Floatel Noise Monitoring Survey - 4 (January 31- February 2, 2025)

Woodfibre LNG Project

March 4, 2025

123221624EN-RPT0059

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.

Limitations and Sign-off

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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
Swiẏát	Historic Squamish Nation village located at Woodfibre Site

Abbreviations

ANSI	American National Standards Institute
BC	British Columbia
BC ER	British Columbia Energy Regulator
dB	Decibel level
dBA	A-weighted decibel level
EAC	Environmental Assessment Certificate
FNMMP	Floatel Noise Monitoring and Mitigation Plan
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[1], MOH[2], BC Energy Regulator, VCH[3] 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.

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1 MOE: Ministry of Environment and Climate Change Strategy
2 MOH: Ministry of Health
3 VCH: Vancouver Coastal Health

1.3 OBJECTIVE

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

The initial noise monitoring program was conducted from July 10 to July 14, 2024, to measure sound levels in the cabins. The results were presented in a report "Floatel Noise Monitoring Survey -1 (July 10 - 14, 2024) – Woodfibre LNG Project" (Stantec 2024a). A second subsequent noise monitoring survey was conducted from September 4 to September 7, 2024; and the results were presented in a report "Floatel Noise Monitoring Survey -2 (September 4 – 7, 2024) – Woodfibre LNG Project" (Stantec 2024b). A third subsequent noise monitoring survey was conducted from October 8 to October 11, 2024; and the results were presented in a report "Floatel Noise Monitoring Survey -3 (October 8 – 11, 2024) – Woodfibre LNG Project" (Stantec 2024c). All reports are listed in References section.

This fourth noise monitoring survey was conducted from January 31 to February 2, 2025, representing the first quarter of 2025. During this period, shore grid power continued to supply electricity to the floatel/ Continuous construction activities were observed during the dayshift, while no construction activities took place during the nightshift.

The objectives of the noise monitoring programs include the following:

- Measure sound levels at the selected cabins.
- Analyze data gathered and evaluate noise effects on the floatel cabins from construction activities.
- Compare the measured sound levels with applicable sleep disturbance thresholds and assess compliance for sleep disturbance effect for sleeping quarter occupants.
- Conduct interviews about noise with 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 additional details for these descriptors.

2.0 CABIN SOUND LEVEL TARGETS

Construction noise may cause sleep disturbance for the floatel occupants during the Project construction phase. This section focuses on the sleep disturbance threshold recommendations by Health Canada, as well as room sound level criteria from 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. Additionally, for individual noise events, Health Canada 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 activities may be scheduled 24 hours per day, meaning that the floatel occupants could be off-duty and sleeping during both daytime and nighttime while construction is ongoing. To assess potential sleep disturbances, the recommended indoor noise thresholds for the floatel are:

- 30 dBA (L_{eq}) for continuous noise level during sleep periods.
- Maximum 15 times of occurrence of L_{Amax} > 45 dBA during both daytime (07:00 to 22:00) and nighttime (22:00 to 07:00).

Although the Heath Canada sleep disturbance threshold of 30 dBA is used in this assessment, it is better suited for private residential bedrooms with very low background noise. However, in spaces with higher occupant density, such as apartment buildings and hotel or motel rooms, background noise from central heating, ventilation and air-conditioning (HVAC) systems, as well as local activities, a sound level of 30 dBA may not be unrealistic.

Therefore, in addition to Health Canada's threshold, the ANSI standard for hotel and motel room sound level criteria is used as a reference target for evaluating 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 January 31 to February 2, 2025. 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 and is selected based on the highest potential noise impact. Key factors in cabin selection included proximity to construction activities, line of sight to noise sources, and availability during the survey period.

Six cabins were selected for the fourth noise monitoring survey: Cabin 2027, Cabin 5632, Cabin 6708, Cabin 7024, Cabin 9436 and Cabin 0103. Each cabin is located on a different deck, indicated by the first digit of the cabin number (e.g., Cabin 5632 on Deck 5 and Cabin 0103 on Deck 10).

Construction activities within the Project area were the major noise sources onsite and were the focus of the fourth noise monitoring survey. Cabin 7024 was selected because it is located at the stern of the floatel which is closest to and in line of sight with the northeastern construction site. The floatel is berthed starboard to shore, Cabin 5632, Cabin 6708, Cabin 9436 and Cabin 0103 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.

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
2027	2	• Deck 2 is under the ship water line. • The 86 cabins on Deck 2 are mainly occupied by the crew members, there are a few workers also living on Deck 2 due to full occupancy. • Some cabins are adjacent to the floatel operating facilities, including Engine Stores (engine room) and workshop. • Shore grid power provided power to the floatel during the survey period. Noise levels due to the Engine Store were reduced along the corridors. • Cabin 2027 is further away from the floatel operating facility. • Cabin ceiling ventilation was continuously operating during the noise monitoring period.	Figure 2 Figure 5
5632	5	• Total of 219 cabins, the second highest numbers of cabins per deck after Deck 6. • Cabins are occupied by the construction workers. • There are Vent Stores (i.e., ventilation rooms) and Service Workshop located at the stern of Deck 5. • Cabin 5632 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.	Figure 2 Figure 6
6708	6	• Total of 248 cabins, highest number of cabins per deck among all decks. • Cabins occupied by the construction workers. • Cabin 6708 is located at the starboard side of the floatel and facing the southwestern construction site. • Cabin ceiling ventilation was continuously operating.	Figure 3 Figure 7
7024	7	• Total of 58 cabins on Deck 7. • Ancillary service facilities on Deck 7 including Reception, Gym, Games Lounge, and other facility rooms. • Cabins are occupied by the construction workers. • Cabin 7024 was selected as it is located at the stern of the floatel and the cabin wall is facing the northeastern marine construction site. • Cabin ceiling ventilation was continuously operating.	Figure 3 Figure 8
9436	9	• Total of 88 cabins on Deck 9. • There is an outdoor area at the stern and a smoking area on the starboard side of Deck 9. • Cabins are 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 9436 is located at the starboard side of the floatel and facing the southwestern construction site. • Cabin ceiling ventilation was continuously operating.	Figure 4 Figure 9

Cabin	Deck	Description and Observations during Monitoring Period	Reference Figures
0103	10	• Total of 17 cabins with office areas on Deck 10. • Cabins are occupied by crew members and construction workers. • There are several Fan Rooms on Deck 10. • Cabin 0103 is located at the starboard side of the floatel and facing the southwestern construction site. • Cabin ceiling ventilation was continuously operating.	Figure 4 Figure 10

3.2 MEASUREMENT INSTRUMENTATION

Noise monitoring was conducted with three Brüel & Kjær Model 2250 and 2270 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 Brüel & Kjær Model 2270 s/n 3002024
Microphone	Brüel & Kjær Model 4189 s/n 2799510 Brüel & Kjær Model 4189 s/n 2866566 Brüel & Kjær Model 4189 s/n 3060527
Calibrator	Brüel & Kjær Model 4231 s/n 3009303
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.

Three sound level meters (Brüel & Kjær Model 2250 and 2270), 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 through Figure 10 in Appendix A illustrate the sound level meter setup at each cabin.

The monitoring procedures are described as below:

- Three sound level meters were setup at Cabin 2027, Cabin 5632, and Cabin 6708 to collect continuous noise data over 24 hours from January 31 to February 1.
- The three sound level meters were switched to Cabin 7024, Cabin 9436, and Cabin 0103 to collect continuous noise data over 24 hours from February 1 to February 2.

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)	
2027	01/31/2025	16:25	02/01/2025	16:28	24 hrs 3 mins
5632	01/31/2025	16:10	02/01/2025	16:12	24 hrs 2 mins
6708	01/31/2025	15:59	02/01/2025	16:02	24 hrs 3 mins
7024	02/01/2025	16:08	02/02/2025	16:16	24 hrs 8 mins
9436	02/01/2025	16:18	02/02/2025	16:27	24 hrs 9 mins
0103	02/01/2025	16:33	02/02/2025	16:36	24 hrs 3 mins

3.4 PROJECT CONSTRUCTION ACTIVITIES

There were Project dayshift construction activities during the noise monitoring period from January 31 to February 2. The dayshift was from 07:00 to 17:00. There were no nighttime construction activities during the noise monitoring period. Figure 11 illustrates the construction areas onsite with Area ID #.

Major daytime construction activities during the noise monitoring period included the following:

- Area 1200: Excavator sorted surplus oversized rock, cast material below for breaking, and mucked out separated oversized material for hammering in the 4100 Area.
- Area 1200: Excavator breaking MSE Wall rockface and building pad at hill cut to prep for RCMI drill.
- Rock trucks continued hauling sifted blast rock material and broken oversized rock from the 1100 Area and 4100 Area stockpile to prepare for crushing.

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.

It was snowing during the noise monitoring period; however, the snow did not impact the noise measurement inside the cabins. Therefore, isolation was not applied for 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.
- Floatel fire alarm drill operating period. During the period of 07:25 to 07:30 on February 1, the floatel scheduled a fire alarm drill operation, the public announcement system (PA) and fire alarm operated.

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 neighbor 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 8,600 minutes logged measurement values at six 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	Overall Average Daytime L_d, dBA	Overall Average Nighttime L_n, dBA	Number of Highest Occurrence of L_{Amax} > 45 dBA	
				Daytime	Nighttime
2027	2	41.1	41.2	35	29
5632	5	38.7	38.6	18	9
6708	6	41.3	41.4	13	12
7024	7	33.7	32.9	14	10
9436	9	37.3	37.5	16	9
0103	10	34.9	34.8	44	10

The overall average daytime L_d sound levels are the logarithmic average of two daytime measurement results at each cabin. 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 2027

Table 4.2 summarizes the daily L_d and L_n sound levels, and quantities of occurrence with L_{Amax} > 45 dBA at Cabin 2027.

Table 4.2 Summary of Daily L_d and L_n at Cabin 2027

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
01/31/2025[1]	41.1	41.2	24	29	30	15	39 to 44
02/01/2025	41.1	-[2]	35	-[2]	30	15	39 to 44

Notes:

[1] The measurements started at 16:25.

[2] "-" indicates no data was measured. The survey ended at 16:28.

Monitoring results for Cabin 2027 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 5632

Table 4.3 summarizes the daily L_d and L_n sound levels, and quantities of occurrence with L_{Amax} > 45 dBA at Cabin 5632.

Table 4.3 Summary of Daily L_d and L_n at Cabin 5632

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
01/31/2025[1]	38.6	38.6	17	9	30	15	39 to 44
02/01/2025	38.8	-[2]	18	-[2]	30	15	39 to 44

Notes:

[1] The measurements started at 16:10.

[2] "-" indicates no data was measured. The survey ended at 16:12.

Monitoring results for Cabin 5632 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 lower limit of 39 dBA.
- Quantities of occurrence with L_{Amax} > 45 dBA are more than 15 times during the daytime periods of January 31 and February 1.
- Quantities of occurrence with L_{Amax} > 45 dBA are less than 15 times during the nighttime period of January 31.

4.1.3 Cabin 6708

Table 4.4 summarizes the daily L_d and L_n sound levels, and quantities of occurrence with L_{Amax} > 45 dBA at Cabin 6708.

Table 4.4 Summary of Daily L_d and L_n at Cabin 6708

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
01/31/2025[1]	41.3	41.4	12	12	30	15	39 to 44
02/01/2025	41.4	-[2]	13	-[2]	30	15	39 to 44

Notes:

[1] The measurements started at 15:59.

[2] "-" indicates no data was measured. The survey ended at 16:02.

Monitoring results for Cabin 6708 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 upper limit of 44 dBA.
- Quantities of occurrence with L_{Amax} > 45 dBA are less than 15 times during both daytime and nighttime periods.

4.1.4 Cabin 7024

Table 4.5 summarizes the daily L_d and L_n sound levels, and quantities of occurrence with L_{Amax} > 45 dBA at Cabin 7024.

Table 4.5 Summary of Daily L_d and L_n at Cabin 7024

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
02/01/2025[1]	33.4	32.9	6	10	30	15	39-44
02/02/2025	34.0	-[2]	14	-[2]	30	15	39-44

Notes:

[1] The measurements started at 16:08.

[2] "-" indicates no data was measured. The survey ended at 16:16.

Monitoring results for Cabin 7024 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 less than 15 times during both daytime and nighttime periods.

4.1.5 Cabin 9436

Table 4.6 summarizes the daily L_d and L_n sound levels, and quantities of occurrence with L_{Amax} > 45 dBA at Cabin 9436.

Table 4.6 Summary of Daily L_d and L_n at Cabin 9436

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
02/01/2025[1]	37.5	37.5	16	9	30	15	39 to 44
02/02/2025	37.1	-[2]	16	-[2]	30	15	39 to 44

Notes:

[1] The measurements started at 16:18.

[2] "-" indicates no data was measured. The survey ended at 16:27.

Monitoring results for Cabin 9436 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 periods of February 1 and February 2.
- Quantities of occurrence with L_{Amax} > 45 dBA are less than 15 times during the nighttime period of February 1.

4.1.6 Cabin 0103

Table 4.7 summarizes the daily L_d and L_n sound levels, and quantities of occurrence with L_{Amax} > 45 dBA at Cabin 0103.

Table 4.7 Summary of Daily L_d and L_n at Cabin 0103

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
02/01/2025[1]	35.1	34.8	14	10	30	15	39 to 44
02/02/2025	34.7	-[2]	44	-[2]	30	15	39 to 44

Note:

[1] The measurements started at 16:33.

[2] "-" indicates no data was measured. The survey ended at 16:36.

Monitoring results for Cabin 0103 are summarized as follows:

- L_d and L_n sound levels at Cabin 0103 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 less than 15 times during the daytime and nighttime periods of February 1.
- Quantities of occurrence with L_{Amax} > 45 dBA are more than 15 times during the daytime of February 2.

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 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 and inform the floatel management for further mitigation plans.

Thirty occupants were randomly selected for the interviews, which represents about 5% of the total occupants at the time. There were approximately 640 total construction worker occupants during the fourth noise monitoring survey. The quantity of the floatel occupants is close to the full capacity.

Four questions were asked regarding noise issues:

1. General evaluation for your sleeping at the floatel.
2. How long have you stayed at the floatel?
3. Can you hear outside construction noise?
4. 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.
- Only two interviewees reported that they barely perceived construction noise inside the cabins previously, including noise from rock breaking and vibratory piling. There were no nighttime shift construction activities during the fourth noise monitoring survey.
- Occasional perceptible noise events raised by several interviewees living on Deck 6, the events are due to activities in the Gym on Deck 7, such as weights dropping on the 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
2027	2	No	No	No	No	Yes	Yes
5632	5	No	No	No	Yes	Yes	Yes
6708	6	No	No	Yes	Yes	Yes	Yes
7024	7	No	No	Yes	Yes	Yes	Yes
9436	9	No	No	No	Yes	Yes	Yes
0103	10	No	No	Yes/No[1]	Yes	Yes	Yes

Notes:
[1] Meet threshold on February 1 but exceed threshold on February 2.

Sound levels at all measured cabins are above the Health Canada sleep disturbance threshold of 30 dBA. Cabin 2027 and Cabin 6708 have the highest daytime and nighttime sound levels.

In terms of meeting the 45 dBA L_{Amax} or above occurrence less than 15 times, Cabin 2027 has the highest occurrence results and exceeds the threshold during both daytime and nighttime, due to its proximity to the Engine Stores with local operating noise on Deck 2.

The nighttime occurrence results at other five cabins meet the threshold. Cabin 6708 and Cabin 7024 also meet the daytime threshold. Cabin 5632 and Cabin 9436 exceed the threshold in daytime. Cabin 0103 meets the threshold on February 1 daytime but exceeds the threshold on February 2 daytime.

Table 6.2 compares the results from the most recent two surveys, including the third (October 2024) and fourth (January – February 2025) surveys.

Table 6.2 Comparisons of Third and Fourth Survey Results

Cabin		Average Daytime Highest L_d, dBA		Average Nighttime Highest L_n, dBA		Highest Occurrence of L_{Amax} > 45 dBA			
						Daytime		Nighttime	
3rd	4th	3rd	4th	3rd	4th	3rd	4th	3rd	4th
2002	2027	52.8	41.1	52.3	41.2	554	35	540	29
5004	5632	38.7	38.7	38.5	38.6	23	18	10	9
6004	6708	40.5	41.3	40.3	41.4	72	13	18	12
7027	7024	28.6	33.7	28.6	32.9	0	14	8	10
9412	9436	30.2	37.3	29.6	37.5	0	16	8	9
0106	0103	38.5	34.9	38.6	34.8	48	44	14	10

During the third noise monitoring survey, Cabin 2002 had the highest daytime and nighttime sound levels. Cabin 2027 was purposely selected during the fourth survey to measure the cabin located further away from the Engine Stores and compare the results with Cabin 2002.

The sound levels inside Cabin 2002 are much higher than Cabin 2027. Cabin 2002 is adjacent to the Engine Stores (engine rooms), intrusive noise emitted from the auxiliary equipment operations was transmitted to the cabin through the partition walls and ceiling plenum and contributed the high interior sound levels. Cabin 2027 is located at the fourth row and further away from the Engine Stores (see Figure 2), intrusive noise through the cabin ceiling plenum is reduced further along the transmission path. In terms of meeting the 45 dBA L_{Amax} or above occurrence less than 15 times, Cabin 2002 had the highest occurrence results, in comparison, results at Cabin 2027 have been reduced significantly.

Cabin 5004 and Cabin 6004, as well as Cabin 5632 and Cabin 6708, were selected in the third and fourth surveys, respectively. The interior L_d and L_n sound levels measured in both surveys were in similar range of 38 dBA for cabins on Deck 5, and between 40 dBA to 41 dBA for cabins on Deck 6.

The ceiling ventilations in Cabin 7027 and Cabin 9412 were not in operation during the third survey, and the ceiling ventilations in Cabin 7024 and Cabin 9436 were in normal operation. The interior sound levels in Cabin 7024 and Cabin 9436 with ceiling ventilations are higher than Cabin 7027 and Cabin 9412 without ceiling ventilations.

Cabin 0103 has lower interior sound levels compared to Cabin 0106, which was part of the third survey.

All cabins do not have the option to open the window. The ceiling ventilation is essential to keep the cabins in comfortable warm or cool air flow 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 hotel/motel rooms. In all surveys, most cabins are within the ANSI S12.2 room sound level criteria range of 39 dBA to 44 dBA, except Cabin 2002 during the third survey. During the fourth survey, results at most cabins are below the lower limit of 39 dBA, the exceptions are Cabin 2027 and Cabin 6708, the results are below the upper limit of 44 dBA threshold.

Regarding the threshold of the 45 dBA L_{Amax} or above occurrence less than 15 times, except Cabin 2027, all other cabins meet the threshold during the nighttime periods, and Cabin 6708 and Cabin 7024 also meet the threshold during the daytime periods.

On all decks, noise from the construction activities does not affect the floatel interior acoustic environment.

The interview results indicate no sleep disturbance issues and no noise concerns or complaints due to 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:

- Shore grid power supply was still providing power to the floatel. The power generation engines inside the Engine Stores kept shutdown and will be used only in emergency situations. In accordance with the results of the third noise monitoring survey, the sound levels at corridors on Deck 2 have been reduced at different locations.
- As discussed in Section 6, Cabins adjacent to the Engine Stores have high interior sound levels. However, sound levels in the cabins further away from the Engine Stores are reduced and will meet the ANSI S12.2 room sound level criteria. Workers cabin allocation to Deck 2 should be reduced, especially at the first row of the cabins, which are located next to the Engine Stores. These cabin locations are illustrated in Stantec 2024c.
- 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 keeps 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 alternative 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 fourth noise monitoring survey was conducted on the floatel from January 31 to February 2, 2025 to fulfill the requirements of Condition 30 of EAC. Continuous sound levels over 24 hours were collected at six 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 fourth noise monitoring survey are above the Health Canada thresholds. The measurement results meet the ANSI S12.2 room sound level criteria for hotel and motel rooms at all cabins. There were 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 from 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.

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

Stantec 2024b. Floatel Noise Monitoring Survey - 2 (September 4 - 7, 2024) – Woodfibre LNG Project. 123222160EN-RPT0053 Revision 1, November 2024.

Stantec 2024c. Floatel Noise Monitoring Survey - 3 (October 8 - 11, 2024) – Woodfibre LNG Project. 123222160EN-RPT0053, November 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

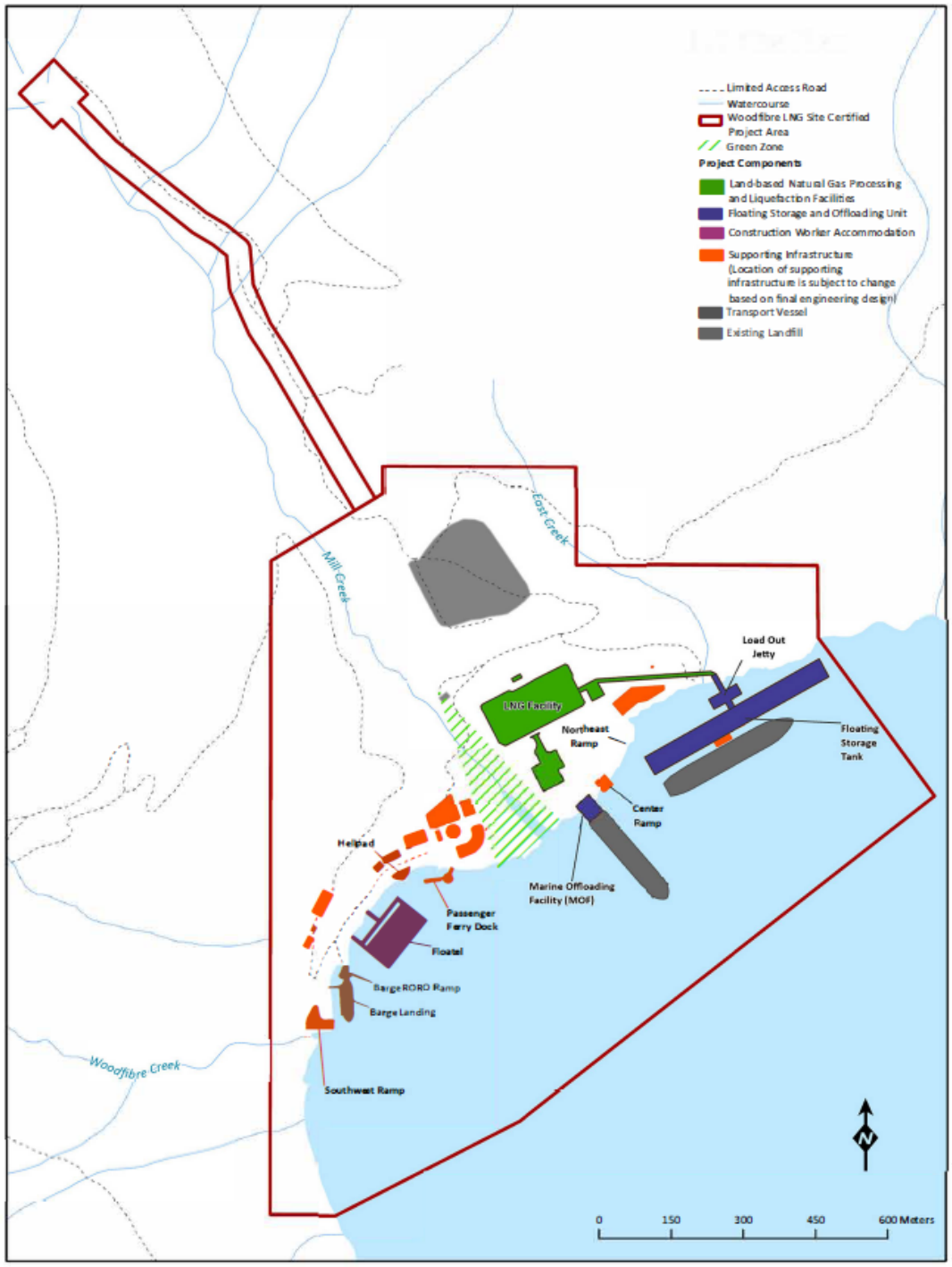


Figure 2 Measurement Location at Cabin 2027 and Cabin 5632 (Deck 2 and Deck 5)

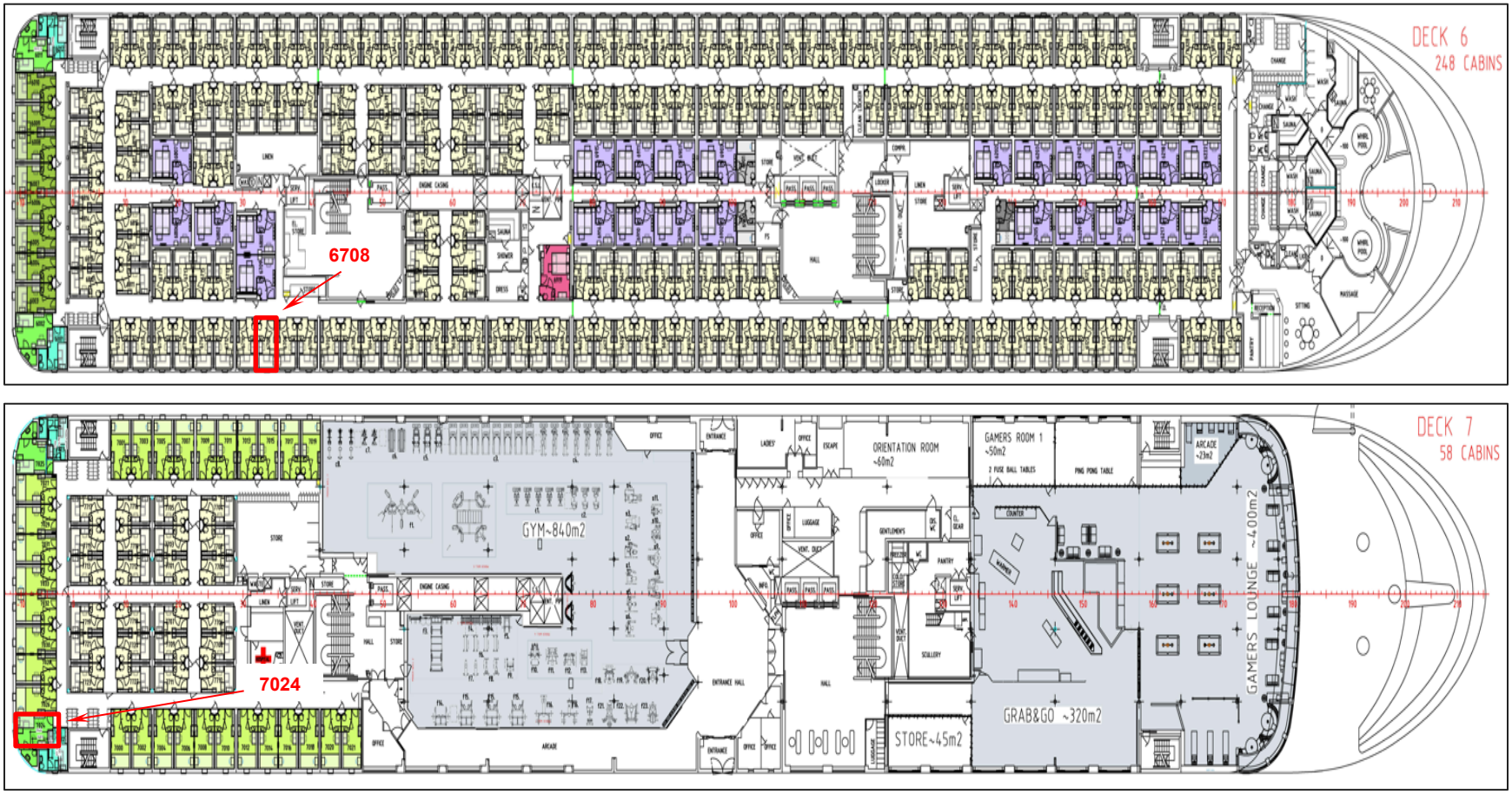
Legend of Figure 2

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 3B	TYPE 4A	TYPE 4B	QUANTITY OF CABINS PER DECK
DECK 10				9																				8		17
DECK 9	18			8								30				2		2	7	1	17	4	2		1	88
DECK 7	24											30														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
CABINS PER TYPE	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

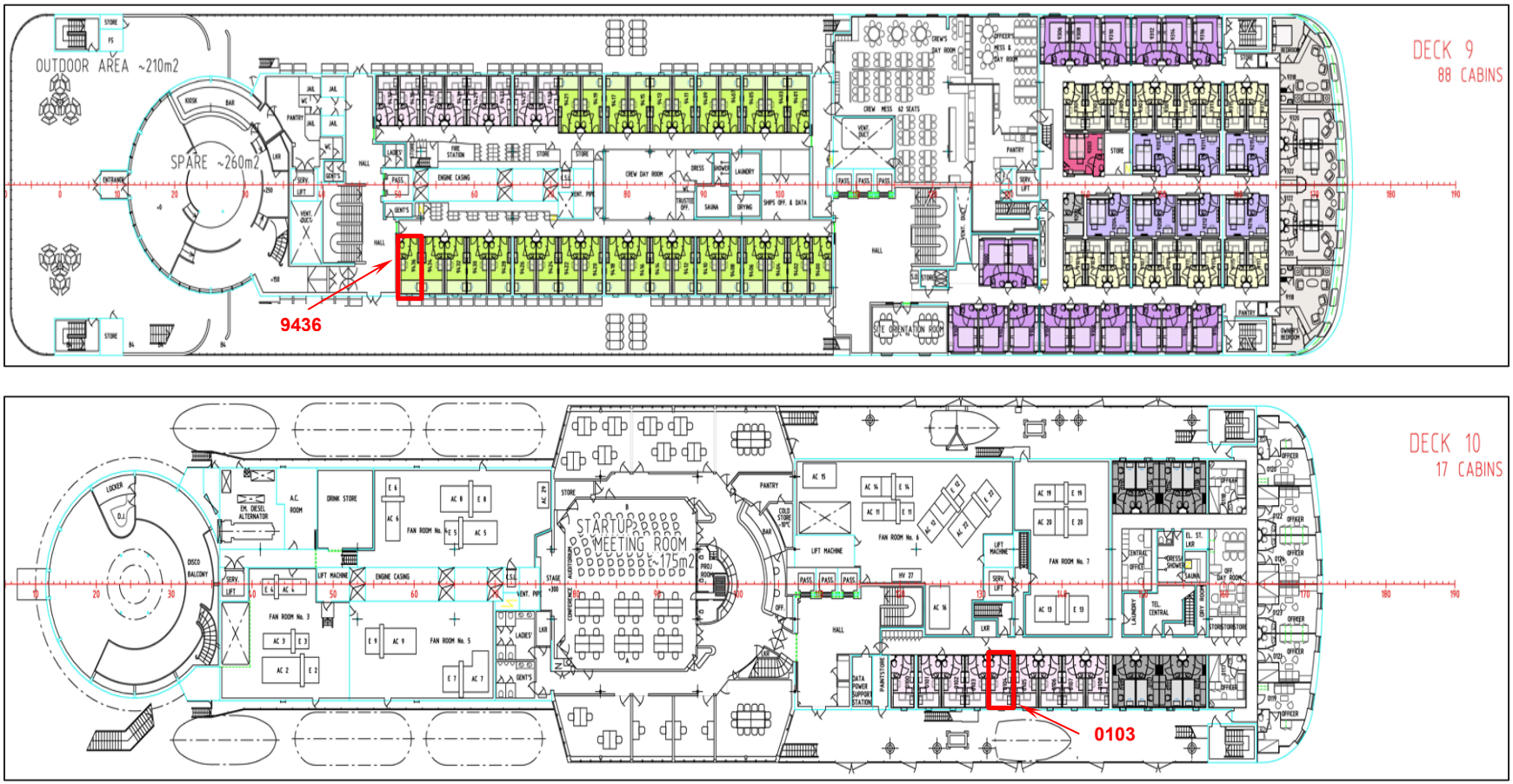
Figure 3 Measurement Location at Cabin 6708 and Cabin 7024 (Deck 6 and Deck 7)



Legend

Noise monitoring cabin

Figure 4 Measurement Location at Cabin 9436 and Cabin 0103 (Deck 9 and Deck 10)



Legend

Noise monitoring cabin

Figure 5 Sound Level Meter Setup at Cabin 2027

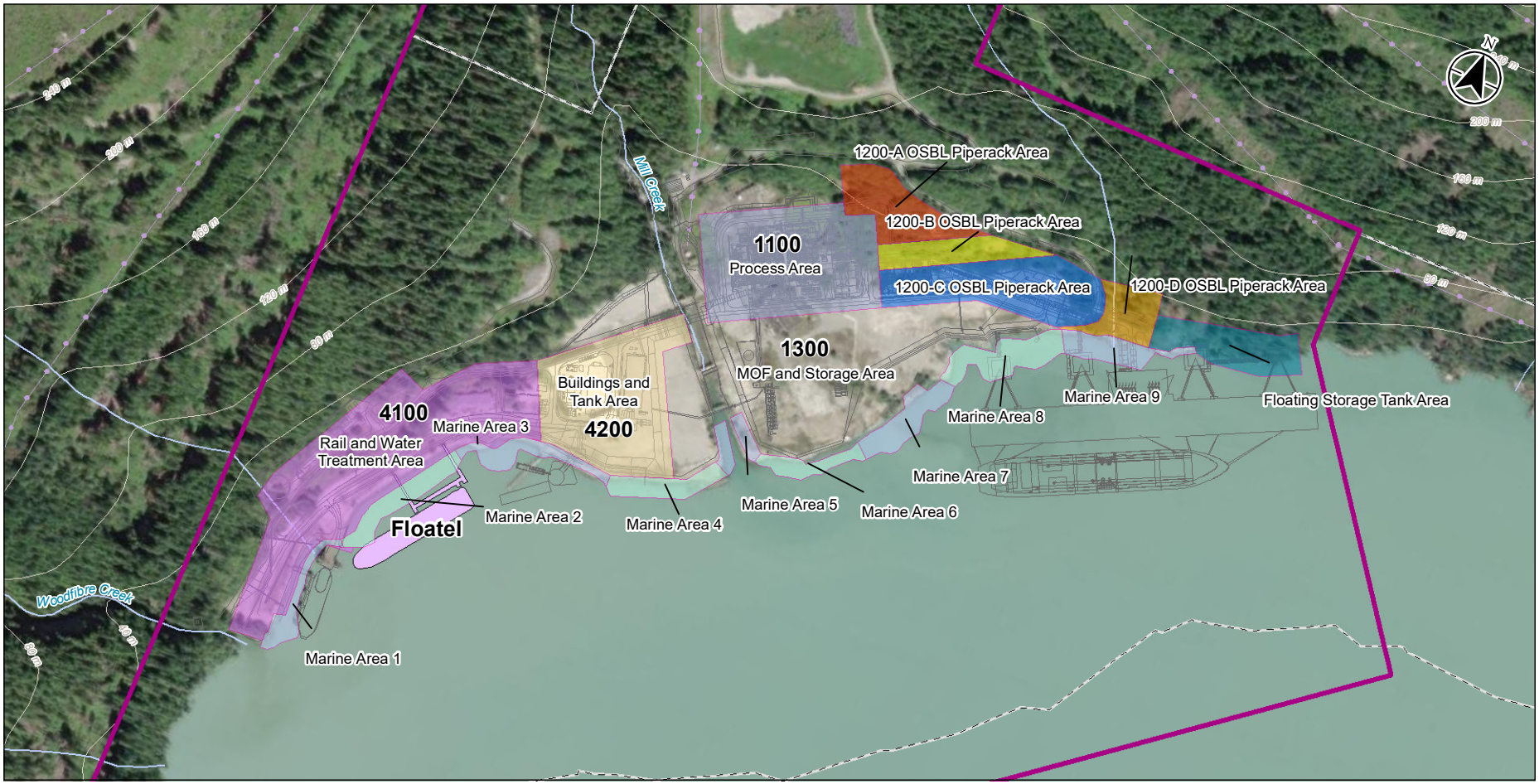
Figure 6 Sound Level Meter Setup at Cabin 5632

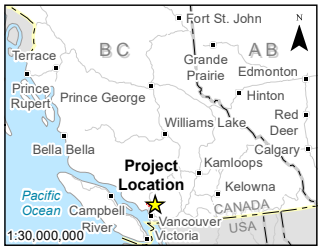
Figure 7 Sound Level Meter Setup at Cabin 6708

Figure 8 Sound Level Meter Setup at Cabin 7024

Figure 9 Sound Level Meter Setup at Cabin 9436

Figure 10 Sound Level Meter Setup at Cabin 0103





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.
11

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.How long have you stayed?	3. Can you hear outside construction noise?	3. Any noise concerns/ complaints
#1	Jan 31	7	Day	No noise issues	6 months	No	No
#2	Jan 31	5	Day	Sleep is OK, some bathroom noise	2 weeks	No	No, all good
#3	Jan 31	6	Day	No problem	2 weeks	No	No, some normal room noise from toilet
#4	Jan 31	5	Day	No sleep disturbance, other than sometimes loud in corridor	4 months	Not really	It's OK, all good
#5	Jan 31	6	Day	No noise problem	4 months	No	No
#6	Jan 31	10	Night	Deck 10 is OK	6 months	On Deck 10 sometimes heard rock breaking noise	Not really
#7	Jan 31	5	Day	No problem	4 months	Not hearing from construction	No
#8	Jan 31	9	Day	No issues, some bathroom noise	7 months	Don't bother sleeping	Nothing, it's fine
#9	Jan 31	7	Night	Little bit corridor noise	5 months	No	People walking and gym noise
#10	Jan 31	6	Day	No issue	5 months	No	No issues
#11	Feb 1	7	Day	No problem, it's OK	1 month	Barely heard from vibratory piling	Not at all
#12	Feb 1	7	Day	It's good	6 months	No	Generally good, some mechanical noise
#13	Feb 1	6	Day	No issue	4 weeks	Not hearing from construction	All Good
#14	Feb 1	6	Day	Little washroom noise	4 months	No	Good
#15	Feb 1	5	Day	No problem	5 months	Not heard	No
#16	Feb 1	5	Day	All good	6 months	No	No problem
#17	Feb 1	6	Day	Good	6 months	Barely heard	No issues
#18	Feb 1	5	Day	It's fine	5 months	No	No problem
#19	Feb 1	6	Night	It's fine	2 weeks	Not heard	No
#20	Feb 1	5	Day	Good	5 months	Nothing heard from construction	No concerns
#21	Feb 1	5	Day	It's good	7 months	No	No, only when nightshift but fire alarm drill noise
#22	Feb 2	6	Night	Gym noise when staying under gym	8 months	No	Gym noise when stay on Deck 6
#23	Feb 2	6	Day	All good	4 months	Not heard from outside	Overall good
#24	Feb 2	5	Day	It's good	1 week	Very little noise from outside	Good
#25	Feb 2	9	Day	Gym noise when staying on Dec 6	1 year	No	Overall good
#26	Feb 2	6	Day	It's OK	4 months	Not yet	No
#27	Feb 2	9	Day	Good	6 months	No	No
#28	Feb 2	6	Day	Gym noise	6 months	Nothing heard from outside	Gym noise on Deck 6
#29	Feb 2	5	Day	Good	6 months	No	Deck 5 OK, gym noise when on Deck 6
#30	Feb 2	7	Day	All good	4 months	No	All OK

APPENDIX C INSTRUMENTATION CALIBRATION CERTIFICATION

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-675620-C0D5T5-701

CALIBRATION OF:

Calibrator:	Brüel & Kjær	Type 4231 IEC Class: 1		Serial No.:	3009303

CUSTOMER:

Stantec
155 Hawkville 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: March 5, 2024

Certificate issued: March 5, 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	94.02	0.12
114	113.80	114.20	114.01	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	999.97	0.10

Total Distortion*

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

Calibration Level [dB]*	Accept Limit [%]*	Measured Distortion [%]*	Measurement Uncertainty [%]*
94	1.00	0.48	0.13
114	1.00	0.28	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

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 %.

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

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 %.

HBK
HOTTINGER BRÜEL & KJÆR

Calibration Certificate Number 1568.01
ACCREDITED

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-B6P3Z4-101

CALIBRATION OF:

Sound Level Meter:	Brüel & Kjær	2270	Serial No: 3002024
Microphone:	Brüel & Kjær	4189	Serial No: 3060527
Preamplifier:	Brüel & Kjær	ZC-0032	Serial No: 19025
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 2270-4189.

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

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.
As evidence was publicly available, from an independent testing organization responsible for approving the results of pattern-evaluation tests performed in accordance with IEC 61672-2:2013, to demonstrate that the model of sound level meter fully conformed to the class 1 specifications in IEC 61672-1:2013, the sound level meter submitted for testing conforms to the class 1 specifications of 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 %.