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TECHNICAL REPORT

Title: Crowned Ridge Wind II Sound Testing November 2022 Data Review and Assessment

Project: Crowned Ridge Wind II, Docket EL19-027
Location: Watertown, SD
Prepared For: South Dakota Public Utilities Commission
Prepared By: David M. Hessler, P.E., INCE
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1.0 Introduction

The Crowned Ridge Wind II Project (CRWII) is required through the permit conditions imposed by the South Dakota Public Utilities Commission (SDPUC) to meet certain sound level limits at potentially sensitive receptors. A previous field survey carried out by the Project's acoustical consulting firm, RSG, Inc., in the summer of 2021 found that the Project is meeting the required noise standards. However, concerns were later raised by some residents in the Project area that the summertime test results could not be considered definitive because the turbines seemed to be louder and more noticeable during the fall and winter. In response to these concerns and complaints an additional survey was organized and carried out in late November/early December of 2022 by RSG to retest the sound emissions from the Project during winter conditions at three complainant's residences. The results of this survey are detailed in RSG's report "Crowned Ridge Wind II – Noise Complaint Monitoring 2022" submitted to the SDPUC in March. The fundamental conclusion of the study is that the Project's sound emissions are still at or below the maximum permissible sound level of 45 dBA at non-participating residences and therefore in compliance with the permit conditions related to noise.

Hessler Associates has been engaged by the staff of the SDPUC to independently evaluate, from scratch, the raw survey data from this survey, calculate the project-only sound levels at all three test points, and assess the validity of the RSG report and its conclusions. This report summarizes the results of this independent data analysis.

1.1 Executive Summary

The Crowned Ridge Wind II Project (CRWII) is required through the permit conditions imposed by the South Dakota Public Utilities Commission (SDPUC) to meet certain sound level limits at potentially sensitive receptors. A previous field survey carried out by the Project's acoustical consulting firm, RSG, Inc., in the summer of 2021 found that the Project is meeting the required noise standards. However, concerns were later raised by some residents in the Project area that the summertime test results could not be considered definitive because the turbines seemed to be louder and more noticeable during the fall and winter. In response to these concerns and complaints an additional survey was ordered by the SDPUC and carried out in late November/early December of 2022 by RSG to retest the sound emissions from the Project during winter conditions at three complainant's residences. The results of this survey are detailed in RSG's report "Crowned Ridge Wind II – Noise Complaint Monitoring 2022" submitted to the Commission in March. The fundamental conclusion of the study is that the Project's sound emissions are still at or below the maximum permissible sound level of 45 dBA at non-participating residences and therefore in compliance with the permit conditions related to noise.

Hessler Associates has been engaged by the staff of the SDPUC to independently evaluate the field data from this survey and assess the validity of the RSG study and its conclusions. The raw data from the survey were analyzed from scratch and conclusions about the Project performance were drawn before ever reading the RSG report. The test results reported by RSG were then reviewed and compared to the project levels derived independently. In general, it was found that the RSG approach of looking at the highest highs when the Project was on and comparing them to the lowest lows when it was off – something not explicitly required by the test protocol – led to conservative results that were typically somewhat higher than we had calculated. In all instances, where a project-only sound level could be derived from on/off shutdown data the values were either equal to or, much more commonly, below the 45 dBA permit limit in both our analysis and in RSG's report. We were not able to identify any instance where a sound level greater than 45 dBA could be ascribed to the Project. Sound levels well above 45 dBA occur all the time but the extensive survey data measured before, during and after 123 Project shutdowns demonstrates that these elevated sound levels are due to naturally occurring sounds that are significantly louder than the Project because the temporary removal of turbine noise has no, or no significant, effect on the overall sound level. In general, wind turbine noise is drowned out by wind-induced background noise during high wind conditions and the turbines are more likely to be audible during moderate or even light winds.

Along this line, the survey data revealed that conditions sometimes occurred when the background sound level was extremely low, yet the Project was still operating at or near full power making it unusually audible. The manifestation of this was that the sound levels dropped dramatically during the shutdowns that took place during these conditions. In one example, around midnight on 11/24 at LT2, the total sound level dropped between 8 and 10 dBA during Shutdowns 25 and 26 from roughly around 40 dBA to 30 dBA. What this 10 dBA differential implies is that Project noise was essentially the only thing that was audible at the time compared to virtual silence during the

shutdowns. Such periods of very pronounced audibility could be the impetus for the complaints that have occurred, even though the actual Project sound level is fairly low – in this case only around 38 dBA.

Some technical issues at Locations LT2 and LT3 were found during the data review. In particular, there were extensive periods of missing data at LT2 due to power supply problems and at LT3 a heating system outside the residence began to cycle on and off intermittently at first and then almost continuously towards the end of the survey contaminating much of the data. Nevertheless, it is our opinion that enough valid measurements were obtained over three weeks of testing and more than 100 shutdowns to adequately establish whether the Project is compliant with the permit conditions or not.

A general comparison of the fundamental results from both analyses is shown in Table 1.1.1.

Table 1.1.1
Comparison of RSG and Hessler Analysis Results

Location	Applicable Permit Limit, Leq (10 min), dBA	Max. Reported Project-only Sound Levels Measured by RSG, dBA	Maximum Observed Project-only Sound Level (Hessler), dBA
LT2	45	44	43
LT3	45	45	44
LT6	45	45	44

In summary, we would conclude, based on the extensive analyses carried out by RSG and our own independent assessment of the raw field data from the ground up, that the Crowned Ridge Wind II Project is compliant with the noise limits contained in permit conditions issued by the South Dakota Public Utilities Commission.

2.0 Independent Assessment

The sound emissions from wind turbines at typical setback distances to residences are quite difficult to measure and quantify. This is because the natural environmental sound level during the windy conditions necessary for the project to operate are similar to and often higher than the project-only sound level. Consequently, it can be generally stated as a fact that the total observed sound level at any given location under virtually all wind and weather conditions is not the project sound level, but rather is a combination of the project sound level and the natural sound level that would otherwise exist. During high wind conditions the project component of the total sound level essentially becomes negligible and is completely drowned out by wind-induced sounds, either actual, such as trees or crops rustling, or artificial, as in microphone distortion from wind.

In an effort to overcome this difficulty, the test procedure specifically relies on the use of more than 100 short-duration project shutdowns to enable the measurement of the total sound level (project + background) and the background level alone within a few minutes of each other so that the wind and background noise conditions are held reasonably constant. The project-only sound level, which is the quantity subject to the regulatory limits, can then be derived by logarithmically subtracting the background level from the total level with the project on. However, even this ostensibly simple approach doesn't always yield a valid, or any, answer because it only works when the differential between the on and off levels is significant, or at least about 3 dB. In practice, such a large signal (project sound) to noise (background noise) ratio is rarely seen because the project sound level is intentionally designed to be low at sensitive receptors while the natural sound level increases essentially indefinitely with wind speed. When the signal to noise differential is lower than 3 dB a technically valid project-only sound level cannot be calculated. Even though all units within 1.75 miles of the measurement locations were shut down 123 times during this three-week survey, there were only a small number on instances when the sound level actually decreased by a significant amount while the turbines were taken offline during full power operation. In many cases there was no significant change, the sound level was higher during the shutdown than during the operational periods immediately before or after, or the winds were too light for the project to operate anywhere near full output.

The graphics discussed below show, for each position, the measured average (Leq) and residual (L90) sound levels, the electrical output of the nearest turbine and the wind speeds at ground level and at hub height. The Project noise limits are expressed in terms of the 10 minute average level, or Leq(10 min). The L90 level is plotted largely for informational purposes but essentially shows the underlying sound level that was present during each 10 minute measurement interval in between sporadic, interfering noise events, such vehicles passing by, wind gusts, etc.

The first two or three figures for each position show the overall survey results broken down into segments to improve their readability, at least to some extent. These graphics, basically comparing the sound levels to Project operation, show the periods when full load operation was occurring and show which shutdowns are of the most relevance when looking for levels that exceed the 45 dBA limit. Shutdowns that occurred during low wind conditions or when the total sound level was well under 45 dBA are of no relevance to this evaluation. Instead, a number of periods, designated as Details A, B, C, etc., containing clean shutdowns during steady, full load operation are highlighted and enlarged for closer analysis in the subsequent graphics. While the test protocol meticulously and rightly defines what test conditions are valid and excludes measurements taken under various temperature, humidity and wind speed conditions, we have largely looked at the raw data with a free hand and have evaluated a number of shutdowns that were automatically excluded from the RSG analysis because one or more parameters were outside the permissible range.

There were three test positions in this survey, designated as Locations LT2, LT3 and LT6. The first two are very close together at two neighboring homes. Maps of the locations and photographs of the instrument set ups are contained in RSG's report.

2.1 Location LT2

The overall survey results for Position LT2 are shown below in Figures 2.1.1 through 2.1.3, along with the shaded regions corresponding to Details A through E.

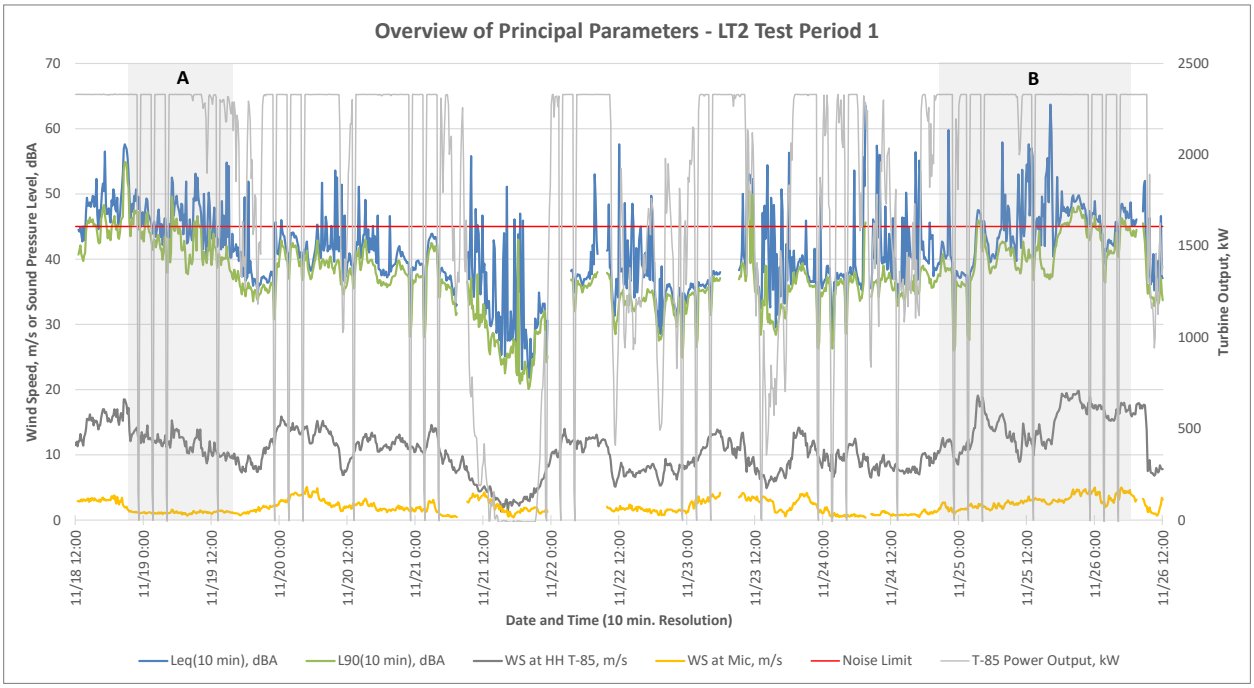

Figure 2.1.1

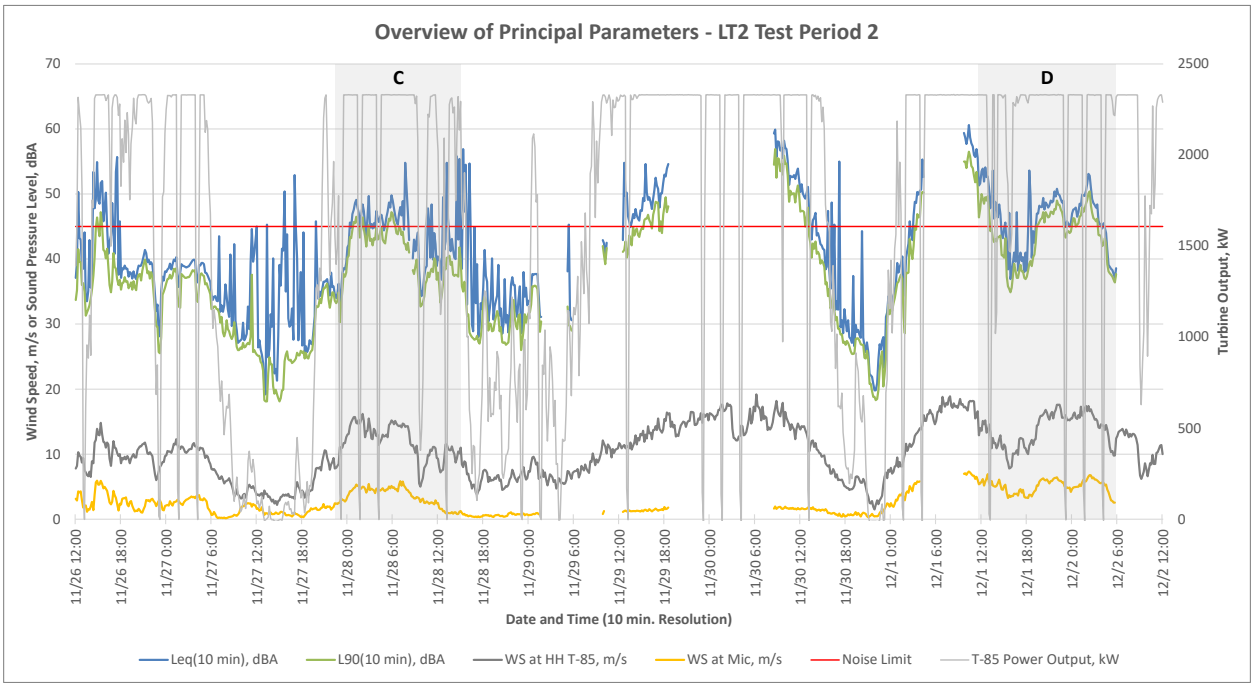

Figure 2.1.2

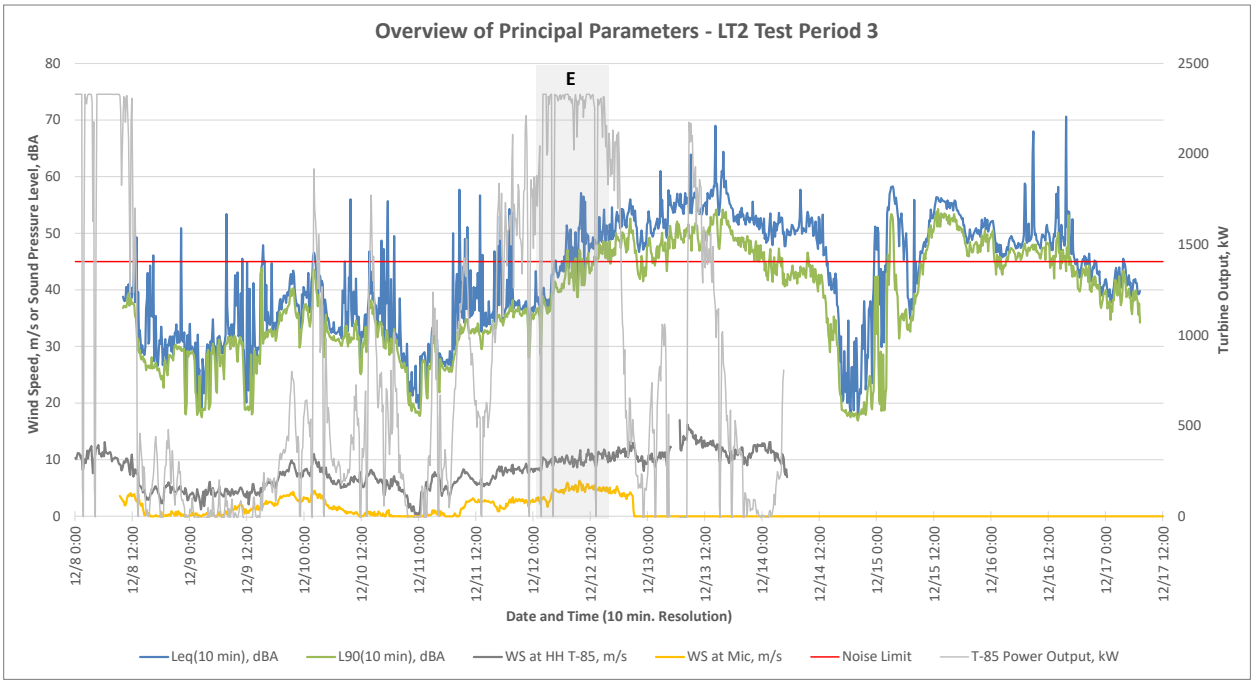

Figure 2.1.3

During the second test period (Fig. 2.1.2) it can be seen that the sound measurements are intermittent with a number of missing periods due to some power supply issue. Based on many

years of field survey experience, it can be said that such problems are remarkably common and unsurprising with long-term sound monitoring equipment, especially during cold weather conditions. The validity of the data that are there was checked by plotting the residual (L90) sound levels from all positions together in one graph. These plots, discussed further in connection with LT3, show that the LT2 sound levels are consistent with those recorded a few hundred feet away at LT3. Consequently, the measurements that were recorded appear to be valid despite the technical difficulties.

Towards the end of the survey, from about December 14th on, the sound measurements at LT2 continued but the anemometer and turbine operation parameters all went to zero due to a severe ice storm shutting down the project and freezing the wind speed gauges.

In any event, the periods identified as Details A through E are enlarged and discussed below.

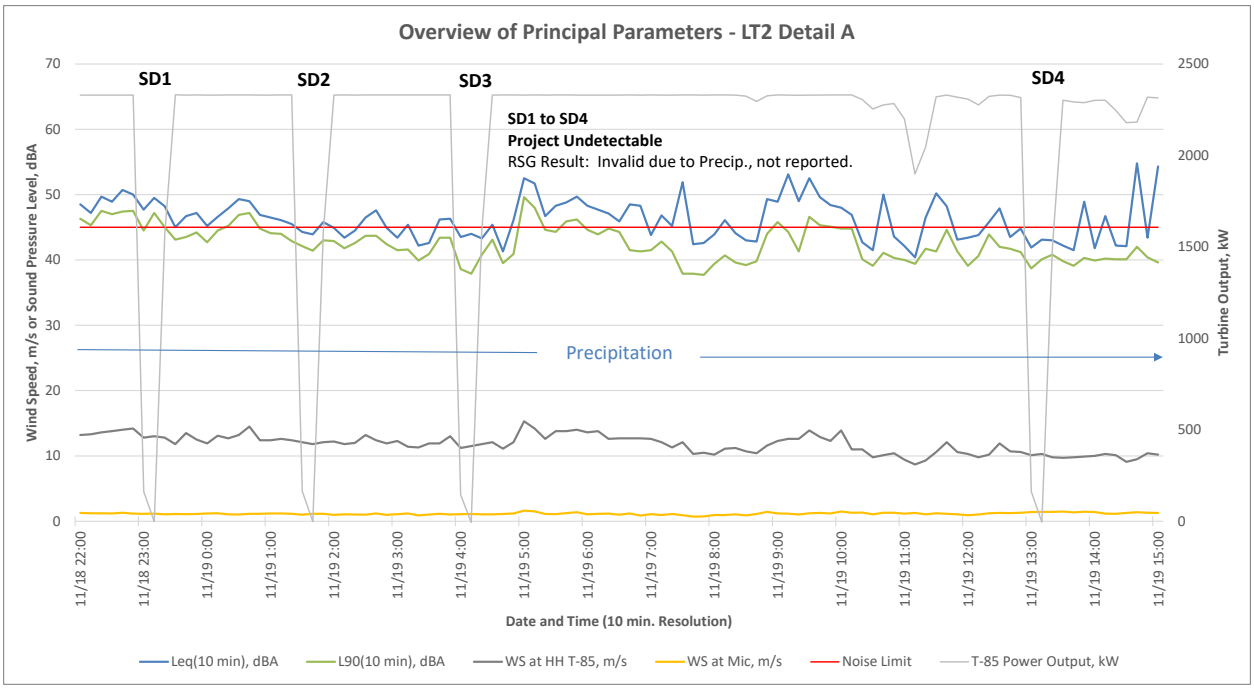

Figure 2.1.4

This period is of interest because the project was running consistently at full power while a number of shutdowns occurred, and the sound levels are right at or higher than the 45 dBA limit. Unfortunately, precipitation was occurring throughout this period so no definite conclusions can be drawn from the data. It appears, however, that Project noise was not perceptible above the ambient because both the Leq and L90 sound levels do not drop convincingly during the Project shutdown periods. The slight dip in the L90 during Shutdown 3 could be due to the temporary absence of Project noise or just a random fluctuation.

Detail B is shown below.

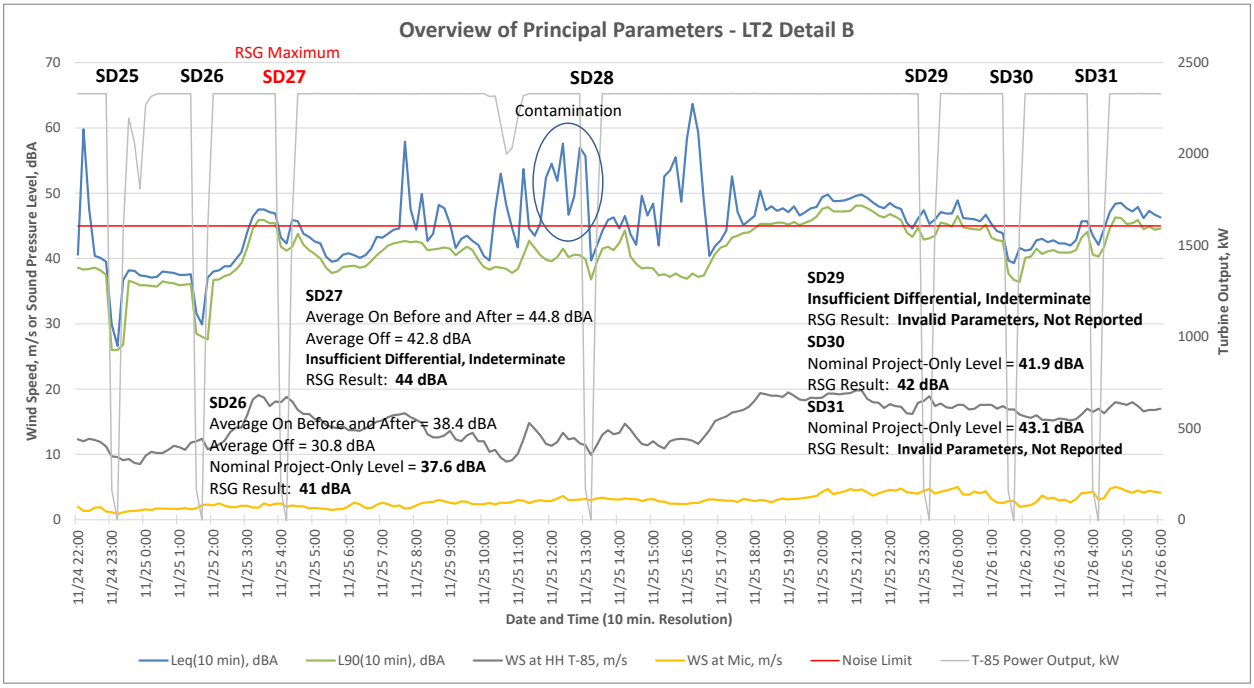

Figure 2.1.5

In this case, the effect of the Project shutdowns is much clearer, especially during Shutdowns 25 and 26 when background noise was apparently quite low – and the Project was quite prominent. A definitive project-only sound level cannot be determined for SD25 because Turbine 85 did not cleanly return to full power after the shutdown and the background level just before was contaminated by some noise event. On the other hand, a Project sound level of 38 dBA can be deduced from SD26 by comparing the off sound level to the average on sound levels for the hour before and the hour after the shutdown. RSG is reporting a project-only level of 41 dBA for this shutdown. This higher value comes from using the last (highest) 10 minute period after the shutdown when the background sound level was rapidly rising, rather than the average of the preceding and following hours. Both of these results are well under the 45 dBA limit; however, it is likely that the Project was very audible and "loud" sounding during this period judging from the very substantial difference between the on and off levels. The off level of about 30 dBA is essentially complete silence, so an operational sound level 8 to 10 dBA higher would have been very noticeable from a subjective perspective, while, at the same time, being compliant with the permit noise limit. Such periods of pronounced audibility could be the impetus for the complaints that have occurred, even though the actual Project sound level is fairly low – in this case only around 38 dBA.

The next shutdown, SD27, is important because it is the shutdown resulting in RSG's maximum, survey high level for this position of 44.2 dBA. This result, as illustrated on p. 49 of the RSG report, was obtained by subtracting mid-frequency (160 to 1kHz) turbine sound occurring in the last 10 minute period (f) prior to the shutdown from the total sound level on a 1/3 octave band

basis as specified in the test protocol. If, looking at it from a less complicated perspective, the project-off level is compared to the hourly average A-weighted levels before and after, the two values (42.8 dBA on and 44.8 dBA off) are too similar to make a valid subtraction. If the average of all 12 before and after 1/3 octave band spectra had been used in the frequency analysis approach a similar indeterminate result may have occurred. Consequently, the individual analysis of select project-on spectra – something not mentioned in the protocol - appears to be a good way of parsing out a result when one might otherwise conclude that no valid differential was observed. In general, this approach tends to yield higher and more conservative Project levels than a simple subtraction of A-weighted on/off levels.

Referring back to Figure 2.1.5, similar results of 41.9 dBA and 42.1 dBA were obtained from SD30 using the simpler A-weighted subtraction method and the frequency analysis method, respectively. For SD31 it is unclear what prevented an RSG result, but we calculate a project-only level at 43.1 dBA.

Detail C (Fig. 2.1.6) shows the next period of interest.

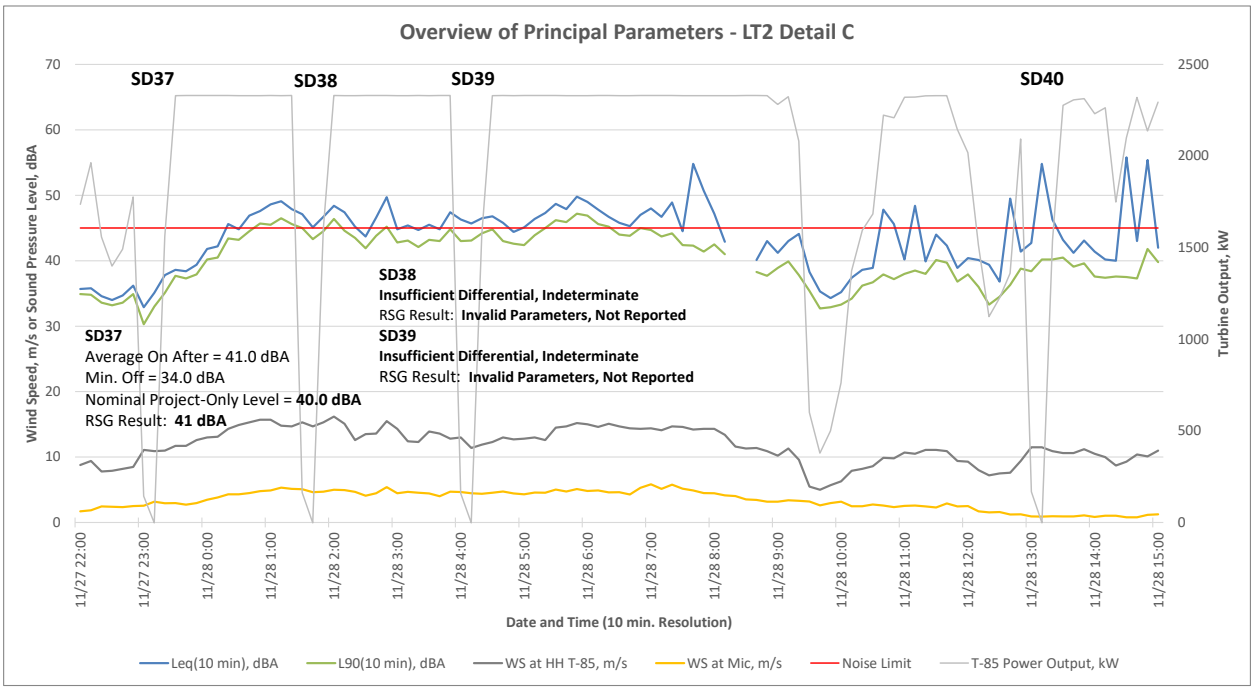

Figure 2.1.6

The non-ideal shutdown at 11 p.m. on 11/27 (SD37) still yielded results in 40 to 41 dBA range considering only the project-on sound levels after the shutdown. As the wind speed and background levels increased later that night Project noise became buried in the natural sound level. The on/off levels were too similar to calculate answers for SD38 or SD39. Clearly, there was nothing to be learned from SD40 where the sound level during the shutdown was significantly higher than before or after.

Detail D is shown below.

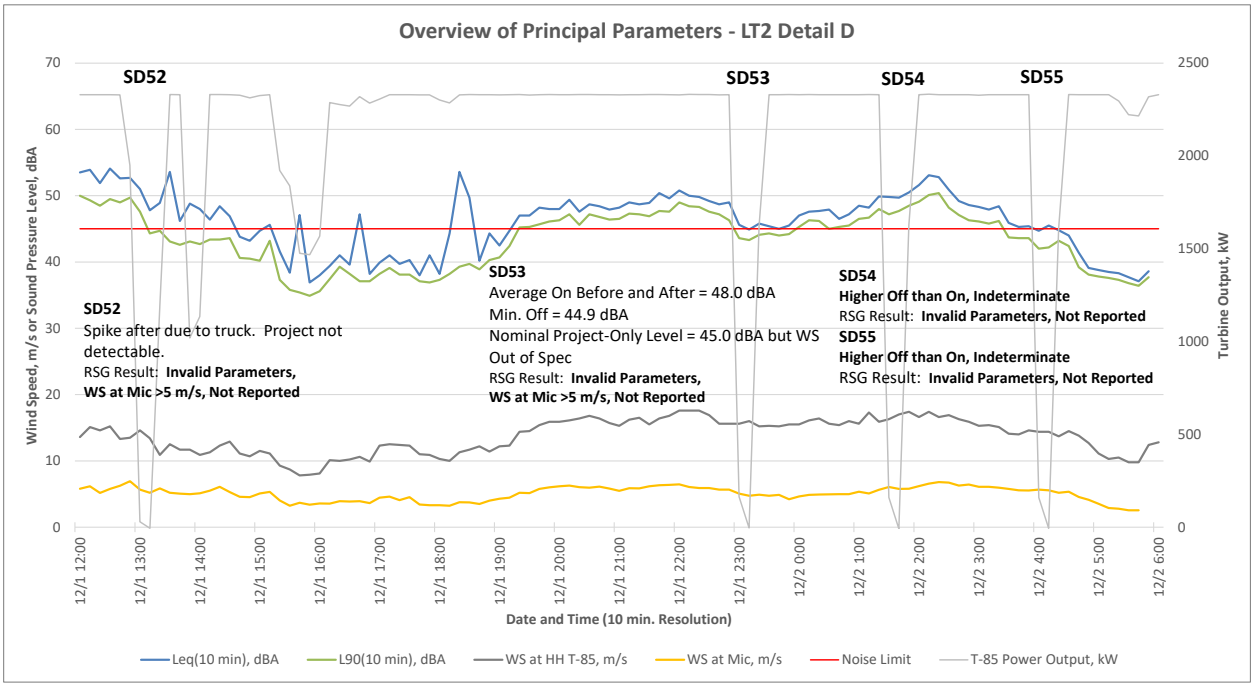

Figure 2.1.7

A project-only sound level was not reported by RSG for Shutdown 52 because the ground level windspeed and possibly other parameters, were out of the permissible range. While the dip in the Leq level seems to coincide with the shutdown, the spike immediately afterwards was due to a truck starting up and idling for about 3 minutes before driving off – as determined from a review of the audio files. Moreover, when sound levels drop during a shutdown because Project noise has been removed, both the Leq and L90 levels go down. In this case, the L90 is unaffected by the shutdown confirming that Project noise was not driving the dip in the Leq level. Moreover, the ground level windspeed was above the acceptable limit of 5 m/s in any case.

A somewhat similar situation occurred during the next shutdown (SD53). In this instance, there is a slight dip in both the Leq and L90 sound levels during the outage. While it's technically possible to calculate a Project level of 45 dBA, the ground level windspeed (and the wind-induced background noise associated with it) is again just above 5 m/s so this value is not valid.

Sound levels during the next two shutdowns are clearly unaffected by the absence of Project noise and nothing can be deduced about its sound level. In fact, the sound levels during both shutdowns were higher than when the Project was in operation.

Detail E is plotted below.

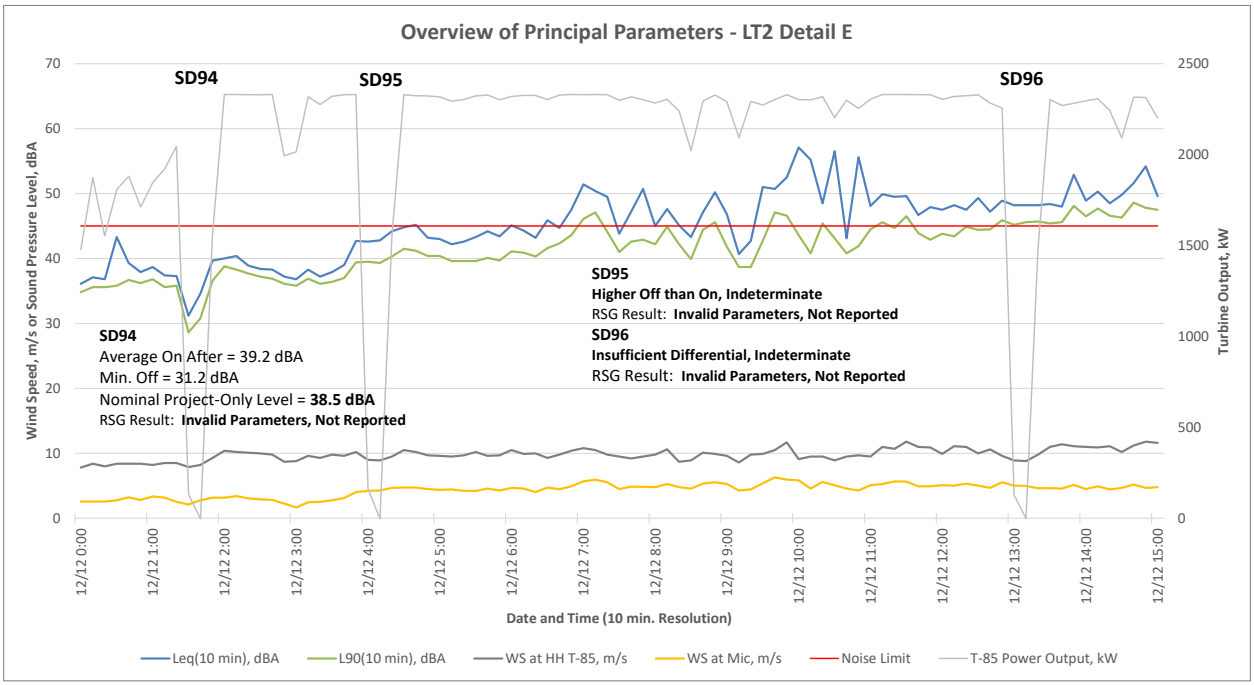

Figure 2.1.8

The first shutdown during this period is similar to SD25 and SD26 in Detail B (Fig. 2.1.5) in the sense that the temporary removal of Project noise drops the sound levels significantly. This was another time when the project probably sounded quite prominent relative to a low background level. In absolute terms, however, the Project level can be pegged at a fairly low level of 38.5 dBA using the off and after data. Just two hours later the Project was no longer prominent and is undetectable during SD95, and during the subsequent midday shutdown SD96. Since the wind speeds remained essentially the same through this period, it appears that atmospheric conditions, such as the thermal gradient, may have changed.

2.2 Location LT3

While the sound level meter at Location LT2 lost power intermittently in the middle of the survey, the meter at LT3 ran continuously as planned for two weeks but the measurements were gradually contaminated by interfering noise from a heating system on the property that intermittently cycled on and off. When running this heater generated a sound level of 45 dBA at the test location. This phenomenon is best visualized by comparing the L90 results for all three positions over the first three quarters of the survey (Figures 2.2.1 through 2.2.3). LT3 is the green trace.

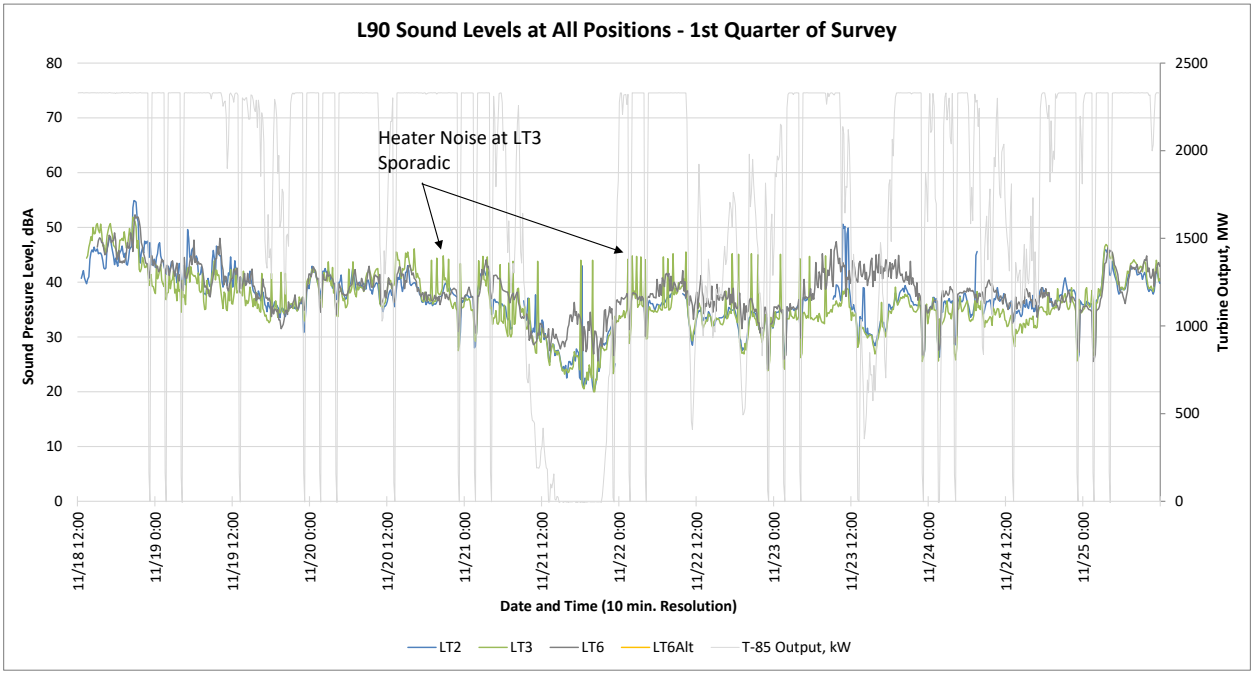

Figure 2.2.1

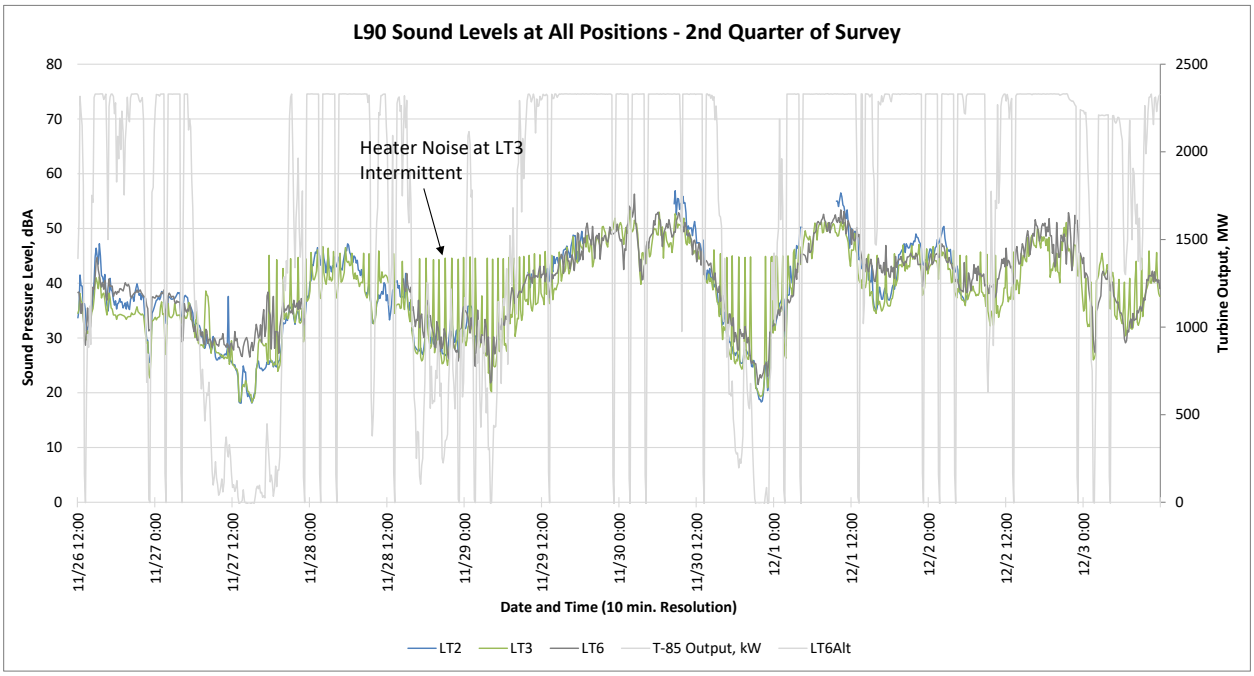

Figure 2.2.2

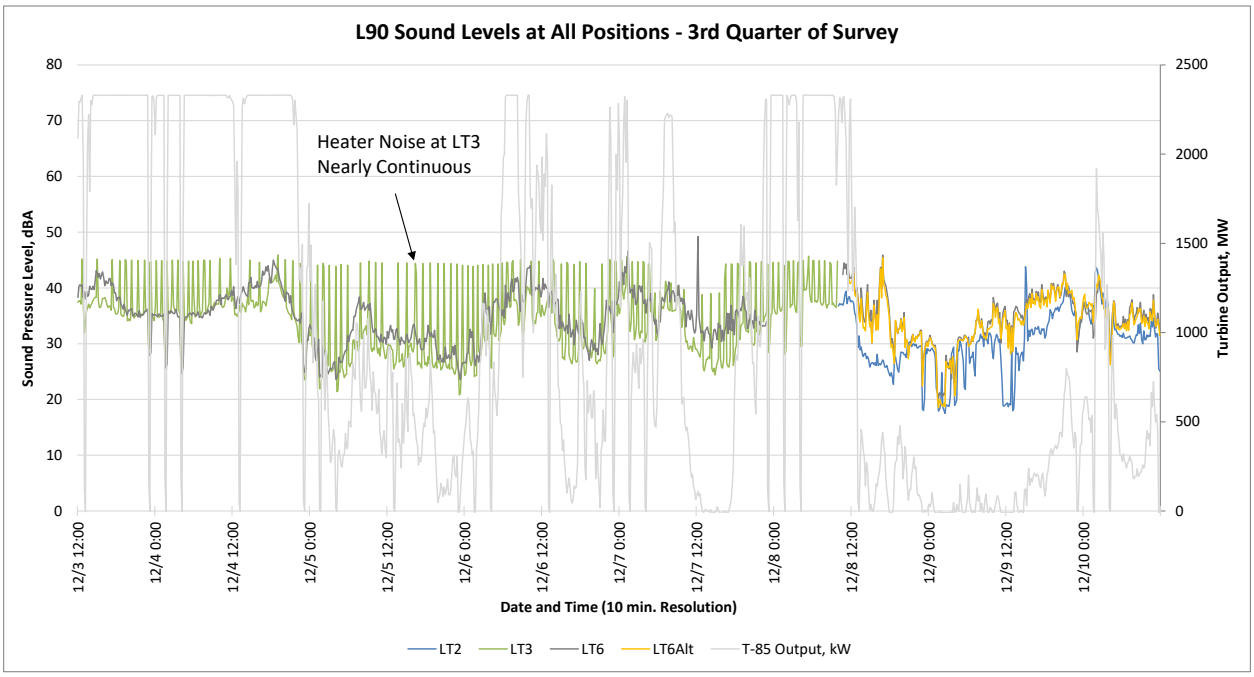

Figure 2.2.3

A regular, very unnatural oscillation due to this heater began sporadically on the third day of the survey, became much more frequent about a week in and occurred nearly continuously for the last five days of the survey. When occurring, the sound level fluctuated between any value less than

45 dBA and 45 dBA with a full cycle period of 50 minutes. When the sound level is above 45 dBA heater noise is either buried in the ambient sound level or not occurring. While, on the face of it, this calls into question the validity of the entire LT3 dataset, this contamination was intermittent and when it was not occurring the measurements are consistent with those at LT2, as might be expected due to their proximity. Consequently, there were still a number of periods where valid data were collected during full load operating conditions. The Leq and L90 sound levels measured exclusively at LT3 are plotted below along with the shaded periods of interest.

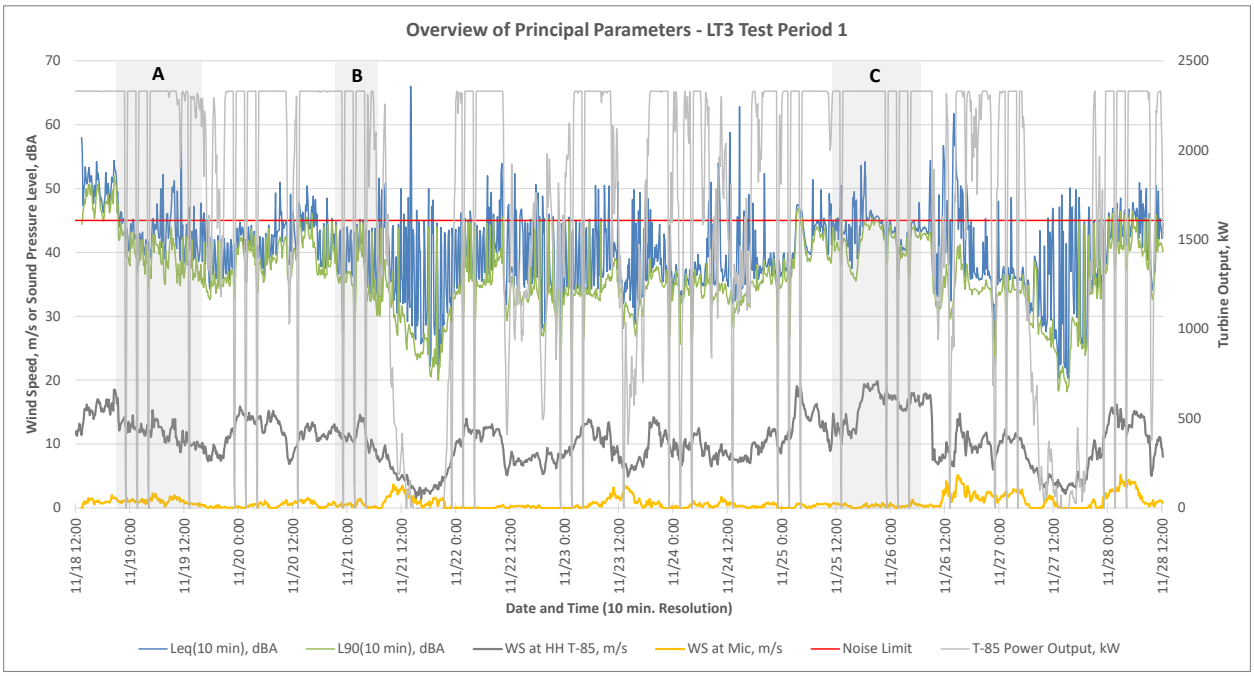

Figure 2.2.4

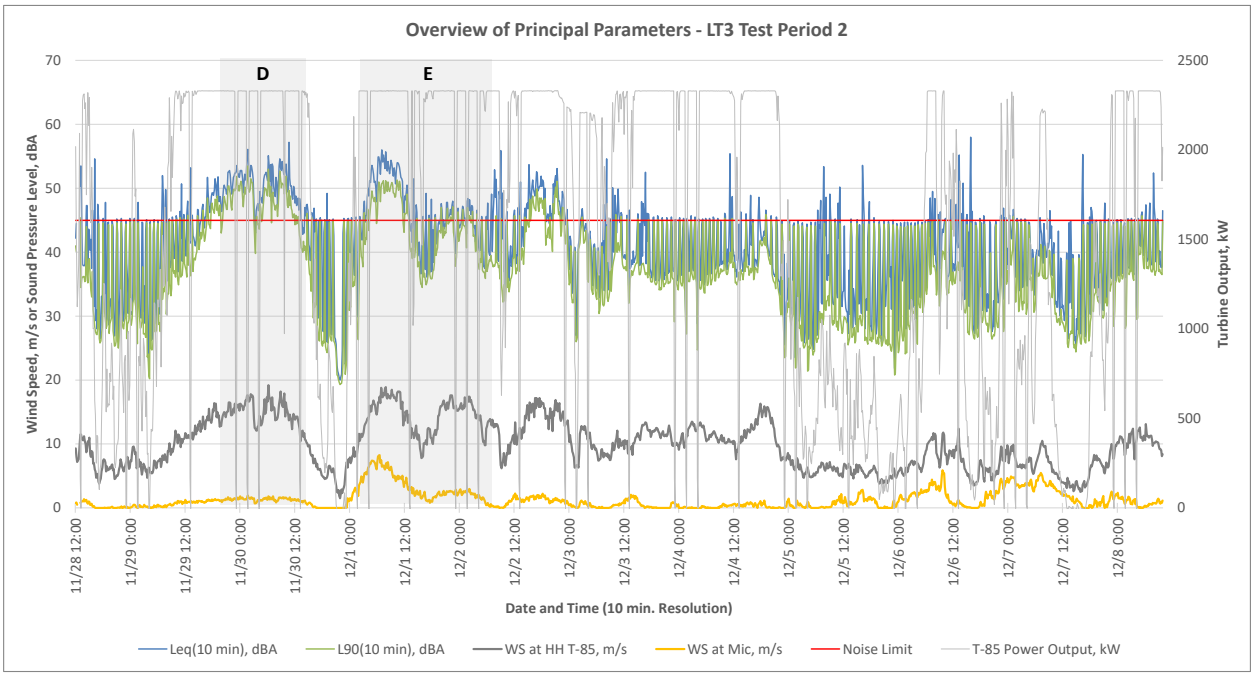

Figure 2.2.5

Detail A is plotted below.

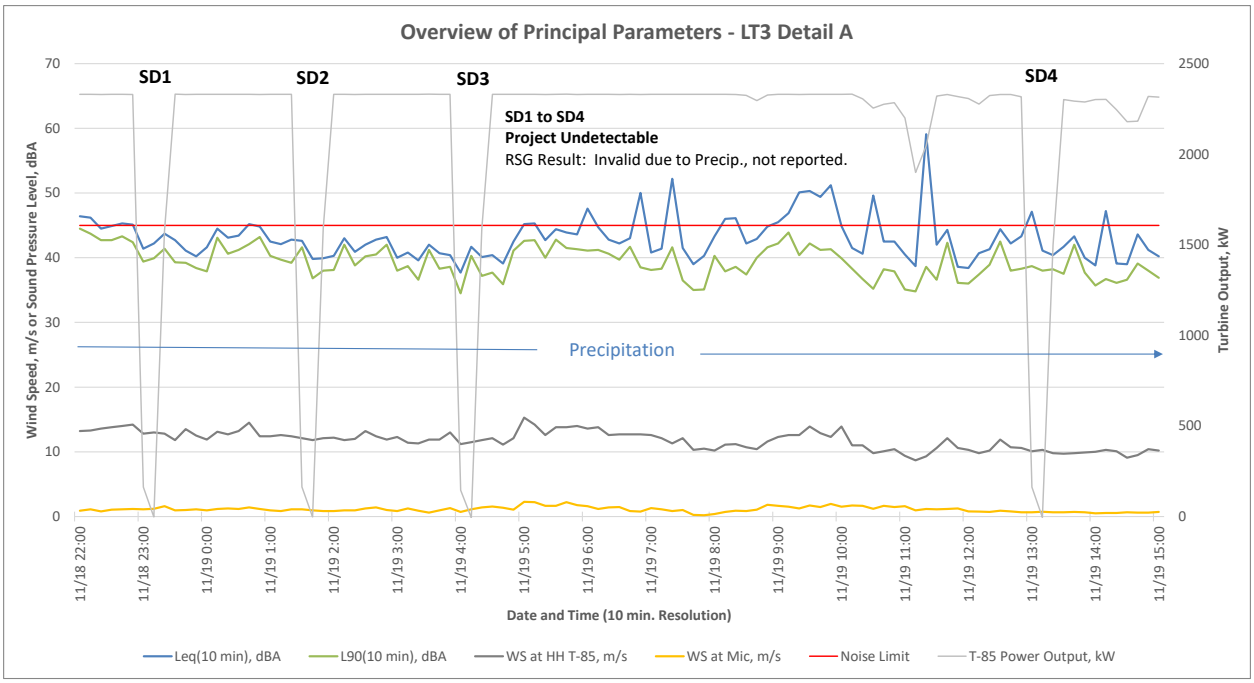

Figure 2.2.6

This plot is nearly identical to Detail A at nearby position LT2 (Fig. 2.1.4), the only difference being that the sound levels are generally lower by about 3 or 4 dBA. This may be due to the relative absence of nearby trees at LT3, and the sound of rain falling on the foliage, compared to LT2. In both cases, the Project is undetectable during the shutdowns; i.e. the sound levels don't drop at all.

The enlargement of Detail B, below, shows the heater noise oscillation pattern that generally occurred when the sound level was below 45 dBA.

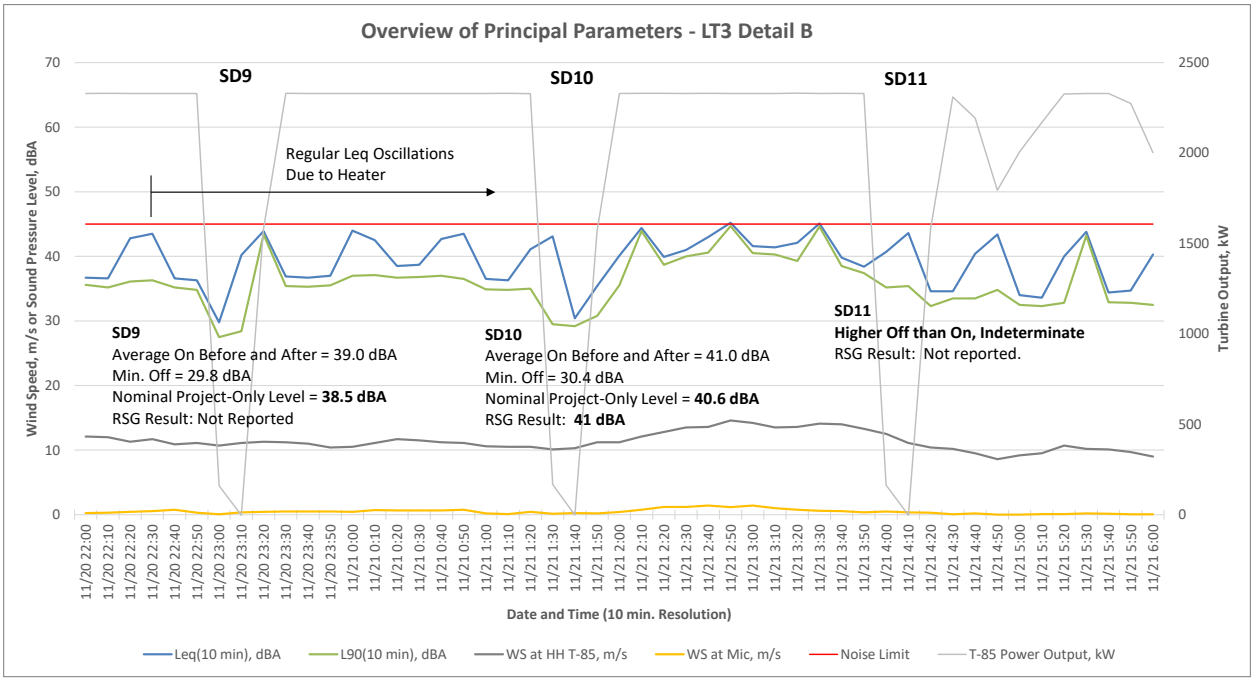

Figure 2.2.7

The residual (L90) sound level appears to react to shutdowns 9 and 10 and the Leq level drops to a lower low when the heater was off during those outages. In general, the sound levels from this period cannot be considered valid or accurate due to the ongoing interference. RSG did report a Project level of 41 dBA for SD10, which is what we would calculate as well. Why they did not report SD9 or SD11 is unknown. However, because all of the sound levels are below the permit limit in absolute terms, the actual performance of the Project during this time is moot.

Detail C, below, shows that the heater did not operate at all times. The four shutdowns from full power during this period all clearly show a correlation to Project operations.

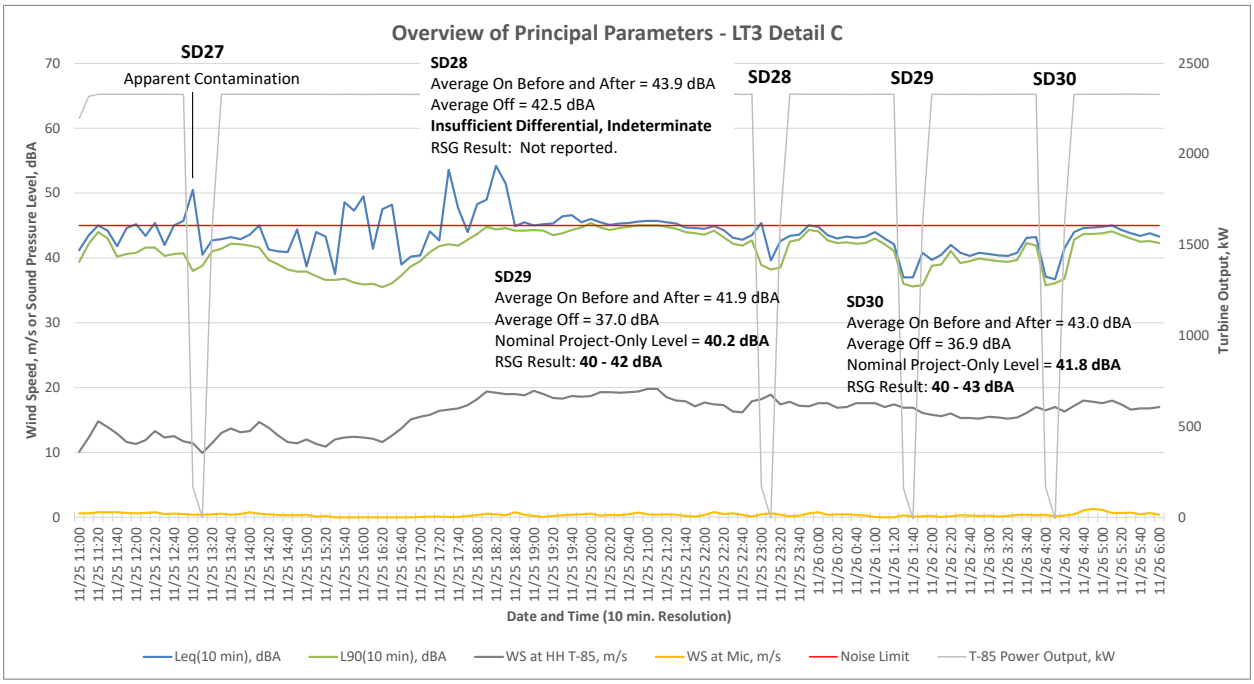

Figure 2.2.8

Shutdown 27 was marred by an apparently unrelated noise event, but it can generally be seen that the level would have been below 45 dBA had this interference not occurred. Something similar happened during the next shutdown (a minor contaminating noise event) and it is not possible to derive a project-only sound level. The next two shutdowns, 29 and 30, were clear of any significant contamination and our calculated Project sound levels agree with what RSG reported. All the levels are in the low 40's dBA and in compliance with the permit conditions.

The next period of full load operation is shown in Detail D.

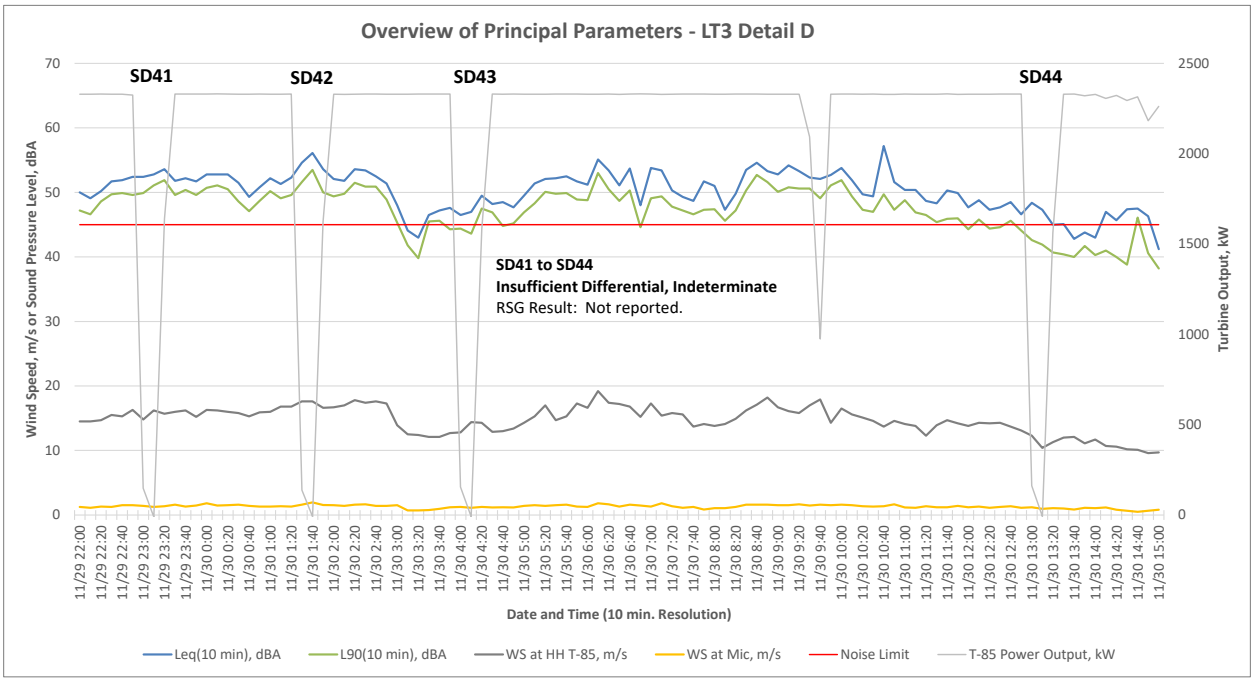

Figure 2.2.9

These levels all look good and free from any artificial contamination. The Project was not detectable above the background level during this period and a Project level cannot be deduced from any of the shutdowns.

Lastly, Detail E is shown below.

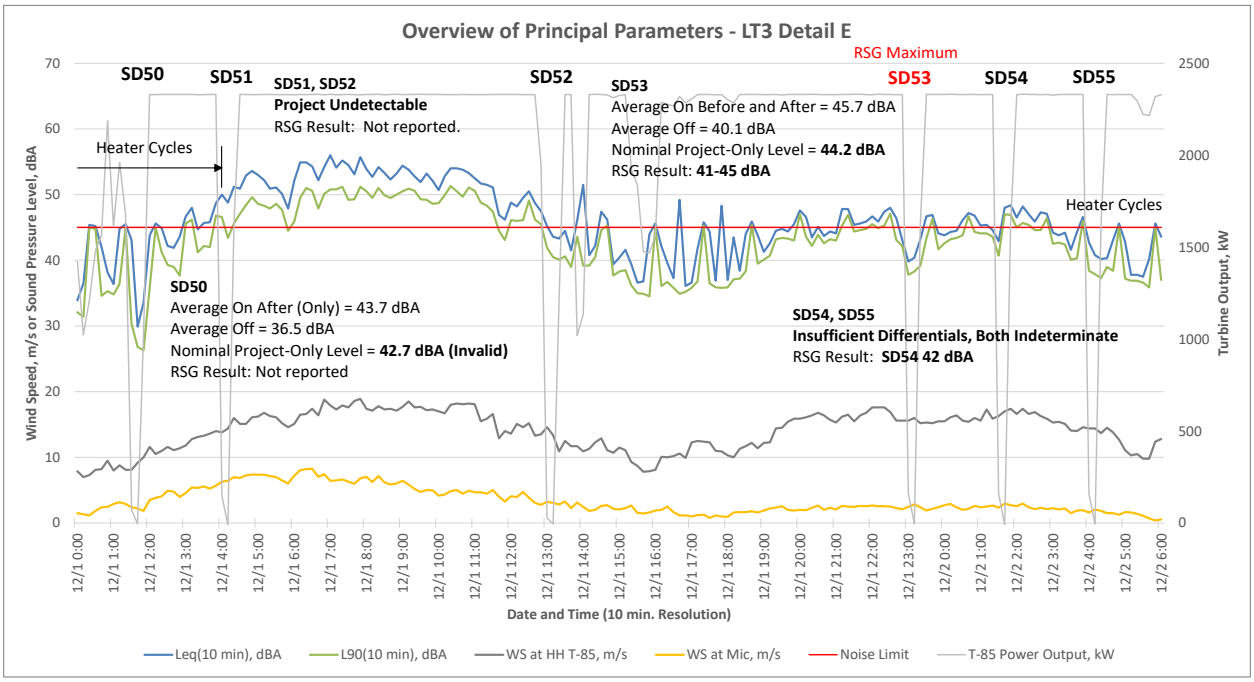

Figure 2.2.10

The first shutdown during this period (SD50) seems to have lined up perfectly with the nadir of a heater cycle oscillation. While it's possible to calculate a project-only level of about 43 dBA, all the data up to about 4:00 a.m. is clearly influenced by the heater and invalid.

Shutdown 53 is important because it is the outage used to derive RSG's maximum, survey high sound level for LT3 of 45 dBA. The detailed derivation, based on the 1/3 octave bands apparently containing wind turbine noise, is shown on pp. 52 - 53 of the report. We calculate a project-only level of 44.2 dBA just based on the A-weighted averages. The more sophisticated RSG derivation represents the conservative maximum possible Project level, and we would agree with their conclusion that the Project sound level is about 44 or 45 dBA at this location at this time. There is also a wide discrepancy between the wind speed at ground level and hub height, which suggests a strong wind speed gradient, or shear. These conditions can lead to amplitude modulation, or a thumping sound, as the wind contacts the rotor sweep with a greater velocity at the top than at the bottom. This phenomenon makes turbine noise more noticeable and potentially disturbing.

The next two shutdowns (SD54 and 55), only 2 and 4 hours later, don't show any correlation to the Project. The sound levels during these outages appear to reflect only background noise. Using the highest high after the shutdown and lowest low when the turbines were off, RSG was able to estimate a level of 42 dBA for SD54, but it's unclear whether these measurements have much of anything to do with the Project. In fact, the regular heater oscillation begins to return around the time of Shutdown 55.

2.3 Location LT6

The sound level meters at Location LT6 and the supplemental position at LT6Alt appear to have functioned perfectly through the entire survey, except for the final few days of the survey when the windscreen blew off the LT6 microphone. At that point, an ice storm had essentially shut down the Project and frozen all the anemometers, so this mishap was of no real consequence. The overall results from LT6 are plotted in the following three charts.

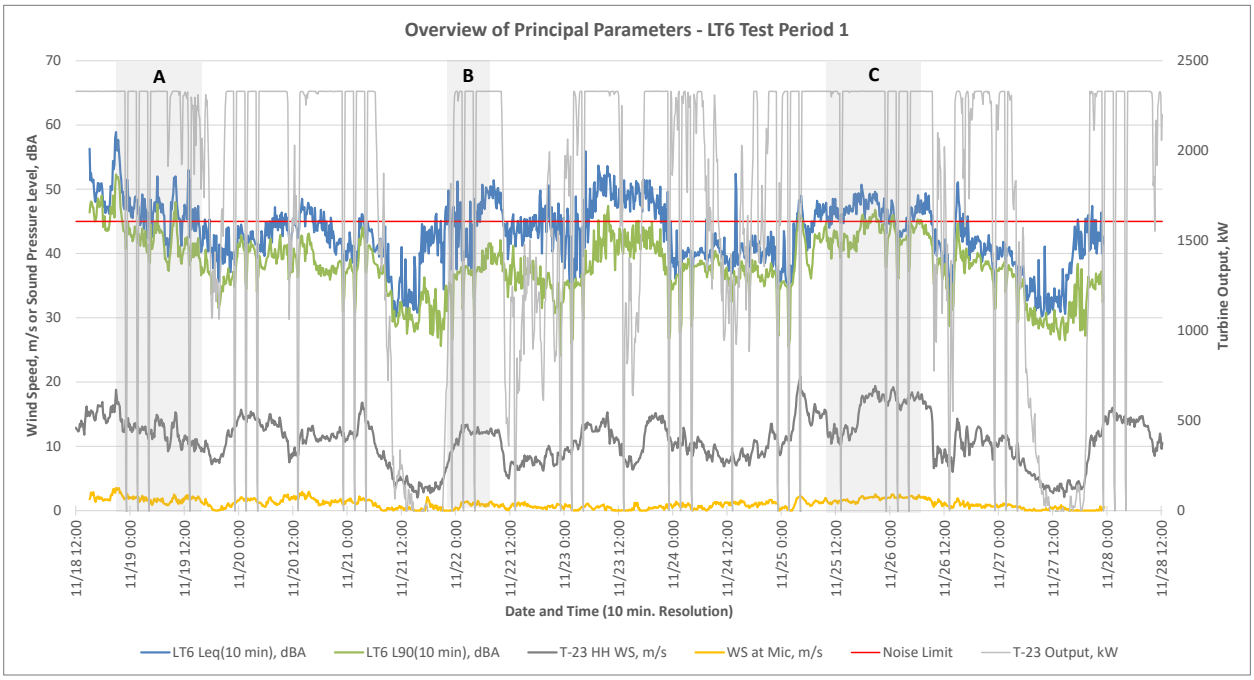

Figure 2.3.1

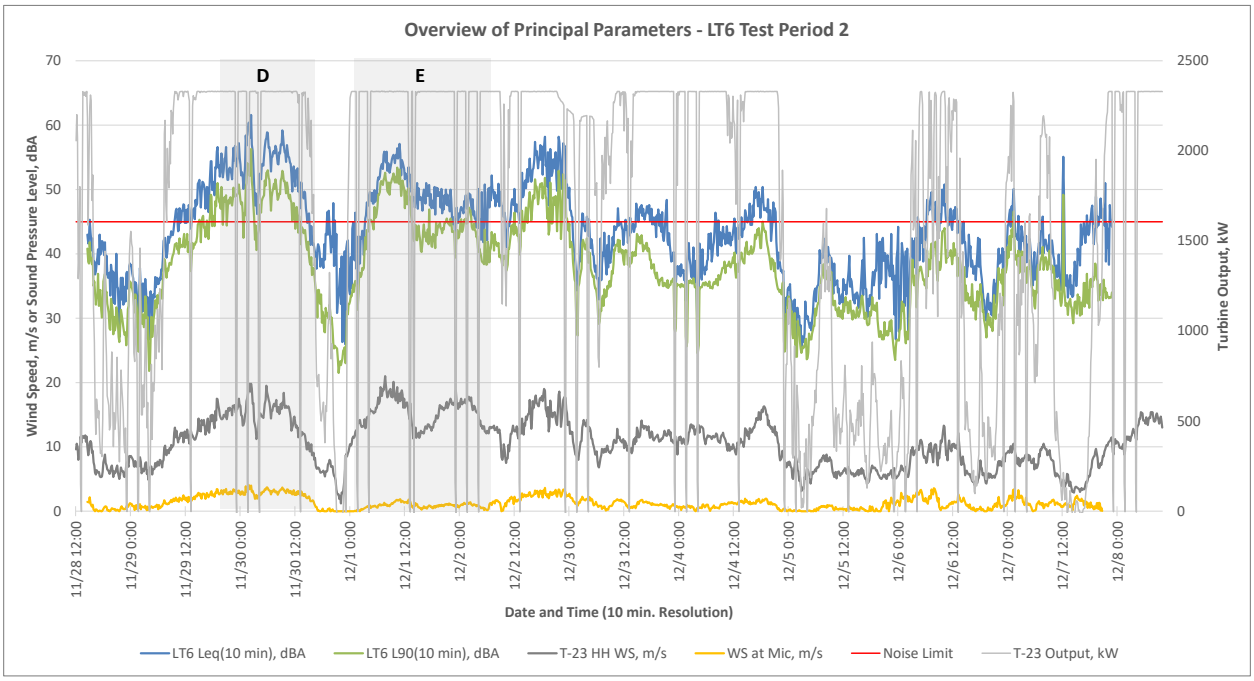

Figure 2.3.2

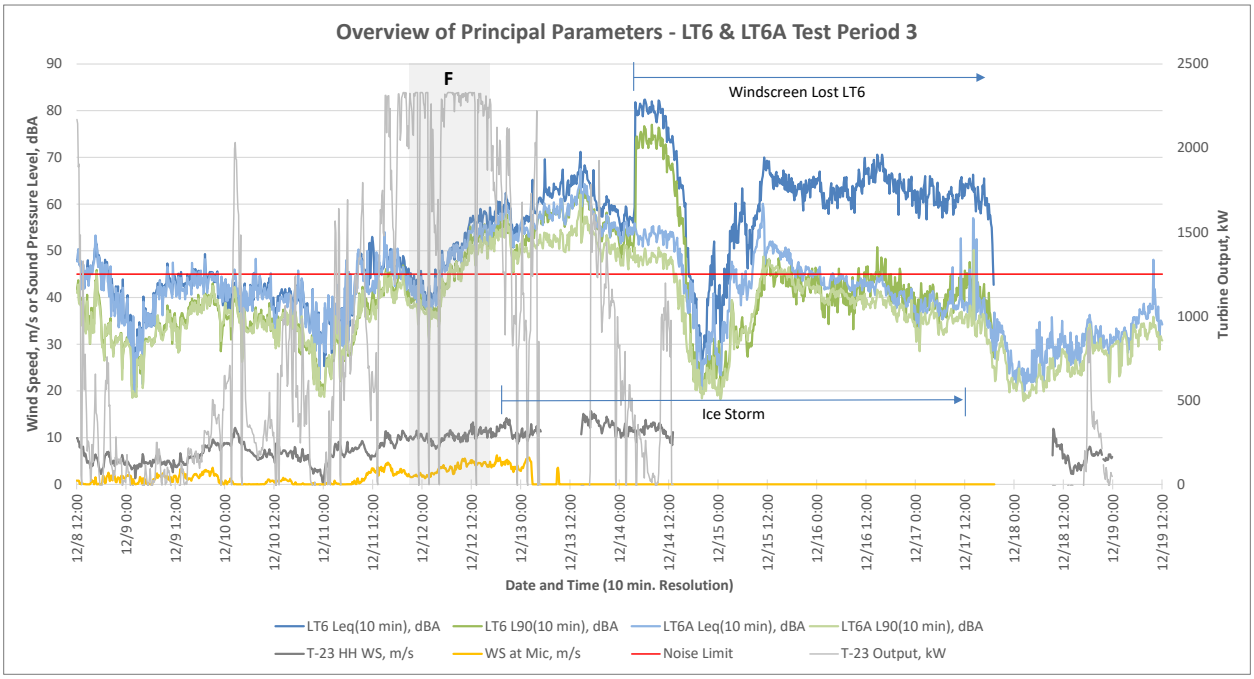

Figure 2.3.3

Periods of interest when the sound levels exceeded 45 dBA during full load operation are highlighted in gray and discussed below.

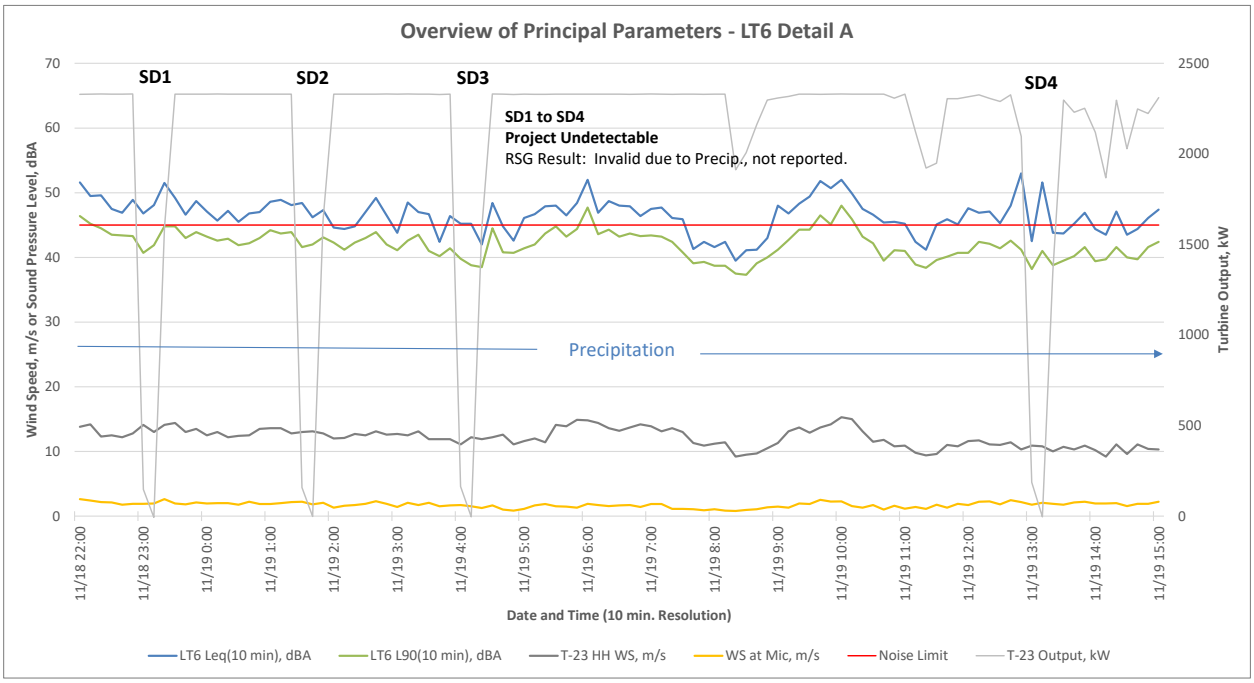

Figure 2.3.4

This detail during the first few shutdowns is largely identical to similar plots from positions LT2 and LT3. In all three cases, any noise from the Project was drowned out by rain or wind-induced background sound.

Detail B is shown below.

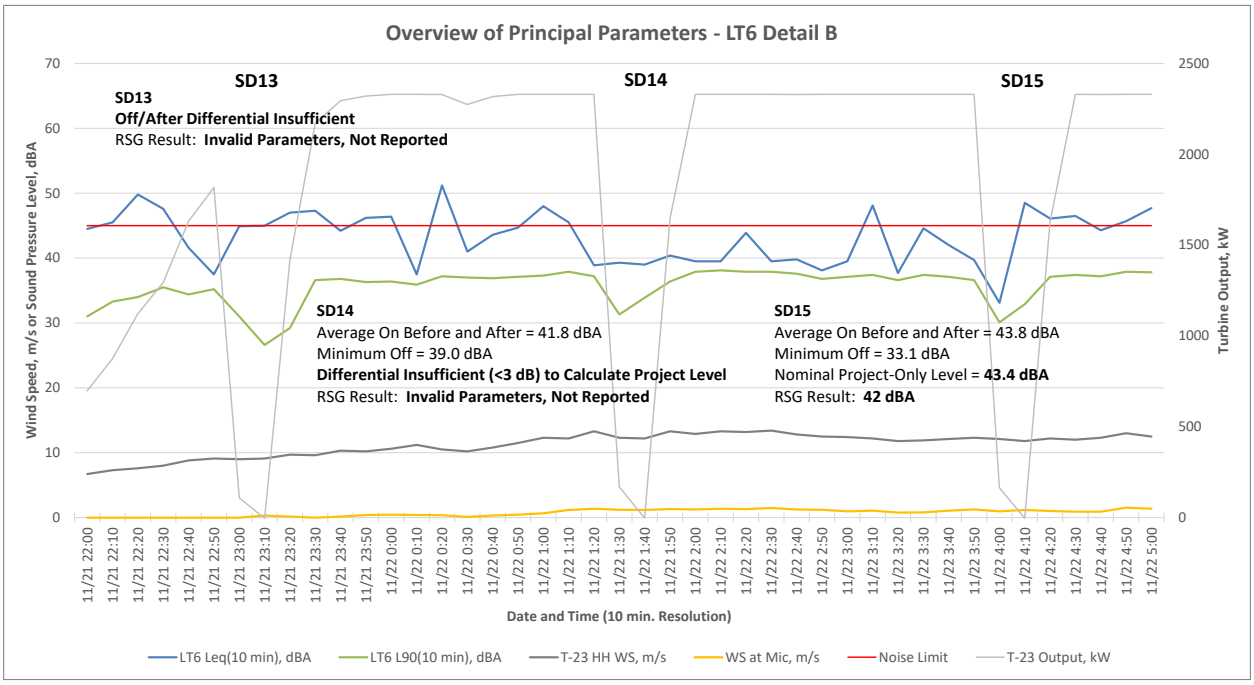

Figure 2.3.5

In this case, the residual sound level (L90) correlates fairly well with the shutdowns but the average (Leq) is very choppy, which means that sporadic background noises were occurring that prevented the average level from dropping smoothly in tandem with the elimination of turbine noise. If the noise spike in the middle of SD15 is ignored as interference, a project-only level of 43 dBA can be deduced from the data, although that number is almost certainly elevated by contaminating noise and should be considered conservative. RSG is reporting a sound level of 42 dBA for SD15.

In Detail C (below) there was less background interference and dips in both the L90 and Leq occurred during three shutdowns.

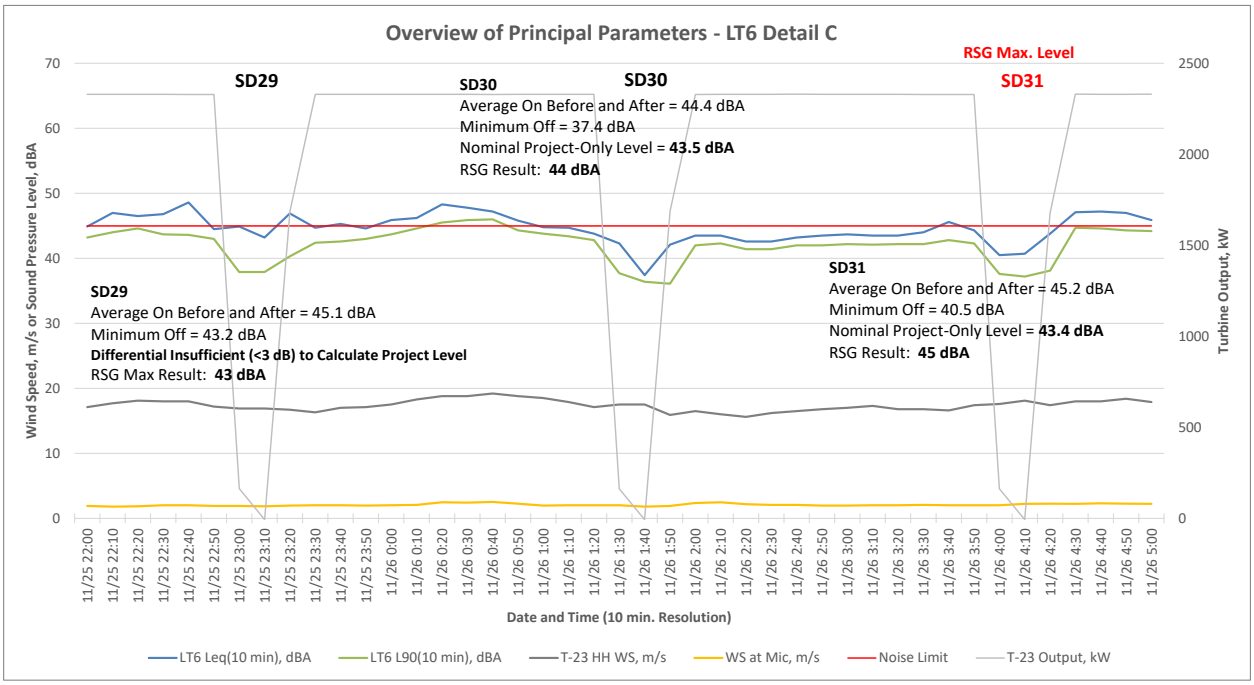

Figure 2.3.6

If the average Leq levels during the hour before and after SD29 are used as the project-on level then there is an insufficient on/off differential to compute a Project sound level. Using the highest high and lowest low RSG has derived a Project sound level of 43 dBA. Similar results were obtained from each method for SD30; essentially 43 dBA using the A-weighted averages and 44 dBA based on an analysis of individual measurements and their frequency content.

RSG has derived a maximum, survey high level of 44.9 dBA for LT6 from Shutdown 31, as detailed on pp. 56 and 57 of their report. This analysis uses the highest project-on levels just after the shutdown rather than the average hours before and after. Using this latter approach, we would estimate a level of 43 dBA for the Project.

Detail D shows another period of full power operation and relatively high sound levels.

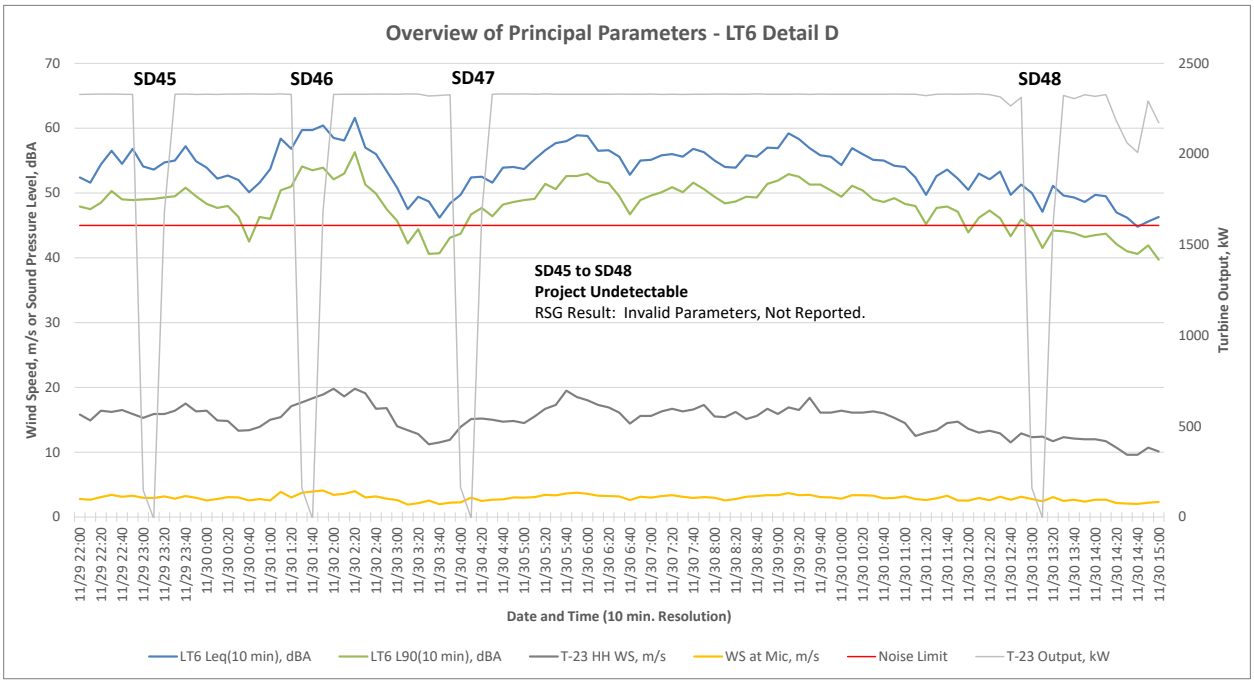

Figure 2.3.7

In this case, the overall sound level is dominated by wind-induced natural sounds because there is no obvious concurrent decline in the sound levels during any of the four shutdowns depicted here.

Detail E is plotted below.

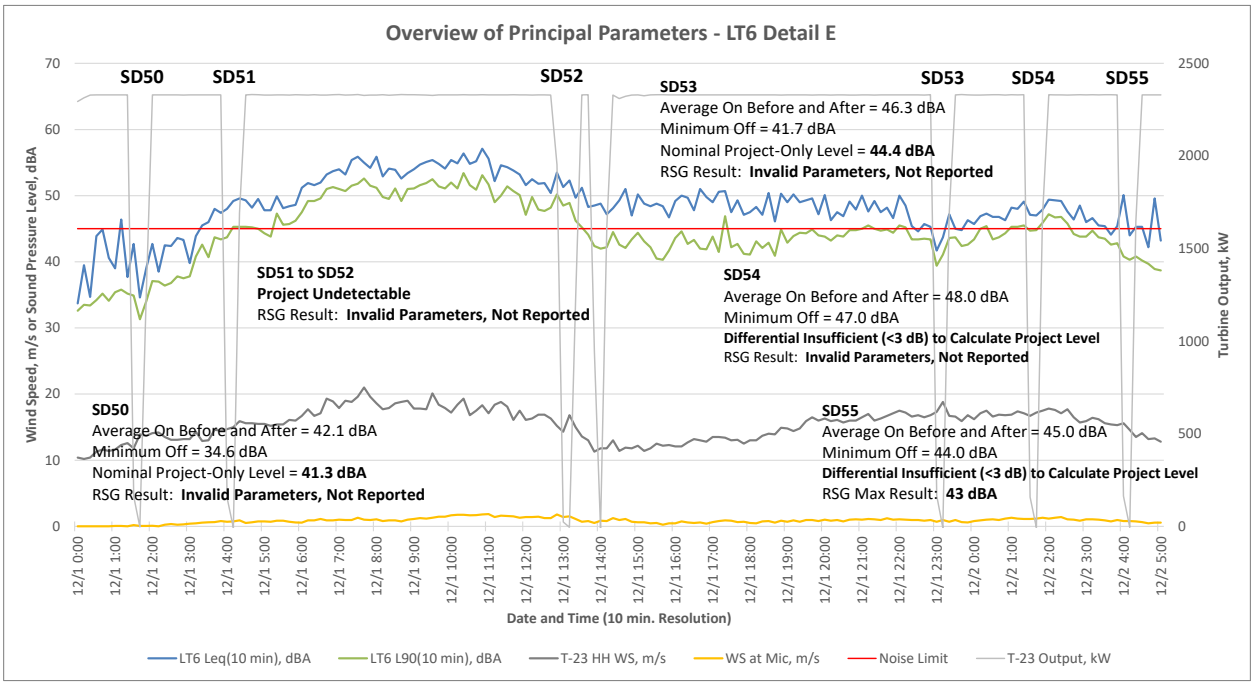

Figure 2.3.8

The dip in sound levels during SD50 allows a calculation of 41 dBA to be made for the Project. It is not known why RSG did not calculate project levels for most of the shutdowns during this period – possibly some unseen parameter like temperature or humidity. The only other shutdown in this group that seems to have moved the needle on the sound level is SD53. We estimate a project-only level of 44 dBA using the hourly averages before and after and the minimum level during the outage. This is the highest Project sound level we have observed for LT6.

Oddly, RSG is reporting a level of 43 dBA for SD55, which isn't a promising looking shutdown at all in terms of the behavior of the sound levels. Some contaminating noise event apparently happened right when the turbines shut down. That impediment notwithstanding, the report indicates that the project-on Leq level 30 minutes before the shutdown of 46 dBA was used as the on level and 42 dBA for the off level. The lowest level during this outage was 44 dBA, at least in terms of 10 minute integrations. Their off value may have come from a 1 second reading, but it's not clear.

The final period of interest from the LT6 data (Detail F, Fig. 2.3.9) occurred late in the survey when both the original LT6 meter was still running along with a second meter at the alternative position somewhat further away from foliage noise.

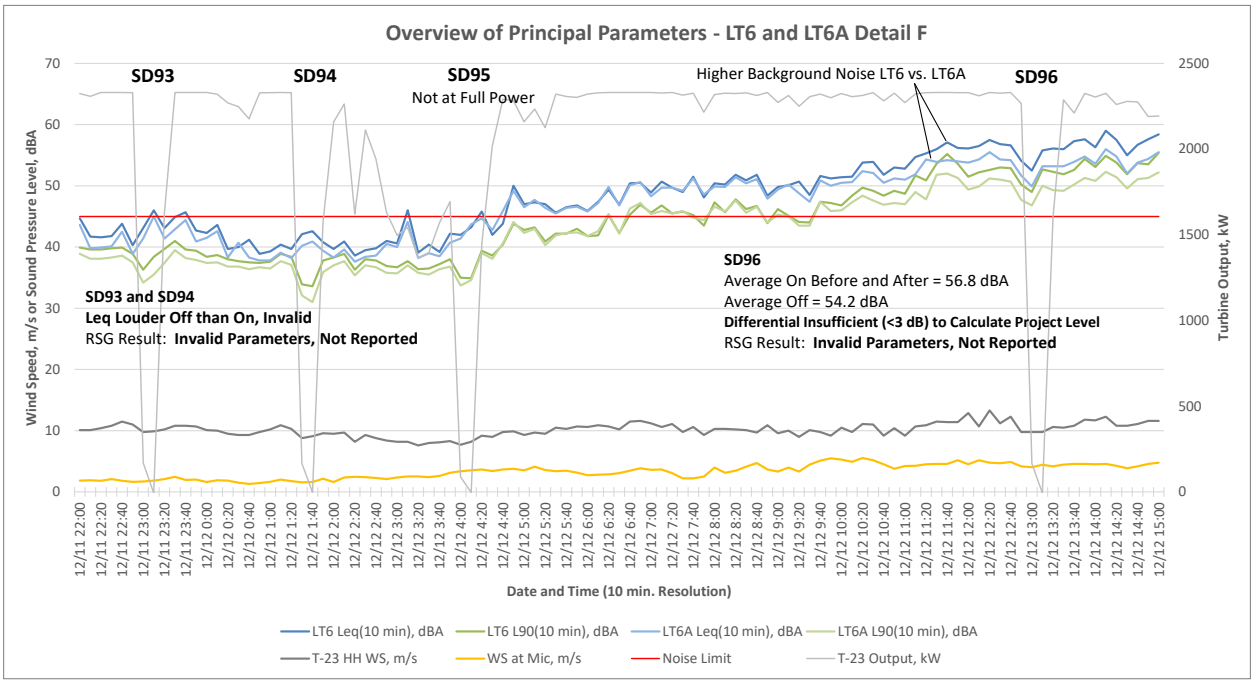

Figure 2.3.9

None of the on/off Leq differentials during this period allowed for a valid calculation of the Project sound level. Around the time of SD96 the sound levels at two positions diverge suggesting that background noise at the alternative location was somewhat lower during that time. Although the average windspeeds were fairly constant during this period, wind gusts may have become more frequent and prominent.

3.0 Conclusions

The Crowned Ridge Wind II Project (CRWII) is required through the permit conditions imposed by the South Dakota Public Utilities Commission (SDPUC) to meet certain sound level limits at potentially sensitive receptors. A previous field survey carried out by the Project's acoustical consulting firm, RSG, Inc., in the summer of 2021 found that the Project is meeting the required noise standards. However, concerns were later raised by some residents in the Project area that the summertime test results could not be considered definitive because the turbines seemed to be louder and more noticeable during the fall and winter. In response to these concerns and complaints an additional survey was ordered by the SDPUC and carried out in late November/early December of 2022 by RSG to retest the sound emissions from the Project during winter conditions at three complainant's residences. The results of this survey are detailed in RSG's report "Crowned Ridge Wind II – Noise Complaint Monitoring 2022" submitted to the Commission in March. The fundamental conclusion of the study is that the Project's sound emissions are still at or below the maximum permissible sound level of 45 dBA at non-participating residences and therefore in compliance with the permit conditions related to noise.

Hessler Associates has been engaged by the staff of the SDPUC to independently evaluate the field data from this survey and assess the validity of the RSG study and its conclusions. The raw data from the survey were analyzed from scratch and conclusions about the Project performance were drawn before ever reading the RSG report. The test results reported by RSG were then reviewed and compared to the project levels derived independently. In general, it was found that the RSG approach of looking at the highest highs when the Project was on and comparing them to the lowest lows when it was off – something not explicitly required by the test protocol – led to conservative results that were typically somewhat higher than we had calculated. In all instances, where a project-only sound level could be derived from on/off shutdown data the values were either equal to or, much more commonly, below the 45 dBA permit limit in both our analysis and in RSG's report. We were not able to identify any instance where a sound level greater than 45 dBA could be ascribed to the Project. Sound levels well above 45 dBA occur all the time but the extensive survey data measured before, during and after 123 Project shutdowns demonstrates that these elevated sound levels are due to naturally occurring sounds that are significantly louder than the Project because the temporary removal of turbine noise has no, or no significant, effect on the overall sound level. In general, wind turbine noise is drowned out by wind-induced background noise during high wind conditions and the turbines are more likely to be audible during moderate or even light winds.

Along this line, the survey data revealed that conditions sometimes occurred when the background sound level was extremely low, yet the Project was still operating at or near full power making it unusually audible. The manifestation of this was that the sound levels dropped dramatically during the shutdowns that took place during these conditions. In one example, around midnight on 11/24 at LT2, the total sound level dropped between 8 and 10 dBA during Shutdowns 25 and 26 from roughly around 40 dBA to 30 dBA. What this 10 dBA differential implies is that Project noise was essentially the only thing that was audible at the time compared to virtual silence during the shutdowns. Such periods of very pronounced audibility could be the impetus for the complaints that have occurred, even though the actual Project sound level is fairly low – in this case only around 38 dBA.

Some technical issues at Locations LT2 and LT3 were found during the data review. In particular, there were extensive periods of missing data at LT2 due to power supply problems and at LT3 a sheating system outside the residence began to cycle on and off intermittently at first and then almost continuously towards the end of the survey contaminating much of the data. Nevertheless, it is our opinion that enough valid measurements were obtained over three weeks of testing and more than 100 shutdowns to adequately establish whether the Project is compliant with the permit conditions or not.

A general comparison of the fundamental results from both analyses is shown in Table 6.0.1.

Table 6.0.1
Comparison of RSG and Hessler Analysis Results

Location	Applicable Permit Limit, Leq (10 min), dBA	Max. Reported Project-only Sound Levels Measured by RSG, dBA	Maximum Observed Project-only Sound Level (Hessler), dBA
LT2	45	44	43
LT3	45	45	44
LT6	45	45	44

In summary, we would conclude, based on the extensive analyses carried out by RSG and our own independent assessment of the raw field data from the ground up, that the Crowned Ridge Wind II Project is compliant with the noise limits contained in permit conditions issued by the South Dakota Public Utilities Commission.