COLORADO ANALYTICS

February 13, 2023

Joshua Leasure, P.E.
4144 Sumter Square
Fort Collins, CO 80525
(970) 673-4383
joshua@coan.co

Jay Sugnet
Housing Senior Manager
City of Boulder
Housing & Human Services
(303) 441-4057
SugnetJ@bouldercolorado.gov

Environmental Noise Analysis

Modular Building Assembly Plant Noise

Dear Mr. Sugnet,

We have conducted an environmental noise analysis for the planned modular building assembly plant building.

In summary, we do not expect noise generated inside of this building to be in violation of the Boulder Municipal Code or to be audible at the nearest residential property line.

Criteria

In section 5-9-4, the Boulder Municipal Code sets a limit of 55 dBA between 7 am and 11 pm on residential properties where sound is received.

No guidance is given on the meaning of “decibels” in the code beyond the use of A-weighting. This leaves a great variety of possible interpretations, especially when considering the time domain. We suggest that the City of Boulder review this section of the code, as this lack of specificity could, in many cases, make it possible to show that a sound is simultaneously in and out of compliance with data from the same measurement.

For this analysis we assumed that the equivalent continuous sound level (Leq) over a period of 1

hour would be appropriate, as this is commonly used in other ordinances.

The Boulder County ordinance makes an exclusion for properties "used for manufacturing, industrial, or commercial business purposes." The numeric limits in the County's ordinance are the same as the City's, so the exclusion makes no difference for this project.

We also considered the potential for audibility of sound from the facility at the exterior of the nearest residences. This was done by comparing the predicted sound from the facility to existing ambient noise levels and looking for frequencies that would exceed ambient by enough to "stick out" to a listener.

For both criteria, we based our calculations on the sound being received at the nearest residence, which is almost directly east of the project site.

Measurements

Our analysis was based on data from two sound monitoring measurements performed between January 10th and January 12th.

First, a monitor was left inside of an existing modular building assembly site for 3 days. The site is in Denver and houses multiple assembly lines that are very similar to what will be at the project site. The monitor was placed on an interior wall, close to an assembly line that was active during the entire measurement. During this time, multiple operations took place close to the monitor.

Due to the monitor's close proximity to both a wall and to the assembly line, the data gathered should be representative of the highest sound pressures we can expect against the exterior walls of the new building and should give us a worst-case view of the sound levels inside the new building.

Second, a monitor was left for 3 days at the far southwest corner of the project site. The data from this measurement gives us a good representation of ambient noise levels in the area for any time of day.

Analysis

To predict the sound power of the exterior panels of the new building resulting from activities inside the building, we followed the ISO 12354-4:2017 standard, titled "Building acoustics – Estimation of acoustic performance of buildings from the performance of elements – Part 4: Transmission of indoor sound to the outside." Our calculations are attached.

For interior noise levels, we used octave bands from one of the highest intervals measured at the existing assembly facility during working hours.

For ambient noise levels, we used octave bands from one of the lowest intervals measured at the project site exterior during working hours.

For our calculations, interior sound levels throughout the new building were considered to be uniform and equal to the sound levels we measured very close to the existing assembly line. This is a very conservative approach as it is unlikely that the entire building will experience noise levels as high as those close to the assembly line.

Each building element was considered separately, including each of the various sizes of industrial roll-up door. We calculated the expected building wall transmission loss values using Insul software. For the roll-up doors, we used Insul to predict an octave-band spectrum for the materials used and then down-graded the resulting TL values to an overall STC provided by the manufacturer of the basis-of-design roll-up door in the project's specifications.

After the sound power of exterior building elements was calculated, sound levels were predicted at the nearest residential property line, to the east. This projection considered distance, air absorption, and "excess attenuation," which is a term that collects various minor effects of sound passing through atmosphere over long distances. These calculations are attached.

Results

Based on all of the above, we predicted noise levels shown in the below tables. We considered separately the noise emitted by both the East and Side building sides. We ignored directionality, which is another conservative assumption.

Leq – Code Compliance	63	125	250	500	1k	2k	4k	dBA
East Building Side to Residence	38	31	25	21	14	6	0	23
South Building Side to Res.	36	29	22	17	11	4	0	20
Total Leq at Residence	40	33	27	22	16	8	3	24

Our predictions are that building noise levels will have an Leq of about 24 dBA, as measured at the nearest residential property line, and only during the loudest periods of operation. This is well below the 55 dBA limit set by the Municipal Code.

To determine audibility, we replaced the Leq values used in the analysis with L10 sound pressure levels for the interior of the building and compared the results to L90 sound pressure levels at the residential property line.

L10 and L90 are statistical levels, often referred to as "Ln", that represent the sound pressure level exceed n% of the time. L90 is the level exceeded 90% of the time and is often used to represent the true ambient sound level of a location. L10 is the level exceeded 10% of the time and can be used to represent the highest noise levels produced by a noise source that is persistent but not continuous.

The measurement periods we used for this analysis are from noon to 6 p.m. on January 11th at both locations. The assembly line was active for this entire period.

Ln - Audibility	63	125	250	500	1k	2k	4k	dBA
East Bldg. Side to Res. L10	33	30	23	18	11	5	0	20
South Bldg. Side to Res. L10	30	27	20	14	8	3	0	17
Total L10 at Residence	35	32	25	19	13	7	3	22
L90 at Residence	48	46	41	36	37	32	25	42
Facility L10 vs Ambient L90	-13	-14	-16	-17	-24	-25	-21	

Our prediction shows L10 noise levels from the facility at least 13 dB below L90 ambient levels at the nearest residential property line in all frequencies. We do not expect noise from inside the assembly building to be audible at the nearest residential property line.

Conclusion and Recommendations

We expect the limits set by the Municipal Code to be met by a large margin when considering noise received at the nearest residential property line.

At the same location, we expect noise generated inside of the project building to be below audibility.

Our calculations assumed the doors to the building were closed – opening the doors could have a different result. Our recommendation is to require that the overhead doors on the project building remain closed while the assembly lines inside are in operation.

We appreciate the opportunity to assist you with this project. Our calculations and relevant information are attached.

Sincerely,

Joshua Leasure, P.E.
Principal

Attachments