Floatel Noise Monitoring Survey - 2 (September 4-7, 2024)

Woodfibre LNG Project

November 12, 2024

123221624EN-RPT0053

Woodfibre LNG

Preamble

The Woodfibre Liquefied Natural Gas Project (the Project) is a liquefied natural gas export facility being constructed on the former Woodfibre Pulp and Paper Mill site in Átl'ka7tsem (Howe Sound), approximately seven kilometres south of Sḵwx̱wú7mesh (Squamish). The Project is on the historical location of a Sḵwx̱wú7mesh Úxwumixw (Squamish Nation) village known as Swiẏát. Swiẏát and Átl'ḵ'a7tsem (Howe Sound) are tied to the cultural well-being of Sḵwx̱wú7mesh Úxwumixw (Squamish Nation) members, their ancestors, and their descendants, and to other Indigenous groups as defined in the Project's Environmental Assessment Certificates. The Project is also operating within the traditional, ancestral, and unceded territory of the səlilwətaɬ (Tsleil-Waututh) Nation, and to other Indigenous groups as defined in the Project's Environmental Assessment Certificates. Woodfibre LNG General Partner Inc. recognizes the importance of these areas to the Sḵwx̱wú7mesh stélmexw (Squamish People), and other Indigenous groups. Woodfibre LNG General Partner Inc., as general partner on behalf of Woodfibre LNG Limited Partnership (Woodfibre LNG) seeks to construct and operate the Project in a manner that is respectful of Indigenous values. This Floatel Noise Monitoring and Mitigation Plan is primarily written in English with important place names, phrases, and passages provided in Sḵwx̱wú7mesh sníchim (the Squamish language).

Temíxwiẏiḵw chet wa naantem chet ti temíxw Swiẏát
Chet wa sméṅhemswit kwis ns7éyx̱nitas chet ti temíxw
We7ú chet kwis t'íchimwit iy íẇas chet eḵ' I tti.

Our ancient ancestors named this place Swiẏát
We, as their descendants safeguard these lands
We will continue to swim and fish in these clear waters.

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Squamish-English Translations

Squamish	English
Átl'ka7tsem	Howe Sound
ínexwantas	monitoring
Skwxwú7mesh	Squamish
Skwxwú7mesh sníchim	Squamish Language
Skwxwú7mesh stélmexw	Squamish people
Skwxwú7mesh Úxwumixw	Squamish Nation
Swiỷát	Historic Squamish Nation village located at Woodfibre Site

Abbreviations

ANSI	American National Standards Institute
BC	British Columbia
BC EAO	British Columbia Environmental Assessment Office
BC ER	British Columbia Energy Regulator
dB	Decibel level
dBA	A-weighted decibel level
EAC	Environmental Assessment Certificate
HVAC	Heating, ventilation, and air-conditioning
Hz	Hertz
L_{max}	Maximum A-weighted equivalent sound level
L_d	Daytime equivalent sound level
L_{eq}	Energy equivalent sound level
L_n	Nighttime equivalent sound level
LNG	Liquified natural gas
MOE	Ministry of Environment and Climate Change Strategy
MOF	Material Offloading Facility
MOH	Ministry of Health
the Project	Woodfibre Liquefied Natural Gas Project
RMS	Root mean square
SPL	Sound pressure level
VCH	Vancouver Coastal Health
WHO	World Health Organization
Woodfibre LNG	Woodfibre LNG General Partner Inc.

Glossary

Adaptive Management	A systematic process for continually improving management policies and practices by learning from the outcomes of operational programs.
Bands (octave, 1/3 octave)	A series of electronic filters separate sound into discrete frequency bands, making it possible to know how sound energy is distributed as a function of frequency. Each octave band has a centre frequency that is double the centre frequency of the octave band preceding it.
daytime	The hours from 07:00 to 22:00.
dB - Decibel	A logarithmic unit associated with sound pressure levels and sound power levels.
dBA - decibel, A-weighted	A logarithmic unit where the recorded sound has been filtered using the A frequency weighting scale. A-weighting somewhat mimics the response of the human ear to sounds at different frequencies. A weighted sound pressure levels are denoted by the suffix 'A' (i.e., dBA), and the term pressure is normally omitted from the description (i.e., sound level or noise level).
energy equivalent sound level (L_{eq})	An energy-average sound level taken over a specified period of time. It represents the average sound pressure encountered for the period. The time period is often added as a suffix to the label (e.g., $L_{eq}(24)$ for the 24-hour equivalent sound level). L_{eq} is usually A-weighted. A L_{eq} value expressed in dBA is a good, single value descriptor of the annoyance of noise.
frequency	Number of cycles per unit of time. In acoustics frequency is expressed in hertz (Hz), i.e., cycles per second.
floatel	The marine-based work camp, associated facilities and mooring infrastructure dedicated to house approximately 650 Workers during the Construction of the Project.
hertz (Hz)	Unit of measurement of frequency, numerically equal to cycles per second.
L_d	Daytime sound level, an equivalent continuous sound level taken over 15 hours from 07:00 to 22:00.
L_{Amax}	The maximum value of the A-weighted sound pressure level during a measurement duration.

L_n	Nighttime sound level, an equivalent continuous sound level taken over 9 hours from 22:00 to 07:00.
nighttime	The hours from 22:00 to 07:00.
noise	Unwanted sound.
noise level	Same as sound level, except applied to unwanted sounds.
sound	A dynamic (fluctuating) pressure.
sound pressure level (SPL)	The logarithmic ratio of the root mean square (RMS) sound pressure to the sound pressure at the threshold of hearing. The sound pressure level is defined by the equation below where P is the RMS pressure due to a sound and P_0 is the reference pressure. P_0 is usually taken as 2.0×10^{-5} Pascals. SPL (dB) = 20 log (P_{RMS}/P_0)

1.0 INTRODUCTION

1.1 OVERVIEW

Woodfibre LNG General Partner Inc. (Woodfibre LNG) is constructing the Woodfibre Liquefied Natural Gas Project (the Project), which is located on the former Woodfibre Pulp Mill site approximately seven kilometres (km) southwest of Sḵwx̱wú7mesh (Squamish), British Columbia (BC).

Woodfibre LNG received an amendment to the Environmental Assessment Certificate (EAC) #E15-02 (Amendment #3) on November 1, 2023, approving the use of temporary accommodations for off-duty construction workers in a self-contained floating housing facility (floatel). The Amendment #3 includes conditions related to air quality and noise monitoring for the floatel occupants.

The floatel was mobilized and moored at the Project site on June 21, 2024, and will be continuously operating for approximately three years during the construction of the Project. The floatel will provide accommodation for approximately 650 persons at peak construction. In addition to the accommodation spaces, the floatel also includes a variety of ancillary service facilities such as medical, food and beverage, laundry, recreational and leisure, and office spaces. Figure 1 in Appendix A shows the site plan and location of the floatel.

1.2 FLOATEL NOISE MONITORING AND MITIGATION PLAN

Amendment #3 includes conditions regarding noise management for the floatel. Condition 30 of Amendment #3 states that:

> *30.1 The Holder must retain a Qualified Professional(s) to develop the following monitoring and mitigation plans, in consultation with MOE, MOH, BC Energy Regulator, VCH[1] and Aboriginal Groups:*
>
> *b) Noise Monitoring and Mitigation Plan.*

In accordance with the requirements of Condition 30, the Noise Monitoring and Mitigation Plan (the FNMMP) has been developed and finalized on July 17, 2024 (Rev.4) by the Stantec Qualified Professional and reviewed by the regulatory agencies. The FNMMP specifically includes the Noise Monitoring Plan, Noise Mitigation Plan and Adaptive Management Plan.

The FNMMP provides general guidance about how to assess workers' sleep disturbance due to Project related construction noise within the floatel cabins. The general guidance includes the monitoring method, sleep disturbance noise threshold, data analysis procedures, and reporting requirements.

[1] MOE: Ministry of Environment and Climate Change Strategy
MOH: Ministry of Health
VCH: Vancouver Coastal Health

1.3 OBJECTIVE

In accordance with the FNMMP, a series of noise monitoring programs will be conducted quarterly or following the construction activity changes.

An initial noise monitoring program was conducted to collect sound levels in the cabins from July 10 to July 14, 2024. The results were presented in a report "Floatel Noise Monitoring Survey -1 (July 10 - 14, 2024) – Woodfibre LNG Project" and listed in References section. This second subsequent noise monitoring was conducted from September 4 to September 7, 2024. During this period, the Project started vibratory and impact piling activities in the Material Offloading Facility (MOF) area during daytime and had more nighttime construction activities than the period of initial noise monitoring. The objectives of the noise monitoring programs include the following:

- Measure sound levels at the selected cabins.
- Analyze data gathered.
- Compare the measured sound levels with applicable sleep disturbance thresholds.
- Conduct interviews about noise with occupants.
- Assess compliance for sleep disturbance effect for sleeping quarter occupants.
- Recommend mitigation or adaptive management plan if required.

1.4 ENVIRONMENTAL NOISE DESCRIPTORS

All noise descriptors in this assessment are based on the A-weighted decibel (dBA) scale. The dBA unit is based on relative loudness of sound at different frequencies and is meant to reflect the human ear's response to noise.

Environmental noise typically varies over time. To account for this variation, single number descriptors are used. It is defined as the steady, continuous sound level over a specified time that has the same acoustic energy as the actual varying sound levels over the specified time. The noise descriptors energy equivalent sound level (L_{eq}), daytime equivalent A-weighted sound level (L_d), nighttime equivalent A-weighted sound level (L_n), and maximum A-weighted sound level (L_{Amax}) are commonly used to quantify noise effects for activities of a project. The following provides a general description for these descriptors:

- L_{eq} represents the energy-average sound pressure encountered for the period.
- L_d is the 15-hour energy equivalent A-weighted sound level during the daytime period from 07:00 to 22:00.
- L_n is a 9-hour energy equivalent A-weighted sound level during the nighttime period from 22:00 to 07:00.
- L_{Amax} is the maximum A-weighted sound level recorded over the measurement duration.

The Glossary section provides addition details for these descriptors.

2.0 CABIN SOUND LEVEL TARGETS

The construction noise may result in sleep disturbance to occupants of the floatel during the Project construction phase. This section focuses on the sleep disturbance threshold recommendations by Health Canada and room sound level criteria from another international standards (i.e., American National Standards Institute [ANSI]).

2.1 HEALTH CANADA SLEEP DISTURBANCE THRESHOLD

Noise may cause sleep disturbance for people and there is clear evidence that ongoing sleep disturbance is associated with a wide variety of health effects, such as cardiovascular effects, mental health and hearing impairment. Health Canada's Guidance for Evaluating Human Health Effects in Impact Assessment: NOISE, 2023 (Health Canada Noise Guidance) references the guidelines and recommendations of the World Health Organization (WHO) for community noise (WHO 1999) and Night Noise Guidelines for Europe regarding sleep disturbance (WHO 2009). The WHO 1999 guideline recommends a threshold for sleep disturbance as being an indoor sound level of no more than 30 dBA L_{eq} for continuous noise during the sleep period. For individual noise events, Health Canada also refers to WHO's recommendations that indoor sound levels should not exceed 45 dBA L_{Amax} more than 10 to 15 times per night to provide for a good sleep environment (WHO 1999). Health Canada recommends that an outdoor-to-indoor transmission loss with windows at least partially open is 15 dBA and fully closed windows are assumed to reduce outdoor sound levels by approximately 27 dBA (Health Canada 2023).

The Project construction work has potential to be scheduled 24 hours per day. For 24 hours per day construction, the sleep disturbance noise effect will be evaluated for the floatel occupants who may be off-duty and sleeping during the daytime or nighttime while construction is ongoing. The indoor sound level sleep disturbance thresholds of 30 dBA (L_{eq}) and quantities of occurrence of L_{max} > 45 dBA (i.e., 15 times) during both daytime (07:00 to 22:00) and nighttime (22:00 to 07:00) are recommended for the floatel.

Although the Heath Canada sleep disturbance threshold of 30 dBA is used it this assessment, it is better suited for private residential bedrooms with very quiet background noise. However, for the spaces with dense occupants, such as apartment buildings and hotel or motel rooms, where central heating, ventilation and air-conditioning (HVAC) systems and local activities are sources of background noise, a sound level of 30 dBA may not be achievable.

Therefore, the ANSI standard for room sound level criteria for the hotel or motel rooms is used as an additional reference target in the evaluation of interior noise on the floatel.

2.2 ANSI S12.2 SOUND LEVEL CRITERIA FOR ROOM

The ANSI S12.2-2019 (Reaffirmed in 2023) Criteria for Evaluating Room Noise is commonly used as a reference guide for assessment of sound level criteria for occupants in various interior environments. The ANSI standard specifies sound level criteria when evaluating the room noise by using the survey method that employs the A-weighted sound level. Table 2-1 lists the A-weighted sound level criteria for individual rooms or suite in hotels and motels, based on ANSI sound level criteria for room of various uses (ANSI S12.2).

Table 2.1 A-weighted Sound Level Criteria for Rooms – Hotels and Motels

Occupancy	A-weighted Sound Level dBA
Hotels/motels	
Individual rooms or suites	39-44
Meeting/banquet rooms	35-44
Service support areas	48-57
Source: Table C.1 of ANSI S12.2	

As the floatel provides the worker accommodation and belongs to the hotels/motels category, the A-weighted sound level criteria of 39 to 44 dBA for individual rooms or suites are also included in the floatel noise evaluation.

3.0 NOISE MONITORING PROGRAM

In accordance with the FNMMP, a Stantec Qualified Professional conducted this noise monitoring program on the floatel from September 4 to September 7, 2024. The following sections outline the monitoring program details, including cabin locations, measurement instrumentation, measurement setup, Project construction activities occurring during the measurement period, and data analysis methods.

3.1 CABIN LOCATIONS

The sound level meters were set up inside the representative cabins on different decks of the floatel. A representative cabin is an unoccupied cabin that is available for occupancy. The cabin is selected based on the highest potential noise impact (e.g., the closest proximity to, and in line of sight with the construction site) and availability for occupancy.

Five cabins were selected for the second noise monitoring survey: Cabin 5010, Cabin 6008, Cabin 7033, Cabin 9410 and Cabin 0106, depending on availability of occupancy during the survey period. Each of the selected cabins is located on a different deck, represented by the first number of the cabin number (e.g., Cabin 5010 on Deck 5). Cabin 5010 was also selected in the first noise monitoring survey.

Construction activities of vibratory and impact piling at the MOF area during daytime were considered as the significant noise sources onsite and were the focus of the second noise monitoring survey. Cabin 5010, Cabin 6008 and Cabin 7033 were selected because they are located at the stern of the floatel which is closest to and in line of sight with the construction piling locations. The floatel is berthed starboard to shore, Cabin 9410 and Cabin 0106 are located at the starboard side of the floatel and facing the southwestern construction site, they were selected to evaluate noise effects from construction activities on the southwest. The rationale for the cabin selections is also presented in Table 3.1.

A Cabin on Deck 2 was not selected due to the following:

- The grid power line was not connected to the floatel yet. Cabins on Deck 2 are next to the engine room in which engine operating conditions remains the same as the initial noise monitoring.
- Deck 2 is located under the ship water line and the cabins were only occupied by the crew members but no construction workers.

Table 3.1 summarizes the selected cabins, general descriptions, and field observations. Figure 2 through Figure 4 illustrate these cabin locations on each deck of the floatel.

Table 3.1 Selected Cabins, Descriptions, and Observations

Cabin	Deck	Description and Observations during Monitoring Period	Reference Figures
5010	5	• Total of 219 cabins, the second highest numbers of cabins per deck after Deck 6. • Cabins occupied by the construction workers. • There are Vent Stores (i.e., ventilation rooms) and Service Workshop located at the stern of Deck 5. • Cabin 5010 was selected as the cabin window is in line of sight with the construction piling site. • Cabin ceiling ventilation was continuously operating.	Figure 2 Figure 5
6008	6	• Total of 248 cabins, highest number of cabins per deck among all decks. • Cabins occupied by the construction workers. • Cabin 6008 was selected as it is located at the stern of the floatel and the cabin wall is facing the construction piling site. • Cabin ceiling ventilation was continuously operating.	Figure 3 Figure 6
7033	7	• Total of 58 cabins. • Ancillary service facilities on Deck 7 including Reception, Gym, Games Lounge, and other facility rooms. • Cabins occupied by the construction workers. • Cabin 7033 was selected as it is located at the stern of the floatel and the cabin wall is facing the construction piling site. • Cabin ceiling ventilation was continuously operating during the noise monitoring period.	Figure 3 Figure 7
9410	9	• Total of 88 cabins. • There is an outdoor area at the stern and a smoking area on the west side of Deck 9. • Cabins occupied by the construction workers. • Some cabins are located underneath several Fan Rooms (rooms with ventilation fans) on Deck 10, e.g., Cabins 9420 to 9436. • Higher noise from Fan Rooms ventilation openings was observed at the smoke area. • Cabin 9410 was selected as it is located at the starboard side of the floatel and facing the southwestern construction site. • Cabin ceiling ventilation was continuously operating during the noise monitoring period.	Figure 4 Figure 8
0106	10	• Total of 17 cabins with office areas. • Cabins were occupied by crew members and construction workers. • There are several Fan Rooms at Deck 10. • Cabin 0106 is located at the starboard side of the floatel and facing the southwestern construction site. • Cabin ceiling ventilation was continuously operating during the noise monitoring period.	Figure 4 Figure 9

3.2 MEASUREMENT INSTRUMENTATION

Noise monitoring was conducted with two Brüel & Kjær Model 2250 sound level meters fitted with Brüel & Kjær 4189 type microphones. The sound level meters meet the ANSI S1.4-2006 Type 1 and IEC 61672-1 Class 1 specifications. The sound level meters were field calibrated before and after each measurement period and have valid laboratory certificates. Laboratory certificates are considered valid within two-year period after last recalibration for the sound level meters and within one year period for the calibrator.

Table 3.2 summarizes details of the measurement instrumentation. Corresponding calibration certificates of sound level meters and calibrator are attached in Appendix C.

Table 3.2 Details of Measurement Instrumentation

Item	Description
Sound Level Meter	Brüel & Kjær Model 2250 s/n 2809183 Brüel & Kjær Model 2250 s/n 3003408
Microphone	Brüel & Kjær Model 4189 s/n 2799510 Brüel & Kjær Model 4189 s/n 2866566
Calibrator	Brüel & Kjær Model 4231 s/n 3009070
Bandwidth	1/3 Octave Band
Frequency Range	12.5 Hz – 20 kHz
Frequency Weightings	Z (Linear), A & C
Calibration Level	94 dB at 1 kHz

3.3 MEASUREMENT SETUP

Dayshift workers sleep during nighttime and nightshift workers sleep during daytime on the floatel. Therefore, continuous sound levels over 24 hours (i.e., over one daytime and one nighttime periods) were measured at the cabins.

Two sound level meters (Brüel & Kjær Model 2250), one per room, were deployed for continuous noise monitoring. The sound level meters were set to 1-minute logging intervals measuring L_{Amax} and L_{eq} sound levels in one-third octave band L_{eq} sound levels from 12.5 Hz to 20 kHz frequency range.

Sound level meters also recorded the continuous digital audio signal simultaneously for further data analysis and post-processing to remove (isolate) extraneous noise events from the dataset.

The microphones were set up at bed height (i.e., 1 metre above the room floor) at each cabin. Figure 5 though Figure 9 in Appendix A illustrate the sound level meter setup at each cabin.

The monitoring events are described as below:

- Two sound level meters were setup at Cabin 5010 and Cabin 6008 to collect continuous noise data over 24 hours from September 4 to September 5.

- The two sound level meters were switched to Cabin 7033 and Cabin 9410 to collect continuous noise data over 24 hours from September 5 to September 6.
- Due to a conflict in cabin schedule, Cabin 7033 was occupied by a worker during the night of September 5; therefore, noise monitoring was re-conducted for 24 hours from September 6 to September 7.
- Noise monitoring was conducted at Cabin 0106 for 24 hours from September 6 to September 7.

Table 3.3 summarizes the measurement duration at each cabin during the noise monitoring period.

Table 3.3 Noise Monitoring Duration at Cabins

Cabin	Measurement Start		Measurement End		Measurement Duration (hrs mm))
	Date (mm/dd/yy yy)	Time (hh:mm)	Date (mm/dd/yy yy)	Time (hh:mm)	
5010	09/04/2024	12:44	09/05/2024	12:45	24 hrs 1 min
6008	09/04/2024	12:58	09/05/2024	12:57	23 hrs 59 mins
7033	09/06/2024	09:40	09/07/2024	09:45	24 hrs 5 mins
9410	09/05/2024	13:05	09/06/2024	13:05	24 hrs
0106	09/06/2024	13:08	09/07/2024	13:12	24 hrs 4 mins

3.4 PROJECT CONSTRUCTION ACTIVITIES

There were Project dayshift and nightshift construction activities during the noise monitoring period from September 4 to September 7. The dayshift was from 07:00 to 17:00 and the nightshift was from 19:00 to 07:00. Figure 10 illustrates the construction areas onsite with Area ID #. Construction activities during the noise monitoring period included the following:

Daytime:

- Area 1200: RCMI drilling and blasting at 1200 B & C
- Area 1100: RCMI blasting and drilling for rock splitter
- Marine Areas 7 & 9: Pulled back 1000 kg riprap and benching for 100 kg
- Area 4100: Pacific rock demolition
- Area 1300: Material Offloading Facility (MOF) – vibratory piling and crane pad building
- Area 4200 (Marine Area 4): Concrete wall demolition started

Nighttime:

- Area 1100: Excavator mucked and loaded out blast rock, and grubbing in the area
- Area 1200 B: Excavator continued mucking out, sorting and loading out blast rock
- Area 1200 D: Excavator hammered oversized rock
- Area 1300: Excavator managed and stacked the blast rock hauled to the area
- Area 4100: Oversized blast rock was hauled to the area for hammering

3.5 DATA ISOLATION ANALYSIS

The FNMMP prescribes that measured noise data that are not representative of the existing acoustic environment, non-anthropogenic sound, or non-representative weather conditions can be isolated from the data set prior to the calculation of any average values. During the noise monitoring, the weather conditions were representative (i.e., no high wind and rain) and therefore, isolation was not applied for the weather conditions.

Noise events isolated from the data set included:

- Qualified Professional activities (e.g., equipment setup and disassembly, daily regular checkups).
- Door knocking or opening at the monitored cabin.

These noise events were identified using audio recordings and also based on the Qualified Professional's field notes, and then removed from the valid measurement data. Noise from local anthropogenic activities from neighbour occupants (e.g., toilet flushing, foot traffic and conversation in the corridor) and crew member activities (e.g., regular operations, cleaning and maintenance activities) was considered to be part of the existing acoustic environment and was not isolated.

After the data isolation, L_{eq}, L_d, L_n, and L_{Amax} values were determined for the different measurement periods. Once the data isolation analysis was completed, the resulting valid noise data set (i.e., with invalid data removed) was logarithmically averaged over the corresponding time periods using the following formula:

$$L_{Aeq}(isolated, ave) = 10lg_{10}\left[\frac{1}{N_V}\sum_{i=1}^{N_V} 10^{(0.1L_{A,eq})}\right] dBA$$

where N_V = number of valid 1-minute logging periods in the measurement data set.

4.0 MEASUREMENT RESULTS

This section summarizes the analysis results. The L_d, L_n, the occurrence of L_{Amax} higher than 45 dBA (i.e., Health Canada threshold) are analyzed and presented in tables herein. In total, there are more than 7,200 minutes logged measurement values at five cabins during the monitoring period.

4.1 MEASUREMENT RESULTS AT CABINS

Table 4.1 provides an overall summary of the noise monitoring results at each noise monitoring cabin.

Table 4.1 Summary of Measurement Results

Cabin	Deck	Average Daytime L_d, dBA	Average Nighttime L_n, dBA	Number of Highest Occurrence of L_{Amax} > 45 dBA	
				Daytime	Nighttime
5010	5	42.1	42.4	48	61
6008	6	34.2	34.3	21	6
7033	7	32.1	31.6	41	8
9410	9	39.1	39.3	40	6
0106	10	38.0	37.9	28	5

Details of daily measurement results at each cabin are described in the following sections. The daily results are compared to the Health Canada sleep disturbance thresholds and ANSI room sound level criteria of 39 to 44 dBA.

4.1.1 Cabin 5010

Table 4.2 summarizes the daily L_d and L_n sound levels, and quantities of occurrence with L_{Amax} > 45 dBA at Cabin 5010.

Table 4.2 Summary of Daily L_d and L_n at Cabin 5010

Date (mm/dd/yyyy)	Average Daytime L_d, dBA	Average Nighttime L_n, dBA	Daytime Quantity of L_{Amax}> 45 dBA	Nighttime Quantity of L_{Amax} > 45 dBA	Health Canada		ANSI S12.2
					L_{eq}, dBA	Qty. of L_{Amax} > 45 dBA	L_{eq}, dBA
09/04/2024[1]	42.0	42.4	48	61	30	15	39 to 44
09/05/2024	42.2	-[2]	26	-[2]	30	15	39 to 44

Notes:

[1] The measurements started at 12:44.

[2] "-" indicates no data was measured. The survey ended at 12:45.

Monitoring results for Cabin 5010 are summarized as follows:

- L_d and L_n are higher than the Health Canada noise threshold of 30 dBA.
- L_d and L_n are lower than recommended ANSI room sound level criteria upper limit of 44 dBA.
- Quantities of occurrence with L_{Amax} > 45 dBA are more than 15 times during both daytime and nighttime periods.

4.1.2 Cabin 6008

Table 4.3 summarizes the daily L_d and L_n sound levels, and quantities of occurrence with L_{Amax} > 45 dBA at Cabin 6008.

Table 4.3 Summary of Daily L_d and L_n at Cabin 6008

Date (mm/dd/yyyy)	Average Daytime L_d, dBA	Average Nighttime L_n, dBA	Daytime Quantity of L_{Amax}> 45 dBA	Nighttime Quantity of L_{Amax} > 45 dBA	Health Canada		ANSI S12.2
					L_{eq}, dBA	Qty. of L_{Amax} > 45 dBA	L_{eq}, dBA
09/04/2024[1]	34.2	34.3	21	6	30	15	39 to 44
09/05/2024	34.2	-[2]	7	-[2]	30	15	39 to 44

Notes:

[1] The measurements started at 12:58.

[2] "-" indicates no data was measured. The survey ended at 12:57.

Monitoring results for Cabin 6008 are summarized as follows:

- L_d and L_n sound levels are higher than the Health Canada noise threshold of 30 dBA.
- L_d and L_n sound levels are lower than the ANSI S12.2 room sound level criteria lower limit of 39 dBA.
- Quantities of occurrence with L_{Amax} > 45 dBA are more than 15 times during the daytime period of September 4 (total of 9 hours duration), and less than 15 times during the daytime of September 5 (total of approximately 6 hours duration).
- Quantities of occurrence with L_{Amax} > 45 dBA are less than 15 times during the nighttime period of September 4.

4.1.3 Cabin 7033

Table 4.4 summarizes the daily L_d and L_n sound levels, and quantities of occurrence with L_{Amax} > 45 dBA at Cabin 7033.

Table 4.4 Summary of Daily L_d and L_n at Cabin 7033

Date (mm/dd/yyyy)	Average Daytime L_d, dBA	Average Nighttime L_n, dBA	Daytime Quantity of L_{Amax}> 45 dBA	Nighttime Quantity of L_{Amax} > 45 dBA	Health Canada		ANSI S12.2
					L_{eq}, dBA	Qty. of L_{Amax} > 45 dBA	L_{eq}, dBA
09/06/2024[1]	32.0	31.6	41	8	30	15	39-44
09/07/2024	32.1	-[2]	1	-[2]	30	15	39-44

Notes:

[1] The measurements started at 09:40.

[2] "-" indicates no data was measured. The survey ended at 09:45.

Monitoring results for Cabin 7033 are summarized as follows:

- L_d and L_n sound levels are higher than the Health Canada noise threshold of 30 dBA.
- L_d and L_n sound levels are lower than the ANSI S12.2 room sound level criteria lower limit of 39 dBA.
- Quantities of occurrence with L_{Amax} > 45 dBA are more than 15 times during the daytime on September 6 (total of 12.4 hours duration), and less than 15 times during the daytime of September 7 (total of approximately 3 hours duration).
- Quantities of occurrence with L_{Amax} > 45 dBA are less than 15 times during the nighttime period of September 6.

4.1.4 Cabin 9410

Table 4.5 summarizes the daily L_d and L_n sound levels, and quantities of occurrence with L_{Amax} > 45 dBA at Cabin 9410.

Table 4.5 Summary of Daily L_d and L_n at Cabin 9410

Date (mm/dd/yyyy)	Average Daytime L_d, dBA	Average Nighttime L_n, dBA	Daytime Quantity of L_{Amax}> 45 dBA	Nighttime Quantity of L_{Amax} > 45 dBA	Health Canada		ANSI S12.2
					L_{eq}, dBA	Qty. of L_{Amax} > 45 dBA	L_{eq}, dBA
09/05/2024[1]	38.9	39.3	24	6	30	15	39 to 44
09/06/2024	39.2	-[2]	40	-[2]	30	15	39 to 44

Notes:

[1] The measurements started at 13:05.

[2] "-" indicates no data was measured. The survey ended at 13:05.

Monitoring results for Cabin 9410 are summarized as follows:

- L_d and L_n sound levels are higher than the Health Canada noise threshold of 30 dBA.
- L_d sound level on September 5 is lower than the ANSI S12.2 room sound level criteria lower limit of 39 dBA.
- L_d sound level on September 6 (i.e., 39.2 dBA) is approximately equal to the ANSI S12.2 room sound level criteria lower limit of 39 dBA, and lower than the upper limit of 44 dBA.
- L_n sound level on September 5 (i.e., 39.3 dBA) is approximately equal to the ANSI S12.2 room sound level criteria lower limit of 39 dBA, and lower than the upper limit of 44 dBA.
- Quantities of occurrence with L_{Amax} > 45 dBA are more than 15 times during the daytimes of September 5 and September 6.
- Quantities of occurrence with L_{Amax} > 45 dBA are less than 15 times during the nighttime period of September 5.

4.1.5 Cabin 0106

Table 4.6 summarizes the daily L_d and L_n sound levels, and quantities of occurrence with L_{Amax} > 45 dBA at Cabin 0106.

Table 4.6 Summary of Daily L_d and L_n at Cabin 0106

Date (mm/dd/yyyy)	Average Daytime L_d, dBA	Average Nighttime L_n, dBA	Daytime Quantity of L_{Amax}> 45 dBA	Nighttime Quantity of L_{Amax} > 45 dBA	Health Canada		ANSI S12.2
					L_{eq}, dBA	Qty. of L_{Amax} > 45 dBA	L_{eq}, dBA
09/06/2024[1]	37.7	37.9	28	5	30	15	39 to 44
09/07/2024	38.3	-[2]	16	-[2]	30	15	39 to 44

Note:

[1] The measurements started at 13:08.

[2] "-" indicates no data was measured. The survey ended at 13:12.

Monitoring results for Cabin 0106 are summarized as follows:

- L_d and L_n sound levels at Cabin 0106 are higher than the Health Canada noise threshold of 30 dBA.
- The L_d and L_n sound levels are lower than the ANSI S12.2 room sound level criteria lower limit of 39 dBA.
- Quantities of occurrence with L_{Amax} > 45 dBA are more than 15 times during the daytimes of September 6 and September 7.
- Quantities of occurrence with L_{Amax} > 45 dBA are less than 15 times during the nighttime period of September 6.

5.0 NOISE INTERVIEWS

During the noise monitoring period on the floatel, the Qualified Professional interviewed various cabin occupants. The purpose of the interview is to obtain an initial understanding of the noise effects of interest to the occupants; and perform an investigation if there are any potential noise issues identified on the floatel. The floatel management has not received noise complaints from the occupants to date.

Twenty occupants were randomly selected for the interviews, which represents about 5% of the total occupants at the time. There were approximately 385 total construction worker occupants during the monitoring period. Three questions were asked regarding noise issues:

1. General evaluation for your sleeping at the floatel.
2. Can you hear outside construction noise? and
3. Any noise concern/complaints.

Details of the interviews, including interviewee ID #, interview date, cabin location, and work shift; and answers for the questions are included in Appendix B.

Feedback for the questions from the interviewees is summarized as below:

- No interviewees have noise concerns or complaints regarding construction noise.
- No interviewees report sleep disturbance issues during the stay on the floatel, including sleeping during the daytime period.
- Interviewees do not perceive construction noise inside the cabins.
- Several interviewees living on Deck 6 reported perceptible noise events occasionally, due to weight dropping on the Deck 7 Gym floor.

6.0 DISCUSSION

Table 6.1 summarizes the measurement results when compared to the Health Canada noise threshold and ANSI S12.2 room sound level criteria.

Table 6.1 Summary of Results

Cabin	Deck	Meet Health Canda Indoor L_{eq} Threshold of 30 dBA		Meet Health Canada L_{Amax} > 45 dBA Occurrence Less Than 15 Times		Meet ANSI S12.2 Room Sound Level Criteria of 39 to 44 dBA	
		Daytime	Nighttime	Daytime	Nighttime	Daytime	Nighttime
5010	5	No	No	No	No	Yes	Yes
6008	6	No	No	Yes/No[1]	Yes	Yes	Yes
7033	7	No	No	Yes/No[2]	Yes	Yes	Yes
9410	9	No	No	No	Yes	Yes	Yes
0106	10	No	No	No	Yes	Yes	Yes

Notes:

[1] Meet threshold on September 5 but exceed threshold on September 4.

[2] Meet threshold on September 7 but exceed threshold on September 6.

Sound levels at all measured cabins are above the Health Canada sleep disturbance threshold of 30 dBA. Cabin 5010 has the highest daytime and nighttime sound levels. In terms of meeting the 45 dBA L_{Amax} or above occurrence less than 15 times, all daytime occurrence results exceed the threshold; and most nighttime occurrence results meet the threshold, except at Cabin 5010. Cabin 5010 has the highest daytime and nighttime occurrence results. This is due to mechanical equipment producing higher noise emission from the Vent Stores (ventilation rooms) and Service Workshop located on Deck 5.

Table 6.2 compares the results from first (July 2024) and second (September 2024) surveys.

Table 6.2 Comparisons of First and Second Survey Results

Cabin		Average Daytime Highest L_d, dBA		Average Nighttime Highest L_n, dBA		Highest Occurrence of L_{Amax} > 45 dBA			
						Daytime		Nighttime	
1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd
5010	5010	30.1	42.1	27.6	42.4	73	48	4	61
6010	6008	35.7	34.2	34.9	34.3	65	21	28	6
7025	7033	38.3	32.1	38.3	31.6	56	41	19	8
9420	9410	36.0	39.1	36.0	39.3	64	40	5	6
0107	0106	38.4	38.0	38.2	37.9	64	28	6	5

On Deck 5, the ceiling ventilation in Cabin 5010 was not in operation during the first survey. The operating ceiling ventilation during the second survey results in higher noise levels. This comparison indicates that the primary noise contributing factor is ceiling ventilation system inside the cabin.

All cabins do not have the option to open the window. The ceiling ventilation is essential to keep the cabins in comfortable conditions for the occupants, similar to any hotel room. Turning off ventilation will affect the air circulation and temperature for cabin occupants. Therefore, the measurement results are compared to the ANSI S12.2 room sound level criteria for the hotel/motel rooms. All cabins are within the ANSI S12.2 room sound level criteria range of 39 dBA to 44 dBA. In both surveys, all cabins are within the ANSI S12.2 room sound level criteria range of 39 dBA to 44 dBA. Results at most cabins are below or close to the lower limit of 39 dBA, the only exception is Cabin 5010 on Deck 5. Results at Cabin 5010 are below the upper limit of 44 dBA threshold.

Except at Cabin 5010, the quantities of occurrence with L_{Amax} > 45 dBA from the second noise monitoring are generally less than the initial noise monitoring results during both daytime and nighttime periods.

On all decks, noise from construction piling at MOF area and activities at the southwest on site does not affect the floatel interior acoustic environment during the noise monitoring period.

The interview results also indicate that there were no sleep disturbance issues and no noise concerns or complaints raised by the interviewed occupants regarding the construction noise during the noise monitoring period.

7.0 MITIGATION MEASURES

To prevent future noise concerns or complaints, potential noise mitigation measures and management controls that have been implemented or may be considered are summarized below:

- Grid power supply is scheduled to be connected to the floatel. The engines inside the Engine Stores would be shut down thereafter and used only in emergency situations. Cabin sound level on Deck 2 is expected to reduce.
- Prior to the grid power line connection, workers cabin allocation to Deck 2 were avoided.
- For activities in the Gym, the floatel management has posted additional signage, and the receptionist also does regular patrolling to remind users that dropping the weights (e.g., deadlifts) should be minimized or avoided.
- The floatel management has been seeking solutions to reduce noise and vibration from weight dropping (e.g., rubber mats on the gym floor to dampen the impact).
- Should the floatel management receive noise complaints, administration controls can be implemented to select or change specific cabins or decks for the workers who need quiet cabins.
- Maintain the Communication Protocol and Complaint Response Procedure to address and manage any future noise concerns or complaints by the floatel occupants.

8.0 CONCLUSIONS

The second noise monitoring survey was conducted on the floatel from September 4 to September 7, 2024, to fulfill the requirements of Condition 30 of EAC. Continuous sound levels over 24 hours were collected at five selected cabins. Measured noise data were analyzed and compared with the Health Canada sleep disturbance thresholds, as well as ANSI S12.2 room sound level criteria and assess the compliance. Interviews with occupants for noise concerns were performed. Mitigation and an adaptive management plan were recommended.

The measurement results of the second noise monitoring survey are above the Health Canada thresholds. However, measurement results meet the ANSI S12.2 room sound level criteria for hotel and motel rooms. There are no sleep disturbance issues and noise concerns or complaints received from the floatel occupants. Noise from the Project construction activities does not affect the floatel interior acoustic environment. In addition, the Communication Protocol and Complaint Response Procedure will be maintained to address and manage any noise concerns or complaints by the floatel occupants.

9.0 REFERENCES

ANSI (American National Standard) 2005. ANSI S12.9 – 2005/Part 4, Quantities and Procedures for Description and Measurement of Environmental Sound – Part 4: Noise Assessment and Prediction of Long-term Community Response. New York, 2005.

ANSI (American National Standard) 2023. ANSI S12.2 – 2019 (Reaffirmed in 2023), Criteria for Evaluating Room Noise. New York, 2023.

British Columbia Energy Regulator (BCER) 2024. British Columbia Noise Control Best Practices Guideline. June 2024.

District of Squamish 2014. Noise Regulation Bylaw No.2312. Available at: https://squamish.ca/our-services/bylaws-and-enforcement/noise-bylaw/.

District of Squamish 2017. Noise Regulation Bylaw No.2541. Available at: https://squamish.ca/business-and-development/home-land-and-property-development/builders-corner-blog/new-noise-regulation-bylaw-hours/.

Health Canada 2023. Guidance for Evaluating Human Health Impacts in Impact Assessment: NOISE, published by Health Canada. December 2023.

Stantec 2022. Construction Phase Noise Assessment Technical Report – Woodfibre LNG. September 2022.

Stantec 2024. Floatel Noise Monitoring and Mitigation Plan – Woodfibre LNG Project. April 2024.

Stantec 2024. Floatel Noise Monitoring Survey -1 (July 10 -14, 2024) – Woodfibre LNG Project. 123222160EN-RPT0052 Revision 1, September 16, 2024.

Woodfibre LNG 2015. Woodfibre LNG Project Application for an Environmental Assessment Certificate.

Woodfibre LNG 2023. Application for a Temporary Use Permit for the District of Squamish – Floatel. August 2023.

APPENDIX A FIGURES

Figure 1 Site Plan with Floatel Location

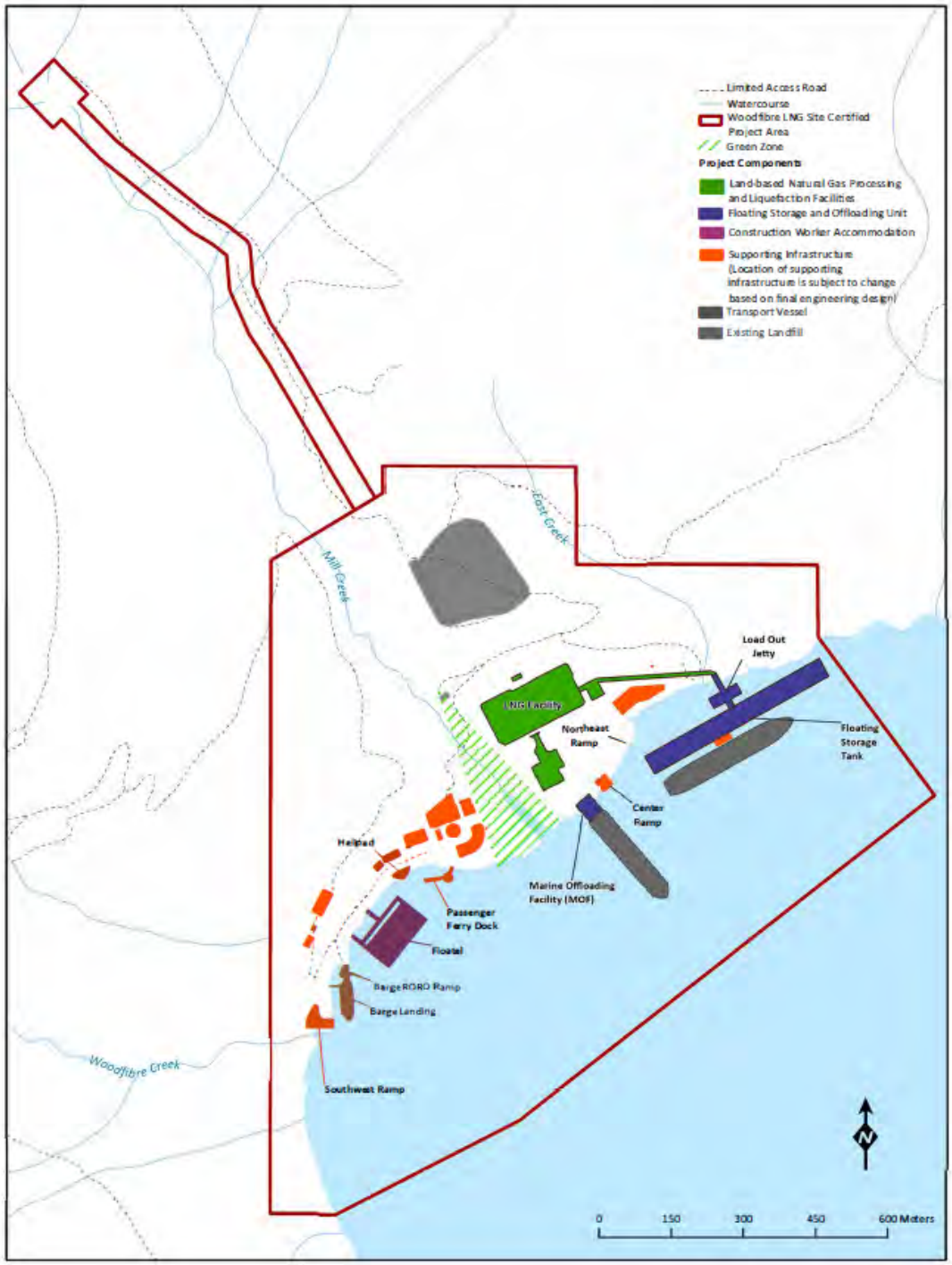


Figure 2 Measurement Location at Cabin 5010 (Deck 5)

Legend

Noise monitoring cabin

Quantity of cabins per deck (unless otherwise indicated, applies to all figures with cabins)

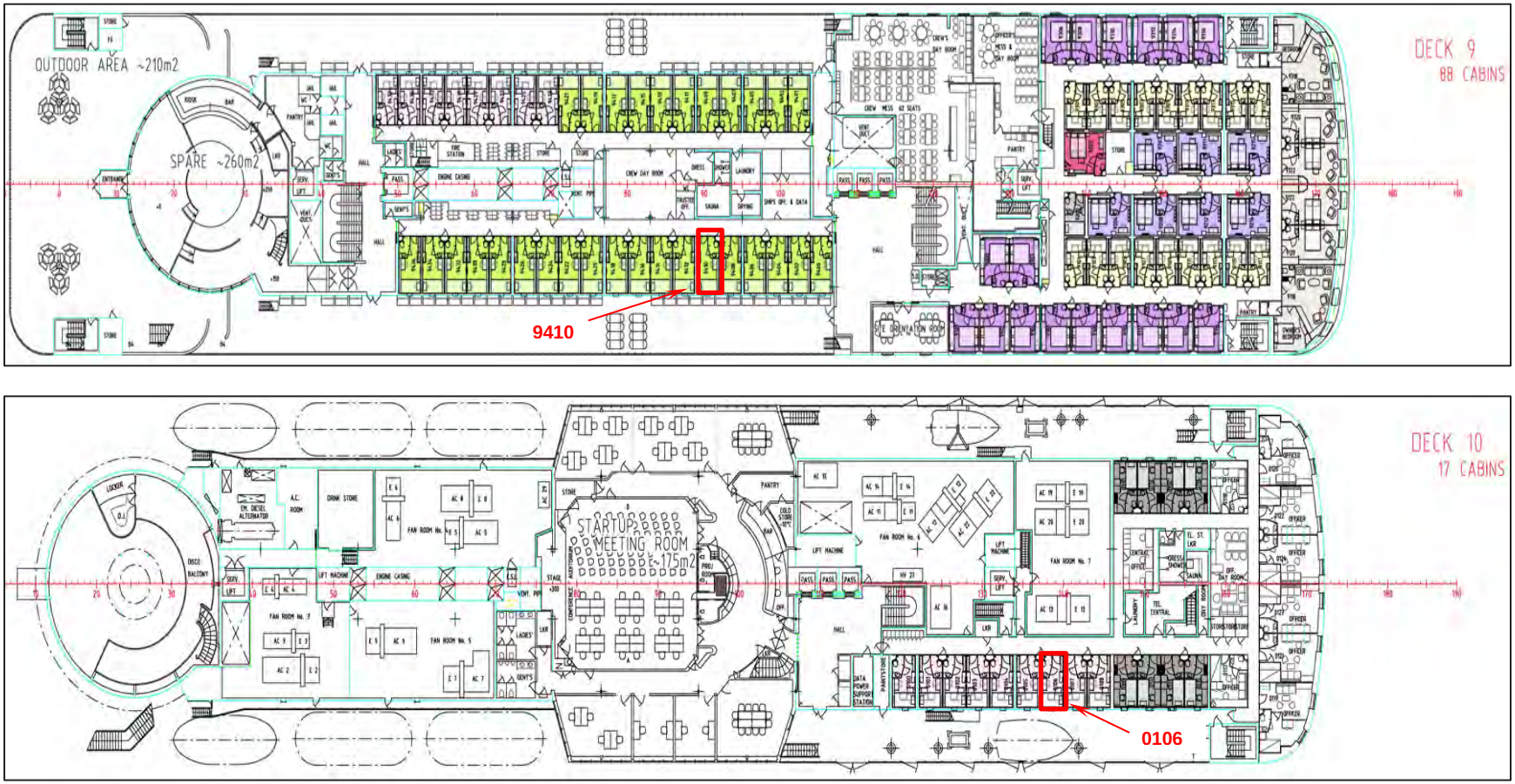
	TYPE 1A-1	TYPE 1A-2	TYPE 1A-3	TYPE 1B-1	TYPE 1B-2	TYPE 1B-3	TYPE 1B-4	TYPE 1B-5	TYPE 1B-6	TYPE 1B-7	TYPE 1B-8	TYPE 1C-1	TYPE 1C-2	TYPE 1D	TYPE 1E-1	TYPE 1E-2	TYPE 1F-1	TYPE 1F-2	TYPE 2A	TYPE 2B	TYPE 2C	TYPE 3A		TYPE 4A	TYPE 4B	
DECK 10				9																				8		17
DECK 9	18			8								30							7	1	17	4			1	88
DECK 7	24											30				2		2								58
DECK 6	208												8		2		2		24	1					3	248
DECK 5	102	6	44		15	5	9	10	7	1	1			4					14						1	219
DECK 2	34																								52	86
	386	6	44	17	15	5	9	10	7	1	1	60	8	4	2	2	2	2	45	2	17	4	2	8	57	716

Figure 3 Measurement Location at Cabin 6008 and Cabin 7033 (Deck 6 and Deck 7)

Legend

Noise monitoring cabin

Figure 4 Measurement Location at Cabin 9410 and Cabin 0106 (Deck 9 and Deck 10)



Legend

Noise monitoring cabin

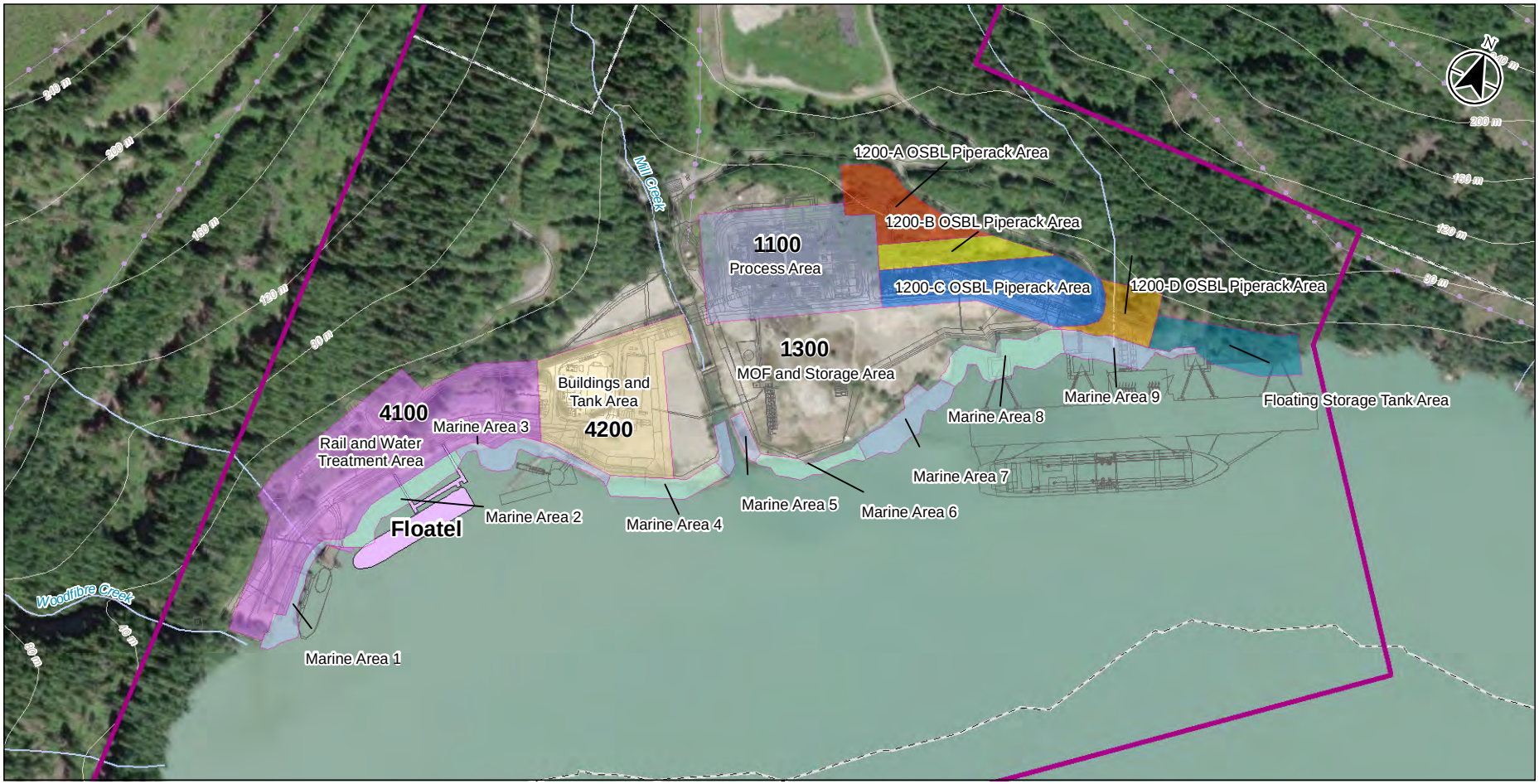
Figure 5 Sound Level Meter Setup at Cabin 5010

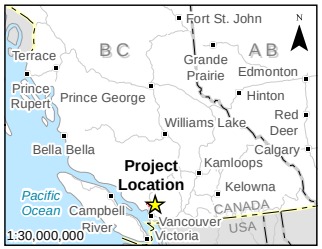
Figure 6 Sound Level Meter Setup at Cabin 6008

Figure 7 Sound Level Meter Setup at Cabin 7033

Figure 8 Sound Level Meter Setup at Cabin 9410

Figure 9 Sound Level Meter Setup at Cabin 0106





- Transmission Line
- Topographic Contour
- Watercourse
- Municipal Boundary
- Project Design Linework
- Floatel
- Certified Project Area

0 50 100 150 200 250 m

1:7,500 (at original document size of 8.5x11)

Notes
1. Coordinate System: NAD 1983 UTM Zone 10N
2. Data Sources: DataBC, Government of British Columbia; Natural Resources Canada
3. Orthoimagery: ESRI World Imagery

Stantec

Project Location:
Woodfibre, British Columbia

Project Number: 123222160
Prepared by PKASIANCHUK on 20241004
Requested by ACALDERON on 20240822
Checked by YMA on 20240828

Client/Project/Report

Woodfibre LNG
Floatel Noise Monitoring Survey

Figure No.
10

Title
Construction Areas Onsite

APPENDIX B NOISE INTERVIEW RECORDS

Interviewer: Yong Ma, P. Eng.				Interview Questionnaire		
Interviewee Information						
ID # of Interviewee	Interview Date	Living Deck	Work Shift	1.General evaluation for your sleeping at Floatel	2.Can you hear outside construction noise?	3. Any noise concerns/ complaints
#1	Sept. 4	7	Day	It's quiet during sleeping	No	OK, nothing to complaint
#2	Sept. 4	6	Day	It's OK	No	No noise issues
#3	Sept. 4	6	Day	Sleep is OK other than Gym noise	Nothing heard from outside construction	No complaints; around 9 pm noise from Gym
#4	Sept. 4	6	Day	Sleeping is good	No	Everything is fine
#5	Sept. 4	5	Day	Good sleeping	Nothing heard from construction	Good conditions
#6	Sept. 5	6	Night	No problem	No sound heard from construction	All good
#7	Sept. 5	6	Day	Good condition	No	Nothing for noise issues
#8	Sept. 5	5	Night	No issues	Not hearing from construction	No concerns for noise
#9	Sept. 5	5	Day	Generally Ok	No	No complaints for noise
#10	Sept. 5	7	Night	No noise issue for sleep	Nothing heard from construction	No noise concerns
#11	Sept. 5	6	Day	Nothing for sleeping	Not hearing from construction	No complaints; other than noise from Gym weight dropping
#12	Sept. 6	7	Day	It's good	No	No noise concerns
#13	Sept. 6	5	Day	Nothing for sleep disturbance	Nothing heard from construction	All good
#14	Sept. 6	7	Day	No noise issue for sleep	Not at all	No noise concerns
#15	Sept. 6	6	Day	Sometimes noise from Gym	No	Noise and vibration from Gym activities
#16	Sept. 6	6	Day	No sleeping problem	No	Gym noise is noticed
#17	Sept. 6	6	Day	No problem	Not hearing from construction	Gym noise
#18	Sept. 7	6	Night	Sometimes banging noise	No	Generally OK
#19	Sept. 7	5	Day	It's fine	No	No problem
#20	Sept. 7	9	Day	Best sleep ever	Nothing heard from construction	No problem

APPENDIX C INSTRUMENTATION CALIBRATION CERTIFICATION

HBK
HOTTINGER BRÜEL & KJÆR

ACCREDITED
Calibration Certificate Number 1568.01

The Hottinger Bruel & Kjaer Calibration Laboratory
3079 Premiere Parkway Suite 120
Duluth, GA 30097
Telephone: 770/209-6907
Fax: 770/447-4033
Web site address: http://www.hbkworld.com

CERTIFICATE OF CALIBRATION

Certificate No: CAS-630035-B6P3Z4-801

CALIBRATION OF:

Sound Level Meter:	Brüel & Kjær	2250	Serial No: 2809183
Microphone:	Brüel & Kjær	4189	Serial No: 2799510
Preamplifier:	Brüel & Kjær	ZC-0032	Serial No: 17456
Supplied Calibrator:	Brüel & Kjær	4231	Serial No: 3009070
Software version:	BZ7222 Version 4.7.7		

CLIENT:

Stantec Consulting Ltd.
155 Hawkville Close NW
Calgary, AB T3G 3C3

CALIBRATION CONDITIONS:

Preconditioning:	4 hours at 23 ± 3 °C
Environment conditions	See actual values in Environmental Condition sections

SPECIFICATIONS:

This document certifies that the instrument as listed under "Model/Serial Number" has been calibrated and unless otherwise indicated under "Final Data", meets acceptance criteria as prescribed by the referenced Procedure. The reported expanded uncertainty is based on the standard uncertainty multiplied by a coverage factor $k = 2$ providing a level of confidence of approximately 95%. Statements of compliance, where applicable, are based on calibration results falling within specified criteria with no reduction by the uncertainty of the measurement. The calibration of the listed instrumentation, was accomplished using a test system which conforms with the requirements of ISO/IEC 17025, ANSI/NCSL Z540-1, and ISO 10012-1. For "as received" and/or "final" data, see the attached page(s). Items marked with one asterisk (*) are not covered by the scope of the current A2LA accreditation This Certificate and attached data pages shall not be reproduced, except in full, without the written approval of the Hottinger Brüel & Kjær Calibration Laboratory-Duluth, GA. Results relate only to the items tested. This instrument has been calibrated using Measurement Standards with values traceable to the National Institute of Standards and Technology, National Measurement Institutes or derived from natural physical constants.

PROCEDURE:

Hottinger Brüel & Kjær Model 3630 Sound Level Meter Calibration System Software 7763 Version 8.6 - DB: 8.60 Test Collection 2250-4189.

RESULTS:

As Received Condition	As Received Data	Final Data
_X_ Received in good condition	_X_ Within acceptance criteria	_X_ Within acceptance criteria
___ Damaged - See attached report	___ Outside acceptance criteria	___ Limited test - See attached details
	___ Inoperative	
	___ Data not taken	

Date of Calibration: 17 Mar. 2023

Certificate issued: 20 Mar. 2023

Grant Kennedy

Calibration Technician

John Avitabile

Quality Representative

Summary

Preliminary inspection	**Passed**
Environmental conditions, Prior to calibration	**Passed**
Reference information	**Passed**
Indication at the calibration check frequency	**Passed**
Acoustical signal tests of a frequency weighting, C weighting	**Passed**
Self-generated noise, Microphone installed	**Passed**
Self-generated noise, Electrical	**Passed**
Electrical signal tests of frequency weightings, A weighting	**Passed**
Electrical signal tests of frequency weightings, C weighting	**Passed**
Electrical signal tests of frequency weightings, Z weighting	**Passed**
Frequency and time weightings at 1 kHz	**Passed**
Long-term stability, Reference	**Passed**
Level linearity on the reference level range, Upper	**Passed**
Level linearity on the reference level range, Lower	**Passed**
Toneburst response, Time-weighting Fast	**Passed**
Toneburst response, Time-weighting Slow	**Passed**
Toneburst response, LAE	**Passed**
C-weighted peak sound level, 8 kHz	**Passed**
C-weighted peak sound level, 500 Hz	**Passed**
Overload indication	**Passed**
Long-term stability, 1. relative	**Passed**
High-level stability	**Passed**
Long-term stability, 2. relative	**Passed**
Environmental conditions, Following calibration	**Passed**

The sound level meter submitted for testing successfully completed the periodic tests of IEC 61672-3:2013, for the environmental conditions under which the tests were performed.
However, no general statement or conclusion can be made about conformance of the sound level meter to the full specifications of IEC 61672-1:2013 because (a) evidence was not publicly available, from an independent testing organization responsible for pattern approvals, to demonstrate that the model of sound level meter fully conformed to the class 1 specifications in IEC 61672-1:2013 or correction data for acoustical test of frequency weighting were not provided in the Instruction Manual and (b) because the periodic tests of IEC 61672-3:2013 cover only a limited subset of the specifications in IEC 61672-1:2013.

Conformance to a performance specification is demonstrated when the following criteria are both satisfied: (a) a measured deviation from a design goal does not exceed the applicable acceptance limit and (b) the corresponding uncertainty of measurement does not exceed the corresponding maximum-permitted uncertainty of measurement given in IEC 61672-1:2013 for the same coverage probability of 95 %.

Instruments

Category:	Type:	Manufacturer:	Serial No.:	Next Calibration Date:	Traceable to:
Voltmeter	DMM34461A	Keysight / Agilent	MY57220483	18 Jan. 2024	488288
Generator	Pulse Generator	Brüel & Kjær	3161-105190	09 May. 2023	CAS-557942-X1W8W3-101
Calibrator	4226	Brüel & Kjær	2590978	19 Apr. 2023	CAS-570928-T3Z7L5-313
AmplifierDivider	WB-3630 Output Module	Brüel & Kjær	3183481	09 May. 2023	CAS-541708-J2Z8Q8-101
Adaptor	WA0302B, 15 pF	Brüel & Kjær	2461380	14 Feb. 2025	489137

Preliminary inspection

Visually inspect instrument, and operate all relevant controls. (clause 5)

	Result
Visual inspection	OK

Environmental conditions, Prior to calibration

Actual environmental conditions prior to calibration. (clause 7)

	Expected	Accept - Limit	Accept + Limit	Measured [Deg / kPa / %RH]
Air temperature	23.00	-3.00	3.00	23.00
Air pressure	101.30	-21.30	3.70	97.47
Relative humidity	50.00	-25.00	20.00	35.00

Reference information

Information about reference range, level and channel. (clause 22.h + 22.m)

	Value [dB SPL]
Reference sound pressure level	94
Reference level range	140
Channel number	1

Indication at the calibration check frequency

Measure and adjust sound level meter using the supplied calibrator. (clause 10 + 22.m)

	Expected [dB SPL / Hz]	Measured [dB SPL / Hz]	Uncertainty [dB]
Calibration check frequency (supplied calibrator)	1000.00	1000.00	1.00
Initial indication (supplied calibrator)	93.85	94.07	0.22
Adjusted indication (supplied calibrator)	93.85	93.86	0.22

Acoustical signal tests of a frequency weighting, C weighting

Frequency weightings measured acoustically with a calibrated multi-frequency sound calibrator. Averaging time is 10 seconds, and the result is the average of 2 measurements. (clause 12)

	Coupler Pressure Lc [dB SPL]	Mic. Correction C4226 [dB]	Body Influence [dB]	Expected [dB SPL]	Measured [dB SPL]	Accept - Limit [dB]	Accept + Limit [dB]	Deviation [dB]	Uncertainty [dB]
1000Hz, Ref. (1st)	94.01	0.10	-0.07	93.98	93.72	-0.7	0.7	-0.26	0.25
1000Hz, Ref. (2nd)	94.01	0.10	-0.07	93.98	93.72	-0.7	0.7	-0.26	0.25
1000Hz, Ref. (Average)	94.01	0.10	-0.07	93.98	93.72	-0.7	0.7	-0.26	0.25
125.89Hz (1st)	94.04	0.00	0.00	93.65	93.67	-1.0	1.0	0.02	0.25
125.89Hz (2nd)	94.04	0.00	0.00	93.65	93.67	-1.0	1.0	0.02	0.25
125.89Hz (Average)	94.04	0.00	0.00	93.65	93.67	-1.0	1.0	0.02	0.25
7943.3Hz (1st)	93.71	2.80	-0.08	87.80	88.68	-2.5	1.5	0.88	0.52
7943.3Hz (2nd)	93.71	2.80	-0.08	87.80	88.68	-2.5	1.5	0.88	0.52
7943.3Hz (Average)	93.71	2.80	-0.08	87.80	88.68	-2.5	1.5	0.88	0.52

Self-generated noise, Microphone installed

Self-generated noise measured with microphone submitted for periodic testing. Averaging time is 30 seconds. An anechoic chamber is used to isolate environmental noise.
The level of self-generated noise is reported for information only and is not used to assess conformance to a requirement. (clause 11.1)

	Max [dB SPL]	Measured [dB SPL]	Uncertainty [dB]
A weighted	17.70	16.76	0.50

Self-generated noise, Electrical

Self-generated noise measured in most sensitive range, with electrical substitution for microphone, according to manufactures specifications.
The level of self-generated noise is reported for information only and is not used to assess conformance to a requirement. (clause 11.2)

	Max [dB SPL]	Measured [dB SPL]	Uncertainty [dB]
A weighted	13.60	12.82	0.30
C weighted	14.30	13.52	0.30
Z weighted	19.40	18.99	0.30

Electrical signal tests of frequency weightings, A weighting

Frequency response measured with electrical signal relative to level at 1 kHz in reference range. (clause 13)
Electrical and acoustical response and body influence corrections are adjusted with the respective correction values at the reference frequency, in accordance with clause 13.6

	Input Level [dBV]	Expected [dB SPL]	Measured [dB SPL]	Response Corr. [dB]	Body Influence [dB]	Corr. Measured [dB SPL]	Accept - Limit [dB]	Accept + Limit [dB]	Deviation [dB]	Uncertainty [dB]
1000Hz, Ref.	-24.91	95.00	95.00	0.00	0.00	95.00	-0.5	0.5	0.00	0.12
63.096Hz	1.29	95.00	95.05	0.00	0.07	95.12	-1.0	1.0	0.12	0.12
125.89Hz	-8.81	95.00	95.02	0.00	0.07	95.09	-1.0	1.0	0.09	0.12
251.19Hz	-16.31	95.00	94.98	0.00	0.14	95.12	-1.0	1.0	0.12	0.12
501.19Hz	-21.71	95.00	94.97	0.00	0.29	95.26	-1.0	1.0	0.26	0.12
1995.3Hz	-26.11	95.00	95.01	-0.01	-0.02	94.98	-1.0	1.0	-0.02	0.12
3981.1Hz	-25.91	95.00	95.00	-0.02	-0.02	94.96	-1.0	1.0	-0.04	0.12
7943.3Hz	-23.81	95.00	95.00	0.00	-0.01	94.99	-2.5	1.5	-0.01	0.12
15849Hz	-18.31	95.00	94.11	0.87	0.18	95.16	-16.0	2.5	0.16	0.12

Electrical signal tests of frequency weightings, C weighting

Frequency response measured with electrical signal relative to level at 1 kHz in reference range. (clause 13)
Electrical and acoustical response and body influence corrections are adjusted with the respective correction values at the reference frequency, in accordance with clause 13.6

	Input Level [dBV]	Expected [dB SPL]	Measured [dB SPL]	Response Corr. [dB]	Body Influence [dB]	Corr. Measured [dB SPL]	Accept - Limit [dB]	Accept + Limit [dB]	Deviation [dB]	Uncertainty [dB]
1000Hz, Ref.	-24.91	95.00	95.00	0.00	0.00	95.00	-0.5	0.5	0.00	0.12
63.096Hz	-24.11	95.00	95.02	0.00	0.07	95.09	-1.0	1.0	0.09	0.12
125.89Hz	-24.71	95.00	95.05	0.00	0.07	95.12	-1.0	1.0	0.12	0.12
251.19Hz	-24.91	95.00	95.01	0.00	0.14	95.15	-1.0	1.0	0.15	0.12
501.19Hz	-24.91	95.00	95.04	0.00	0.29	95.33	-1.0	1.0	0.33	0.12
1995.3Hz	-24.71	95.00	95.04	-0.01	-0.02	95.01	-1.0	1.0	0.01	0.12
3981.1Hz	-24.11	95.00	95.01	-0.02	-0.02	94.97	-1.0	1.0	-0.03	0.12
7943.3Hz	-21.91	95.00	95.00	0.00	-0.01	94.99	-2.5	1.5	-0.01	0.12
15849Hz	-16.41	95.00	94.08	0.87	0.18	95.13	-16.0	2.5	0.13	0.12

Electrical signal tests of frequency weightings, Z weighting

Frequency response measured with electrical signal relative to level at 1 kHz in reference range. (clause 13)
Electrical and acoustical response and body influence corrections are adjusted with the respective correction values at the reference frequency, in accordance with clause 13.6

	Input Level	Expected	Measured	Response Corr.	Body Influence	Corr. Measured	Accept - Limit	Accept + Limit	Deviation	Uncertainty
	[dBV]	[dB SPL]	[dB SPL]	[dB]	[dB]	[dB SPL]	[dB]	[dB]	[dB]	[dB]
1000Hz, Ref.	-24.91	95.00	95.00	0.00	0.00	95.00	-0.5	0.5	0.00	0.12
63.096Hz	-24.91	95.00	95.04	0.00	0.07	95.11	-1.0	1.0	0.11	0.12
125.89Hz	-24.91	95.00	95.02	0.00	0.07	95.09	-1.0	1.0	0.09	0.12
251.19Hz	-24.91	95.00	95.01	0.00	0.14	95.15	-1.0	1.0	0.15	0.12
501.19Hz	-24.91	95.00	95.00	0.00	0.29	95.29	-1.0	1.0	0.29	0.12
1995.3Hz	-24.91	95.00	95.01	-0.01	-0.02	94.98	-1.0	1.0	-0.02	0.12
3981.1Hz	-24.91	95.00	95.03	-0.02	-0.02	94.99	-1.0	1.0	-0.01	0.12
7943.3Hz	-24.91	95.00	95.01	0.00	-0.01	95.00	-2.5	1.5	0.00	0.12
15849Hz	-24.91	95.00	94.14	0.87	0.18	95.19	-16.0	2.5	0.19	0.12

Frequency and time weightings at 1 kHz

Frequency and time weighting measured at 1 kHz with electrical signal in reference range. Measured relative to A-weighted and Fast response. (clause 14)

	Expected	Measured	Accept - Limit	Accept + Limit	Deviation	Uncertainty
	[dB SPL]	[dB SPL]	[dB]	[dB]	[dB]	[dB]
LAF, Ref.	94.00	94.00	-0.5	0.5	0.00	0.12
LCF	94.00	94.00	-0.2	0.2	0.00	0.12
LZF	94.00	94.00	-0.2	0.2	0.00	0.12
LAS	94.00	93.96	-0.1	0.1	-0.04	0.12
LAeq	94.00	94.00	-0.1	0.1	0.00	0.12

Long-term stability, Reference

Long-term stability over 25 to 35 minutes, with steady 1kHz signal at reference level. (clause 15)
Adjusting to reference level indication.

	Measured	Accept - Limit	Accept + Limit	Deviation	Timestamp	Uncertainty
	[dB SPL]	[dB]	[dB]	[dB]		[dB]
Reference	94.00	-0.5	0.5	0.00	2023-03-17 10:11:57	0.10

Level linearity on the reference level range, Upper

Level linearity in reference range, measured at 8 kHz until overload. (clause 16)

	Expected	Measured	Accept - Limit	Accept + Limit	Deviation	Uncertainty
	[dB SPL]	[dB SPL]	[dB]	[dB]	[dB]	[dB]
94 dB	94.00	94.00	-0.2	0.2	0.00	0.13
99 dB	99.00	99.01	-0.8	0.8	0.01	0.13
104 dB	104.00	104.00	-0.8	0.8	0.00	0.13
109 dB	109.00	109.00	-0.8	0.8	0.00	0.13
114 dB	114.00	114.01	-0.8	0.8	0.01	0.13
119 dB	119.00	119.01	-0.8	0.8	0.01	0.13
124 dB	124.00	124.01	-0.8	0.8	0.01	0.13
129 dB	129.00	129.00	-0.8	0.8	0.00	0.13
134 dB	134.00	134.00	-0.8	0.8	0.00	0.13
135 dB	135.00	135.00	-0.8	0.8	0.00	0.13
136 dB	136.00	136.00	-0.8	0.8	0.00	0.13
137 dB	137.00	137.00	-0.8	0.8	0.00	0.13
138 dB	138.00	137.99	-0.8	0.8	-0.01	0.13
139 dB	139.00	138.99	-0.8	0.8	-0.01	0.13
140 dB	140.00	139.99	-0.8	0.8	-0.01	0.13

Level linearity on the reference level range, Lower

Level linearity in reference range, measured at 8 kHz down to lower limit, or until underrange. (clause 16)

	Expected	Measured	Accept - Limit	Accept + Limit	Deviation	Uncertainty
	[dB SPL]	[dB SPL]	[dB]	[dB]	[dB]	[dB]
94 dB	94.00	94.00	-0.2	0.2	0.00	0.13
89 dB	89.00	89.00	-0.8	0.8	0.00	0.13
84 dB	84.00	84.01	-0.8	0.8	0.01	0.13
79 dB	79.00	79.00	-0.8	0.8	0.00	0.13
74 dB	74.00	74.00	-0.8	0.8	0.00	0.13
69 dB	69.00	69.01	-0.8	0.8	0.01	0.13
64 dB	64.00	64.00	-0.8	0.8	0.00	0.13
59 dB	59.00	59.00	-0.8	0.8	0.00	0.13
54 dB	54.00	54.00	-0.8	0.8	0.00	0.13
49 dB	49.00	49.01	-0.8	0.8	0.01	0.13
44 dB	44.00	44.02	-0.8	0.8	0.02	0.13
39 dB	39.00	39.03	-0.8	0.8	0.03	0.24
34 dB	34.00	34.07	-0.8	0.8	0.07	0.24
30 dB	30.00	30.13	-0.8	0.8	0.13	0.24
29 dB	29.00	29.15	-0.8	0.8	0.15	0.24
28 dB	28.00	28.18	-0.8	0.8	0.18	0.24
27 dB	27.00	27.23	-0.8	0.8	0.23	0.24
26 dB	26.00	26.26	-0.8	0.8	0.26	0.24
25 dB	25.00	25.37	-0.8	0.8	0.37	0.24
24 dB	24.00	24.40	-0.8	0.8	0.40	0.24

Toneburst response, Time-weighting Fast

Response to 4 kHz toneburst measured in reference range, relative to continuous signal. (clause 18)

	Expected	Measured	Accept - Limit	Accept + Limit	Deviation	Uncertainty
	[dB SPL]	[dB SPL]	[dB]	[dB]	[dB]	[dB]
Continuous, Ref.	137.00	137.00	-0.5	0.5	0.00	0.12
200 ms Burst	136.00	136.00	-0.5	0.5	0.00	0.12
2 ms Burst	119.00	118.94	-1.5	1.0	-0.06	0.12
0.25 ms Burst	110.00	109.85	-3.0	1.0	-0.15	0.12

Toneburst response, Time-weighting Slow

Response to 4 kHz toneburst measured in reference range, relative to continuous signal. (clause 18)

	Expected	Measured	Accept - Limit	Accept + Limit	Deviation	Uncertainty
	[dB SPL]	[dB SPL]	[dB]	[dB]	[dB]	[dB]
Continuous, Ref.	137.00	137.00	-0.5	0.5	0.00	0.12
200 ms Burst	129.60	129.60	-0.5	0.5	0.00	0.12
2 ms Burst	110.00	109.98	-3.0	1.0	-0.02	0.12

Toneburst response, LAE

Response to 4 kHz toneburst measured in reference range, relative to continuous signal. (clause 18)

	Expected	Measured	Accept - Limit	Accept + Limit	Deviation	Uncertainty
	[dB SPL]	[dB SPL]	[dB]	[dB]	[dB]	[dB]
Continuous, Ref.	137.00	137.00	-0.5	0.5	0.00	0.12
200 ms Burst	130.00	129.99	-0.5	0.5	-0.01	0.12
2 ms Burst	110.00	109.95	-1.5	1.0	-0.05	0.12
0.25 ms Burst	101.00	100.84	-3.0	1.0	-0.16	0.12

C-weighted peak sound level, 8 kHz

Peak-response to a 8 kHz single-cycle sine measured in least-sensitive range, relative to continuous signal. (clause 19)

	Expected	Measured	Accept - Limit	Accept + Limit	Deviation	Uncertainty
	[dB SPL]	[dB SPL]	[dB]	[dB]	[dB]	[dB]
Continuous, Ref.	132.00	132.00	-0.5	0.5	0.00	0.09
Single Sine	135.40	135.47	-2.0	2.0	0.07	0.20

C-weighted peak sound level, 500 Hz

Peak-response to a 500 Hz half-cycle sine measured in least-sensitive range, relative to continuous signal. (clause 19)

	Expected	Measured	Accept - Limit	Accept + Limit	Deviation	Uncertainty
	[dB SPL]	[dB SPL]	[dB]	[dB]	[dB]	[dB]
Continuous, Ref.	135.00	135.00	-0.5	0.5	0.00	0.09
Half-sine, Positive	137.40	137.11	-1.0	1.0	-0.29	0.12
Half-sine, Negative	137.40	137.11	-1.0	1.0	-0.29	0.12

Overload indication

Overload indication in the least sensitive range determined with a 4 kHz positive/negative half-cycle signal. (clause 20)

	Measured / Input Level	Accept - Limit	Accept + Limit	Deviation	Uncertainty
	[dB SPL]	[dB]	[dB]	[dB]	[dB]
Continuous	140.00	-0.5	0.5	0.00	0.20
Half-sine, Positive	141.70	-10.0	10.0	1.70	0.20
Half-sine, Negative	142.00	-10.0	10.0	2.00	0.20
Difference	142.00	-1.5	1.5	0.30	0.24

Long-term stability, 1. relative

Long-term stability over 25 to 35 minutes, with steady 1kHz signal at reference level. (clause 15)
Relative to prior adjustment to reference level indication.

	Measured	Accept - Limit	Accept + Limit	Deviation	Timestamp	Uncertainty
	[dB SPL / Min]	[dB / Min]	[dB / Min]	[dB / Min]		[dB]
Measurement	94.00	-0.1	0.1	0.00	2023-03-17 10:28:00	0.10
Time passed	16.03	0.0	35.0	16.03		0.00

High-level stability

High-level stability over 5 minutes, with steady 1kHz signal, 1dB below upper boundary. (clause 21)

	Measured	Accept - Limit	Accept + Limit	Deviation	Uncertainty
	[dB SPL]	[dB]	[dB]	[dB]	[dB]
High-level, Ref.	139.00	-0.5	0.5	0.00	0.10
High-level, after 5min	139.00	-0.1	0.1	0.00	0.10

Long-term stability, 2. relative

Long-term stability over 25 to 35 minutes, with steady 1kHz signal at reference level. (clause 15)
Relative to prior adjustment to reference level indication.

	Measured	Accept - Limit	Accept + Limit	Deviation	Timestamp	Uncertainty
	[dB SPL/ Min]	[dB / Min]	[dB / Min]	[dB / Min]		[dB]
Wait	25.00	25.0	120.0	25.00		0.00
Measurement	94.00	-0.1	0.1	0.00	2023-03-17 10:37:22	0.10

Environmental conditions, Following calibration

Actual environmental conditions following calibration. (clause 7)

	Expected	Accept - Limit	Accept + Limit	Measured
				[Deg / kPa / %RH]
Air temperature	23.00	-3.00	3.00	23.00
Air pressure	101.30	-21.30	3.70	97.47
Relative humidity	50.00	-25.00	20.00	35.00

HBK
HOTTINGER BRÜEL & KJÆR

Calibration Certificate Number 1568.01

The Hottinger Bruel & Kjaer Calibration Laboratory
3079 Premiere Parkway Suite 120
Duluth, GA 30097
Telephone: 770/209-6907
Fax: 770/447-4033
Web site address: http://www.hbkworld.com

CERTIFICATE OF CALIBRATION

Certificate No: CAS-630035-B6P3Z4-102

CALIBRATION OF:

Sound Level Meter:	Brüel & Kjær	2250	Serial No: 3003408
Microphone:	Brüel & Kjær	4189	Serial No: 2866566
Preamplifier:	Brüel & Kjær	ZC-0032	Serial No: 19030
Supplied Calibrator:	Brüel & Kjær	4231	Serial No: 3009070
Software version:	BZ7222 Version 4.7.7		

CLIENT:

Stantec
155 Hawkville Close NW
Calgary, AB T3G 3C3

CALIBRATION CONDITIONS:

Preconditioning:	4 hours at 23 ± 3 °C
Environment conditions	See actual values in Environmental Condition sections

SPECIFICATIONS:

This document certifies that the instrument as listed under "Model/Serial Number" has been calibrated and unless otherwise indicated under "Final Data", meets acceptance criteria as prescribed by the referenced Procedure. The reported expanded uncertainty is based on the standard uncertainty multiplied by a coverage factor $k = 2$ providing a level of confidence of approximately 95%. Statements of compliance, where applicable, are based on calibration results falling within specified criteria with no reduction by the uncertainty of the measurement. The calibration of the listed instrumentation, was accomplished using a test system which conforms with the requirements of ISO/IEC 17025, ANSI/NCSL Z540-1, and ISO 10012-1. For "as received" and/or "final" data, see the attached page(s). Items marked with one asterisk (*) are not covered by the scope of the current A2LA accreditation This Certificate and attached data pages shall not be reproduced, except in full, without the written approval of the Hottinger Brüel & Kjær Calibration Laboratory-Duluth, GA. Results relate only to the items tested. This instrument has been calibrated using Measurement Standards with values traceable to the National Institute of Standards and Technology, National Measurement Institutes or derived from natural physical constants.

PROCEDURE:

Hottinger Brüel & Kjær Model 3630 Sound Level Meter Calibration System Software 7763 Version 8.6 - DB: 8.60 Test Collection 2250-4189.

RESULTS:

As Received Condition	As Received Data	Final Data
_X_ Received in good condition	_X_ Within acceptance criteria	_X_ Within acceptance criteria
___ Damaged - See attached report	___ Outside acceptance criteria	___ Limited test - See attached details
	___ Inoperative	
	___ Data not taken	

Date of Calibration: 17 Mar. 2023

Certificate issued: 20 Mar. 2023

John Avitabile
Calibration Technician

Aundra Welch
Quality Representative

HBK HOTTINGER BRÜEL & KJÆR
The Hottinger Brüel & Kjær Inc. Calibration Laboratory
3079 Premiere Parkway Suite 120
Duluth, GA 30097
Telephone: 770-209-6907
Fax: 770-447-4033
Web site address: http://www.hbkworld.com

ACCREDITED

Calibration Certificate # 1568.01

CERTIFICATE OF CALIBRATION

No.: CAS-675839-J5S4Z9-701

CALIBRATION OF:

Calibrator:	Brüel & Kjær	Type	4231	Serial No.:	3009070
Identification:	Stantec Noise	IEC Class:	1		

CUSTOMER:

Stantec
155 Hawkvill Close NW
Calgary, AB, T3G 3C3
Canada

CALIBRATION CONDITIONS:

Environment conditions:	Air temperature:	23.3	°C
	Air pressure:	97.48	kPa
	Relative Humidity:	40.7	%RH

SPECIFICATIONS: This document certifies that the acoustic calibrator as listed under "Type" has been calibrated and unless otherwise indicated under "Final Data", meets acceptance criteria as prescribed by the referenced Procedure. Hottinger Bruel & Kjaer Inc. utilizes a simple acceptance decision rule as defined by ILAC G8 with measurement uncertainty value which will not exceed 50% of the tolerance. The calibration of the listed transducer was accomplished using a test system which conforms to the requirements of ISO/IEC 17025, ANSI/NCSL Z540-1, and guidelines of ISO 10012-1. For "as received" and "final" data, see the attached page(s). Items marked with one asterisk (*) are not covered by the scope of the current A2LA accreditation. This Certificate and attached data pages shall not be reproduced, except in full, without written approval of the Hottinger Brüel & Kjær Inc. Calibration Laboratory-Duluth, GA. Results relate only to the items tested. The transducer has been calibrated using Measurement Standards with values traceable to the National Institute of Standards and Technology, National Measurement Institutes or derived from natural physical constants. The acoustic calibrator has been calibrated in accordance with the requirements as specified in IEC60942.

PROCEDURE:

The measurements have been performed with the assistance of Hottinger Brüel & Kjær Inc. acoustic calibrator calibration application
Software version 2.3.4 Type 7794 using calibration procedure 4231 Complete

RESULTS:

- [X] "As Received" Data: Within Acceptance Criteria
- [ ] "As Received" Data: Outside Acceptance Criteria
- [X] "Final" Data : Within Acceptance Criteria
- [ ] "Final" Data : Outside Acceptance Criteria

The reported expanded uncertainty 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 EA-4/02from elements originating from the standards, calibration method, effect of environmental conditions and any short time contribution from the calibrator under calibration.

Date of Calibration: February 13, 2024

Certificate issued: February 13, 2024

Can Phan
Calibration Technician

Meshaun Hobbs
Quality Representative

Sound Pressure Levels

All stated values are valid at environmental reference conditions

Nominal Level [dB]	Accept Limit Lower [dB]	Accept Limit Upper [dB]	Measured Level [dB]	Measurement Uncertainty [dB]
94	93.80	94.20	94.01	0.12
114	113.80	114.20	114.00	0.12

Frequency

Nominal Frequency [Hz]	Accept Limit Lower [Hz]	Accept Limit Upper [Hz]	Measured Frequency [Hz]	Measurement Uncertainty [Hz]
1000	999.00	1001.00	999.98	0.10

Total Distortion*

Distortion mode: [X] **TD*** [ ] **THD***

Calibration Level [dB]*	Accept Limit [%]*	Measured Distortion [%]*	Measurement Uncertainty [%]*
94	1.00	0.75	0.13
114	1.00	0.20	0.13

Environmental Reference Conditions:

Pressure: 101.3 kPa, Temperature: 23 °C, Relative Humidity: 50%

Instrument List

Type	Description	Serial no	Cal. date	Due date	Calibrated by	Trace number
3560	PULSE Analyzer	2723320	2023-10-19	2024-10-18	GK	CAS-664166-V3L2K7-801
9545	Transfer Microphone	3	2023-10-31	2024-10-30	MH	CAS-664166-V3L2K7-403
4228	Reference Sound Source	1618502	2023-04-19	2025-04-30	WS	CAS-632564-L2S0L9-708

During the calibration the calibrator has been loaded by the load volume of the Transfer Microphone. The load volumes for a number of different types of Transfer Microphones are listed in the table below.
For Brüel & Kjær Pistonphones types 4220 and 4228 the result of the SPL calibration has been corrected to be valid for a load volume of 1333 mm^3 . For all other types the result is valid with the actual load volume.

Transfer Microphone Type	Fulfils standard IEC 61094-1 LS	Fulfils standard IEC 61094-4 WS	Load Volume 1" (1/2" mic including DP-0776)	Load Volume 1/2"
4180	yes	yes	1126 mm^3	43 mm^3
4192	-	yes	1273 mm^3	190 mm^3
9545	-	-	1333 mm^3	-

Condition "As Received": Good

Summary

Preliminary inspection	**Passed**
Environmental conditions, Prior to calibration	**Passed**
Reference information	**Passed**
Indication at the calibration check frequency	**Passed**
Acoustical signal tests of a frequency weighting, C weighting	**Passed**
Self-generated noise, Microphone installed	**Passed**
Self-generated noise, Electrical	**Passed**
Electrical signal tests of frequency weightings, A weighting	**Passed**
Electrical signal tests of frequency weightings, C weighting	**Passed**
Electrical signal tests of frequency weightings, Z weighting	**Passed**
Frequency and time weightings at 1 kHz	**Passed**
Long-term stability, Reference	**Passed**
Level linearity on the reference level range, Upper	**Passed**
Level linearity on the reference level range, Lower	**Passed**
Toneburst response, Time-weighting Fast	**Passed**
Toneburst response, Time-weighting Slow	**Passed**
Toneburst response, LAE	**Passed**
C-weighted peak sound level, 8 kHz	**Passed**
C-weighted peak sound level, 500 Hz	**Passed**
Overload indication	**Passed**
Long-term stability, 1. relative	**Passed**
High-level stability	**Passed**
Long-term stability, 2. relative	**Passed**
Environmental conditions, Following calibration	**Passed**

The sound level meter submitted for testing successfully completed the periodic tests of IEC 61672-3:2013, for the environmental conditions under which the tests were performed.
However, no general statement or conclusion can be made about conformance of the sound level meter to the full specifications of IEC 61672-1:2013 because (a) evidence was not publicly available, from an independent testing organization responsible for pattern approvals, to demonstrate that the model of sound level meter fully conformed to the class 1 specifications in IEC 61672-1:2013 or correction data for acoustical test of frequency weighting were not provided in the Instruction Manual and (b) because the periodic tests of IEC 61672-3:2013 cover only a limited subset of the specifications in IEC 61672-1:2013.

Conformance to a performance specification is demonstrated when the following criteria are both satisfied: (a) a measured deviation from a design goal does not exceed the applicable acceptance limit and (b) the corresponding uncertainty of measurement does not exceed the corresponding maximum-permitted uncertainty of measurement given in IEC 61672-1:2013 for the same coverage probability of 95 %.

Instruments

Category:	Type:	Manufacturer:	Serial No.:	Next Calibration Date:	Traceable to:
Voltmeter	DMM34461A	Keysight / Agilent	MY57220483	18 Jan. 2024	488288
Generator	Pulse Generator	Brüel & Kjær	3161-105309	19 Apr. 2023	CAS-594143-C0Q8W1-814
Calibrator	4226	Brüel & Kjær	2590978	19 Apr. 2023	CAS-570928-T3Z7L5-313
AmplifierDivider	WB-3630 Output Module	Brüel & Kjær	3328633	19 Apr. 2023	CAS-594143-C0Q8W1-814
Adaptor	WA0302B, 15 pF	Brüel & Kjær	2368672	31 Aug. 2023	470615

Preliminary inspection

Visually inspect instrument, and operate all relevant controls. (clause 5)

	Result
Visual inspection	OK

Environmental conditions, Prior to calibration

Actual environmental conditions prior to calibration. (clause 7)

	Expected	Accept - Limit	Accept + Limit	Measured [Deg / kPa / %RH]
Air temperature	23.00	-3.00	3.00	23.00
Air pressure	101.30	-21.30	3.70	97.47
Relative humidity	50.00	-25.00	20.00	35.00

Reference information

Information about reference range, level and channel. (clause 22.h + 22.m)

	Value [dB SPL]
Reference sound pressure level	94
Reference level range	140
Channel number	1

Indication at the calibration check frequency

Measure and adjust sound level meter using the supplied calibrator. (clause 10 + 22.m)

	Expected [dB SPL / Hz]	Measured [dB SPL / Hz]	Uncertainty [dB]
Calibration check frequency (supplied calibrator)	1000.00	1000.00	1.00
Initial indication (supplied calibrator)	93.85	94.02	0.22
Adjusted indication (supplied calibrator)	93.85	93.86	0.22

Acoustical signal tests of a frequency weighting, C weighting

Frequency weightings measured acoustically with a calibrated multi-frequency sound calibrator. Averaging time is 10 seconds, and the result is the average of 2 measurements. (clause 12)

	Coupler Pressure Lc [dB SPL]	Mic. Correction C4226 [dB]	Body Influence [dB]	Expected [dB SPL]	Measured [dB SPL]	Accept - Limit [dB]	Accept + Limit [dB]	Deviation [dB]	Uncertainty [dB]
1000Hz, Ref. (1st)	94.01	0.10	-0.07	93.98	93.72	-0.7	0.7	-0.26	0.25
1000Hz, Ref. (2nd)	94.01	0.10	-0.07	93.98	93.71	-0.7	0.7	-0.27	0.25
1000Hz, Ref. (Average)	94.01	0.10	-0.07	93.98	93.72	-0.7	0.7	-0.26	0.25
125.89Hz (1st)	94.04	0.00	0.00	93.64	93.69	-1.0	1.0	0.05	0.25
125.89Hz (2nd)	94.04	0.00	0.00	93.64	93.70	-1.0	1.0	0.06	0.25
125.89Hz (Average)	94.04	0.00	0.00	93.64	93.69	-1.0	1.0	0.05	0.25
7943.3Hz (1st)	93.71	2.80	-0.08	87.79	87.38	-2.5	1.5	-0.41	0.52
7943.3Hz (2nd)	93.71	2.80	-0.08	87.79	87.36	-2.5	1.5	-0.43	0.52
7943.3Hz (Average)	93.71	2.80	-0.08	87.79	87.37	-2.5	1.5	-0.42	0.52

Self-generated noise, Microphone installed

Self-generated noise measured with microphone submitted for periodic testing. Averaging time is 30 seconds. An anechoic chamber is used to isolate environmental noise.
The level of self-generated noise is reported for information only and is not used to assess conformance to a requirement. (clause 11.1)

	Max [dB SPL]	Measured [dB SPL]	Uncertainty [dB]
A weighted	17.70	16.32	0.50

Self-generated noise, Electrical

Self-generated noise measured in most sensitive range, with electrical substitution for microphone, according to manufactures specifications.
The level of self-generated noise is reported for information only and is not used to assess conformance to a requirement. (clause 11.2)

	Max [dB SPL]	Measured [dB SPL]	Uncertainty [dB]
A weighted	13.60	11.46	0.30
C weighted	14.30	11.55	0.30
Z weighted	19.40	16.72	0.30

Electrical signal tests of frequency weightings, A weighting

Frequency response measured with electrical signal relative to level at 1 kHz in reference range. (clause 13)
Electrical and acoustical response and body influence corrections are adjusted with the respective correction values at the reference frequency, in accordance with clause 13.6

	Input Level [dBV]	Expected [dB SPL]	Measured [dB SPL]	Response Corr. [dB]	Body Influence [dB]	Corr. Measured [dB SPL]	Accept - Limit [dB]	Accept + Limit [dB]	Deviation [dB]	Uncertainty [dB]
1000Hz, Ref.	-23.59	95.00	95.00	0.00	0.00	95.00	-0.5	0.5	0.00	0.12
63.096Hz	2.61	95.00	95.06	0.00	0.07	95.13	-1.0	1.0	0.13	0.12
125.89Hz	-7.49	95.00	95.02	0.00	0.07	95.09	-1.0	1.0	0.09	0.12
251.19Hz	-14.99	95.00	94.98	0.00	0.14	95.12	-1.0	1.0	0.12	0.12
501.19Hz	-20.39	95.00	94.97	0.00	0.29	95.26	-1.0	1.0	0.26	0.12
1995.3Hz	-24.79	95.00	95.01	-0.01	-0.02	94.98	-1.0	1.0	-0.02	0.12
3981.1Hz	-24.59	95.00	95.00	-0.02	-0.02	94.96	-1.0	1.0	-0.04	0.12
7943.3Hz	-22.49	95.00	95.00	0.00	-0.01	94.99	-2.5	1.5	-0.01	0.12
15849Hz	-16.99	95.00	94.10	0.87	0.18	95.15	-16.0	2.5	0.15	0.12

Electrical signal tests of frequency weightings, C weighting

Frequency response measured with electrical signal relative to level at 1 kHz in reference range. (clause 13)
Electrical and acoustical response and body influence corrections are adjusted with the respective correction values at the reference frequency, in accordance with clause 13.6

	Input Level [dBV]	Expected [dB SPL]	Measured [dB SPL]	Response Corr. [dB]	Body Influence [dB]	Corr. Measured [dB SPL]	Accept - Limit [dB]	Accept + Limit [dB]	Deviation [dB]	Uncertainty [dB]
1000Hz, Ref.	-23.59	95.00	95.00	0.00	0.00	95.00	-0.5	0.5	0.00	0.12
63.096Hz	-22.79	95.00	95.01	0.00	0.07	95.08	-1.0	1.0	0.08	0.12
125.89Hz	-23.39	95.00	95.04	0.00	0.07	95.11	-1.0	1.0	0.11	0.12
251.19Hz	-23.59	95.00	95.00	0.00	0.14	95.14	-1.0	1.0	0.14	0.12
501.19Hz	-23.59	95.00	95.03	0.00	0.29	95.32	-1.0	1.0	0.32	0.12
1995.3Hz	-23.39	95.00	95.04	-0.01	-0.02	95.01	-1.0	1.0	0.01	0.12
3981.1Hz	-22.79	95.00	95.01	-0.02	-0.02	94.97	-1.0	1.0	-0.03	0.12
7943.3Hz	-20.59	95.00	95.00	0.00	-0.01	94.99	-2.5	1.5	-0.01	0.12
15849Hz	-15.09	95.00	94.08	0.87	0.18	95.13	-16.0	2.5	0.13	0.12

Electrical signal tests of frequency weightings, Z weighting

Frequency response measured with electrical signal relative to level at 1 kHz in reference range. (clause 13)
Electrical and acoustical response and body influence corrections are adjusted with the respective correction values at the reference frequency, in accordance with clause 13.6

	Input Level	Expected	Measured	Response Corr.	Body Influence	Corr. Measured	Accept - Limit	Accept + Limit	Deviation	Uncertainty
	[dBV]	[dB SPL]	[dB SPL]	[dB]	[dB]	[dB SPL]	[dB]	[dB]	[dB]	[dB]
1000Hz, Ref.	-23.59	95.00	95.00	0.00	0.00	95.00	-0.5	0.5	0.00	0.12
63.096Hz	-23.59	95.00	95.03	0.00	0.07	95.10	-1.0	1.0	0.10	0.12
125.89Hz	-23.59	95.00	95.01	0.00	0.07	95.08	-1.0	1.0	0.08	0.12
251.19Hz	-23.59	95.00	95.00	0.00	0.14	95.14	-1.0	1.0	0.14	0.12
501.19Hz	-23.59	95.00	95.00	0.00	0.29	95.29	-1.0	1.0	0.29	0.12
1995.3Hz	-23.59	95.00	95.01	-0.01	-0.02	94.98	-1.0	1.0	-0.02	0.12
3981.1Hz	-23.59	95.00	95.03	-0.02	-0.02	94.99	-1.0	1.0	-0.01	0.12
7943.3Hz	-23.59	95.00	95.00	0.00	-0.01	94.99	-2.5	1.5	-0.01	0.12
15849Hz	-23.59	95.00	94.13	0.87	0.18	95.18	-16.0	2.5	0.18	0.12

Frequency and time weightings at 1 kHz

Frequency and time weighting measured at 1 kHz with electrical signal in reference range. Measured relative to A-weighted and Fast response. (clause 14)

	Expected	Measured	Accept - Limit	Accept + Limit	Deviation	Uncertainty
	[dB SPL]	[dB SPL]	[dB]	[dB]	[dB]	[dB]
LAF, Ref.	94.00	94.00	-0.5	0.5	0.00	0.12
LCF	94.00	94.00	-0.2	0.2	0.00	0.12
LZF	94.00	94.00	-0.2	0.2	0.00	0.12
LAS	94.00	93.95	-0.1	0.1	-0.05	0.12
LAeq	94.00	93.99	-0.1	0.1	-0.01	0.12

Long-term stability, Reference

Long-term stability over 25 to 35 minutes, with steady 1kHz signal at reference level. (clause 15)
Adjusting to reference level indication.

	Measured	Accept - Limit	Accept + Limit	Deviation	Timestamp	Uncertainty
	[dB SPL]	[dB]	[dB]	[dB]		[dB]
Reference	94.00	-0.5	0.5	0.00	2023-03-17 10:52:33	0.10

Level linearity on the reference level range, Upper

Level linearity in reference range, measured at 8 kHz until overload. (clause 16)

	Expected	Measured	Accept - Limit	Accept + Limit	Deviation	Uncertainty
	[dB SPL]	[dB SPL]	[dB]	[dB]	[dB]	[dB]
94 dB	94.00	94.00	-0.2	0.2	0.00	0.13
99 dB	99.00	99.00	-0.8	0.8	0.00	0.13
104 dB	104.00	104.00	-0.8	0.8	0.00	0.13
109 dB	109.00	109.00	-0.8	0.8	0.00	0.13
114 dB	114.00	114.01	-0.8	0.8	0.01	0.13
119 dB	119.00	119.02	-0.8	0.8	0.02	0.13
124 dB	124.00	124.02	-0.8	0.8	0.02	0.13
129 dB	129.00	129.02	-0.8	0.8	0.02	0.13
134 dB	134.00	134.02	-0.8	0.8	0.02	0.13
135 dB	135.00	135.02	-0.8	0.8	0.02	0.13
136 dB	136.00	136.02	-0.8	0.8	0.02	0.13
137 dB	137.00	137.02	-0.8	0.8	0.02	0.13
138 dB	138.00	138.02	-0.8	0.8	0.02	0.13
139 dB	139.00	139.02	-0.8	0.8	0.02	0.13

Level linearity on the reference level range, Lower

Level linearity in reference range, measured at 8 kHz down to lower limit, or until underrange. (clause 16)

	Expected	Measured	Accept - Limit	Accept + Limit	Deviation	Uncertainty
	[dB SPL]	[dB SPL]	[dB]	[dB]	[dB]	[dB]
94 dB	94.00	94.00	-0.2	0.2	0.00	0.13
89 dB	89.00	89.00	-0.8	0.8	0.00	0.13
84 dB	84.00	84.00	-0.8	0.8	0.00	0.13
79 dB	79.00	79.00	-0.8	0.8	0.00	0.13
74 dB	74.00	74.00	-0.8	0.8	0.00	0.13
69 dB	69.00	69.00	-0.8	0.8	0.00	0.13
64 dB	64.00	64.00	-0.8	0.8	0.00	0.13
59 dB	59.00	59.00	-0.8	0.8	0.00	0.13
54 dB	54.00	54.00	-0.8	0.8	0.00	0.13
49 dB	49.00	49.01	-0.8	0.8	0.01	0.13
44 dB	44.00	44.01	-0.8	0.8	0.01	0.13
39 dB	39.00	39.02	-0.8	0.8	0.02	0.24
34 dB	34.00	34.04	-0.8	0.8	0.04	0.24
30 dB	30.00	30.09	-0.8	0.8	0.09	0.24
29 dB	29.00	29.11	-0.8	0.8	0.11	0.24
28 dB	28.00	28.14	-0.8	0.8	0.14	0.24
27 dB	27.00	27.15	-0.8	0.8	0.15	0.24
26 dB	26.00	26.20	-0.8	0.8	0.20	0.24
25 dB	25.00	25.24	-0.8	0.8	0.24	0.24

Toneburst response, Time-weighting Fast

Response to 4 kHz toneburst measured in reference range, relative to continuous signal. (clause 18)

	Expected	Measured	Accept - Limit	Accept + Limit	Deviation	Uncertainty
	[dB SPL]	[dB SPL]	[dB]	[dB]	[dB]	[dB]
Continuous, Ref.	137.00	137.00	-0.5	0.5	0.00	0.12
200 ms Burst	136.00	136.00	-0.5	0.5	0.00	0.12
2 ms Burst	119.00	118.94	-1.5	1.0	-0.06	0.12
0.25 ms Burst	110.00	109.83	-3.0	1.0	-0.17	0.12

Toneburst response, Time-weighting Slow

Response to 4 kHz toneburst measured in reference range, relative to continuous signal. (clause 18)

	Expected	Measured	Accept - Limit	Accept + Limit	Deviation	Uncertainty
	[dB SPL]	[dB SPL]	[dB]	[dB]	[dB]	[dB]
Continuous, Ref.	137.00	137.00	-0.5	0.5	0.00	0.12
200 ms Burst	129.60	129.60	-0.5	0.5	0.00	0.12
2 ms Burst	110.00	109.99	-3.0	1.0	-0.01	0.12

Toneburst response, LAE

Response to 4 kHz toneburst measured in reference range, relative to continuous signal. (clause 18)

	Expected	Measured	Accept - Limit	Accept + Limit	Deviation	Uncertainty
	[dB SPL]	[dB SPL]	[dB]	[dB]	[dB]	[dB]
Continuous, Ref.	137.00	137.00	-0.5	0.5	0.00	0.12
200 ms Burst	130.00	129.99	-0.5	0.5	-0.01	0.12
2 ms Burst	110.00	109.95	-1.5	1.0	-0.05	0.12
0.25 ms Burst	101.00	100.84	-3.0	1.0	-0.16	0.12

C-weighted peak sound level, 8 kHz

Peak-response to a 8 kHz single-cycle sine measured in least-sensitive range, relative to continuous signal. (clause 19)

	Expected	Measured	Accept - Limit	Accept + Limit	Deviation	Uncertainty
	[dB SPL]	[dB SPL]	[dB]	[dB]	[dB]	[dB]
Continuous, Ref.	132.00	132.00	-0.5	0.5	0.00	0.09
Single Sine	135.40	135.47	-2.0	2.0	0.07	0.20

C-weighted peak sound level, 500 Hz

Peak-response to a 500 Hz half-cycle sine measured in least-sensitive range, relative to continuous signal. (clause 19)

	Expected	Measured	Accept - Limit	Accept + Limit	Deviation	Uncertainty
	[dB SPL]	[dB SPL]	[dB]	[dB]	[dB]	[dB]
Continuous, Ref.	135.00	135.00	-0.5	0.5	0.00	0.09
Half-sine, Positive	137.40	137.13	-1.0	1.0	-0.27	0.12
Half-sine, Negative	137.40	137.14	-1.0	1.0	-0.26	0.12

Overload indication

Overload indication in the least sensitive range determined with a 4 kHz positive/negative half-cycle signal. (clause 20)

	Measured / Input Level	Accept - Limit	Accept + Limit	Deviation	Uncertainty
	[dB SPL]	[dB]	[dB]	[dB]	[dB]
Continuous	140.00	-0.5	0.5	0.00	0.20
Half-sine, Positive	140.40	-10.0	10.0	0.40	0.20
Half-sine, Negative	140.70	-10.0	10.0	0.70	0.20
Difference	140.70	-1.5	1.5	0.30	0.24

Long-term stability, 1. relative

Long-term,stability over 25 to 35 minutes, with steady 1kHz signal at reference level. (clause 15)
Relative to prior adjustment to reference level indication.

	Measured	Accept - Limit	Accept + Limit	Deviation	Timestamp	Uncertainty
	[dB SPL / Min]	[dB / Min]	[dB / Min]	[dB / Min]		[dB]
Measurement	94.00	-0.1	0.1	0.00	2023-03-17 11:06:44	0.10
Time passed	14.11	0.0	35.0	14.11		0.00

High-level stability

High-level stability over 5 minutes, with steady 1kHz signal, 1dB below upper boundary. (clause 21)

	Measured	Accept - Limit	Accept + Limit	Deviation	Uncertainty
	[dB SPL]	[dB]	[dB]	[dB]	[dB]
High-level, Ref.	139.00	-0.5	0.5	0.00	0.10
High-level, after 5min	139.00	-0.1	0.1	0.00	0.10

Long-term stability, 2. relative

Long-term stability over 25 to 35 minutes, with steady 1kHz signal at reference level. (clause 15)
Relative to prior adjustment to reference level indication.

	Measured	Accept - Limit	Accept + Limit	Deviation	Timestamp	Uncertainty
	[dB SPL/ Min]	[dB / Min]	[dB / Min]	[dB / Min]		[dB]
Wait	25.00	25.0	120.0	25.00		0.00
Measurement	94.00	-0.1	0.1	0.00	2023-03-17 11:18:04	0.10

Environmental conditions, Following calibration

Actual environmental conditions following calibration. (clause 7)

	Expected	Accept - Limit	Accept + Limit	Measured
				[Deg / kPa / %RH]
Air temperature	23.00	-3.00	3.00	23.00
Air pressure	101.30	-21.30	3.70	97.47
Relative humidity	50.00	-25.00	20.00	35.00