

March 15, 2026

Howell Township Planning Commission  
3525 Byron Road  
Howell, MI 48855

To the members of the Howell Township Planning Commission,

The following information on decibel limits and noise is being provided for consideration from the Howell Township Resident Research Committee (RRC).

### **DECIBEL LIMITS & NOISE RESEARCH**

**The following information on decibel limits is being provided by the RRC so that the planning commission has information and research available for reference on sound/noise related to high impact land uses including data centers, cryptocurrency mining and the impact they have on surrounding areas.**

#### **Suggested Limits and Requirements are as Follows:**

- All sound studies shall include a full, unweighted  $\frac{1}{3}$  Octave Band analysis.
- A maximum of 70dB(Z), 55dB(C), and 55dB(A) shall be required of all high impact land uses. All octave bands 125Hz and below shall not exceed 60dB(Z).

#### **Analysis of Infrasound Impacts, Regulations, & Recommendations:**

One of the most frequent complaints from communities with hyperscale data centers, multiple data centers, or cryptocurrency mining facilities, is that of noise. Yet, at quick glance, one passing by may not think much of the low, steady hum of the cooling equipment utilized by these facilities. It is frequently mentioned how 60 decibels is approximately the level of a normal conversation... There are clearly other, louder sources of noise in industrial areas, so what could possibly be the issue? It seems easy to brush this off as nothing more than an excuse to complain from a bunch of NIMBYs.

Aside from the fact that constant, tonal noises are much more of a nuisance than transient sounds, such as a passing train or an airplane lifting off, the sounds emitted by data centers are loaded with low-frequency sound waves. Low frequencies are generally considered to be in the 20Hz-200Hz range, and Infrasound being the frequencies that fall below 20Hz. Although some individuals report being able to hear infrasound as low as 12Hz, 20Hz is generally considered to be the lower threshold of human perception. Low frequencies are also not perceived at the same level of loudness, which is why most sound measurements are done in A-weighted decibel units, which adjusts the measurement to primarily reflect the more perceptible frequencies in the range of human hearing by filtering out low frequencies. This results in a wildly inadequate measure of potential physical harm to anything other than hearing loss. As one study explains, "The A-weighted acoustic measuring method is specifically designed to diminish the inaudible part of the acoustic spectrum. As a result, an exposure to a

high-level 100dBz infrasound signal with a frequency of 16Hz would measure merely 45dBA, deeming it acceptable according to many of the present-day noise regulations” (6). There are other weighting scales used to better reflect the perceptible impacts—both auditory and physical—of low-frequencies and infrasound. As an example, C-weighted decibels, dB(C), is a weighting scale used to adjust for the audible sensations and physical perceptions of low frequencies.

Noise generated by newer high impact land uses such as data centers and cryptocurrency mining facilities comes from generators, cooling equipment, and in some cases, on-site power generation such as gas turbines. These are all significant sources of Low Frequency and Infrasound; generators often operate around 75Hz, cooling equipment between 48 and 98Hz, and gas turbines around 25Hz (9). Another study concludes high decibels (110-132dB(Z)) of infrasound frequencies ranging from 1-12Hz can be found near diesel engines, turbines, piston pumps, compressors, fans, and other large air-blowing machines (6).

Just because we can't necessarily hear many of the lowest frequencies, and don't perceive those that we do as being particularly loud, does not mean they aren't problematic. This can be clearly understood with an analogy to light and vision used in a paper by Alves-Pereira & Branco: “Within electromagnetic spectrum, the human eye perceives light in a certain range of frequencies, just as within the acoustical spectrum, the human ear perceives sound in a specific range of frequencies. There exist electromagnetic phenomena that are not perceived by any of the human senses during actual exposure (e.g. X-rays), and yet, excessive exposure to X-rays can cause severe biological damage” (3). They also say it is a “...scientifically unsubstantiated, but prevalent, notion that noise only affects hearing”. Low frequencies emitted at a high sound pressure level (flat, or unweighted, decibels), are still being received by our bodies, and those vibrations do produce physiological effects.

So, let's take a look at what sort of effects low frequencies and infrasound can have on the human body (there is also research about the effects on animals as well as plant life, which we have not yet fully explored, but for which there is existing information). There are seemingly countless studies documenting the connection between low frequency noise and various ailments in humans, stretching back decades. Complaints from those affected include reports of sleep disturbances, fatigue, annoyance, stress, hypertension, concentration deficits, mood swings, digestive issues, psychiatric disturbances, headaches, severe joint pain, neurological disturbances including late-onset epilepsy, balance disturbances such as dizziness and vertigo, progressive neurological deterioration, endocrine disorders, changes in cardiac rhythm, cardiac arrhythmias, reduction in the force of contraction of the heart muscle, malignant tumors, autoimmune disease...all of this, at statistically-significant levels above the general population's incidences (1, 2, 3, 6).

This is clearly a wide-ranging collection of problems, so we would like to break it down by summarizing a few of the studies:

1. A 2023 article in the peer-reviewed International Journal of Environmental Research and Public Health found that all participants exposed to low-frequencies felt a number of wide-ranging complaints of hearing humming, droning, and buzzing, feeling sensations such as ear pressure, and perceiving vibrations in their torso and limbs. The average rating, on a scale from 1 to 10, on the impact on their daily living was quite high at 7.1 out of 10. These disturbances impacted sleep, caused them to spend less time in their homes, impacted their ability to work, and resulted in overall less full-time work, and even impacted

relationships. Another notable finding was that the perception was impossible to escape; participants used earplugs, noise-cancelling headphones, tried to mask it with white noise, TV, or radio, closing windows, insulating walls, changing sleeping location or relocating their bed, placing their mattress on dampening materials, and even medicating. And yet, the perceptions persisted.

2. A 2010 paper in the journal “Neuroscience” notes that being in the presence of infrasound has been shown to spike cortisol levels. Cortisol is the “stress hormone”, and elevations in cortisol result in occurrences of stress and hypertension, as well as contributing to vestibular issues like vertigo, nausea, and loss of balance. They measured cortisol and rated their subjects’ stress and annoyance before, during, and after being exposed to two hours of low or flat frequency spectrum noises, both at a level of just 40dBA, on two different occasions. This confirmed physiological evidence of increased stress and neuroendocrine activity. Note that *the A-weighted decibels were just 40dB(A)...*
3. A 2007 study published in Hearing Research noted that high levels of infrasound produces large movements of cochlear fluid, and when combined with a 4kHz (4,000Hz) octave band of noise, it can cause high-frequency hearing loss. This is notable, because especially in the context of high impact land uses such as data centers and cryptocurrency mining facilities, low-frequencies do not often exist alone. While high levels of 4kHz octave band frequencies alone can cause hearing damage, that damage is exacerbated when combined with low frequencies.
4. A 2021 study in Noise & Health looked into the effects of infrasound on human myocardial contractility—the force of heart contractions. They found that the higher the dBZ, the weaker the cardiac contraction force. Exposure to high levels of infrasound (over 100dB(Z), which—as mentioned above—may measure as low as 45dB(A), depending on the exact frequency), affects cardiac muscle in as little as one hour. The authors also note that because lower frequencies have longer wavelengths, they reflect, refract, diffract, and resonate more than higher frequencies of more audibly-perceptible sound frequencies. This means infrasound and low-frequency sounds move through and around obstacles like buildings and terrain, while maintaining energy even after traveling very long distances. As such, common noise barriers utilized are often ineffective against them. Also, the decibels of infrasound can actually increase inside residential rooms, especially through open windows or ventilation ducts, because enclosed spaces condense the waves’ energy by means of resonance. It can reach up to 25dB(Z) higher than the measured level outside, and explains why people may complain about the effects despite not being in direct vicinity of the source. The authors also cited a study by Karpova et. al., who tested the effects of infrasound on healthy, young men and found that mental stress, vegetative reactions, and unpleasant auditory sensations occurred within 1 minute of exposure. Within 15 minutes, additional symptoms including fatigue, dizziness, depression were noted. They, too, observed changes in cardiac rhythm, arrhythmias, and a reduction in the force of contraction of the heart muscle.

5. One of the most thorough articles we reviewed is a 2007 study in the journal *Progress in Biophysics and Molecular Biology*, titled “Vibroacoustic disease: Biological effects of infrasound and low-frequency noise explained by mechanotransduction cellular signalling”. Vibroacoustic disease (VAD) is a “whole-body pathology that develops in individuals excessively exposed to infrasound and low-frequency noise”. It was seemingly originally diagnosed within the aeronautical and other heavy industrial uses, but is increasingly being diagnosed in the general population as new sources of infrasound begin to grow in our communities (such as wind turbines, data centers, cryptocurrency mining facilities, and the like). The findings of this study involve abnormal growth in cells that thickens blood vessels, affects cardiac structures, as well as in the cells of the trachea, lungs, and kidneys of VAD patients and animals. They studied a group of 306 aircraft technicians, and found all of them had abnormal pericardial and/or cardiac valve thickening. In this group, 10% of them presented with late-onset epilepsy, when the general population was just 0.2%. It was determined back in the early ‘90’s that infrasound and low frequency noise (ILFN) was the agent for disease for aircraft technicians. In the mid-‘90’s, animal studies showed the respiratory tract could be a primary target for ILFN, with studies finding abnormal amounts of fibrosis in the trachea and lungs, damaged tracheal and bronchial cilia, among other abnormalities. At this same time, in addition to epilepsy, other neurological disorders were identified in ILFN-exposed populations as well: palmo-mental reflex (usually only seen in newborns and the elderly), balance disturbances, and facial dyskinesia. They tracked the development of VAD symptoms over the course of many years and charted them into stages. The symptoms in these stages were identified in over 50% of the aircraft technicians. Stage 1, which is 1-4 years of exposure, typically results in slight mood swings, indigestion, heart burn. Stage 2, from 4-10 years, brings chest pain, definitive mood swings, back pain, fatigue, fungal, viral, and parasitic skin infections, inflammation of the stomach lining, pain and blood in urine, conjunctivitis, and allergies. Stage 3, over 10 years, involved psychiatric disturbances, hemorrhages of nasal, digestive, and conjunctive mucosa, varicose veins and hemorrhoids, duodenal ulcers, spastic colitis, decrease in visual acuity, headaches, severe joint pain, intense muscular pain, and neurological disturbances. There were additional, statistically significant symptoms occurring well above the general population incidences, experienced by fewer than 50% of the aircraft technicians, including: respiratory problems, late-onset epilepsy (whose seizures subsided when away from work), progressive neurological deterioration and early aging, endocrine disorders, malignant tumors (often multiple different types at once), among other problems. It might be tempting to brush off this data, as the levels of low-frequencies must surely be higher than that of high impact land uses such as data center or cryptocurrency mining facilities, but as you’ll see in the conversion decibel weighting conversions chart below on page 7—even seemingly-reasonable dB(A) levels can result in astonishingly high dB(Z) levels of low-frequencies...on par with, if not exceeding, that which the airline technicians were exposed to.

To address the question – what to do about this – we are lucky to have the opportunity to not only address, but hopefully prevent this problem proactively, before the community is subjected to unsafe levels of sound that lead to any number of the ailments outlined above. Some of the studies referenced have also provided recommendations for prevention of harm.

### **Additional Recommendations for Prevention of Harm:**

- Conduct noise assessments, before any development is permitted. Specifically, for existing dB(C) and dB(Z) levels in the township, particularly in the industrial area and in the residential areas in the closest vicinity to the proposed High Impact Land Use Overlay District. The current, pre-development low-frequency and infrasound levels must be documented before any data centers come to town.
- The assessment should include a 1/3 Octave Band analysis, with no weighting (ie, in Linear Decibels/dB(Z)), down to the lowest frequency the equipment is able to detect, ideally including the lowest 1/3 octave bands.
- If a spectral analysis is not possible, the dB(C) and/or dB(Lin/Z) Leq measurements should be performed, under real-world conditions.
- An absolute maximum of 80dB(Z) should be the limit on infrasound in the ordinance, as that is the threshold for significant symptoms to begin with chronic exposure.

Given the nature of low frequency sounds, especially with regard to resonance and traveling long distances, we were inclined to suggest even lower than that. But, we wanted to see what other ordinances have already set as their limits.

### **Examples from Ordinances:**

6. Fort Lauderdale, FL, includes some context in their ordinance:

“Unlike standard dBA measurements, which primarily detect mid-range sounds like speech and traffic, dBC measurements capture deeper, low-frequency noises such as bass from music or heavy machinery. These sounds can travel farther and penetrate walls, making them more disruptive in residential areas. Adding dBC limits ensures that noise enforcement addresses all types of sound, improving fairness and effectiveness”.

They include both dBA and dBC, and for Commercial and Industrial uses, differentiate between indoor and outdoor limits. They also note that measurements are to be taken 5 feet from the building or structure, to ensure a clear, consistent standard. However, their Industrial limit is 85dB(C) during the day and 75dB(C) at night, both of which exceed the evidence-based recommendation of no more than 80dB(Z), mentioned above. (Residential outdoor limits are 70dB(C) day, and 60 dB(C) night; indoor is lower, at 55/45dB(C).

**7. Fort Pierce, FL limits sounds by use-occupancy of receiving properties. For residential properties, that limit is 55 dBA, C, and Z; Commercial properties are 60 dBA, C, and Z; and Industrial properties are 65 dBA, C, and Z. They go further, and specifically regulate low-frequency and infrasound octave bands (31.5, 63, and 125 Hz), all which must not exceed 65dB. This approach appears to be the most evidence-based and comprehensive attempt we have seen to account for frequency variations of perceived loudness, and ensure residential properties are adequately protected from low-frequency noise.** It is important to note the difference in regulating from a sending property versus a receiving property.

8. The Wisconsin Citizens Safe Wind Siting Guidelines recommend that the dBC from wind turbines shall not exceed 50dBC at residences, or 55 near highways, or a

difference between dBC and dBA over 20dB, whichever is lower. Wind Turbines are a significant source of infrasound, with an increasing amount of data and research.

9. The Wind Energy Conversion Systems Zoning Ordinance says not to exceed 45dBA or 55dBC Lmax.

As you can see, there are a variety of approaches to consider and to put into context of the research. To recap the research: an absolute maximum of 80dB(Z) for infrasound (frequencies less than 20Hz) is recommended, as that is the point at which *perceptible* symptoms begin. Many places include dB(C) and dB(A), and even dB(Z). Some locations limit sound from the sending property, others set limits at the receiving properties.

To help visualize what limits will accomplish the desired outcome without being mutually exclusive or impossible to achieve, we have constructed a chart, based on the standard A and C weighting curves (10), to illustrate how different limits affect unweighted low frequency and overall community impact. The numbers in red indicate an unsafe (unweighted) noise level. The darkest gray boxes are the 1/3 octave bands in the infrasound range, while the lighter gray boxes are low-frequency octave bands.

### Decibel Weighting Conversions by Frequency

| Octave Band (Hz) | 70dB(C)→Z | 60dB(C)→Z | 55dB(C)→Z | 55dB(C)→dB(A) | 70dB(A)→Z | 55dB(A)→Z |
|------------------|-----------|-----------|-----------|---------------|-----------|-----------|
| 1                | 122.5     | 112.5     | 107.5     | -41.1         | 218.6     | 203.6     |
| 6.3              | 91.3      | 81.3      | 71.3      | -14.1         | 155.4     | 140.4     |
| 8                | 87.6      | 77.6      | 72.6      | -5            | 147.6     | 132.6     |
| 10               | 84.3      | 74.3      | 69.3      | -1.1          | 140.4     | 125.4     |
| 12.5             | 81.3      | 71.3      | 66.3      | 2.7           | 133.6     | 118.6     |
| 16               | 78.4      | 68.4      | 63.4      | 7             | 126.4     | 111.4     |
| 31.5             | 73        | 63        | 58        | 18.5          | 109.5     | 94.5      |
| 63               | 70.8      | 60.8      | 55.8      | 29.6          | 96.2      | 81.2      |
| 125              | 70.2      | 60.2      | 55.2      | 39            | 86.2      | 71.2      |
| 250              | 70        | 60        | 55        | 46.3          | 78.7      | 63.7      |
| 500              | 70        | 60        | 55        | 51.8          | 73.2      | 58.2      |
| 1000             | 70        | 60        | 55        | 55            | 70        | 55        |
| 2000             | 70.2      | 60.2      | 55.2      | 56.4          | 68.8      | 53.8      |
| 4000             | 70.8      | 60.8      | 55.8      | 56.8          | 69        | 54        |
| 8000             | 73        | 63        | 58        | 56.9          | 71.1      | 56.1      |
| 16000            | 78.6      | 68.6      | 63.6      | 56.9          | 76.7      | 61.7      |
| 20000            | 81.3      | 71.3      | 71.3      | 62            | 79.3      | 64.3      |

The octave band frequency spectrum includes all the infrasonic and low-frequency 1/3 octave bands (125Hz and below), and 1/1 octave bands for everything above. We converted levels of 70dB(C), 60dB(C), and 55dB(C) to flat, zero-weighted decibels. The unweighted decibels that exceed the maximum safe level of 80dB(Z) are noted in red. The C-weighted decibels clearly do a much better job of reflecting the impact of low-frequency and infrasound. A limit of 55dB(C) ensures virtually all but the absolute lowest frequencies will remain at safe levels. The incredible inadequacy of A-weighting is illustrated here in the two columns to the furthest right; at the current Industrial zoning limit of 70dB(A), infrasound and low frequencies

may still be astonishingly, and dangerously strong. It is especially interesting to notice how lowering dB(A) all the way to 55dB(A) will not make a significant change to the overall low-frequency impact on the community if the sound is primarily composed of low frequencies and infrasound; virtually *all* low frequencies could potentially be dangerously high. Combine this data with the fact that low frequency wavelengths are not easily buffered or mitigated by barriers or atmosphere, it is clear to see why residents, even those several miles away from sources of low-frequency noise (like that from high impact land uses such as data centers, crypto currency mining facilities, and the like), report problems despite the facilities meeting the seemingly-reasonable dB(A) limits in applicable ordinances.

Based on this chart, a limit of 55dB(C) appears to be the highest threshold where most of the low frequencies and infrasound will not pose a threat to the community. For further comparison, we also converted it to dB(A), as seen in the column labeled “dB(C)—>dB(A)”. You can see that you would need impossibly-low dB(A) limits to adequately address low frequencies and infrasound. Additionally, you can see the frequencies that are the most audibly-perceptible to humans (500-8,000Hz) are comparable between the two weightings: they are both in the 55dB(A) range, which is in line with the original intent of a 55dB(A) limit. In other words, 55dB(C) will ensure *both* the low-frequency physical impacts and the mid-range frequency (audible) impacts are compatible with the community. While dB(C) is clearly the primary metric to regulate, including a dB(A) limit will ensure the tonal and continuous, audible noises emitted from a data center and other high-impact land uses do not pose an audible nuisance to the community, either.

To further ensure that there are not a significant amount of low-frequency sounds impacting the community, establishing a dB(Z) limit will help cover those <10Hz frequencies. An overall limit of 70dB(Z) is compatible with the ideal 55dB(C) limit, and will provide an additional layer of protection for the community from nuisances related to data center and high-impact land uses. However, as one of the studies above noted (and it is widely acknowledged in the scientific community), low frequencies have a tendency to resonate and therefore amplify their sound levels in enclosed spaces. To understand this, think of two guitars: one electric guitar (that is not plugged in or amplified), and one acoustic guitar. The body of the electric guitar is flat and solid. When you pluck a string on an electric guitar that is not plugged in, the sound is relatively soft. Now, picture an acoustic guitar: its body is hollow, and there are holes near the strings. These holes are not merely decorative, they are strategically placed to allow the sound from the string to enter into the hollow body of the guitar. The sound waves enter the body of the guitar, where they resonate... and amplify. This is why an acoustic guitar is magnitudes louder than an unamplified electric guitar. This means, if a 70dB(Z) low-frequency sound wave travels the relatively short distance to a nearby residence and enter through windows or ventilation ducts, that low frequency or infrasound wave may amplify by up to an additional 20+dB(Z)— *a 100-times greater intensity*—suddenly subjecting them to unsafe levels *in their own home*, even if the decibels outside are reasonable. This likely explains why noise complaints are one of the most common reasons for resident lawsuits against their cities for data centers; most noise ordinances do not adequately account for low frequency, and certainly not for the potential for resonance. To prevent this and protect the community from the far-reaching impacts of low-frequency sound waves, given that 80dB(Z) is the absolute maximum the current research shows as being safe, setting a lower limit of 60dB(Z) for low-frequency octave bands, a strategy Fort Pierce, FL employs, would ensure residents will remain safe and comfortable in their homes.

Therefore, we feel the best approach to ensuring the community is adequately protected from high levels of continuous, tonal, low-frequencies, is to set the following limits which must *all* be (and as the chart illustrates, can be) met:

- 70dB(Z) maximum for octave bands >125Hz; 60dB(Z) maximum for all octave bands <125Hz
- 55dB(C) maximum
- 55dB(A) maximum

Given how far infrasound and low frequencies travel without being attenuated by atmosphere or environment (potentially, hundreds of miles (11)), if the intent is to ensure levels do not exceed safe limits at the relatively-nearby residential properties, the limits at the high impact land use property lines should be set at these levels. Fort Pierce, FL appears to do almost exactly this, and is among one of the only ordinances which appear to take a genuinely evidence-based approach. Their ordinance sets limits at receiving property lines, but we feel that would add a lot of complexity to enforcement. It is important to keep in mind that when far-reaching, low frequencies get trapped indoors, they resonate and may become amplified by 10-20dB(Z), which represents a ten to one-hundredfold increase in intensity. For that reason, the township may wish to consider setting dB(Z) for low-frequency octave bands even lower, to 60dB(Z), which would bring Howell Township’s ordinances closer in line with the limits that Fort Pierce, FL has established, and our research supports, to be acceptable for receiving residential properties to be exposed to.

**Examples in Other Ordinances & Guidelines:**

6. Fort Lauderdale, Florida:

“Unlike standard dBA measurements, which primarily detect mid-range sounds like speech and traffic, dBC measurements capture deeper, low-frequency noises such as bass from music or heavy machinery. These sounds can travel farther and penetrate walls, making them more disruptive in residential areas. Adding dBC limits ensures that noise enforcement addresses all types of sound, improving fairness and effectiveness”.

|                      | Day     | Night  |
|----------------------|---------|--------|
| Residential outdoor: | 70dBC   | 60dBC  |
| Residential indoor:  | 55dBC   | 45dBC  |
|                      | Outdoor | Indoor |
| Commercial:          | 75dBC   | 65dBC  |
| Industrial:          | 85dBC   | 75dBC  |

-Noise measurements to be taken 5ft from building/structure/establishment-clear, consistent standard

-Noise complaints are assessed from property line of complainant, and at the noise source

**7. Fort Pierce, Florida:**

**-Low-frequency octave band limits: 31.5Hz, 63Hz, 125Hz- must not exceed 65dB**

**-Sound limits by use-occupancy of receiving property:**

|                    | <b>dBA</b> | <b>dBC</b> | <b>dBZ</b> |
|--------------------|------------|------------|------------|
| <b>Residential</b> | <b>55</b>  | <b>55</b>  | <b>55</b>  |
| <b>Commercial</b>  | <b>60</b>  | <b>60</b>  | <b>60</b>  |
| <b>Industrial</b>  | <b>65</b>  | <b>65</b>  | <b>65</b>  |

**8. Wisconsin Citizens Safe Wind Siting Guidelines:**

1. dBC from Wind Turbines anywhere on non-participating properties shall not exceed the lower of either:

- -maximum 50dBC at residences,Maximum 55dBC near highways
- -dBC-dBA L90A > 20dB

2. If modeling or testing at any time shows dBC-dBA > 10 dB, a frequency analysis shall be performed to determine the source and nature of the low frequency sound.

- L90 is noise level exceeded for 90% of the time of the measurement duration (used to determine ambient/background noise level)

**9. Wind energy Conversion Systems Zoning Ordinance:**

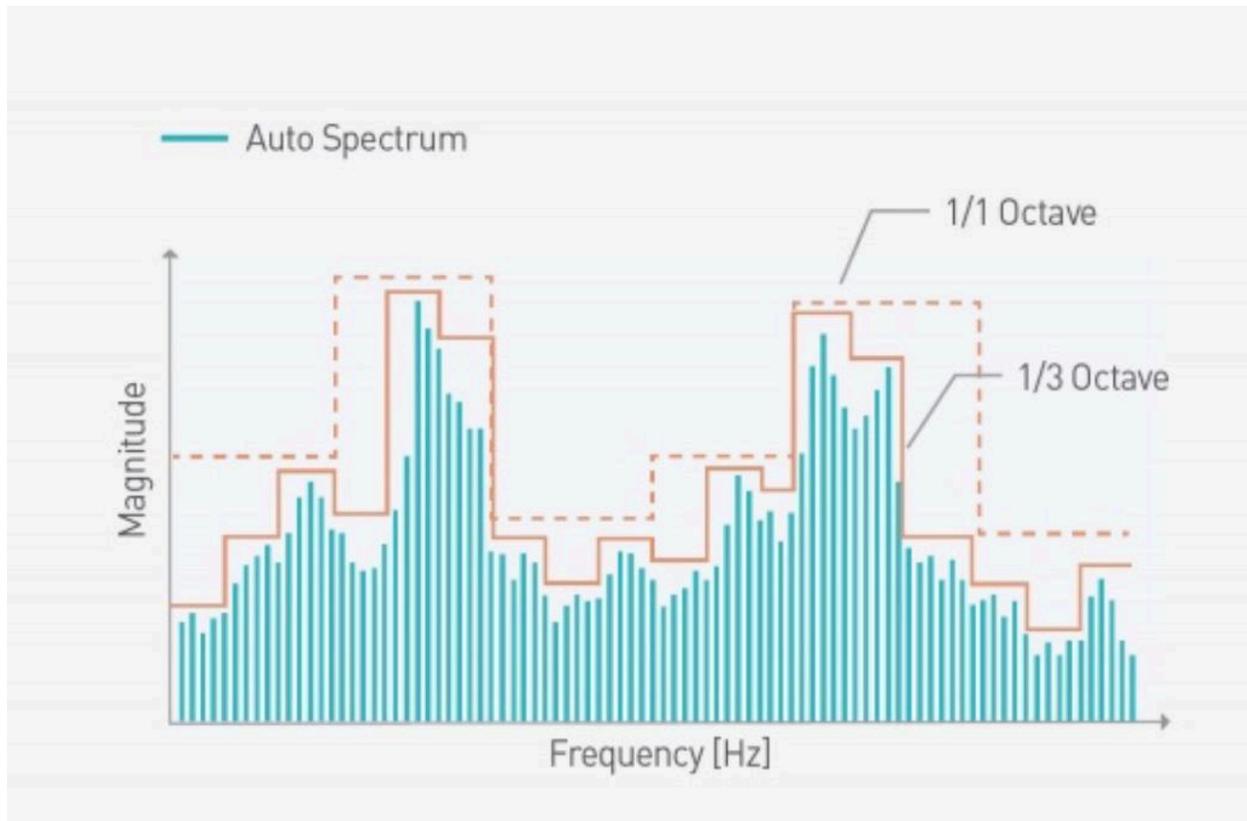
1. 45dBA, or 55dBC Lmax- exceeding either is considered a nuisance

**Additional Notes on Octave Bands:**

Most people are probably familiar with an “octave” in music—from one note to another of the same sound, but with an exact doubling of pitch, or frequency. The acoustical frequency spectrum is often similarly broken up into octaves, where the upper frequency is double that of the lower frequency. Most noises have a variety of frequencies within them; performing an octave band analysis helps illustrate which frequencies are being projected the loudest. Octave bands can be further broken into thirds, and the 1/3 Octave Band analysis provides a more detailed breakdown of the types of frequencies emitted from a noise source.

This is useful to understand, because while the chart above contains conversions of various A and C-weighted decibels into flat decibels, it is important to remember that, for example, a noise which measures 60dB (of any weighting) does not mean it contains all of the frequencies in the spectrum, nor are all of the frequencies which are emitted being projected at the same force or volume.

The image below from Daeil Systems (10) illustrates this concept:



The blue bars show the various frequencies emitted from a noise sample. You can see how there is a great deal of variability in magnitude (or “volume”) of each frequency in the spectrum. The 1/1 Octave Bands are outlined in the orange, dashed lines. The  $\frac{1}{3}$  Octave Bands are outlined in the solid, orange lines. You can see how the  $\frac{1}{3}$  octaves more closely resemble what is actually being emitted by the noise as compared to the 1/1 octaves, which are much more generalized.

By requiring sound studies and monitoring to include a full  $\frac{1}{3}$  Octave Band analysis of unweighted sound levels, the township will be able to see the actual impact of infrasound and low-frequencies, and how they are contributing to the overall decibel levels being emitted. If, despite the township’s noise ordinances, residents are still reporting disturbances (especially related to low-frequencies), this type of analysis will be able to confirm the nature of the nuisance, and will help inform the township in revising their ordinances to adequately address any ongoing complaints.

#### Sources:

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3. Effect of infrasound on cochlear damage from exposure to a 4kHz octave band of noise (Gary W Harding, Barbara A. Bohne, Steve C. Lee, Alec N. Salt) <https://www.sciencedirect.com/science/article/abs/pii/S0378595507000329>

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6. Fort Lauderdale, FL: <https://www.fortlauderdale.gov/government/departments-a-h/community-services/community-enhancement-and-compliance/enhancement-and-compliance/noise-ordinance>
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8. Wisconsin Citizens Safe Wind Siting Guidelines: <https://www.wind-watch.org/documents/wisconsin-citizens-safe-wind-siting-guidelines/>
9. Wind Energy Conversion Systems Zoning Ordinance: <https://www.wind-watch.org/documents/wind-energy-conversion-systems-zoning-ordinance/>
10. Daeil Systems Octave Band Chart: <https://www.daeilsys.com/support/technical-notes/generic-vibration-criteria/>
11. Georgia Tech, Infrasound: <https://www.gtri.gatech.edu/newsroom/infrasound>