

May 26, 2016

Mr. Michael Wood
Burrillville Town Manager
105 Harrisville Main St.
Harrisville, RI 02830

Reference: L-2024-051816-A

Subject: Invenergy Clear River Energy Center
Facility Noise and Community Noise Impacts

Dear Mr. Wood:

As you know, we have reviewed the initial noise study submitted with Invenergy's permit application for the Clear River Energy Center (CREC) project and their responses to subsequent data requests. At this point we are generally comfortable with what is being proposed in the sense that Invenergy has been appropriately responsive and has committed to an acoustical design that, as long as it's fully realized, should lead to minimal and most likely acceptable community noise levels during all operating modes.

Summarized below are our opinions and views on some specific noise issues we feel are important to the Town.

Town Noise Ordinance Compliance – Overall A-weighted Limits

Section 16-39 of the Burrillville Noise Ordinance restricts the sound emissions from the plant (or any source) to 53 dBA during the day and 43 dBA at night. For a source that will operate around the clock, at least at times, the nighttime limit of 43 dBA is the effective design limit. This level is unusually low and restrictive because essentially all known State and local ordinances and regulations do not go below a limit of 45 dBA at night. Consequently, we believe that compliance with such a low level at all of the nearest residences will be adequately protective of the community. To put it in context, a sound level of 43 dBA is low in absolute terms and might be the sound level that is found in a typical conference room or library and it is also low in relative terms compared to the existing background sound level at the nearest residences, which was

measured by Invenergy's acoustical engineer to range from about 41 to 49 dBA. This means that during the quietest overnight hours, when 41 dBA was measured, a plant sound level of 43 dBA will be unobtrusive, if not entirely imperceptible relative to the background level at the nearest residences on Wallum Lake Road. Because of the way decibels add logarithmically the new total would theoretically be 45 dBA (and *not* 84 dBA, as might be imagined). A new source generally has to exceed the prevailing background level by about 5 dBA or more before it starts to become noticeable, so we would not expect a sound level of 43 dBA (attributable solely to the plant) to be intrusive or even perceptible relative to the minimum observed background level of 41 dBA. Consequently, it should subjectively sound about the same as it does now at the nearest residences, even in the middle of the night. By "the same" we mean that noise from the compressor station will continue to be what is heard and the CREC will be quiet enough that it is essentially covered up by existing sounds, even in the absence of road traffic.

At the next nearest residences in other directions somewhat lower facility sound levels can be expected simply because they are further away than the closest residences on Wallum Lake Road - which is the effective design point for the plant and where the Ordinance limit of 43 dBA must be met. These lower levels are on the order of 40 dBA or less, which is extremely quiet. Many years of experience with power plant noise indicates¹ that such a sound level is so low in absolute terms that disturbance is highly unlikely - even in rural environments where the background sound level is essentially negligible, as it appears to be at locations like Doe Crossing Drive and Jackson Schoolhouse Road. Consequently, we would not expect any issues at any other residences, despite the absence of any significant masking noise, so long as the facility is meeting the Ordinance limit at the closest houses on Wallum Lake Road.

Town Noise Ordinance Compliance – Octave Band Limits

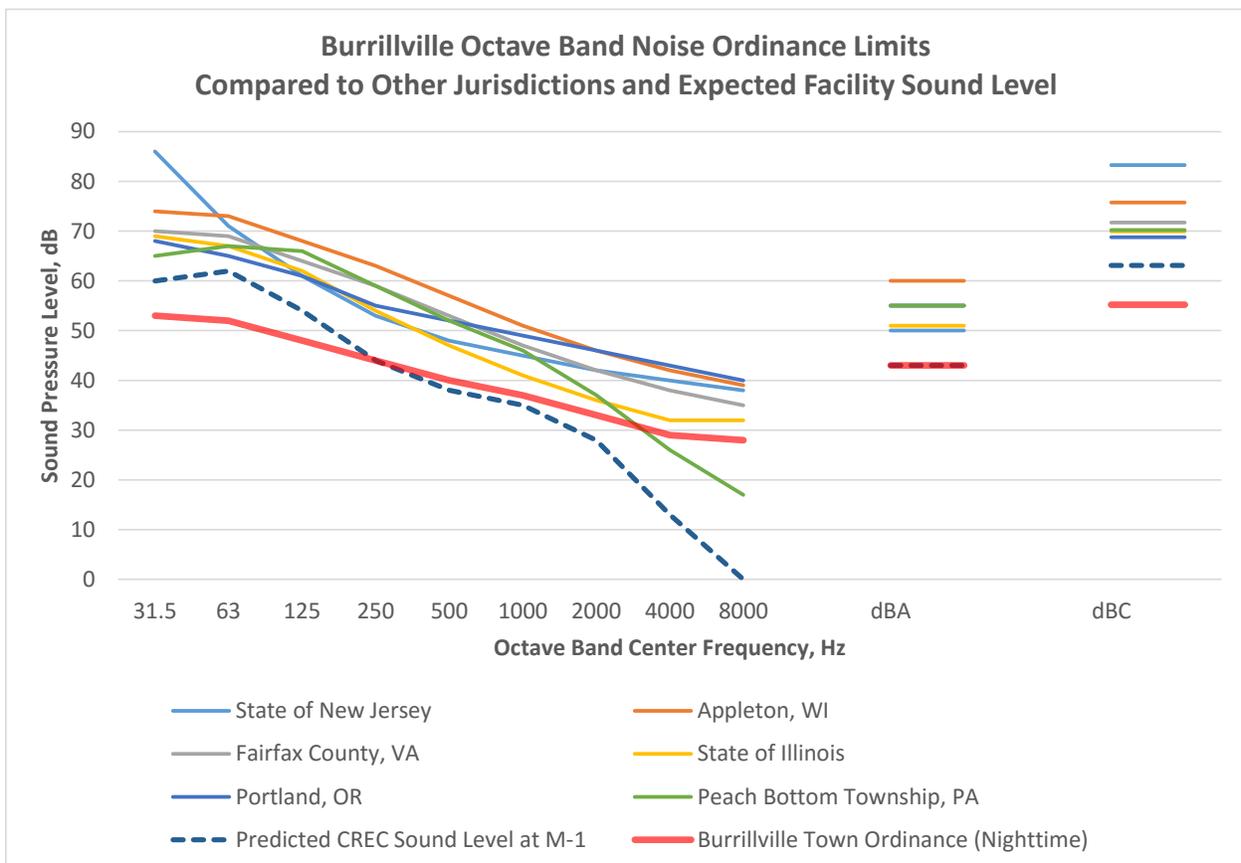
In addition to the overall A-weighted sound limits, the Town Ordinance also contains a restriction on the frequency content of the sound in the form of nine octave band limits, each covering a section, or band, of the audible frequency spectrum. In general, octave band limits are fairly uncommon because, among other things, it takes somewhat sophisticated instrumentation to measure them, they add technical complexity to what would otherwise be a fairly simple regulatory statute and they effectively impose 10 noise limits (9 octave bands and the overall A-weighted limit) on an applicant or noise generator instead of one. Their only real usefulness is in placing very specific limits on low frequency noise; i.e. below about 125 Hz, and even that could be handled by other means (a C-weighted limit, for example).

In this particular case, there is no need for a special restriction on the lower frequencies, or on any other frequencies, because combined cycle plants like the CREC do not produce problematic levels of low frequency noise and more generally emit a bland, broadband sound that is evenly spread

¹ A conference paper I wrote some years ago on this very topic is attached for reference: Hessler, D. M., "Recommended Noise Criteria for Siting Industrial Facilities Near Residential Communities with Extremely Low Ambient Sound Levels", Noise-Con 2005, Minneapolis, MN, Oct. 2005.

across the frequency spectrum; a sound that is not typically considered noticeable or intrusive at the levels and receptor distances associated with this project. Other types of plants, such as simple cycle gas turbines and gas compressors, on the other hand, do commonly generate excessive and detrimental levels of low frequency noise, but the boilers associated with combined cycle plants act, coincidentally, as expansion chamber mufflers (like very large car mufflers), which, because of their physical size, happen to be effective at breaking up long wavelength low frequency noise coming from the gas turbine exhaust. Consequently, in our decades of experience designing and testing combined cycle plants we have never seen complaints or issues specifically associated with low frequency noise, irrespective of the plant sound level at nearby neighbors or its proximity to sensitive receptors.

In addition to this it is important to realize that the octave band limits contained in the Town Ordinance, especially in the lower frequencies, are well below all the other octave band regulatory limits that we're familiar with. The chart below shows a series of nighttime octave band noise limits from a variety of jurisdictions compared to the Town's limits (thick red line).



This graphic shows that the Town's limits are well below what might be considered the norm, but, more to the point, there is no actual need for the limits to be this low. The expected plant sound level at the closest residences is shown as the blue dotted line. Although it's not intuitively obvious, the plant would not be any less audible or sound any quieter if its sound levels in the three lowest octave bands were equivalent to the Ordinance rather than over the limits as currently predicted because, in a nutshell, the human ear is not very sensitive to frequencies below about 200 Hz, so the facility would effectively sound the same either way. In fact, subjective audibility is basically quantified by the overall A-weighted sound level and both the Ordinance spectrum and the plant sound spectrum in the chart both total up to 43 dBA, indicating that the sounds are of the same subjective magnitude. This overall limit of 43 dBA fully serves the purpose of limiting the project's noise to an acceptable level in the community. Invenenergy has repeatedly argued that it is not feasible to meet the lower octave band limits and they have asked for a waiver on the octave band requirements. This is a legitimate assertion and a legitimate request. We would agree that it is probably technically impractical - and would add that it would do nothing to reduce the subjective audibility of the plant if it were.

Facility Noise during Plant Start-ups

In the noise study in the initial permit application the sound emissions from the plant were evaluated during normal steady-state operation at full load. While this sounds like it would be the time when the plant produces its maximum noise, it isn't. Combined cycle plants have to go through a warm up period when they start-up that generally takes anywhere from 40 minutes to 2 hours. During this time there are various processes that occur that, if inadequately mitigated, can result in substantially higher noise levels during this period, which is often in the early morning hours (5 to 6 a.m.) when additional noise is clearly undesirable.

There is no proviso in the Burrillville Ordinance, or in any other regulatory statute, that makes an exception for start-up noise or distinguishes between different operating modes. In fact, all noise ordinances are mute on the subject, which implies that the limit is the limit irrespective of what process happens to be occurring at the plant.

Despite the fact that regulatory noise limits implicitly cover all non-emergency operating modes, start-up noise, or the potential for it, is not commonly brought up in noise impact studies prepared for permit applications - or is swept under the rug as a short-lived and intermittent noise of no consequence. We believe there are several reasons for this:

- Start-up noise is frequently specifically excluded from contractual noise guarantees; i.e. the performance guarantees between a plant owner and the company that actually builds the plant for them normally specify the maximum permissible sound level from the facility during normal, full load operation only. Start-up, shutdown and transients are usually excluded; even, sometimes, in cases where they shouldn't be, such as when a state or local noise limit exists.

- The potential for louder facility noise emissions during start-up is something that might be perceived as a negative in the eyes of permitting authorities. Moreover, the very possibility of higher noise levels during start-up is an esoteric fact that only those intimately familiar with power plants are even aware of – so why unilaterally bring it up.
- And, somewhat surprisingly, many in the industry, including some developers and many acoustical consultants, are themselves unfamiliar with the mechanics of combined cycle plants and the potentially serious noise issues associated with start-up.

Consequently, while not all that unusual, we would fault the Applicant for avoiding any mention of start-up noise in their initial noise study for the important reason that the plant will employ air cooled condensers (ACC's). In our experience, ACC's are particularly prone to extremely high noise levels during start-up because very high pressure steam, not yet suitable for introduction into the steam turbine, is bypassed directly into a cavernous duct leading to the condenser (Figure 2). Because this duct is maintained at less than atmospheric pressure by vacuum pumps and noise generation over a valve is largely proportional to the pressure differential, it is quite difficult to keep this process, essentially a continuous explosion, quiet, even with "low noise" valves.



Figure 2 Typical ACC Steam Duct

To their credit, when queried about this issue through the data request process, Invenergy did the right thing and commissioned an additional, detailed noise modeling study to evaluate the sound emissions from the facility specifically during start-up and steam turbine bypass. We have reviewed this new study and consider it competently done; however, the model inputs representing noise from steam turbine bypass into the condenser duct appear to be rather optimistic and much

lower than we would realistically expect. Even with these low sound levels the conclusion of the study was that the plant sound level would increase to 46 dBA at the nearest residences on Wallum Lake Road on a temporary basis during start-up.

In response to this information a set of further data requests was submitted with technical questions about the report and its conclusions. When asked about the origin of the apparently low sound levels assumed for bypass noise, the response from Invenergy's consultant was that they were obtained from the bypass valve supplier and represented the supplier's guaranteed sound levels. Because we have never seen a case where bypass noise was anywhere close to the valve manufacturer's guarantees, we are skeptical that such levels will be realized. If we were designing this plant we would seriously consider extending the turbine building to encompass the ACC steam duct and add heavy duty acoustical lagging to any parts of the horizontal manifold or risers that end up outside the building envelope. Or, in other words, we would not rely entirely on the valve noise guarantees, if only because it would be quite expensive and difficult for the facility EPC (engineering, procurement and construction) contractor or owner to enclose or lag this duct on a retrofit basis.

The data requests following the submission of the start-up noise report also questioned the predicted Ordinance exceedance of 46 dBA at the nearest houses (vs. the 43 dBA Town limit). The unequivocal response was that Invenergy would do whatever was needed to ensure that 43 dBA would be maintained during all normal modes of operation including start-up and shutdown. It was also pointed out in the data request responses that the EPC contractor, the plant builder Invenergy hires to actually construct the facility, would be contractually required to realize this performance. This last statement is highly reassuring because contractual performance guarantees are taken very seriously by EPC contractors, who are obligated to meet each requirement in a timely manner or risk significant financial penalties known as liquidated damages.

A compliance test, performed by the owner or, more commonly the EPC contractor, is normally required to verify that the contract conditions on noise have been satisfied. Although such a test is practically inevitable here given the stringent noise limits associated with the project, the Town may want to make this test a mandatory condition of the permit and reserve the right to witness the test and/or conduct its own independent testing.

Although we foresee some significant additional costs for transient noise abatement, we are satisfied that Invenergy has now been fully alerted to this potentially serious noise problem (along with most of the townsfolk during the April 28th board meeting) and will pay appropriate attention to keeping steam turbine bypass noise in check.

In summary, then, it is our opinion that the CREC facility will have a minimal and generally acceptable noise impact on the community so long as the overall, A-weighted nighttime Ordinance noise limit of 43 dBA or less is maintained during all normal, non-emergency operating modes at all of the nearest residences. Compliance with the octave band frequency limits also contained in



the Ordinance is not a precondition to this outcome and these unusually and unnecessarily demanding limits may be waived as requested by the Applicant without detriment to the community, if only because combined cycle plants do not generate problematic levels of the low frequency noise. Furthermore, we are satisfied with the data request responses and believe that the Applicant has been alerted to the seriousness of the steam turbine bypass noise situation during plant start-ups and will ensure through contractual performance guarantees that the facility EPC contractor will take appropriate steps to contain and control this noise – something that might otherwise have been a unpleasant surprise to all and something that would have been difficult to resolve on a retrofit basis.

Of course, please let me know if you have any questions.

Sincerely,

A handwritten signature in blue ink, appearing to read 'D.M. Hessler', with a long horizontal flourish extending to the right.

David M. Hessler, P.E., INCE
Principal Consultant
Hessler Associates, Inc.