ln based on: LAeq_dt

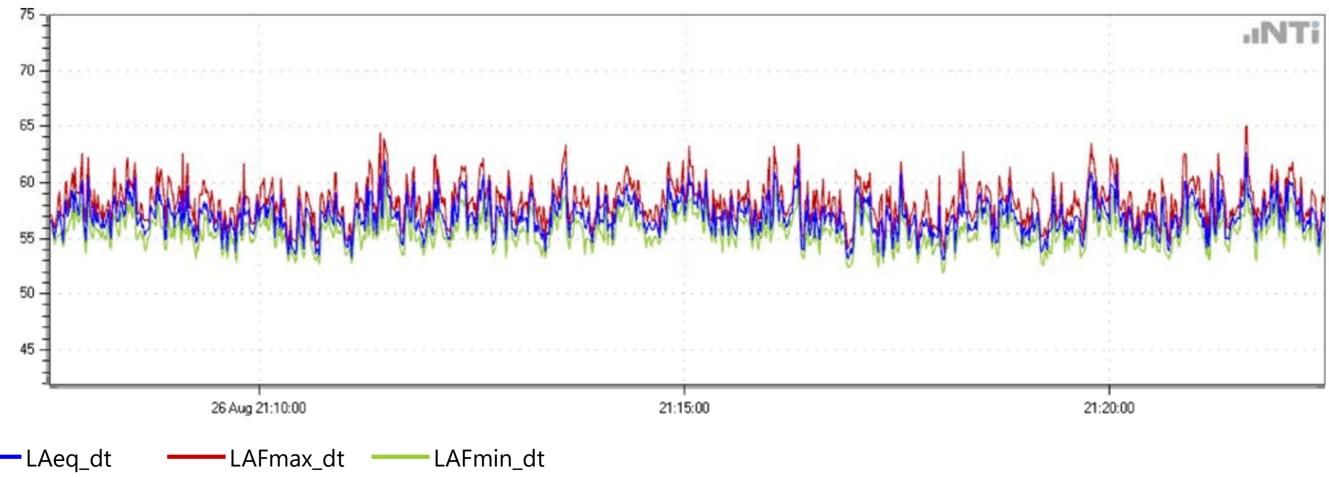
Results

Type	Start Date and Time	Duration	LAeq [dB]	LAFmax [dB]	LAFmin [dB]	L 10.0 % [dB]	L 90.0 % [dB]
Recorded		**00:15:00**	**57.2**	**79.7**	**50.0**		
Project Result		**00:15:00**	**57.2**	**79.7**	**50.0**	**59.2**	**53.7**

B6 Evening

Start: 2019-08-26 21:07:32

End: 2019-08-26 21:22:32



Configuration

Device Info: XL2, SNo. A2A-08898-E0, FW3.11 Type Approved

Mic Type: NTi Audio M2230, SNo. 5062, User calibrated 2019-08-26 18:59

Mic Sensitivity: 43.2 mV/Pa

Range: 20 - 120 dB

Ln based on: LAeq_dt

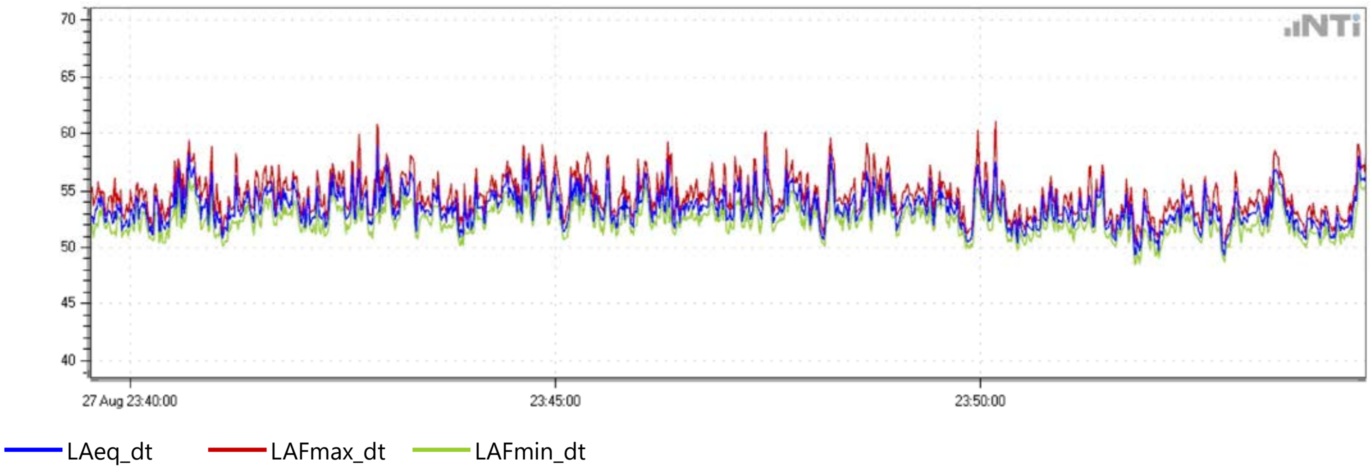
Results

Type	Start Date and Time	Duration	LAeq [dB]	LAFmax [dB]	LAFmin [dB]	L 10.0 % [dB]	L 90.0 % [dB]
Recorded		**00:15:00**	**57.2**	**65.0**	**51.9**		
Project Result		**00:15:00**	**57.2**	**65.0**	**51.9**	**59.2**	**55.1**

B6 Night time #1

Start: 2019-08-27 23:39:32

End: 2019-08-27 23:54:32



Configuration

Device Info: XL2, SNo. A2A-08898-E0, FW3.11 Type Approved

Mic Type: NTi Audio M2230, SNo. 5062, User calibrated 2019-08-27 22:51

Mic Sensitivity: 43.1 mV/Pa

Range: 20 - 120 dB

Ln based on: LAeq_dt

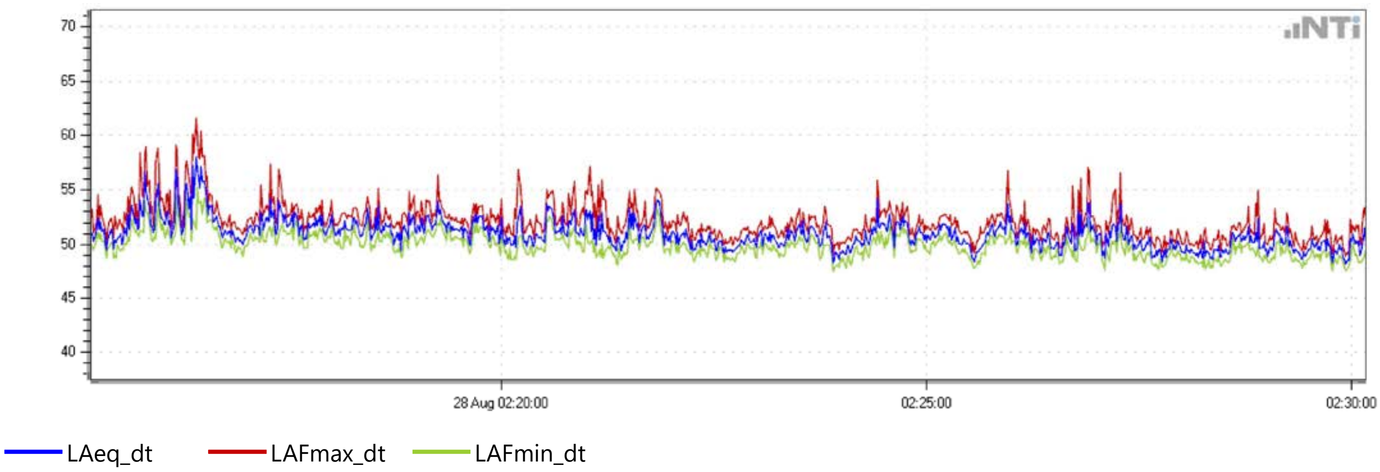
Results

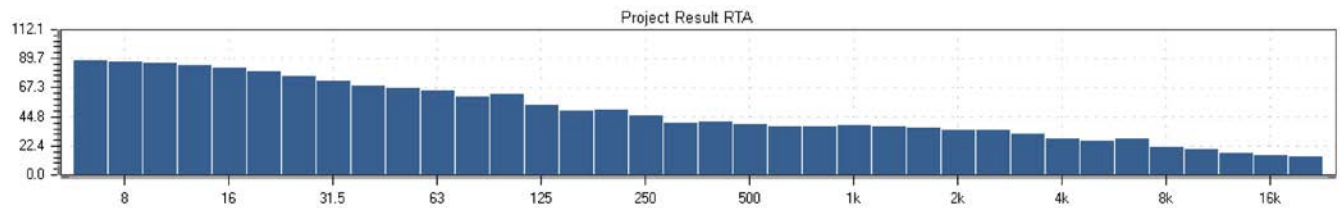
Type	Start Date and Time	Duration	LAeq [dB]	LAFmax [dB]	LAFmin [dB]	L 10.0 % [dB]	L 90.0 % [dB]
Recorded		**00:15:00**	**53.8**	**61.1**	**48.5**		
Project Result		**00:15:00**	**53.8**	**61.1**	**48.5**	**55.6**	**51.7**

B6 Night time #2

Start: 2019-08-28 02:15:10

End: 2019-08-28 02:30:10





Configuration

Device Info: XL2, SNo. A2A-08898-E0, FW3.11 Type Approved

Mic Type: NTi Audio M2230, SNo. 5062, User calibrated 2019-08-28 01:15

Mic Sensitivity: 43.3 mV/Pa

Range: 20 - 120 dB

Ln based on: LAeq_dt

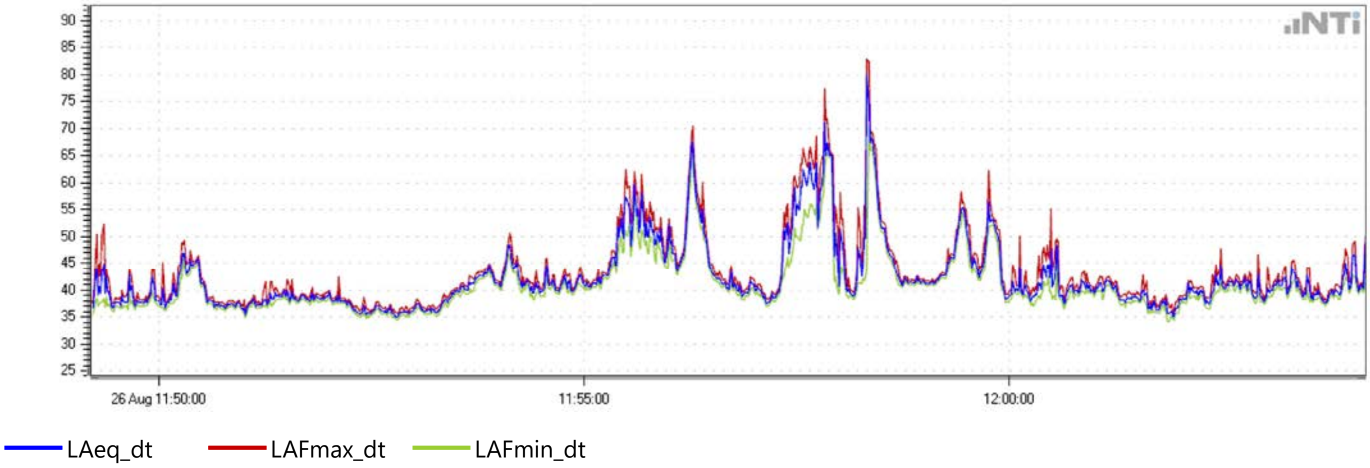
Results

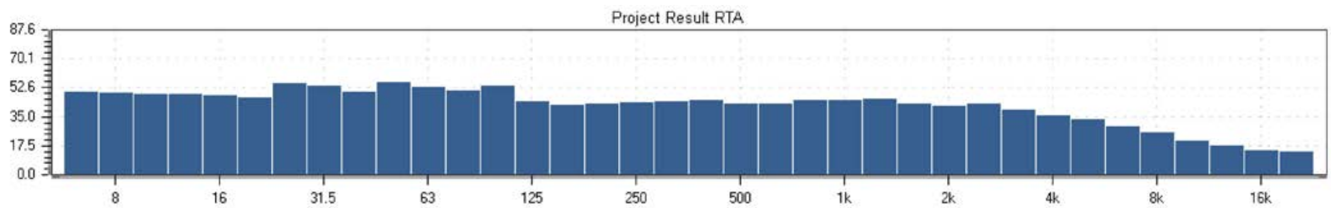
Type	Start Date and Time	Duration	LAeq [dB]	LAFmax [dB]	LAFmin [dB]	L 10.0 % [dB]	L 90.0 % [dB]
Recorded		**00:15:00**	**51.2**	**61.6**	**47.5**		
Project Result		**00:15:00**	**51.2**	**61.6**	**47.5**	**52.7**	**49.5**

B7 Daytime #1

Start: 2019-08-26 11:49:12

End: 2019-08-26 12:04:12





Configuration

Device Info: XL2, SNo. A2A-16311-E0, FW4.20

Mic Type: NTi Audio M2230, SNo. 8567, User calibrated 2019-08-26 11:24

Mic Sensitivity: 41.1 mV/Pa

Range: 20 - 120 dB

Ln based on: LAeq_dt

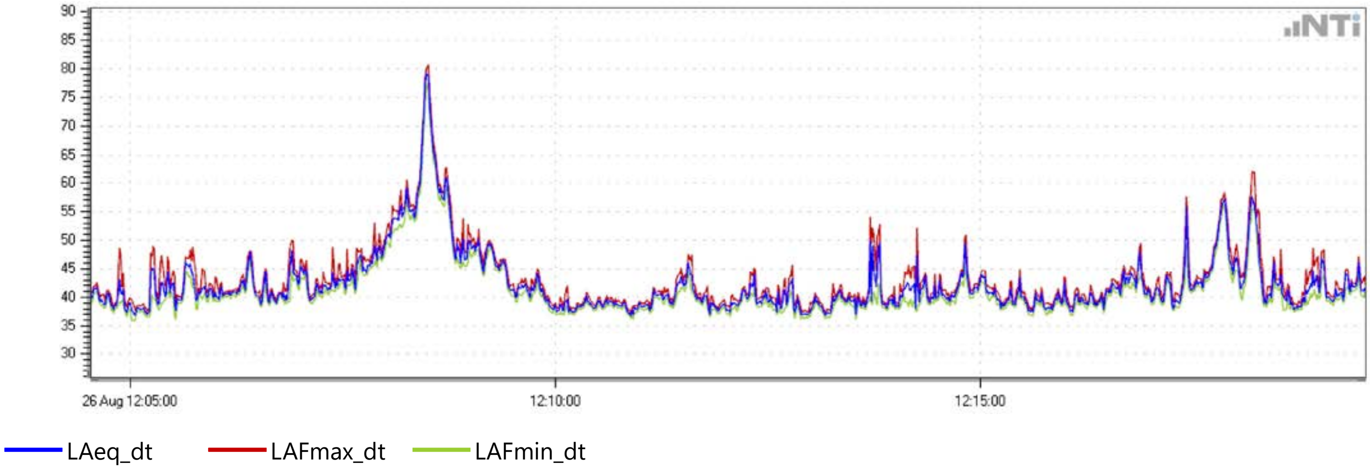
Results

Type	Start Date and Time	Duration	LAeq [dB]	LAFmax [dB]	LAFmin [dB]	L 10.0 % [dB]	L 90.0 % [dB]
Recorded		**00:15:00**	**54.2**	**82.8**	**34.2**		
Project Result		**00:15:00**	**54.2**	**82.8**	**34.2**	**51.3**	**37.1**

B7 Daytime #2

Start: 2019-08-26 12:04:32

End: 2019-08-26 12:19:32



Configuration

Device Info: XL2, SNo. A2A-16311-E0, FW4.20

Mic Type: NTi Audio M2230, SNo. 8567, User calibrated 2019-08-26 11:24

Mic Sensitivity: 41.1 mV/Pa

Range: 20 - 120 dB

Ln based on: LAeq_dt

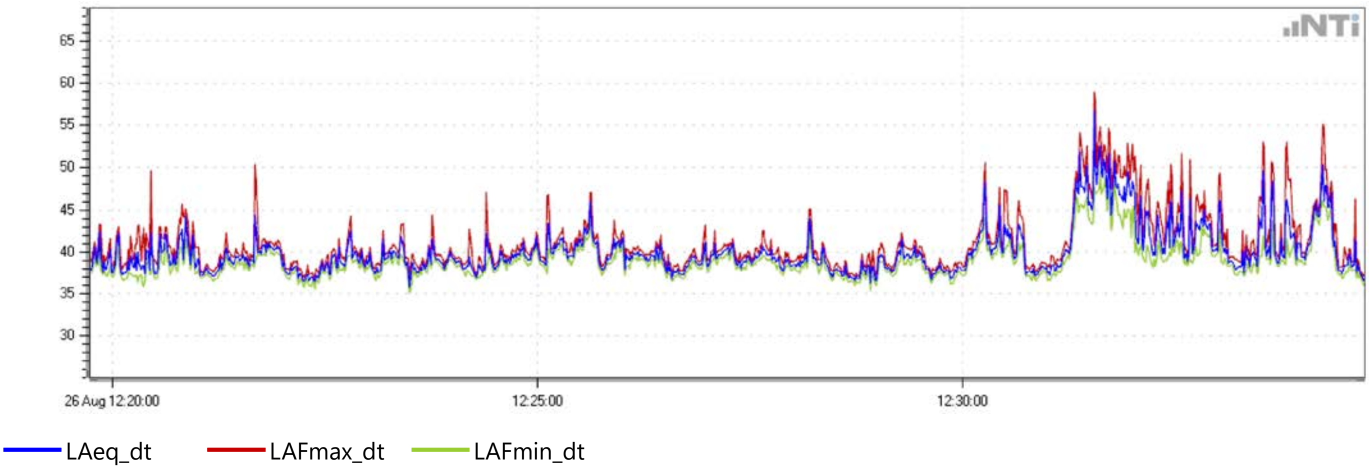
Results

Type	Start Date and Time	Duration	LAeq [dB]	LAFmax [dB]	LAFmin [dB]	L 10.0 % [dB]	L 90.0 % [dB]
Recorded		**00:15:00**	**55.3**	**80.7**	**35.9**		
Project Result		**00:15:00**	**55.3**	**80.7**	**35.9**	**48.8**	**38.3**

B7 Daytime #3

Start: 2019-08-26 12:19:44

End: 2019-08-26 12:34:44



Configuration

Device Info: XL2, SNo. A2A-16311-E0, FW4.20

Mic Type: NTi Audio M2230, SNo. 8567, User calibrated 2019-08-26 11:24

Mic Sensitivity: 41.1 mV/Pa

Range: 20 - 120 dB

Ln based on: LAeq_dt

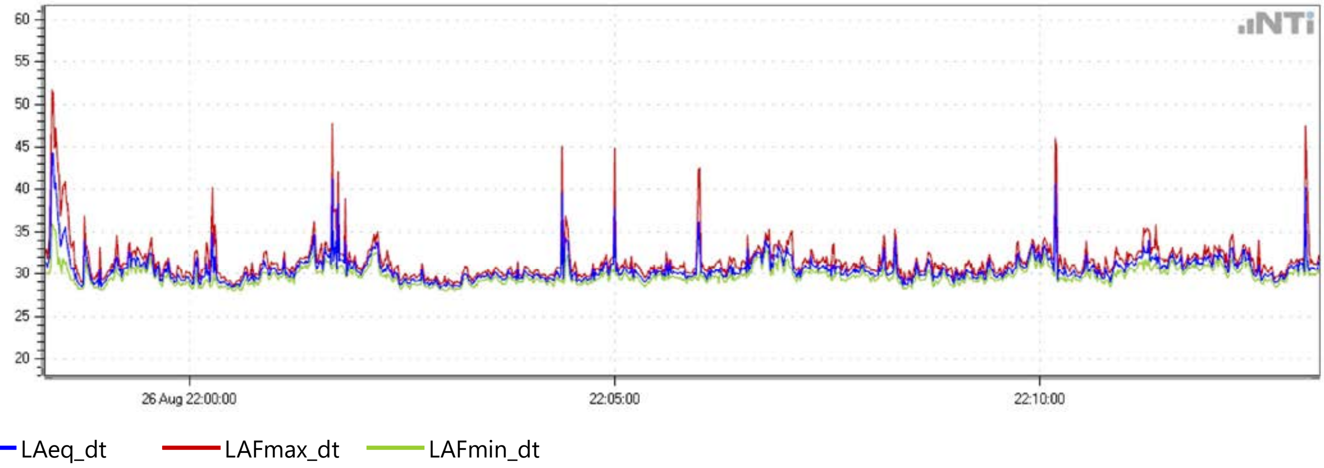
Results

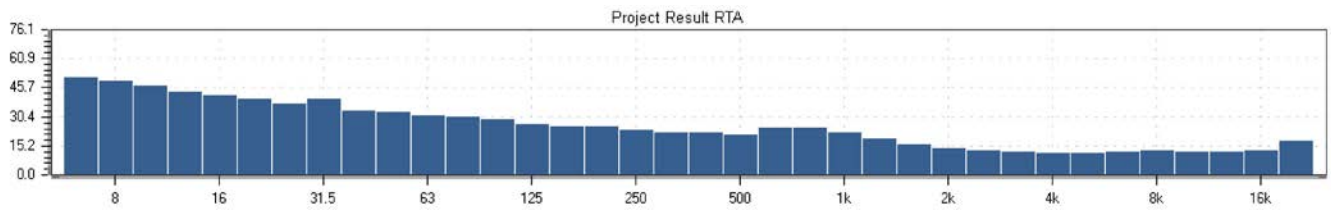
Type	Start Date and Time	Duration	LAeq [dB]	LAFmax [dB]	LAFmin [dB]	L 10.0 % [dB]	L 90.0 % [dB]
Recorded		**00:15:00**	**41.5**	**58.9**	**35.1**		
Project Result		**00:15:00**	**41.5**	**58.9**	**35.1**	**44.0**	**37.6**

B7 Evening

Start: 2019-08-26 21:58:18

End: 2019-08-26 22:13:18





Configuration

Device Info: XL2, SNo. A2A-08898-E0, FW3.11 Type Approved

Mic Type: NTi Audio M2230, SNo. 5062, User calibrated 2019-08-26 21:49

Mic Sensitivity: 42.9 mV/Pa

Range: 20 - 120 dB

Ln based on: LAeq_dt

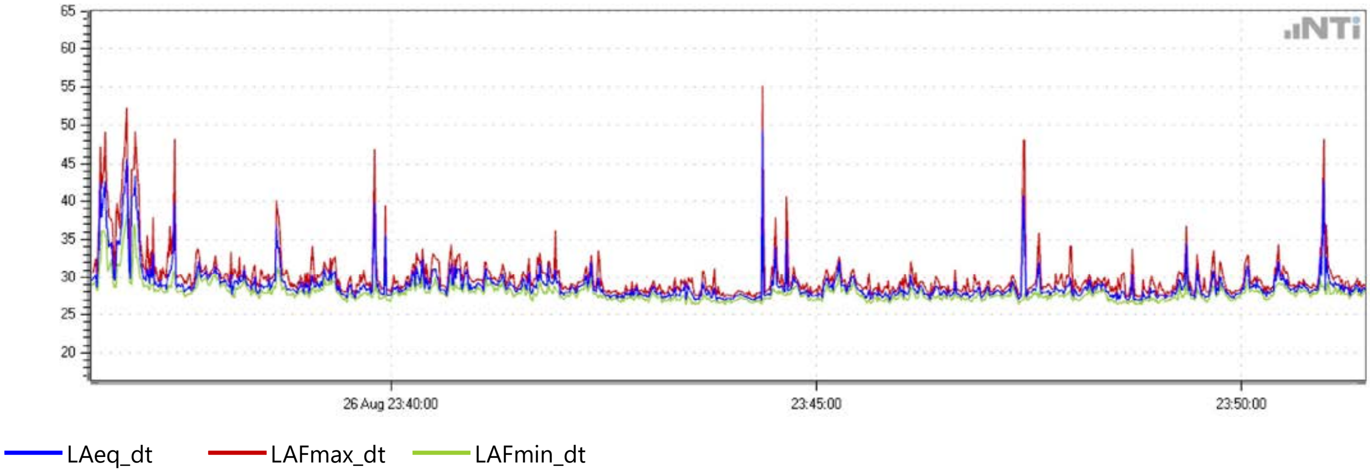
Results

Type	Start Date and Time	Duration	LAeq [dB]	LAFmax [dB]	LAFmin [dB]	L 10.0 % [dB]	L 90.0 % [dB]
Recorded		**00:15:00**	**31.2**	**51.7**	**28.0**		
Project Result		**00:15:00**	**31.2**	**51.7**	**28.0**	**32.3**	**29.2**

B7 Night time #1

Start: 2019-08-26 23:36:28

End: 2019-08-26 23:51:28



Configuration

Device Info: XL2, SNo. A2A-08898-E0, FW3.11 Type Approved

Mic Type: NTi Audio M2230, SNo. 5062, User calibrated 2019-08-26 21:49

Mic Sensitivity: 42.9 mV/Pa

Range: 0 - 100 dB

Ln based on: LAeq_dt

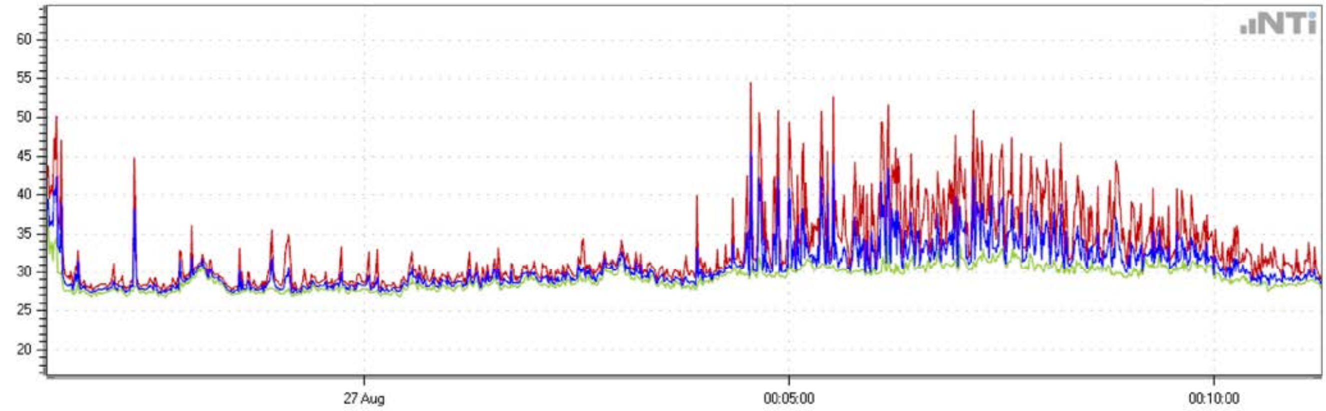
Results

Type	Start Date and Time	Duration	LAeq [dB]	LAFmax [dB]	LAFmin [dB]	L 10.0 % [dB]	L 90.0 % [dB]
Recorded		**00:15:00**	**30.5**	**55.1**	**26.4**		
Project Result		**00:15:00**	**30.5**	**55.1**	**26.4**	**30.6**	**27.5**

B7 Night time #2

Start: 2019-08-26 23:56:16

End: 2019-08-27 00:11:16



LAeq_dt LAFmax_dt LAFmin_dt

Configuration

Device Info: XL2, SNo. A2A-08898-E0, FW3.11 Type Approved

Mic Type: NTi Audio M2230, SNo. 5062, User calibrated 2019-08-26 21:49

Mic Sensitivity: 42.9 mV/Pa

Range: 0 - 100 dB

Ln based on: LAeq_dt

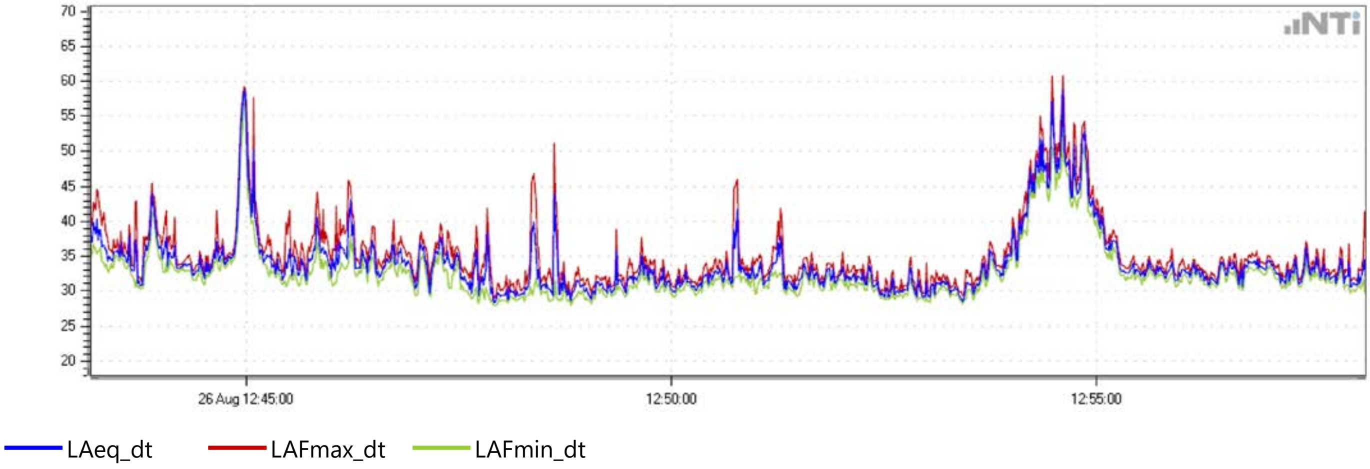
Results

Type	Start Date and Time	Duration	LAeq [dB]	LAFmax [dB]	LAFmin [dB]	L 10.0 % [dB]	L 90.0 % [dB]
Recorded		**00:15:00**	**32.2**	**54.5**	**26.7**		
Project Result		**00:15:00**	**32.2**	**54.5**	**26.7**	**34.7**	**27.9**

B8 Daytime #1

Start: 2019-08-26 12:43:10

End: 2019-08-26 12:58:10



Configuration

Device Info: XL2, SNo. A2A-08898-E0, FW3.11 Type Approved

Mic Type: NTi Audio M2230, SNo. 5062, User calibrated 2019-08-26 11:16

Mic Sensitivity: 43.5 mV/Pa

Range: 20 - 120 dB

Ln based on: LAeq_dt

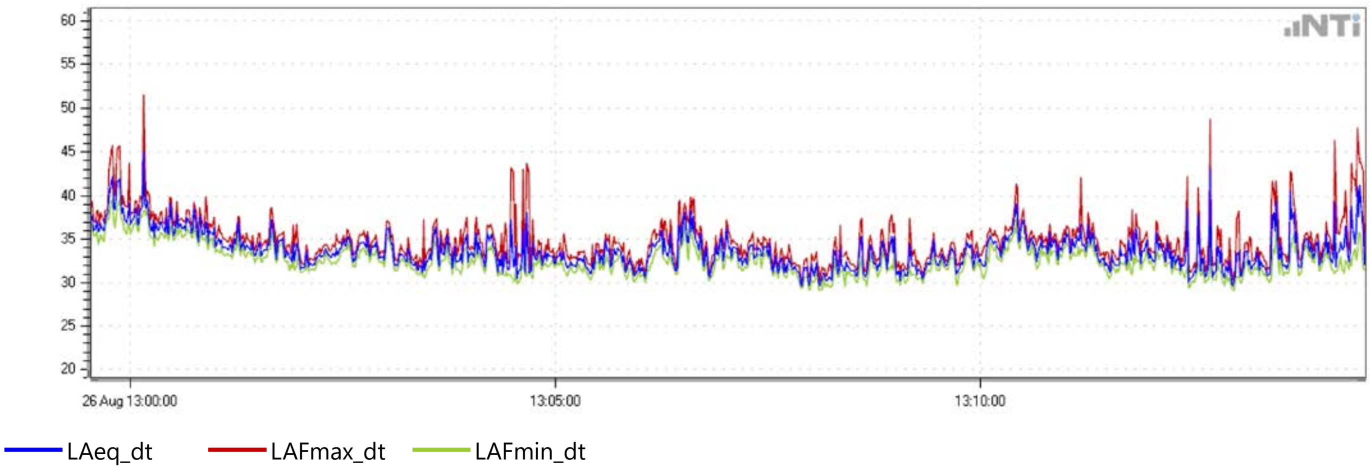
Results

Type	Start Date and Time	Duration	LAeq [dB]	LAFmax [dB]	LAFmin [dB]	L 10.0 % [dB]	L 90.0 % [dB]
Recorded		**00:15:00**	**39.9**	**60.8**	**27.9**		
Project Result		**00:15:00**	**39.9**	**60.8**	**27.9**	**39.1**	**30.3**

B8 Daytime #2

Start: 2019-08-26 12:59:32

End: 2019-08-26 13:14:32



Configuration

Device Info: XL2, SNo. A2A-08898-E0, FW3.11 Type Approved

Mic Type: NTi Audio M2230, SNo. 5062, User calibrated 2019-08-26 11:16

Mic Sensitivity: 43.5 mV/Pa

Range: 20 - 120 dB

Ln based on: LAeq_dt

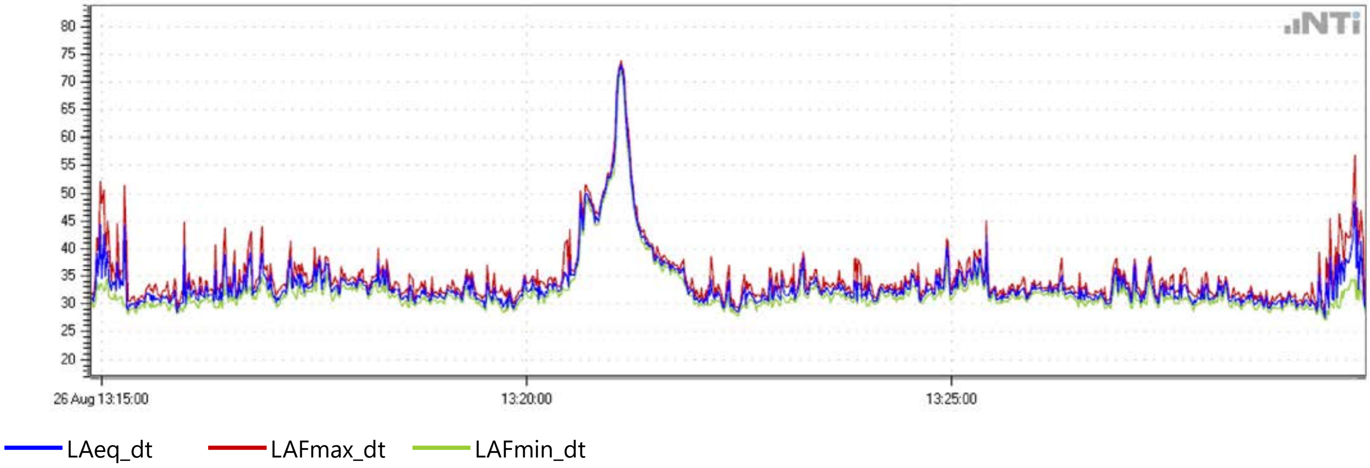
Results

Type	Start Date and Time	Duration	LAeq [dB]	LAFmax [dB]	LAFmin [dB]	L 10.0 % [dB]	L 90.0 % [dB]
Recorded		**00:15:00**	**34.3**	**51.5**	**29.1**		
Project Result		**00:15:00**	**34.3**	**51.5**	**29.1**	**36.5**	**31.4**

B8 Daytime #3

Start: 2019-08-26 13:14:52

End: 2019-08-26 13:29:52



Configuration

Device Info: XL2, SNo. A2A-08898-E0, FW3.11 Type Approved

Mic Type: NTi Audio M2230, SNo. 5062, User calibrated 2019-08-26 11:16

Mic Sensitivity: 43.5 mV/Pa

Range: 20 - 120 dB

Ln based on: LAeq_dt

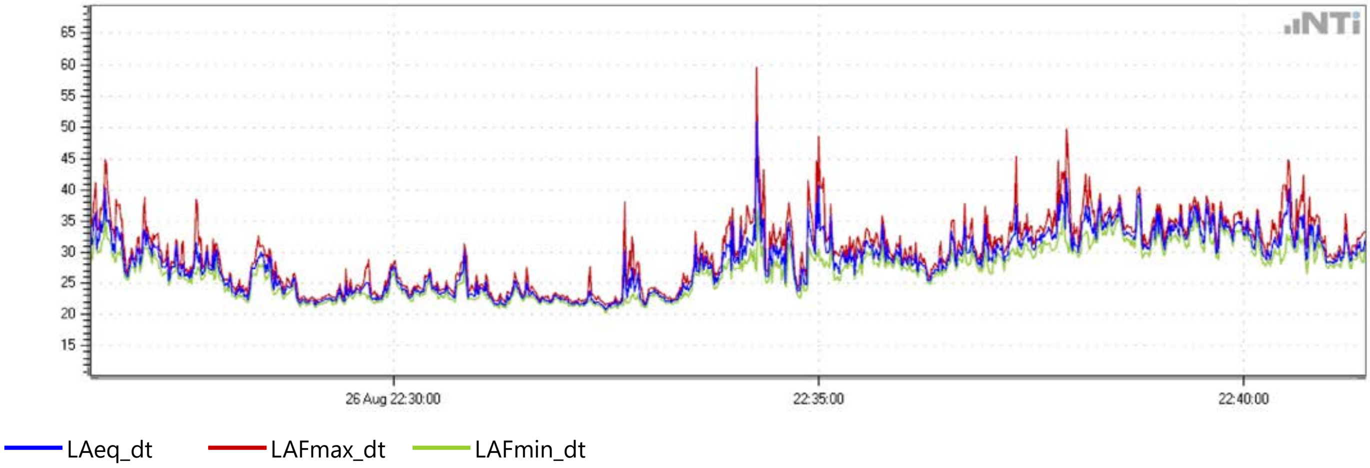
Results

Type	Start Date and Time	Duration	LAeq [dB]	LAFmax [dB]	LAFmin [dB]	L 10.0 % [dB]	L 90.0 % [dB]
Recorded		**00:15:00**	**50.0**	**73.8**	**27.1**		
Project Result		**00:15:00**	**50.0**	**73.8**	**27.1**	**37.8**	**30.4**

B8 Evening

Start: 2019-08-26 22:26:26

End: 2019-08-26 22:41:26



Configuration

Device Info: XL2, SNo. A2A-08898-E0, FW3.11 Type Approved

Mic Type: NTi Audio M2230, SNo. 5062, User calibrated 2019-08-26 21:49

Mic Sensitivity: 42.9 mV/Pa

Range: 0 - 100 dB

Ln based on: LAeq_dt

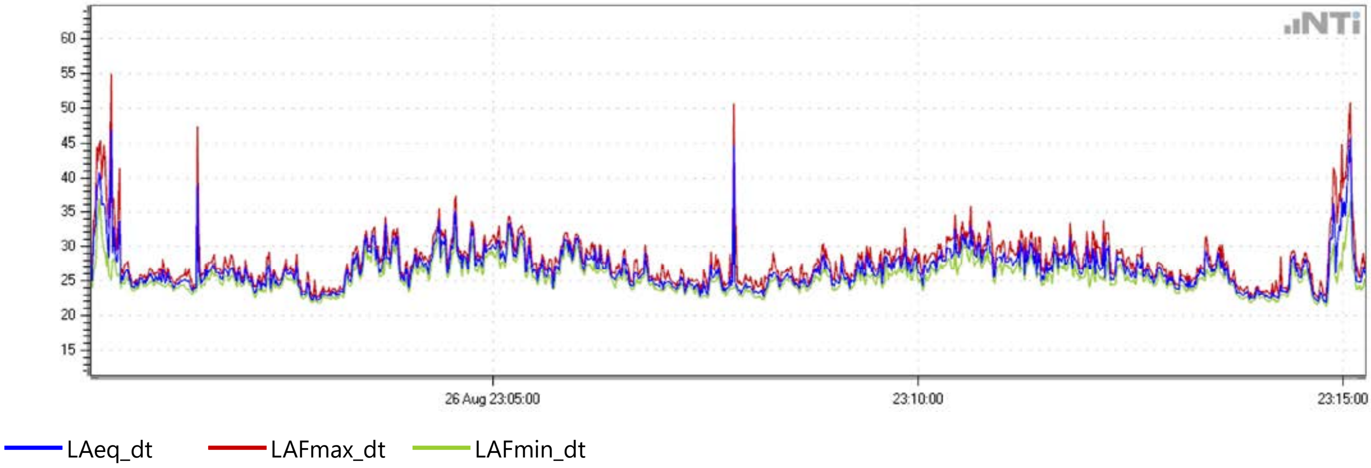
Results

Type	Start Date and Time	Duration	LAeq [dB]	LAFmax [dB]	LAFmin [dB]	L 10.0 % [dB]	L 90.0 % [dB]
Recorded		**00:15:00**	**31.2**	**59.5**	**20.3**		
Project Result		**00:15:00**	**31.2**	**59.5**	**20.3**	**34.5**	**22.5**

B8 Night time #1

Start: 2019-08-26 23:00:16

End: 2019-08-26 23:15:16



Configuration

Device Info: XL2, SNo. A2A-08898-E0, FW3.11 Type Approved

Mic Type: NTi Audio M2230, SNo. 5062, User calibrated 2019-08-26 21:49

Mic Sensitivity: 42.9 mV/Pa

Range: 0 - 100 dB

Ln based on: LAeq_dt

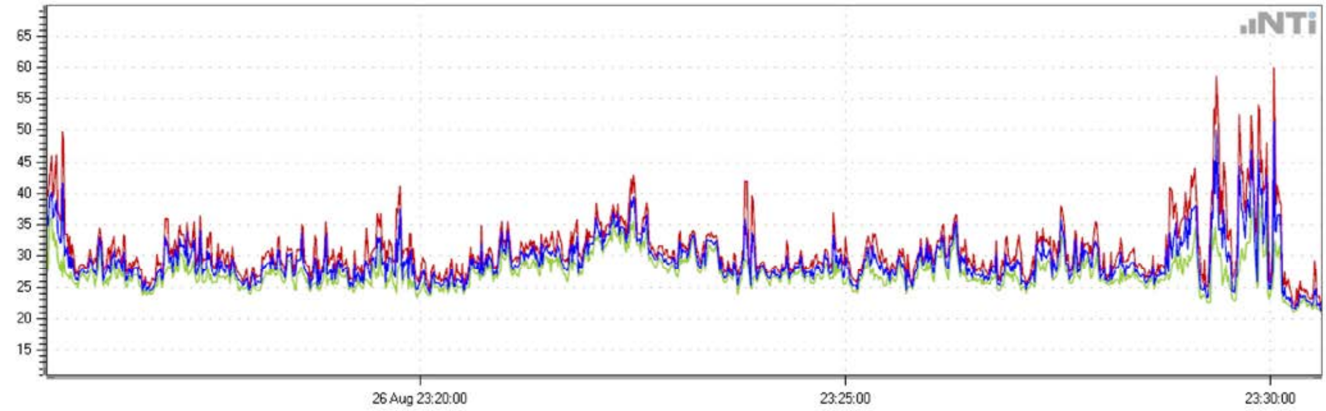
Results

Type	Start Date and Time	Duration	LAeq [dB]	LAFmax [dB]	LAFmin [dB]	L 10.0 % [dB]	L 90.0 % [dB]
Recorded		**00:15:00**	**28.8**	**54.9**	**21.3**		
Project Result		**00:15:00**	**28.8**	**54.9**	**21.3**	**30.2**	**23.6**

B8 Night time #2

Start: 2019-08-26 23:15:36

End: 2019-08-26 23:30:36



LAeq_dt LAFmax_dt LAFmin_dt

Configuration

Device Info: XL2, SNo. A2A-08898-E0, FW3.11 Type Approved

Mic Type: NTi Audio M2230, SNo. 5062, User calibrated 2019-08-26 21:49

Mic Sensitivity: 42.9 mV/Pa

Range: 0 - 100 dB

Ln based on: LAeq_dt

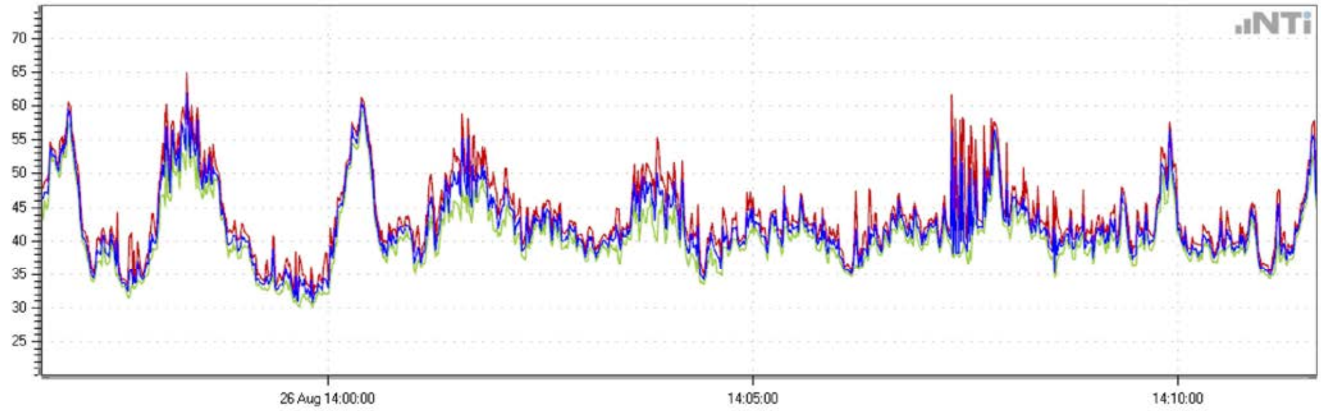
Results

Type	Start Date and Time	Duration	LAeq [dB]	LAFmax [dB]	LAFmin [dB]	L 10.0 % [dB]	L 90.0 % [dB]
Recorded		**00:15:00**	**31.9**	**59.9**	**21.0**		
Project Result		**00:15:00**	**31.9**	**59.9**	**21.0**	**33.5**	**25.7**

B9 Daytime #1

Start: 2019-08-26 13:56:38

End: 2019-08-26 14:11:38



LAeq_dt LAFmax_dt LAFmin_dt

Configuration

Device Info: XL2, SNo. A2A-08898-E0, FW3.11 Type Approved

Mic Type: NTi Audio M2230, SNo. 5062, User calibrated 2019-08-26 13:30

Mic Sensitivity: 43.1 mV/Pa

Range: 20 - 120 dB

Ln based on: LAeq_dt

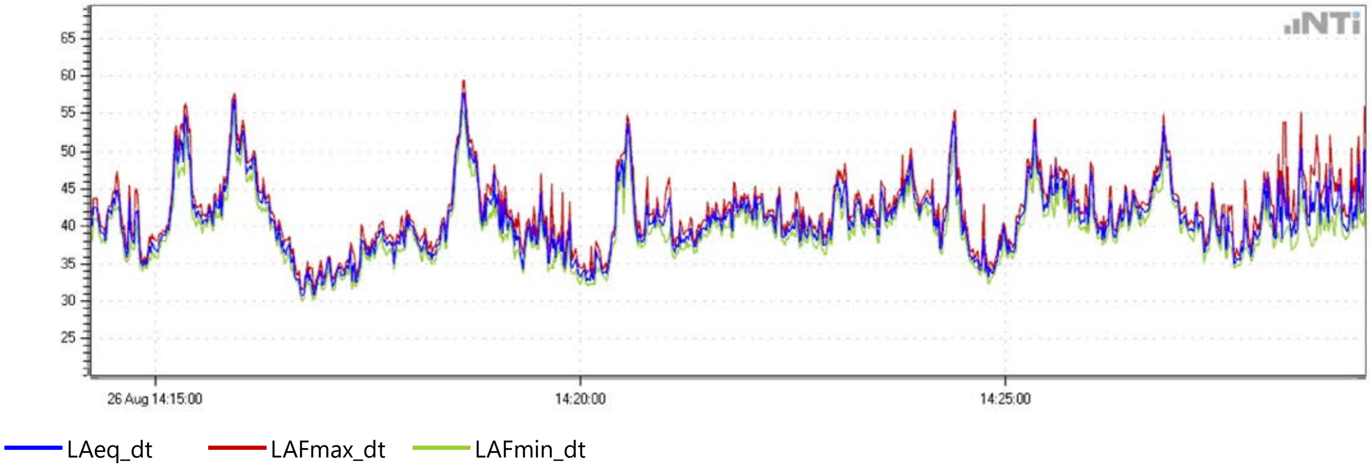
Results

Type	Start Date and Time	Duration	LAeq [dB]	LAFmax [dB]	LAFmin [dB]	L 10.0 % [dB]	L 90.0 % [dB]
Recorded		**00:15:00**	**46.9**	**64.9**	**30.1**		
Project Result		**00:15:00**	**46.9**	**64.9**	**30.1**	**50.4**	**35.9**

B9 Daytime #2

Start: 2019-08-26 14:14:14

End: 2019-08-26 14:29:14



Configuration

Device Info: XL2, SNo. A2A-08898-E0, FW3.11 Type Approved

Mic Type: NTi Audio M2230, SNo. 5062, User calibrated 2019-08-26 13:30

Mic Sensitivity: 43.1 mV/Pa

Range: 20 - 120 dB

Ln based on: LAeq_dt

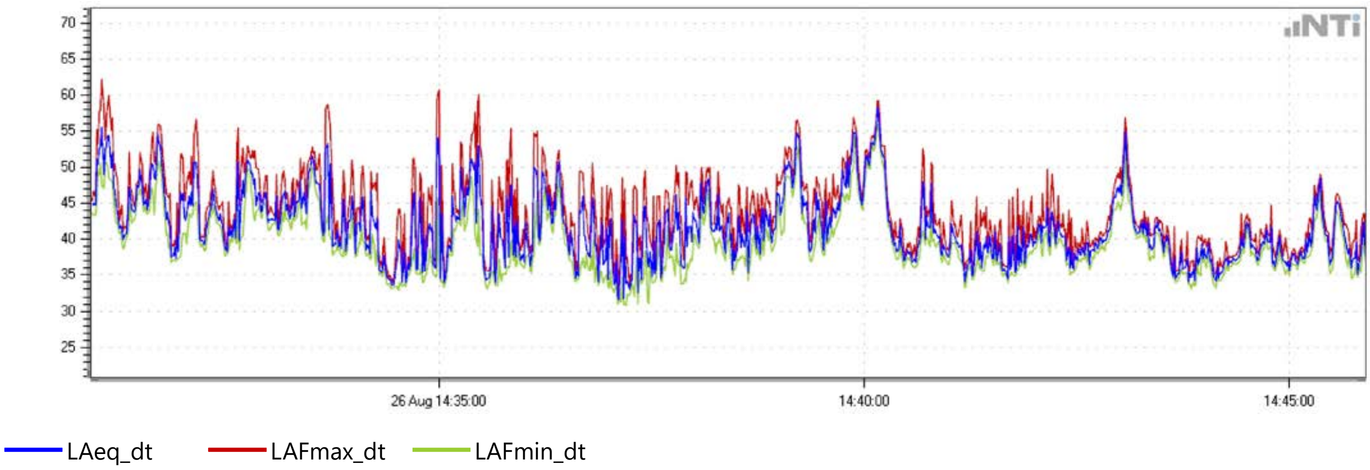
Results

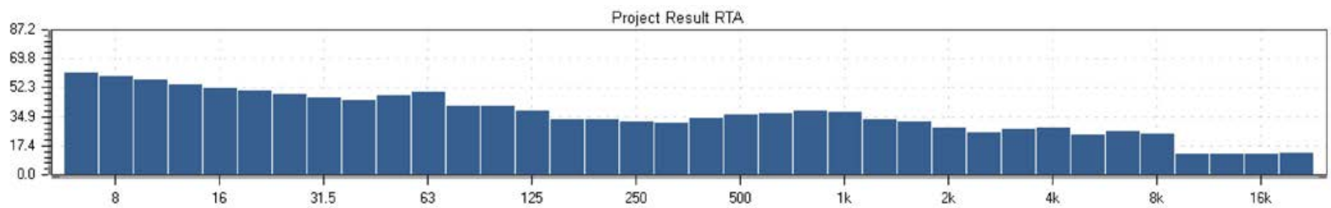
Type	Start Date and Time	Duration	LAeq [dB]	LAFmax [dB]	LAFmin [dB]	L 10.0 % [dB]	L 90.0 % [dB]
Recorded		**00:15:00**	**43.8**	**59.4**	**30.1**		
Project Result		**00:15:00**	**43.8**	**59.4**	**30.1**	**46.8**	**35.3**

B9 Daytime #3

Start: 2019-08-26 14:30:54

End: 2019-08-26 14:45:54





Configuration

Device Info: XL2, SNo. A2A-08898-E0, FW3.11 Type Approved

Mic Type: NTi Audio M2230, SNo. 5062, User calibrated 2019-08-26 13:30

Mic Sensitivity: 43.1 mV/Pa

Range: 20 - 120 dB

Ln based on: LAeq_dt

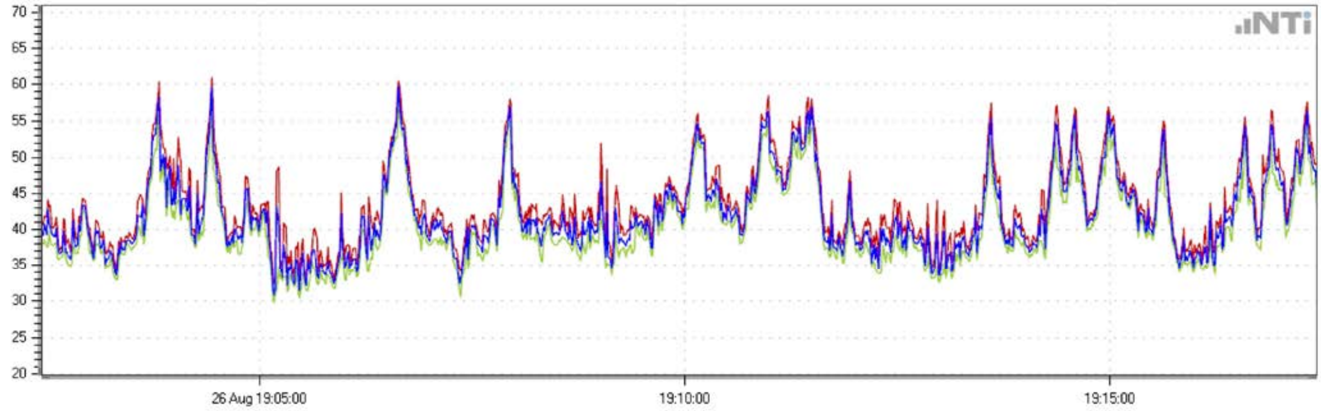
Results

Type	Start Date and Time	Duration	LAeq [dB]	LAFmax [dB]	LAFmin [dB]	L 10.0 % [dB]	L 90.0 % [dB]
Recorded		**00:15:00**	**44.9**	**62.1**	**30.8**		
Project Result		**00:15:00**	**44.9**	**62.1**	**30.8**	**48.7**	**36.2**

B9 Evening

Start: 2019-08-26 19:02:26

End: 2019-08-26 19:17:26



LAeq_dt LAFmax_dt LAFmin_dt

Configuration

Device Info: XL2, SNo. A2A-08898-E0, FW3.11 Type Approved

Mic Type: NTi Audio M2230, SNo. 5062, User calibrated 2019-08-26 18:59

Mic Sensitivity: 43.2 mV/Pa

Range: 20 - 120 dB

Ln based on: LAeq_dt

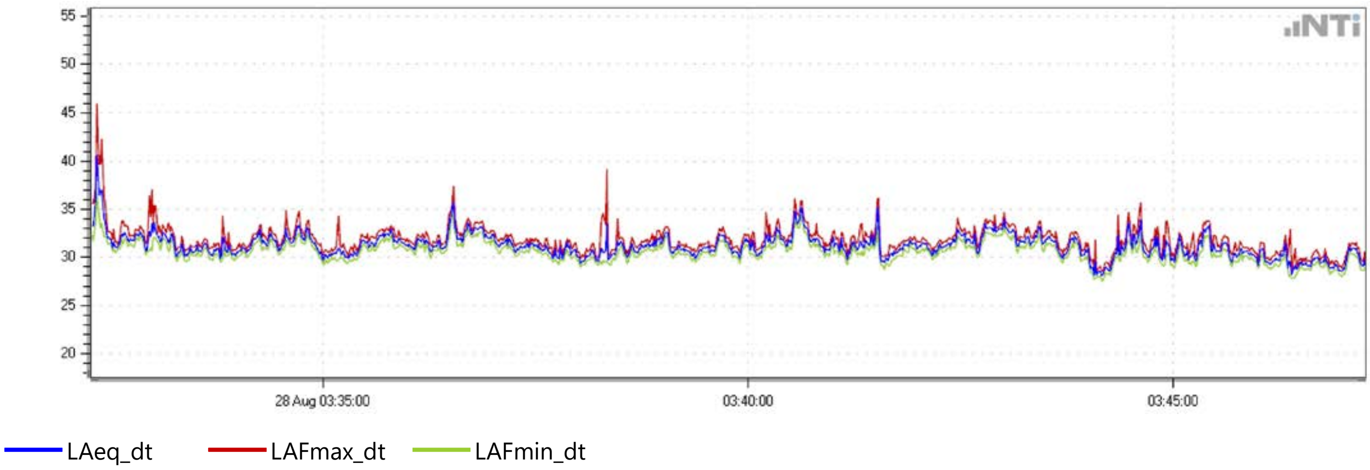
Results

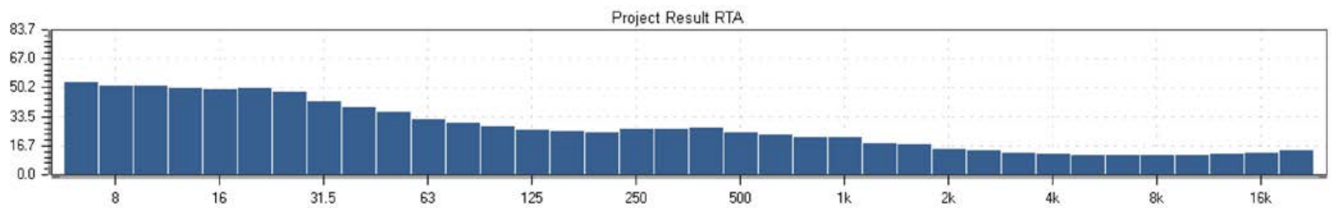
Type	Start Date and Time	Duration	LAeq [dB]	LAFmax [dB]	LAFmin [dB]	L 10.0 % [dB]	L 90.0 % [dB]
Recorded		**00:15:00**	**46.4**	**61.0**	**29.8**		
Project Result		**00:15:00**	**46.4**	**61.0**	**29.8**	**50.7**	**35.9**

B9 Night time #1

Start: 2019-08-28 03:32:16

End: 2019-08-28 03:47:16





Configuration

Device Info: XL2, SNo. A2A-08898-E0, FW3.11 Type Approved

Mic Type: NTi Audio M2230, SNo. 5062, User calibrated 2019-08-28 03:18

Mic Sensitivity: 43.1 mV/Pa

Range: 20 - 120 dB

Ln based on: LAeq_dt

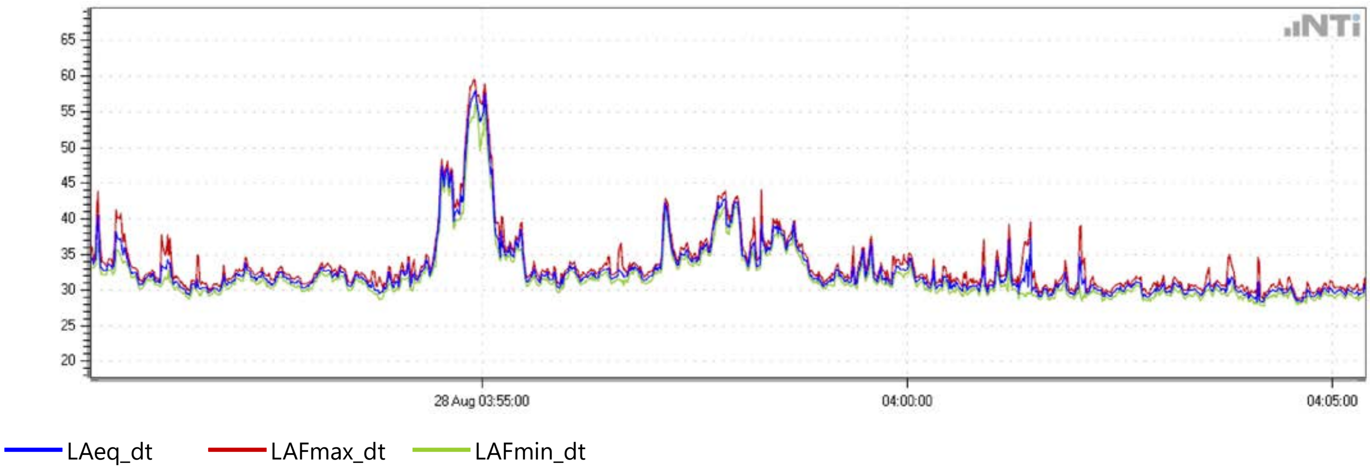
Results

Type	Start Date and Time	Duration	LAeq [dB]	LAFmax [dB]	LAFmin [dB]	L 10.0 % [dB]	L 90.0 % [dB]
Recorded		**00:15:00**	**31.4**	**45.9**	**27.5**		
Project Result		**00:15:00**	**31.4**	**45.9**	**27.5**	**32.7**	**29.9**

B9 Night time #2

Start: 2019-08-28 03:50:24

End: 2019-08-28 04:05:24



Configuration

Device Info: XL2, SNo. A2A-08898-E0, FW3.11 Type Approved

Mic Type: NTi Audio M2230, SNo. 5062, User calibrated 2019-08-28 03:18

Mic Sensitivity: 43.1 mV/Pa

Range: 20 - 120 dB

Ln based on: LAeq_dt

Results

Type	Start Date and Time	Duration	LAeq [dB]	LAFmax [dB]	LAFmin [dB]	L 10.0 % [dB]	L 90.0 % [dB]
Recorded		**00:15:00**	**39.7**	**59.6**	**27.7**		
Project Result		**00:15:00**	**39.7**	**59.6**	**27.7**	**37.4**	**29.7**

Attachment 6 - Tabulated 1/3 Octave Band Data

Committed to **your** success

Daytime Spectra

	NSL1			NSL2			NSL3			NSL4			NSL5			B1		
Band	#1	#2	#3	#1	#2	#3	#1	#2	#3	#1	#2	#3	#1	#2	#3	#1	#2	#3
6.3Hz	53.9	54.9	53.9	53.2	52.4	53.2	57.7	55.9	53.4	57.8	59.8	59.7	50.8	47.2	47.7	54.5	52.8	52.5
8Hz	55.9	56.4	56	52.7	52.1	52.4	55.7	53.7	51.5	57.1	57.9	57.7	49	47.2	47.5	55.4	55.1	54.8
10Hz	51.7	52.1	51.7	51.3	51.2	50.9	53.6	51.2	49.9	57	55.8	55.8	49	48	49.3	54.4	53.9	53.7
12.5Hz	51	51.5	51	49.1	50.5	49.4	51.8	49.5	48.5	57.3	54.7	54.4	51.6	49.4	51.3	56.9	56.6	56.3
16Hz	51.2	51.2	51	49.2	51	48.7	50.4	48.3	47.8	60.4	58.7	59.2	53.5	49.7	51.7	60.6	61.1	60.5
20Hz	55.4	55.5	55.1	50.8	51.7	51	48.6	47.2	51.6	58.5	52.5	53.3	53.1	50.6	52.5	61	61.5	61.1
25Hz	56.5	56.5	55.9	49	53.1	53	47.4	47.8	50.2	60.7	56.6	57.7	53.6	52	52.4	63.5	64.2	63.6
31.5Hz	51.2	51.1	51.1	49.4	51.9	54.6	46.9	49.1	47.7	61.8	54.9	57.1	54.3	52.5	53.8	62.6	62.5	63.2
40Hz	52.7	52.5	51.9	50.7	52.3	54.4	47.4	48.7	48.6	64	59.8	61.1	54.6	54.5	53	61.7	61.8	61.4
50Hz	49.6	50.2	50.4	47.4	49.9	48.9	48.4	51.3	51	68.1	65.9	59.7	56.7	61.4	57.1	67.2	68.1	70.7
63Hz	46.9	47.5	48.8	46.4	48.2	56.2	49.3	51.3	55.3	62.2	52.8	58	59.1	55.9	59.1	61.4	59.9	57.4
80Hz	42.6	42.3	44.3	47.6	47.6	50.2	47.6	48.5	49.2	58.7	57	57.6	53.7	52.9	52.1	70.3	63.8	56.8
100Hz	40.3	40	40.9	42.8	44.1	46.9	45.2	45.3	44.3	56.7	50.8	55.2	52.4	51.3	51.4	62.8	60.5	59.2
125Hz	39.6	40.2	41.4	41.4	44.5	44.8	41.9	45	41.7	53.8	48	53.8	49.6	48.7	49.1	58.3	56.9	57.8
160Hz	37.6	37.7	41.8	40.3	46.3	43.5	38.8	45.6	37.4	53.1	49.3	52.3	46.7	46.6	46.5	61.1	57.6	54.9
200Hz	36.6	36.3	41.6	40.5	49.2	43	37.3	46.8	35.4	52	46.9	50.3	47	47.3	47.3	57.8	54.1	52.7
250Hz	40	39	38.9	40.7	46.3	44.6	36.8	46.2	34.7	50.4	45.8	48	46.9	46.9	47.4	55.4	52.5	51.5
315Hz	33.6	31.8	34.8	39.1	43.4	44.4	34.3	42.7	31.5	49.9	45.9	46.7	47.9	48.2	48.5	56.1	53.5	52.8
400Hz	31.1	29.9	35	37.1	40.2	43.7	32.7	42.5	30.8	49.3	44.7	45.6	48.3	49.1	49.6	55.3	51.2	49.3
500Hz	33.2	32.7	33.9	37.1	41.2	45.1	28.8	40.7	33.5	49	45.6	44.5	50.6	51.2	51.3	54.4	52.2	50.2
630Hz	32.5	32.7	35.5	37.3	39.2	42	28.1	40.1	32.1	48.5	46.2	42.3	51.9	51.9	52.6	54.2	50.7	48.1
800Hz	29.7	30	34.4	38.1	39.1	42	26.3	39.3	29.3	47.6	45.4	42	51.1	51.5	51.4	52.6	50.2	45.5
1kHz	31	30.9	32.6	38.6	39.4	44.3	25.3	37.7	27.8	46.7	44	43	49	49.9	49.9	54.4	49.9	44.2
1.25kHz	31	30.7	28.9	36.8	37.2	43.1	23.2	34	26.5	45.1	41.8	41.4	45.7	46.8	46.5	58.1	49	42.3
1.6kHz	30.2	29.5	26.6	34.7	34.7	40.5	21.1	31.5	25.6	43.7	41.3	40.8	43.2	43.7	43.8	54.5	48.4	42.6
2kHz	27.3	26.5	23.2	32.6	32.4	39.5	18.6	29.6	23.9	42.9	39.2	40.9	40.5	41.4	41.6	53.4	48.3	44.7
2.5kHz	23	21.9	20.5	30.2	29.2	36.9	17.4	26.4	20.7	40.8	37.1	35.4	37.8	38.7	39.4	53.4	51.4	52.4
3.15kHz	25.8	18.7	22.9	29.1	27.2	34.7	18.3	25.6	20.3	39.1	34	35.3	36.1	37.4	38.1	53.6	45.6	36.3
4kHz	30.8	18.9	28.7	27.9	25.6	32.7	20.1	24.2	21.2	36.9	31.1	31.9	33.9	35.8	36.4	56.8	43.7	34
5kHz	25.8	21	25.6	25.7	23.7	30.7	19.2	21.7	19.6	32.2	28.4	28.9	32.1	34.2	35.1	55.8	42.2	30.9
6.3kHz	24.7	22.9	29.4	24.3	23.1	28.7	18.3	20.3	15.5	29	24.6	26.5	30.5	35	33.9	53.7	39.6	29.3
8kHz	25.9	26.2	29.2	23	22.2	24.6	16.2	15.7	13.8	25.2	22.9	23.5	28.5	28.7	31	51	37.9	25.3
10kHz	13.8	14	13.6	18.1	17	21.9	13.4	15	13.2	22.6	20.2	20.3	29	26	29.6	47.2	34.2	21.1
12.5kHz	12.6	12.5	13.1	16.2	14.9	19.6	13	13.5	13	17.7	16.6	40.4	24.5	23.7	26.4	45.5	47	18
16kHz	13.1	13.2	13.7	15	14.2	16.6	13.4	13.5	13.4	14.6	14.6	19.8	19.4	19.9	24.2	40.3	39.1	16.6
20kHz	13.9	13.9	14.1	14.6	14.4	15.4	14.2	14.2	14.1	14.2	14.3	14.4	15.8	16.2	23.1	34.2	24.8	16.4

Daytime Spectra

	B2			B3			B4			B5			B6			B7		
Band	#1	#2	#3	#1	#2	#3	#1	#2	#3	#1	#2	#3	#1	#2	#3	#1	#2	#3
6.3Hz	62.9	65.8	69.2	62.2	66.5	68.2	59.9	59.7	58.4	69.5	64.3	68.4	65.3	68.7	69.7	50.5	52.4	47.4
8Hz	62.4	64.7	68.1	62.3	65.6	67.4	57.5	57.9	55.9	67.9	63.1	66.5	64.3	67.9	68.7	49.7	51	47.2
10Hz	61.7	63.3	66.5	60.8	64.3	65.9	54.7	55.9	53.6	65.8	60.8	64.4	62.6	66.1	67.3	49.6	49.5	45.1
12.5Hz	61.9	63.2	65.8	60.9	63.1	64.3	52.5	53.3	52.1	64	58.6	62.1	62.3	65.1	66.7	49.1	46.8	45
16Hz	62.8	63.4	65.1	60.9	62.1	62.6	50.3	50.6	50.5	61.5	56.2	59.6	62.2	63.8	65.3	48.3	46.7	45.9
20Hz	67.2	67.6	68.4	61.1	61.4	61.8	47.9	48.4	52.4	58.3	54.1	56.7	64	64.6	65.5	47.4	47.4	45.5
25Hz	67.4	67.5	68.4	62.2	61.1	64.3	49.1	47.3	52.3	56.2	52.9	54	61.7	62.4	63.2	55.8	49.8	47.4
31.5Hz	64.3	64.4	65.4	62	60.3	65.4	48.5	45.7	50.5	55.2	52	51.2	61.6	61.6	62.2	54.5	47.6	48.5
40Hz	66.2	66.4	66.7	62.4	59.9	60.9	52.6	47.7	49.2	59.3	52.2	49.8	64	64.4	64.5	50.3	48.3	47.9
50Hz	66.7	66.2	66.7	62.6	60.4	62.3	51.1	51.7	52.5	55	61.9	61.2	66.1	65.9	65.8	56.6	51.8	51.1
63Hz	64.5	64.5	64.9	61	59.5	59.9	54.4	48.9	50.2	55.8	50.5	43.8	60.8	61	61	53.3	52.3	50.6
80Hz	64	64	64.3	60.1	59.6	60.3	57.7	44.8	45.6	53.9	52.1	50.9	57.7	57.8	59.2	51.5	58.1	48.8
100Hz	61.5	61.4	61.6	58.9	59.7	60.2	47.1	49	45.9	54.5	46	46.8	62.3	62.3	61.9	54.3	60.6	51.6
125Hz	56.8	57.3	57	58.5	56	57.2	49.3	46.3	44	51.3	42.6	36.7	51.6	52.6	54.1	44.6	54.2	42.3
160Hz	53.6	54.7	53.8	58.4	54.5	55.1	47.3	43.3	43.1	52.9	43.5	35.5	50.7	50.7	53.9	42.4	53.8	38.9
200Hz	50.9	52.2	52	57.9	53.6	53.8	44.6	43.4	41.5	52.7	43.8	33.3	53.4	53.6	54.2	43.2	55.2	36.4
250Hz	49.2	50	50.6	54.7	50.9	51.7	44.2	43.4	40	47.5	41.2	31.4	47	47.6	50.5	44.4	49.4	34.7
315Hz	51.5	48.7	49.6	52.1	46.7	48.6	40.7	42.1	38.9	47.3	39.4	31	44.2	44	48.6	44.8	48	35.7
400Hz	49.7	48.8	49.3	52.3	47.3	48.6	39.6	39.4	38.8	47	37.6	32.8	51.1	49.2	51.2	45.4	48.8	34.4
500Hz	49.9	49	49.7	51.9	48.3	49.2	40.7	39.7	39.5	47.1	36.4	34	51.4	50.3	51.1	43.3	47.1	31
630Hz	48.9	49.4	50.4	51	47.9	49.2	40.4	40.6	41	47.7	39.3	34.3	46.5	46.8	48.1	43.1	45.4	30.2
800Hz	46.3	46.2	46.8	50.5	48	49.2	40.5	40.8	41.5	44.4	35.4	29.7	47	44.8	45.9	45.5	44.2	31.2
1kHz	44.6	44	44.5	49.7	47.4	49	39.2	39.6	40.3	44.3	37.8	28.3	53.3	51.7	50.9	45.6	44.8	30.8
1.25kHz	42.3	42.5	43.7	49.7	48.2	49.4	38.3	36.6	38.4	45.8	40.8	27.5	47.2	45.9	45.9	46.1	44.8	30.1
1.6kHz	40.9	41	42	48.5	46.7	48.2	37.3	34.3	38.2	47.5	42.2	27.7	45.4	44	43.7	43.6	44.2	30.3
2kHz	39.9	39.9	40.9	47.3	45.7	47.2	35.5	32.6	35.4	42.5	34.8	26.5	44	42.4	43	41.7	42	29.5
2.5kHz	38.1	38.8	39.3	45.6	43.5	45.5	34.1	31.3	33.6	41.4	34.7	23.8	40.9	39.7	39.7	43.5	39.7	26.9
3.15kHz	35.9	36.4	36.5	43.6	41.5	44.6	32.5	29	30.4	40.9	32.2	22.8	39.6	38.4	37.7	39.5	39.6	23.9
4kHz	34.5	35	35	42.2	40.1	43.3	29.3	25.1	28.2	39.6	28.5	22	36.1	35.5	34.2	36	39.1	20.5
5kHz	31.7	32.1	32.2	40.3	38.1	41.3	25.6	23.6	25	37.6	26.1	20.7	33.1	32.4	32.6	33.8	35.6	18.2
6.3kHz	30.6	29.7	28.9	38.5	35.9	39.9	23.8	23.2	26	35.2	23.9	20.6	35.2	36	34.8	29.7	32	16.4
8kHz	28.7	27.6	23.6	34	28.9	34.3	21.9	17.3	26.2	32	19	20.6	29.8	32.4	30.1	26	29	15.4
10kHz	18.4	17.8	17.5	30.8	20.6	29.9	19.3	14.1	15	30	14.9	15.2	15.8	17.4	16.2	21.4	25.9	13.4
12.5kHz	14	14.1	14	31.8	16	32.4	17.1	13.3	13.8	29.2	13.6	14.3	14.3	14.7	14.4	18.3	25.9	13
16kHz	14.2	14.1	13.8	25.6	14.8	25.5	15.2	13.4	13.7	25.8	13.4	13.9	13.9	14.1	13.9	15.1	22.4	13.5
20kHz	14.4	14.5	14.5	21.4	14.6	19.7	14.6	14.1	14.1	20.7	14	14.2	14.2	14.3	14.3	14.6	16.5	14.3

Daytime Spectra

	B8			B9		
Band	#1	#2	#3	#1	#2	#3
6.3Hz	59.4	65.3	61.9	61.9	67.6	61.7
8Hz	57.6	64.1	60.3	60.5	65.6	59.8
10Hz	55.4	61.9	58.5	58.1	63.7	57.9
12.5Hz	53.2	59.7	55.7	56.1	61.6	55
16Hz	50.7	57.2	52.8	54.2	58.8	52.9
20Hz	48.6	54.3	49.5	53.3	55.9	50.8
25Hz	48.3	51.4	47	53.1	53	48.9
31.5Hz	47.7	48	45.7	52.6	49.5	46.9
40Hz	47.7	45.4	42.1	52.8	47.1	45.4
50Hz	47.8	45	41.7	57.3	47	48.6
63Hz	46.2	40.5	51.9	52.6	45.9	50.3
80Hz	46.3	36.5	46.6	48	43.6	42.2
100Hz	43.8	34.1	42	50	40.7	41.6
125Hz	42.8	30.8	44.5	46.6	37.2	39
160Hz	39.6	28.1	42.8	44.9	34.7	34.1
200Hz	35.8	26.1	41.2	43.9	32.6	33.6
250Hz	37	23.9	41.3	42.8	30.6	32.5
315Hz	37	23.4	37	41.9	31.4	31.6
400Hz	34.4	24.6	44	39.7	33.9	34.4
500Hz	31.3	27.3	38.6	39.3	36.6	36.5
630Hz	31.1	28.7	40.6	39.1	37.1	37.7
800Hz	30.6	28.1	42.7	38.9	38.3	38.7
1kHz	29.8	25.9	37.6	38	37.6	38.5
1.25kHz	27.1	22.3	38.1	35.3	33.6	34.2
1.6kHz	25.5	19.6	43.3	32.5	30.1	32.5
2kHz	23.7	17.1	37.7	29.3	26	29
2.5kHz	21.8	14.8	36.2	26.8	23	25.9
3.15kHz	23.1	15.2	33.4	25.4	20.5	27.8
4kHz	19.4	16.7	30.8	25.4	18.6	29.1
5kHz	15.4	14.5	26.3	31.8	18.8	24.2
6.3kHz	14.8	14.9	23.7	21.2	19	26.8
8kHz	14.1	14.3	21.8	19.3	16.1	25
10kHz	13.1	13.4	18.6	13.1	13.6	13.2
12.5kHz	13.1	13.4	16.2	12.9	13.2	12.9
16kHz	13.6	13.7	14.9	13.3	13.4	13.3
20kHz	14.1	14.2	14.5	14.1	14.1	14

Evening Spectra - dB

	NSL1	NSL2	NSL3	NSL4	NSL5	B1	B2	B3
Band	#1	#1	#1	#1	#1	#1	#1	#1
6.3Hz	52.9	43	51.8	49.6	41.4	59.6	65	57.3
8Hz	54.4	45.8	49.8	47.1	41.6	58.7	64.2	58.9
10Hz	49.9	44.9	47.3	44.6	41.2	58.4	63.3	57.6
12.5Hz	50.6	44.6	44.4	42.7	41.3	62.8	63	58.8
16Hz	49.6	46.9	42.8	42.2	42.4	63.6	63.6	58.4
20Hz	54.8	47.7	42.5	40.2	45.3	64.1	68.6	59.3
25Hz	56.2	50.2	43.6	40	46.8	71.2	68.5	59.8
31.5Hz	51.1	50.1	43.8	40.3	45.3	67.1	65.9	59.4
40Hz	51.5	51.2	44.7	40.7	45.8	66.3	67.5	60.4
50Hz	50.8	52.5	46.4	46.7	46.9	65.9	67.6	60.7
63Hz	47	46.7	46.8	39.8	47.4	62.5	65.6	58.4
80Hz	45.5	45.4	44.1	47.4	46	62.6	64.7	58.6
100Hz	42.5	43.7	40.5	33.2	42.3	62.5	61.7	59.1
125Hz	44.9	40.8	38.1	32.6	39.2	61	56.4	56.5
160Hz	46.9	40.8	37.8	30.7	38.6	59.5	52.5	55.3
200Hz	47	40.6	39.5	29.5	39.5	63.9	51.5	53.1
250Hz	44.3	40.4	40.4	27.6	41.8	63.2	50.7	50.9
315Hz	44.2	39.4	38.4	26.7	41.3	59.8	48	48.3
400Hz	41.5	39.9	36.9	26.2	40.7	54.8	48.7	48.1
500Hz	40	39.1	35.2	26.4	43.3	55.2	49.4	48.2
630Hz	38.6	38.7	35.2	25.7	45.3	54.8	49.8	47.8
800Hz	37.3	39.9	38.6	26.3	48.7	52.9	45.6	47.2
1kHz	36.5	40	38.8	26.9	49.9	54	43.5	46.4
1.25kHz	33.8	38.3	35.8	24.3	46	51.5	44.2	47.4
1.6kHz	30.8	36.2	31.4	23	41.7	52.9	41.9	45.9
2kHz	28.2	34.3	26.6	19.9	37.9	56.8	41.1	45.1
2.5kHz	24.7	30.5	22.4	18.2	33.9	54.4	39.8	43
3.15kHz	21.8	28.9	18	15.9	31.4	51.6	37.8	41.6
4kHz	19.3	27.2	14.8	13.3	28	47.2	35.8	38.9
5kHz	17.8	25.7	13.7	12.2	24.3	44	33.3	37.6
6.3kHz	15	24.8	13.8	10.8	21.5	38.9	30.6	35.2
8kHz	14.3	28.8	13.5	9.6	19.1	34.9	25.3	27.4
10kHz	13.2	19.2	12.8	8.5	17.1	29.1	18.9	22.1
12.5kHz	14.2	18	13.3	7.9	15.4	22.8	14.2	19
16kHz	13.7	15.9	13.3	6.6	14.4	16.9	13.6	15.8
20kHz	14.2	14.7	14.5	21.5	14.3	14.4	14.2	14.5

Evening Spectra - dB

	B4	B5	B6	B7	B8	B9
Band	#1	#1	#1	#1	#1	#1
6.3Hz	49.1	59.2	69.6	51.7	44.4	50.9
8Hz	47.2	57.4	68.6	49.7	44.4	48.7
10Hz	45.7	55.3	66.6	47.3	43.7	47.6
12.5Hz	44.9	52.4	65.1	44.1	40.8	45.9
16Hz	45.4	50.7	63.9	41.9	39.4	44.7
20Hz	48	49.8	62.7	40.2	39	45.8
25Hz	48.1	49.3	62.7	37.8	36	47.6
31.5Hz	46.2	49	62.1	40.4	36.3	47.2
40Hz	44.1	48	63.6	34.2	35.2	45.3
50Hz	46.5	47.5	67.2	33.3	33	48.6
63Hz	45.4	45.2	61	31.1	32.3	53.6
80Hz	43.5	43	57.4	30.6	32	44.6
100Hz	41.9	42.6	61.6	29.7	30	41.6
125Hz	40.7	45	52.3	26.8	23.9	42
160Hz	40.2	46.3	50.8	25.9	21.1	35.3
200Hz	39.1	44.5	50.1	25.6	18.7	33.2
250Hz	39	43.9	46	24.1	16.9	30.8
315Hz	36.1	45.7	43.2	22.9	17.5	30.8
400Hz	35.2	42.7	49.1	22.7	18.7	33.5
500Hz	36.8	40.9	50.1	21.4	21.9	36.8
630Hz	38.9	38.6	45.7	25.1	24.2	38.4
800Hz	41.1	36.6	44.9	25.3	25.1	41.4
1kHz	40.9	35.1	52.7	22.7	24.1	41.2
1.25kHz	37.1	34.1	46.7	19.3	21.8	36.4
1.6kHz	33.3	30.6	45.2	16.6	20.9	31.6
2kHz	31.4	26.6	42.8	14.6	16.5	28.8
2.5kHz	28.7	22	40	13.5	12.3	26.6
3.15kHz	26.5	15.1	39.2	12.6	10.8	25.2
4kHz	23.7	13.4	35.9	11.9	10.5	25.2
5kHz	21.4	12.6	33.9	12	10.2	20.3
6.3kHz	20.6	12.7	39.7	12.8	9.9	20.4
8kHz	26.1	12.7	37.4	13	9.9	18.3
10kHz	15.9	12.5	15.2	12.5	8.9	14.4
12.5kHz	15.1	12.7	12.8	12.7	8.2	13.9
16kHz	14.4	13.1	13.2	13.2	6.7	13.6
20kHz	14.3	14.2	14	18.3	5.5	14.1

Night time Spectra - dB

	NSL2		NSL3		NSL4		NSL5	
Band	#1	#2	#1	#2	#1	#2	#1	#2
6.3Hz	42.9	44.4	46.5	46.5	42	37.4	38	43
8Hz	46.7	49.3	44.2	44.3	41.5	38.6	37.3	42.9
10Hz	46.8	49.7	45.8	41.7	39.8	38.4	40.2	41.2
12.5Hz	44.5	48.2	38.8	39.2	39.2	38.8	41.1	41.4
16Hz	44.7	49.5	37.4	38.1	40.4	40.6	42.2	41.9
20Hz	46.7	51.4	34.9	36.3	39.8	38.2	44.7	43.5
25Hz	45.8	49.5	36.5	37.9	39.6	38.5	44.7	45
31.5Hz	47.8	49.8	33.8	34.3	40.5	35.2	41.6	38.1
40Hz	46.5	47.7	31.8	33.9	35.8	34.6	43.7	39.1
50Hz	39.9	42	32	36.8	34.2	32.7	43	38.6
63Hz	33	37.7	35.9	36.9	33.7	32.8	37.3	35.4
80Hz	36.4	36.1	33	33.3	56.2	56.9	39.4	44.9
100Hz	26.9	29	26	28.3	29.4	26.9	35.8	33.3
125Hz	29.5	30	21.4	23.9	26.9	25.9	33.9	30.3
160Hz	24.4	28.3	18.6	20.6	34.7	40.2	31.5	28.2
200Hz	21.4	24.8	16.8	17.4	29.9	27.6	32.6	31.9
250Hz	22.6	26.2	18.8	19.1	29.6	30.1	35.2	30.8
315Hz	22.8	24.2	17.4	17.7	28.7	28.3	36	28.7
400Hz	24.2	24.8	21	19.6	22.7	22.6	35.1	29.4
500Hz	23.4	26.7	23.3	25.5	24	22.6	36.9	30.1
630Hz	24.6	27.1	25.6	29	25.1	24.5	39.6	34.2
800Hz	24.7	26.3	29.6	33.2	27.3	27.9	41.8	37.6
1kHz	24.1	25.6	28.9	32.2	27.7	29.2	42.3	37.1
1.25kHz	21.6	23.1	26.2	29.2	24	25.4	39	32.8
1.6kHz	18.7	20.7	24.1	25.4	21.8	21.3	34.5	28.3
2kHz	14.4	15.6	20.3	21.1	23.1	18.7	30.5	24.6
2.5kHz	11.7	10.5	16.2	17.2	22.8	13.6	26.4	20.7
3.15kHz	11	7.9	12.6	13.8	19.1	10.6	23.9	19.8
4kHz	10.9	9.3	10.1	11	13.7	9.8	20.7	19.5
5kHz	11.6	13.6	9.4	9.4	11.1	9.4	17.9	20.6
6.3kHz	11	11.4	8.9	9.1	8.9	9	14.7	18.4
8kHz	10.4	10.4	8.8	9	8.4	8.9	12.3	18.8
10kHz	10.1	11	8.1	8.2	7.9	8.2	10.7	18.1
12.5kHz	8.6	8.7	7.6	7.7	7.5	7.6	9.6	15.7
16kHz	17.2	6.9	11.1	22.2	6.3	6.3	8	13.2
20kHz	16.1	5.4	17.8	24.4	11.4	12.8	7.1	10.3

Night time Spectra - dB

	B1		B2		B3		B4		B5
Band	#1	#2	#1	#2	#1	#2	#1	#2	#1
6.3Hz	87.5	86.7	74.7	72.8	73.8	73.5	60.6	53.3	73
8Hz	86.4	85.7	73.5	71.7	72	72.1	59.2	52.2	70.9
10Hz	84.4	83.4	71.3	70.9	70	69.9	57.7	51.2	69.4
12.5Hz	83.1	81.4	69.3	68.5	68.6	68.3	55.8	50.5	67.1
16Hz	81.1	79.6	68.9	68.5	67.2	66.8	54.4	50.1	65
20Hz	79.3	77.9	70.2	69.8	65.8	65.3	52.1	48.3	62.5
25Hz	78.1	77.5	70.7	70.7	64.4	64.2	50.7	47.2	60.2
31.5Hz	77.1	74.6	69.7	69.8	63.2	62.7	47.8	44.1	57.7
40Hz	73.1	70.5	67.6	67.7	62.8	62.6	44.9	42.2	54.7
50Hz	79.9	75	68	67.9	62	62.5	45	41.1	52.1
63Hz	77.9	74.5	66.3	66.3	60	60.1	41.9	36.5	49.1
80Hz	76.7	73.1	64.8	65	59.8	60.5	40.2	37.2	46.1
100Hz	78.4	74.1	63.7	63.3	61	60.8	39.5	36.6	43.1
125Hz	66.5	64.9	58.2	58.1	56.4	57	38	35	39.8
160Hz	67	66	52.8	52.8	54.7	54.6	35.4	33.3	36.8
200Hz	63.4	60.4	48.4	48.4	54.4	54.5	34.1	32.3	34
250Hz	63.2	59.7	49.6	49.9	50.8	51.2	33.6	33	32.2
315Hz	60.8	60.7	50.2	50.8	49.3	49.4	33.2	30	31
400Hz	58.6	55.7	52.1	53.3	51.8	51.7	33	29.7	30.2
500Hz	57.6	55.2	53.6	54.5	51	51.1	33.4	30.8	28.4
630Hz	52.5	50.1	56.1	56.5	49.8	50	33.3	31.4	26.4
800Hz	51.1	48.2	49.3	50	49.6	49.9	32.8	32.6	25
1kHz	49.4	46.5	48.1	48.6	50.2	50.7	32.9	34.9	24.6
1.25kHz	48.1	45.3	48.9	50	50.4	50.9	32	32	23.7
1.6kHz	47.6	44.7	46.2	47.2	48.9	49.6	31.9	29.2	22.4
2kHz	46.6	43.6	45	45.9	47.3	47.9	31.1	25.9	22.6
2.5kHz	44.4	41	45.3	44.9	45.7	46.1	30.1	24.2	23.2
3.15kHz	42.8	39.2	39	37.2	43.5	44.2	29.3	22.9	22.6
4kHz	40.5	37.1	35.5	33.6	39.9	40.9	28.2	21.5	21.3
5kHz	38.3	34.9	31.5	30.1	36.6	36.8	27.6	20.3	19.7
6.3kHz	35	31.4	26.9	25.7	31.3	32	26	18.8	17.7
8kHz	31.2	27.6	22.3	22.5	24.5	26.3	23.1	16.3	15.6
10kHz	27.1	24.3	19	19.4	17.4	21.5	21.1	14.8	13.2
12.5kHz	22.8	23	18	17.8	13.8	19.5	19.2	13.7	10.3
16kHz	18.6	22.4	16.3	16.6	13.4	16.2	17.7	13.6	7.5
20kHz	15.4	15.2	15.1	15.1	14	14.5	16.5	14.3	5.5

Night time Spectra - (Cirrus Meter

	B5	B6		B7		B8		B9	
Band	#2	#1	#2	#1	#2	#1	#2	#1	#2
6.3Hz	74.6	75.1	89	47	46.6	42.7	46.2	54	48.6
8Hz	73.5	74	88.2	46.6	45.3	41.5	46.7	52.2	48
10Hz	71.2	72.4	87.2	46.4	43.3	40.2	46.4	52.1	47.6
12.5Hz	69	70.7	85.1	42.6	41.6	40.7	42.5	50.5	48.7
16Hz	66.7	68.5	83.2	40.5	40.4	38.8	41.1	49.8	48.9
20Hz	64.3	65.7	80.2	39.4	38.7	36.8	38.5	50.4	50.3
25Hz	61.6	64.3	76.8	36.4	36.3	35.5	36.5	48.7	48.3
31.5Hz	58.6	62.3	73	35.5	35.3	33.4	35.6	42.8	41.7
40Hz	55.2	62.8	69.3	33.9	34.7	32.7	35.3	39.5	39.5
50Hz	51.9	63	67.6	33.3	34.1	33.3	34.6	36.4	40.4
63Hz	48.7	59.7	65.3	30.3	31	29.8	31.2	32.7	41.5
80Hz	45.5	57	61	31.7	31.6	28.4	31.3	30.7	34.5
100Hz	42.2	60.4	63.4	28.6	30.3	23.9	25.2	28	33.1
125Hz	39	51.2	54.5	25.6	26.3	21.7	23.7	26	29.7
160Hz	35.6	49.7	50.2	24.3	25.1	19.8	22.3	25.6	27.5
200Hz	32.3	49.4	50.6	26	26.7	17.5	19.8	24.8	26.9
250Hz	29.6	46.8	46.1	21.2	21.9	15.7	19	27.3	28.8
315Hz	27.8	41.8	40.6	20.8	21.8	15.8	18.5	27.2	28.5
400Hz	26.7	45.1	41.3	20.4	22	17.5	19.2	27.5	29.7
500Hz	26	47.4	39.4	20.5	22.3	19.5	20.7	24.9	29.1
630Hz	25.2	43.9	38.2	25	25.5	22	23.1	23.4	30.8
800Hz	24.5	41.9	37.8	23.8	25.1	22.9	25.4	22	33.7
1kHz	24.4	48.2	39.4	21.4	23.9	21.3	24.6	22.2	35.6
1.25kHz	23.6	43.6	38.2	19.7	23.1	18.5	22.6	18.8	29.1
1.6kHz	22.5	41.2	36.9	18.7	21	17.1	21.7	17.9	25.3
2kHz	22.9	38.3	35.6	17.1	18.9	15.4	19.9	15.3	22.1
2.5kHz	23.1	35.5	35.1	13.5	15.1	12.3	17.3	14.2	18.1
3.15kHz	22.4	33.6	32	10.9	13.4	10	13.3	13.2	14.8
4kHz	21.1	30.2	29	12.3	14	9.7	12.2	12.3	12.2
5kHz	19.7	28.2	26.7	12.6	13.3	9.9	12.4	11.9	11.6
6.3kHz	18	33.8	28.6	11.3	12.1	9.9	13	11.7	11.4
8kHz	16	28.5	22.4	10.6	10.7	9.3	11.8	11.8	11.6
10kHz	13.4	15	20.4	9.9	9.6	8.6	10.1	12	11.9
12.5kHz	10.6	14	17.8	8.5	8.7	7.8	11.5	12.5	12.4
16kHz	7.7	13.8	16.2	7	7.3	6.5	8.5	13.1	13
20kHz	5.6	14.2	14.8	5.7	11.1	5.3	5.4	14.4	13.9

Attachment 7 -Historical Data

Committed to **your** success

Daytime Results

Year		2010			2011			2012			2013			2014			2015			2016			2017			2018	
Monitoring location	LAEQ	LA90	LA10	LAEQ	LA90	LA10	LAEQ	LA90	LA10	LAEQ	LA90	LA10	LAEQ	LA90	LA10	LAEQ	LA90	LA10	LAEQ	LA90	LA10	LAEQ	LA90	LA10	LAEQ	LA90	LA10
B1	51	47	52	54	49	56	55	52	55	65	63	66	60	53	61	62	61	63	58	45	61	67	62	68	65	59	65
B2	49	48	51	56	55	57	56	55	57	54	53	56	47	46	48	56	55	56	56	55	57	55	53	56	54	52	55
B3	58	38	55	59	47	60	53	47	56	59	58	60	56	40	52	60	57	62	62	58	65	61	58	61	61	57	62
B4	54	42	52	53	41	48	52	43	52	62	42	64	45	36	47	49	35	51	46	38	47	55	42	59	50	39	52
B5	40	34	42	39	35	42	42	36	45	50	42	53	47	40	46	49	36	44	34	31	35	44	40	46	48	41	51
B6	54	51	56	52	50	54	52	48	54	51	48	53	54	52	56	50	49	52	48	47	50	45	43	47	50	44	53
B7	51	44	53	40	35	42	45	40	47	70	40	60	40	34	40	38	33	38	36	30	36	55	46	59	43	40	45
B8				40	37	41	42	36	45	55	35	51	37	33	39	41	37	43	35	31	36	39	34	41	45	37	48
B9	53	43	53	46	34	50	53	45	55	51	38	56	50	39	52	48	41	51	49	35	54	47	37	51	48	38	52
NSL1	35	31	36	45	42	46	49	46	51	46	44	48	39	30	40	44	42	45	45	41	47	49	46	51	40	37	42
NSL2	53	39	49	53	41	46	53	43	53	44	31	43	43	33	44	45	34	41	46	35	45	49	36	49	46	39	47
NSL3	50	41	52	48	42	48	51	43	51	50	40	48	46	39	49	48	35	45	49	42	50	50	42	52	47	39	48
NSL4	44	39	46	49	40	52	46	41	47	45	39	48	48	39	47	43	37	44	58	35	60	59	39	61	59	47	62
NSL5	49	41	51	54	38	53	53	42	52	59	41	60	67	42	70	60	34	55	57	36	50	67	42	72	64	43	68

Evening Results

Year		2010			2011			2012			2013			2014			2015			2016			2017			2018	
Monitoring location	LAEQ	LA90	LA10	LAEQ	LA90	LA10	LAEQ	LA90	LA10	LAEQ	LA90	LA10	LAEQ	LA90	LA10	LAEQ	LA90	LA10	LAEQ	LA90	LA10	LAEQ	LA90	LA10	LAEQ	LA90	LA10
B1													62	57	59	54	52	55	51	48	54	61	59	61	58	57	58
B2													50	49	51	52	51	53	54	53	55	51	50	53	55	53	56
B3													46	45	47	60	59	60	58	58	59	58	57	59	60	60	61
B4													42	38	42	38	29	36	44	34	43	48	36	51	47	36	46
B5													42	41	44	52	45	51	43	34	40	33	28	34	35	32	37
B6													59	56	61	54	51	54	53	51	55	48	46	48	52	50	53
B7													37	35	38	46	43	45	35	31	37	39	38	40	38	36	38
B8													35	31	38	39	36	41	35	30	37	30	27	32	31	25	34
B9													45	33	47	45	33	45	37	32	38	45	34	50	52	37	56
NSL1										52	48	52	46	38	48	34	30	37	48	46	49	44	38	45	45	41	48
NSL2										49	39	51	50	35	48	45	33	42	47	42	48	54	37	47	49	38	48
NSL3										43	36	46	44	36	47	50	41	52	49	39	50	47	33	52	47	37	49
NSL4										54	33	52	41	39	42	47	39	46	36	30	38	34	30	30	44	40	47
NSL5										45	35	40	57	31	49	52	34	47	57	35	55	55	40	51	54	37	51

Night time Results

Year		2010			2011			2012			2013			2014			2015			2016			2017			2018	
Monitoring location	LAEQ	LA90	LA10	LAEQ	LA90	LA10	LAEQ	LA90	LA10	LAEQ	LA90	LA10	LAEQ	LA90	LA10	LAEQ	LA90	LA10	LAEQ	LA90	LA10	LAEQ	LA90	LA10	LAEQ	LA90	LA10
B1	63	61	65	58	55	59	66	64	67	56	53	58	59	53	62	62	55	63	54	47	57	63	59	63	51	48	53
B2	51	50	52	58	57	59	51	50	52	53	53	54	50	49	51	53	52	53	55	54	56	49	49	50	53	52	54
B3	48	27	38	32	29	34	52	36	41	59	58	59	42	37	40	60	59	60	59	58	59	58	57	58	59	59	59
B4	38	28	40	53	32	43	36	35	37	36	34	38	37	35	38	41	35	39	38	33	38	35	32	37	43	27	39
B5	40	37	40	34	32	36	30	27	30	41	37	43	42	39	43	42	41	44	38	38	43	35	29	37	30	26	32
B6	48	46	48	65	64	66	51	50	52	47	46	47	57	55	59	53	51	54	51	50	53	46	44	47	52	50	53
B7	41	36	40	34	32	35	30	28	36	37	35	38	38	34	39	39	36	41	36	32	38	47	47	47	41	39	40
B8				36	33	38	36	28	32	40	37	42	33	30	35	38	35	40	39	36	42	36	30	38	33	27	35
B9	35	20	38	33	25	33	53	45	55	35	29	33	36	27	33	41	21	40	37	28	39	34	31	35	35	32	37
NSL1	38	30	39	33	30	35	44	39	43	47	42	50	43	41	43	35	30	35	43	40	45	-	-	-	-	-	-
NSL2	34	23	37	42	30	37	46	34	38	38	36	40	34	31	35	41	34	42	37	31	39	32	24	35	42	32	37
NSL3	36	17	35	46	32	51	37	34	39	38	33	40	29	24	32	38	21	42	42	29	45	36	25	38	38	31	42
NSL4	44	26	37	54	37	45	46	32	37	43	34	41	41	39	42	43	37	42	34	29	36	47	32	48	42	40	44
NSL5	36	21	38	35	27	38	39	34	38	37	33	36	32	26	32	37	23	37	54	30	40	55	24	43	35	27	32

Attachment 5
Ambient Air Monitoring Locations

Continuous and External Ambient Air Monitoring Locations:

Parameter	1 Ballysteen (Kennricks)	3 Morgans Nth (Keanes)	4 WTP (LCC)	5 Foynes (LCC Reservoir)	7 Fawnamore (Fitzsimons)	8 A23 North	9 BRDA (P Stack)	11 Cronin	12 Sullivan	13 Ford (DG#33)
PM10 (continuous)	Osiris		Osiris	Osiris		Osiris	Osiris			
PM2.5 (continuous)	Osiris		Osiris	Osiris		Osiris	Osiris			
Deposited dust (monthly)		Dust Gauge (DG#29)			Dust Gauge (DG#30)			Dust Gauge (DG#31)	Dust Gauge (DG#32)	Dust Gauge (DG#33)
SOx (monthly)	Diffusion tube			Diffusion tube						

Note: Locations 2, 6 & 10 are no longer monitored (SOx diffusion tubes) following EPA approval in 2016. Primary fuel source is no longer HFO since changeover of plant to natural gas.

Attachment 6
BRDA Restoration Works Report by Enrich

Report To

Aughinish Alumina

On

BRDA Rehabilitation

Monitoring and soil analysis of rehabilitated areas

2019

From:

Enrich Environmental Limited

March, 18th 2020

CONTENTS

FIGURES

TABLES

1. Introduction

In 2019 Enrich Environmental Ltd provided on going soil consultancy services to Aughinish Alumina. Rehabilitation Areas 1-6 of the BRDA were monitored and managed to ensure the development of a sustainable vegetative cap on the BRDA to meet the requirements of the sites closure plan. No compost was imported to the BRDA in 2019. Compost set aside in 2018 was applied as topdressing to BRDA Rehabilitation Areas 1 to 6 in June 2019.

2. Methodology

Enrich staff made sampling trips to Aughinish on the 19th of June 2019 and 25th of October 2019. In June Areas 1-6 were inspected for grass establishment, root development and salt precipitation. Enrich staff advised on the required maintenance and improvement plan for grass (e.g cutting height, aeration, need for fertilization). Soil samples were taken for monitoring analysis (Table 1). In October, herbage samples were collected (Table 2) from the BRDA areas 1-6.

2.1 Sampling & analysis

A minimum sample size of 30 grab samples were taken to create composites of topsoil from the areas listed in Table 1. In areas 5 and 6 patches of salt crystallisation were noted on visual inspection. These areas were sampled to assess their soil chemistry. Samples were taken by walking in a “W” pattern to ensure a representative sampling of the areas. Soil samples were analysed, as proposed, for pH, % Organic matter, total nitrogen, electrical conductivity, plant available: Phosphorous, Potassium, Magnesium, Sodium and Calcium, exchange cations and actual cation exchange capacity.
Composite samples of herbage were also taken using a “W” sampling pattern, 30 grab samples were combined into composite samples (Table 2). A control herbage sample from a roadside field at the entrance to Aughinish Alumina was also taken as a comparison sample.

Table 1 List of soil samples taken in June 2019 in Aughinish Alumina.

Sample ID	Areas
210619/OH19012	Area 1&2
210619/OH19013	Area 3&4
210619/OH19014	Area 5 &6
210619/OH19015	Area 5&6 salt affected

Table 2 List of grass samples taken in October 2019 in Aughinish Alumina.

Sample ID	Areas
191119/OH19029	Control
191119/OH19025	Area 1&2
191119/OH19026	Area 3&4
191119/OH19027	Area 5
191119/OH19028	Area 6

3. Visual Soil Evaluation

A visual assessment of the remediated areas 1-6 was carried out in October. In areas 1-4 grass meadow, a multi species grass sward has been established and presented good growth. Patchy growth was observed due to recent compost application as topdressing and the unusually dry weather. These areas will recover stronger in due time, new grass was already visible (Figure 1).

Root establishment in the soil profile is achieving 20cm depth. Soils texture has been greatly improved by using compost as a multifunctional soil improver.

Figure 1 Grass sward typical of areas 1-4, June 2019 (after recent topdressing with compost).

Salt precipitation occurs in the surface soil in low rainfall periods. This effect reduces as soil aggregates form and salt is leached out of the soil.

Despite salt crystallisation, areas 5&6, which were only remediated in 2018, presented with good grass establishment.

4. Soil Analysis - Results and Interpretation

Soil analysis for the Areas 1&2, the initial areas to be remediated, confirm the success of the remediation procedure. In line with the visual assessment, the chemical results demonstrate that electrical conductivity and sodium levels had decreased to concentrations that support a sustainable grass sward. Annual compost application is required.

In line with the visual assessment, available and exchangeable sodium levels confirm that some patches in Areas 5&6 are affected by salt precipitation.

Table 3 Soil pH, Electrical Conductivity (EC), Organic Matter (%OM) and total nitrogen.

Sample ID	Areas	Soil pH	Organic Matter (%)	Electrical Conductivity (uS/cm)	Total Nitrogen (%)
210619/OH19012	Area 1&2	8.5	11.3	392	0.231
210619/OH19013	Area 3&4	7.9	9.1	3027	0.137
210619/OH19014	Area 5 &6 good	8.9	11.9	761	0.271
210619/OH19015	Area 5 &6 salt affected	8.9	9.4	4104	0.155

For grassland, maintenance recommendations (Defra, 2019) outline that established phosphorous in soil should be between 16-25 mg/kg (Olsen-P), and potassium between 121-180 mg/kg and magnesium between 26-50 mg/L. Phosphorus levels in Areas 3&4 are slightly below recommended levels (Table 3) whereas all others areas presented adequate levels of primary nutrients. Since the sward is required to establish a semi-natural landscape and is not driven by primary productivity, annual topdressing with compost is sufficient to sustain the grass growth.

Table 4 Available Phosphorus (P), Potassium (K), magnesium (Mg), sodium (Na) and calcium (Ca) in the soil.

Sample ID	Areas	P (mg/l)	K (mg/l)	Mg (mg/l)	Na (mg/l)	Ca (mg/l)
210619/OH19012	Area 1&2	16.2	148	62.3	569	1705
210619/OH19013	Area 3&4	12.8	138	33.8	1309	3430
210619/OH19014	Area 5 &6 good	33.4	410	135	1486	1355
210619/OH19015	Area 5 &6 salt affected	23.6	536	94.7	4150	860

Table 5 Exchangeable calcium (Ca), potassium (K), magnesium (Mg), sodium (Na) and cation exchange capacity (CEC) in the soil.

Sample ID	Areas	Ca meq/100g	K meq/100g	Mg meq/100g	Na meq/100g	CEC meq/100g
210619/OH19012	Area 1&2	4.3	0.63	1.00	4.28	10.2
210619/OH19013	Area 3&4	<0.1	0.58	0.5	9.04	8.8
210619/OH19014	Area 5 &6 good	<0.1	1.60	2.39	11.8	15.2
210619/OH19015	Area 5 &6 salt affected	<0.1	1.91	1.65	25.7	14.9

5. Herbage Analysis – Results and Interpretation

Table 6 Herbage control nutrient analysis.

		Interpretation				
Analysis	**Result**	**Deficient**	**Low**	**Normal**	**High**	**Excessive**
Nitrogen	2.45 %					
Sulphur	0.235%					
Phosphorus	0.26%					
Potassium	1.90%					
Calcium	0.95%					
Magnesium	0.18%					
Sodium	0.17%					
Manganese	72.6 mg/kg					
Iron	216 mg/kg					
Copper	6.3 mg/kg					
Zinc	27.4 mg/kg					
Molybdenum	5.19 mg/kg					
Boron	7.3 mg/kg					

Table 7 Herbage Area 1&2 nutrient analysis.

		Interpretation				
Analysis	**Result**	**Deficient**	**Low**	**Normal**	**High**	**Excessive**
Nitrogen	2.34 %					
Sulphur	0.242%					
Phosphorus	0.34%					
Potassium	1.63%					
Calcium	0.45%					
Magnesium	0.17%					
Sodium	0.18%					
Manganese	76.6 mg/kg					
Iron	366 mg/kg					
Copper	7.7 mg/kg					
Zinc	35 mg/kg					
Molybdenum	4.11 mg/kg					
Boron	6.6 mg/kg					

Table 8 Herbage Area 3&4 nutrient analysis.

		Interpretation				
Analysis	**Result**	**Deficient**	**Low**	**Normal**	**High**	**Excessive**
Nitrogen	2.89 %					
Sulphur	0.316%					
Phosphorus	0.41%					
Potassium	2.02%					
Calcium	0.50%					
Magnesium	0.20%					
Sodium	0.27%					
Manganese	68.6 mg/kg					
Iron	387 mg/kg					
Copper	10 mg/kg					
Zinc	38.2 mg/kg					
Molybdenum	5.99 mg/kg					
Boron	6.9 mg/kg					

Table 9 Herbage Area 5 nutrient analysis.

		Interpretation				
Analysis	**Result**	**Deficient**	**Low**	**Normal**	**High**	**Excessive**
Nitrogen	2.90 %					
Sulphur	0.308%					
Phosphorus	0.45%					
Potassium	2.42%					
Calcium	0.44%					
Magnesium	0.24%					
Sodium	0.45%					
Manganese	219 mg/kg					
Iron	240 mg/kg					
Copper	8.4 mg/kg					
Zinc	39.3 mg/kg					
Molybdenum	4.16 mg/kg					
Boron	6.5 mg/kg					

Table 10 Herbage Area 6 nutrient analysis.

		Interpretation				
Analysis	**Result**	**Deficient**	**Low**	**Normal**	**High**	**Excessive**
Nitrogen	2.08 %					
Sulphur	0.244%					
Phosphorus	0.31%					
Potassium	1.65%					
Calcium	0.32%					
Magnesium	0.17%					
Sodium	0.36%					
Manganese	322 mg/kg					
Iron	231 mg/kg					
Copper	5.0 mg/kg					
Zinc	26.4 mg/kg					
Molybdenum	3.28 mg/kg					
Boron	5.7 mg/kg					

Table 11 Herbage heavy metals analysis.

Total Metals (mg/kg)	Control Area	Area 1&2	Area 3&4	Area 5	Area 6	Maximum allowed in animal feed *
Lead	0.38	0.91	0.76	0.49	0.28	5
Nickel	1.5	2.0	2.1	1.4	1.2	--
Cadmium	0.05	0.04	0.03	0.02	0.02	0.5
Aluminium	134	109	106	116	94	--
Mercury	<0.01	<0.01	0.01	0.02	0.01	--
Arsenic	0.08	0.17	0.14	0.12	0.11	2
Chromium	2.1	3.9	3.8	2.9	2.5	--
Titanium	11.4	12.1	6.7	4.6	3.3	--

* COMMISSION REGULATION (EU) No 1275/2013of 6 December 2013

Heavy metals concentrations in the herbage are low. For comparison, The European Agricultural Commission has set limits for some of these metals in animal feed. The grass growing on the BRDA meets these limits.

6. Maintenance plan for remediated areas

Based on inspection, sampling and analysis of the BRDA remediation areas Areas 1-4, yearly topdressing is essential to maintain grass growth. Aeration followed by topdressing will improve soil structure and reduce compaction. Topdressing with compost, is preferable to application of artificial fertilizers. Artificial fertilizers will provide a short-term solution but in the long term they do not promote a healthy soil microbiome. Topdressing is required to support long-term sustainable growth. Creating a long-term, self-sustaining grass sward on the BRDA is directly linked to the health of the soil microbiome.

The rehabilitated areas of the BRDA will continue to be regularly assessed and actions such as tilling and reseeding will be performed if deemed necessary.

Brian Murphy, Ph.D, B.Sc.
Senior Scientist

Attachment 7
Constructed Wetland Overview

Constructed Wetland – 2019

Overview

Bauxite residue from the Bayer process contains residual caustic soda with alkaline leachate of pH > 10.5. Bauxite Residue Disposal Area (BRDA) closure and aftercare plans must address the timeframes required for runoff to reduce to ≤ pH 9.0 so it can be discharged to the receiving environment. A novel approach to ensure that BRDA runoff can be passively treated and made suitable for discharge within a short period (months) of BRDA closure is to incorporate constructed wetland(s) into the Closure Plan. Constructed wetlands are gaining global acceptance by regulators in mine closure. However, little research has been conducted into using wetlands to treat bauxite residue leachate.

Constructed Wetland - Field Demonstration

In 2012 Aughinish Alumina received funding from its owner UC Rusal and the International Aluminium Association for a research programme investigating the use of a constructed wetland to treat alkaline residue leachate. A field scale wetland demonstration unit was implemented in August 2013 and successfully treated leachate to pH <9 over a 1 year period.

A second phase of the field demonstration commenced in Spring 2015. To determine the effectiveness of wetland technology for low Ca leachate, the mixing system was modified to contain de-ionised water for dilution. Results to date (Figure 1) demonstrate that the constructed wetland can effectively buffer alkalinity of low Ca content residue leachate over a 44 months period. The trial wetland is successfully treating residue leachate to pH<9 (range pH 6.7 – 8.2) with no indications of the system reaching capacity. The 3.5+ years of continuous wetland operation, plus the previous 1-year operation from Phase I, illustrates the capacity for wetland systems to treat alkaline bauxite residue leachate for up to 5 years.

As per previous wetland demonstration the component parts of the wetland systems (soil and vegetation) have been periodically sampled and are currently undergoing analysis.

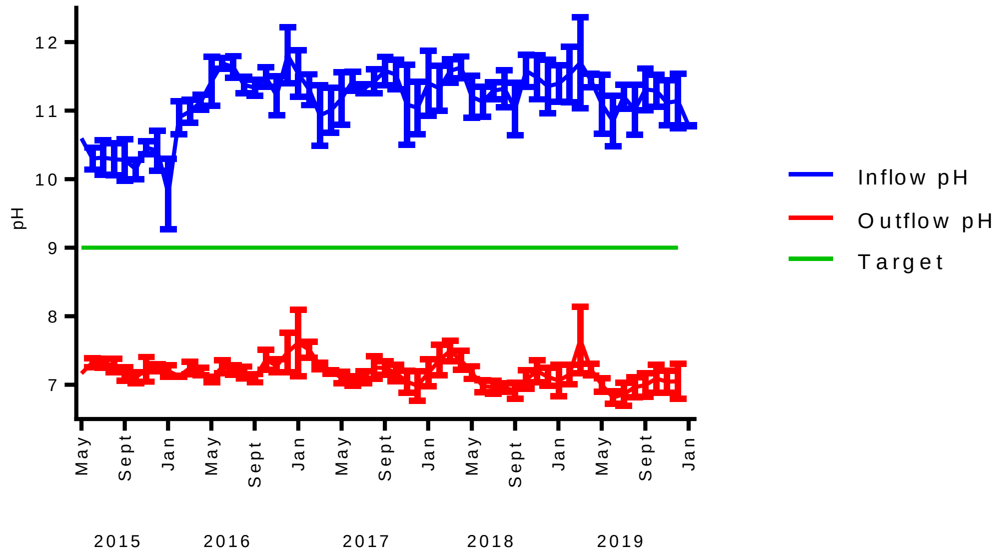


Figure 1. **Monthly average pH values of inflow and outflow in constructed wetland treating bauxite residue leachate**

Wetland feed (inflow) pH monthly mean varied between 9.23 and 12.17 (mean 11.23) with treated leachate (outflow) ranging from 6.6 to 8.27 (mean of 7.21) (Fig. 1) with consistent reduction to below the target value (pH 9).

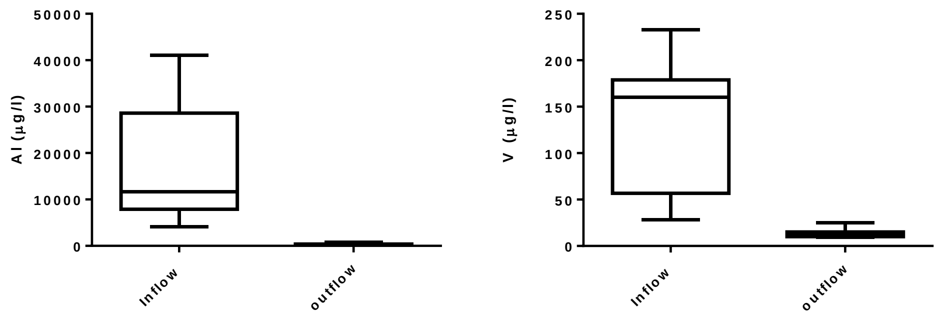


Figure 2. **Trace element (Al and V) content in constructed wetland inflow and outflow water for year 2019**

Content of both Al and V was significantly decreased in wetland outflow. Reductions in trace element (mean values) were Al 98% and V 90 %.

Soil Analysis

Baseline soil samples were taken prior to commencement of Phase I operation (August 2013). Soil and vegetation sampling of the wetland is divided into a front section, middle section and bottom section, with each monitoring section approx. 3 m in length. Further soil sampling (0–10 cm) taken at seasonal intervals has continued since. Soil pH and EC were determined on 1:5 soil/solution. Soil Na content was determined following aqua regia digestion and determination by ICP.

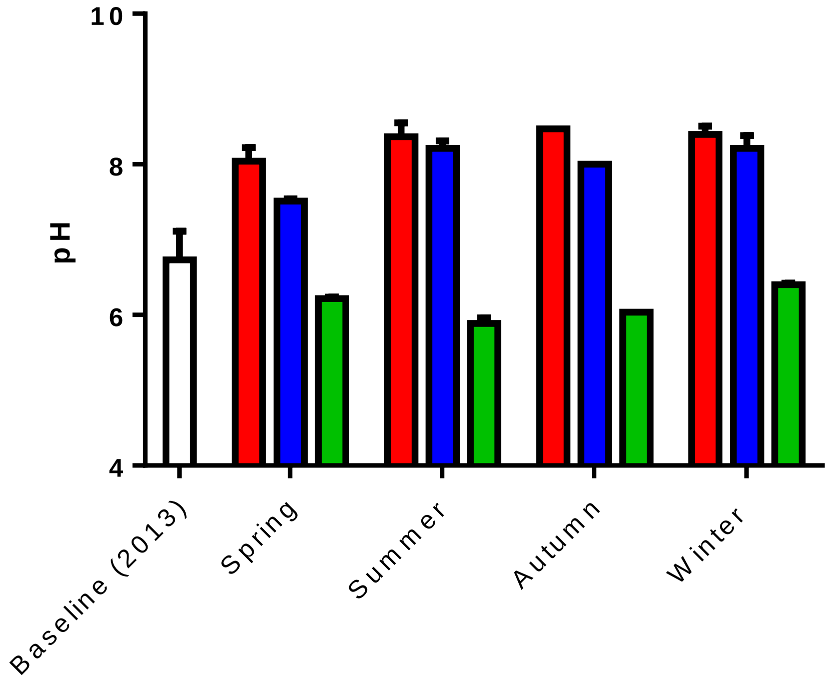


Figure 3. **Wetland soil pH for baseline and spatial/temporal changes in 2019**

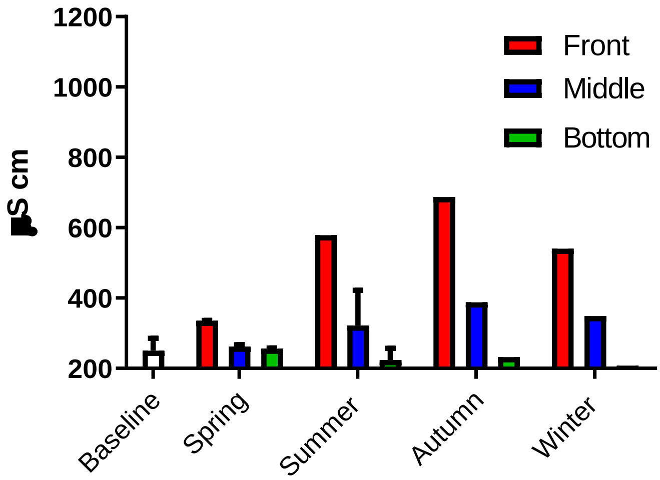


Figure 4. **Wetland soil EC for baseline and spatial/temporal changes in 2019**

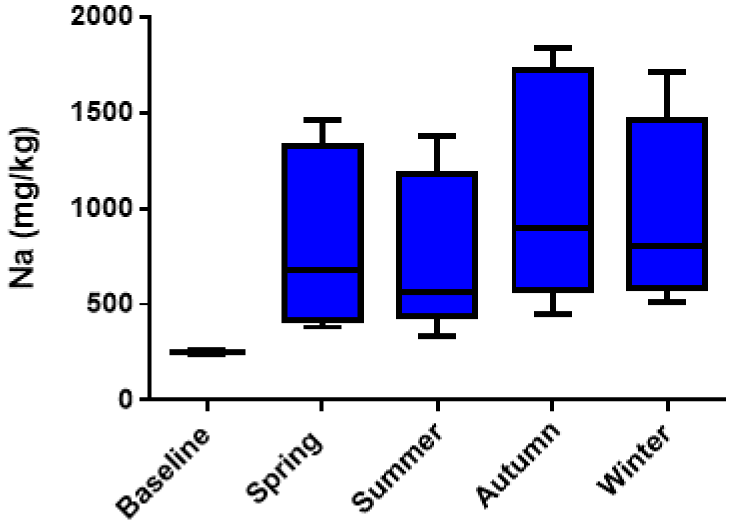


Figure 5. **Wetland soil Na for baseline and spatial/temporal changes in 2019**

Wetland soil pH, EC and Na varied significantly both temporally and spatially over the monitoring period. Increases in soil pH and EC are most evident in the front and middle sections of the wetland with increases from the baseline pH 6.7 to pH > 8.4 for the front section.

Findings & Continuing Work

Decrease in leachate pH is achievable within a constructed wetland with results achieved below the target pH 9 permissible for discharge. Successful reduction of leachate pH has now been achieved for 4.5 + years over Phase I and Phase II operation.

Seasonal variation in wetland efficiency observed during Phase I is not as evident for Phase II study. This is attributed, in part, to the consistency in leachate feed mix discharging to wetland.

The bauxite residue leachate trial wetland system will continue to be operated and monitored. Ongoing analysis is assessing trace element content in soils and vegetation.

Research outputs

Higgins, D., Curtin, T. and Courtney, R., 2017. Effectiveness of a constructed wetland for treating alkaline bauxite residue leachate: a 1-year field study. Environmental Science and Pollution Research, 24(9), pp.8516-8524.

Higgins, D., Curtin, T., Burke, I. and Courtney, R., 2018. The potential for constructed wetland mechanisms to treat alkaline bauxite residue leachate: carbonation and precipitate characterisation. Environmental Science and Pollution Research, 25(29), pp.29451-29458.

Attachment 8
Golder Technical Memorandum

MEMORANDUM

DATE 20 March 2020 **Project No.** 19116817.TM07.B0

TO Tom Hartney, Aughinish Alumina Limited

CC Kevin McMahon, Gerd Janssens

FROM Brian Keenan, Dave Buxton **EMAIL** bkeenan@golder.com

ANNUAL SITE INSPECTION OF THE AAL BRDA

Following a site visit by Dave Buxton and Brian Keenan on 04 and 05 February 2020, observations of the dam walls indicate no signs of distress and together with the Q4 monitoring data indicates that the performance of the Phase 1 and Phase 2 BRDAs are performing satisfactory and in accordance with the design criteria. In summary, the BRDA is well maintained and managed.

The Annual Review Report will be issued in March 2020 and will contain a full report on the site inspection.

Brian Keenan
Associate, Tailings Engineer

Dave Buxton
Associate, Principal Tailings Engineer

BK/DB/ar

c:\users\bkeenan\documents\golder\aughinish\brda monitoring\2019\annual review 2019\19116817.tm07.b0_memo_aal site visit_mar 2020.docx