

## **Concern 6:** Evaluating the Current Relevance of the 0.336 nm Threshold

The 0.336 nm displacement threshold originates from measurements taken in 2004, utilizing different instrumentation and under limited noise conditions compared to those present today. Over time, vegetation in the area has increased substantially, potentially resulting in greater mass and, consequently, higher levels of background noise on windy days than in the early 2000s. Furthermore, the instrumentation used for these measurements was replaced around 2007 to comply with CTBT/IMS Treaty requirements. The upgraded system is expected to demonstrate improved performance relative to the previous configuration, suggesting that current data may reflect increased ground motion when compared to results obtained with older sensors and data loggers. Recent records transmitted by the array to IRIS/DMC in Seattle, Washington, indicate that, under moderate wind conditions of 5–8m/s, and when local wind turbines have been shown to be inactive, background noise frequently exceeds the 0.336 nm threshold. Using displacement data from the AWE portal on a calm wind day the array shows an average noise level of ~6.85nm and on a windy day with 12.5m/s winds an average of ~20.37nm in the 2-8Hz range. For the same data the borehole shows only 0.68nm and 1.039nm in the 2-8Hz range. Note these are not RMS average but Peak to Peak averages over ~30min of data with spikes removed from the data so as not to bias the data with random noise, but to try and measure a good overall background noise average for the array. The results clearly show how the use of the borehole sensor clearly reduces the overall background noise.

Upon reviewing the data collected from the EKA array and the borehole during periods when both the Crossdykes and Ewe Hill wind farms operated at approximately 90% capacity before being curtailed to 0% for several hours and subsequently restarted, no discernible changes were observed in the background noise levels at either location. The following figure presents the spectrograms and power spectral density (PSD) for the timeframe immediately preceding the curtailment of the two wind farms on 27 April 2025. If DB's model is accurate, it should reveal turbine-related noise if present; however, such evidence is absent. Additionally, there is a notable spike at approximately 6.6 Hz on EKR3 and EKR5 that ceases when Ewe Hill was curtailed, but does not reappear upon its reactivation around 13:30 GMT. While this phenomenon is also detectable on the EKR4 element of the array, its amplitude is significantly lower—despite EKR4 being equidistant from EKR3 and EKR5. This suggests that the detected noise likely originates from a different anthropogenic source, such as forestry operations or other local activities, rather than from the wind farms themselves.

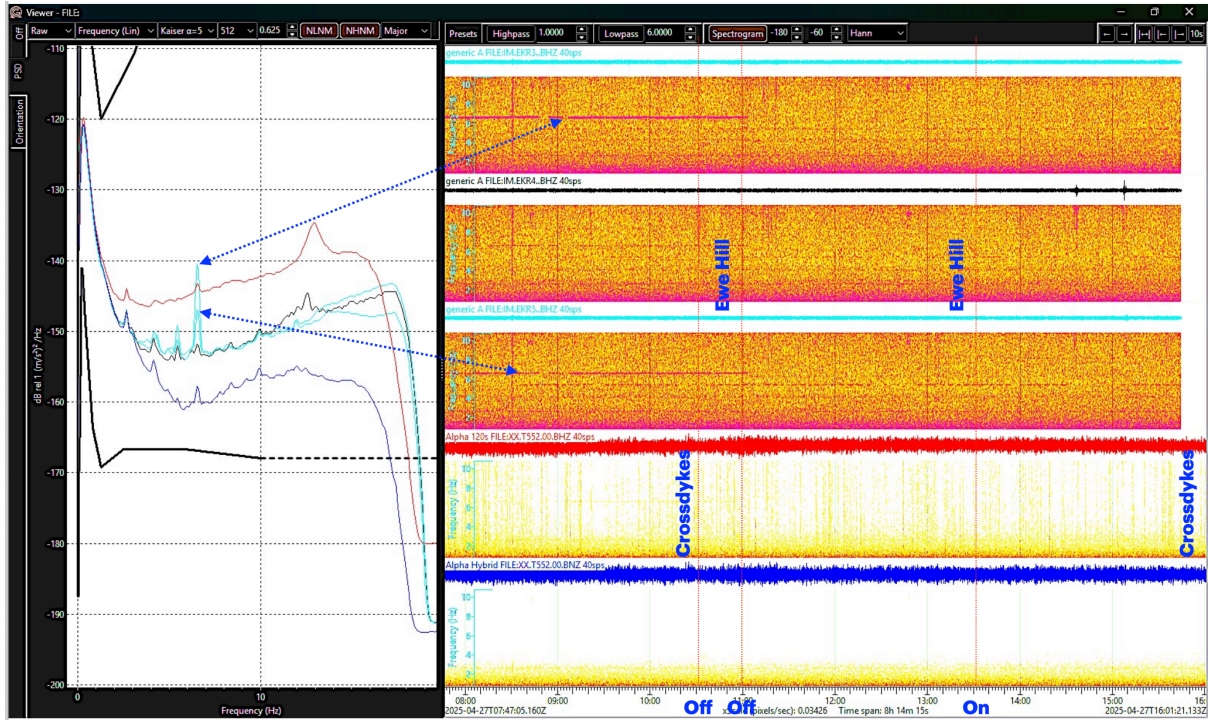


Figure 13, Data around turbines from Ewe Hill and Crossdykes being turned on and off, EKR3, EKR4, EKR5, Surface Alpha and Borehole Alpha, 27 April 2025

Additionally, a review of data at a time when winds were measured at 50m AGL to be approximately 12.5m/s shows that the background noise levels are well above the 0.336nm displacement threshold. A look at a 30min segment of data between 23:30 and 24:00 GMT on 2 June 2025, downloaded from the AWE website and the XML calibration file, shows that the array average background noise when filtered between 2-8Hz and 2-4Hz is well above the threshold limit, even in the borehole. However, the borehole has much less displacement showing approximately 5.1% at 2-8Hz and ~8.7% at 2-4Hz displacement as compared to the array average. In the selected data without spikes, and no filtering, the borehole has about 33% of the noise as the array average. Even using the quietest element(s) in the array the borehole shows only 55%, 9% and 15% in displacement compared to the quietest element in the array for raw data, and 2-8Hz and 2-4Hz respectively, see table 1. These numbers compare to a calm wind day on 5 June 2025 at 02:00GMT when the borehole sensor still shows a noise of ~3% of the raw selected data noise, and 14% and 17% for the 2-8Hz and 2-4Hz data respectively, see table 1. Note, the surface array has large random spikes in the data so I used data between spikes to get a better average, but the waveforms clearly shows how much noise there is in the surface when compared to the borehole, Figure 14. Note, this is just one example of higher background noise that is well above the threshold, and is supported by results in Concern 2 and figures 5 and 6 above when looking at the data in acceleration units.

Station	High Winds, 12.5m/s						Calm Winds, 0 to 0.1 m/s				
	All Data nm 1-20Hz	15 Min RMS nm 1-20Hz	Data Between Spikes nm	2-8Hz Filter nm	2-4Hz Filter nm	15 Min RMS nm 2-4Hz	All Data nm 1-20Hz	Data Between Spikes nm	2-8Hz Filter nm	2-4Hz Filter nm	15 Min RMS nm 2-4Hz
EKB1	211	13.80	63	47	15	2.44	167	17	7	4	1.26
EKB2	79	6.30	33	15	8	1.72	61	17	6	5	1.30
EKB3	44	5.90	37	16	11	1.84	24	19	7	5	1.26
EKB4	84	8.10	69	30	23	1.95	27	16	5	5	1.14
EKB5	124	10.10	60	19	10	1.67	59	22	7	4	1.11
EKB6	75	7.30	75	31	17	1.81	1066	18	6	4	2.04
EKB7	371	27.60	145	135	63	3.90	22	20	6	4	1.18
EKB8	324	19.60	50	30	20	2.24	250	23	6	5	1.08
EKB9	285	15.20	76	20	10	1.88	22	20	6	5	1.17
EKB10	174	19.30	87	18	13	1.82	22	22	7	5	1.13
EKR1	143	8.00	49	18	14	1.73	23	20	6	4	1.11
EKR2	74	6.50	44	19	11	1.77	23	17	7	5	1.20
EKR3	50	8.10	37	14	8	1.79	31	19	7	4	1.24
EKR4	63	9.60	45	13	7	1.73	36	18	6	5	1.16
EKR5	53	7.70	39	12	7	1.74	63	17	7	5	1.22
EKR6	765	17.40	76	17	12	2.31	318	21	7	6	1.42
EKR7	98	8.30	43	17	10	1.87	1114	53	9	6	1.46
EKR8	83	9.40	38	20	12	1.95	1134	19	9	5	1.27
EKR9	253	17.30	51	17	9	2.55	72	20	10	6	1.21
EKR10	54	8.20	53	14	8	1.75	30	22	6	4	1.10
Array Average	126.17	10.85	53.95	20.37	11.84	1.92	73.53	21.00	6.85	4.80	1.21
Borehole	27.40	2.07	18.00	1.039	1.035	0.26	0.90	0.68	0.68	0.67	0.20
Ratio AA ÷ BH	4.60	5.25	3.00	19.60	11.44	7.43	81.70	30.88	10.07	7.16	6.18
Quietest Array Element	1.61	2.86	1.83	11.55	6.76	6.45	24.44	23.53	7.35	5.97	5.51
Element Used	EKB3	EKB3	EKB2	EKR5	EKR4	EKB5	EKB9	EKB4	EKR4	EKR3	EKB8

Table 1, Note cell in Cyan were removed from Array Average Calculation as the data showed large spikes, or was significantly above the average. Darker Green Columns are RMS measurements for 36,000 data points.

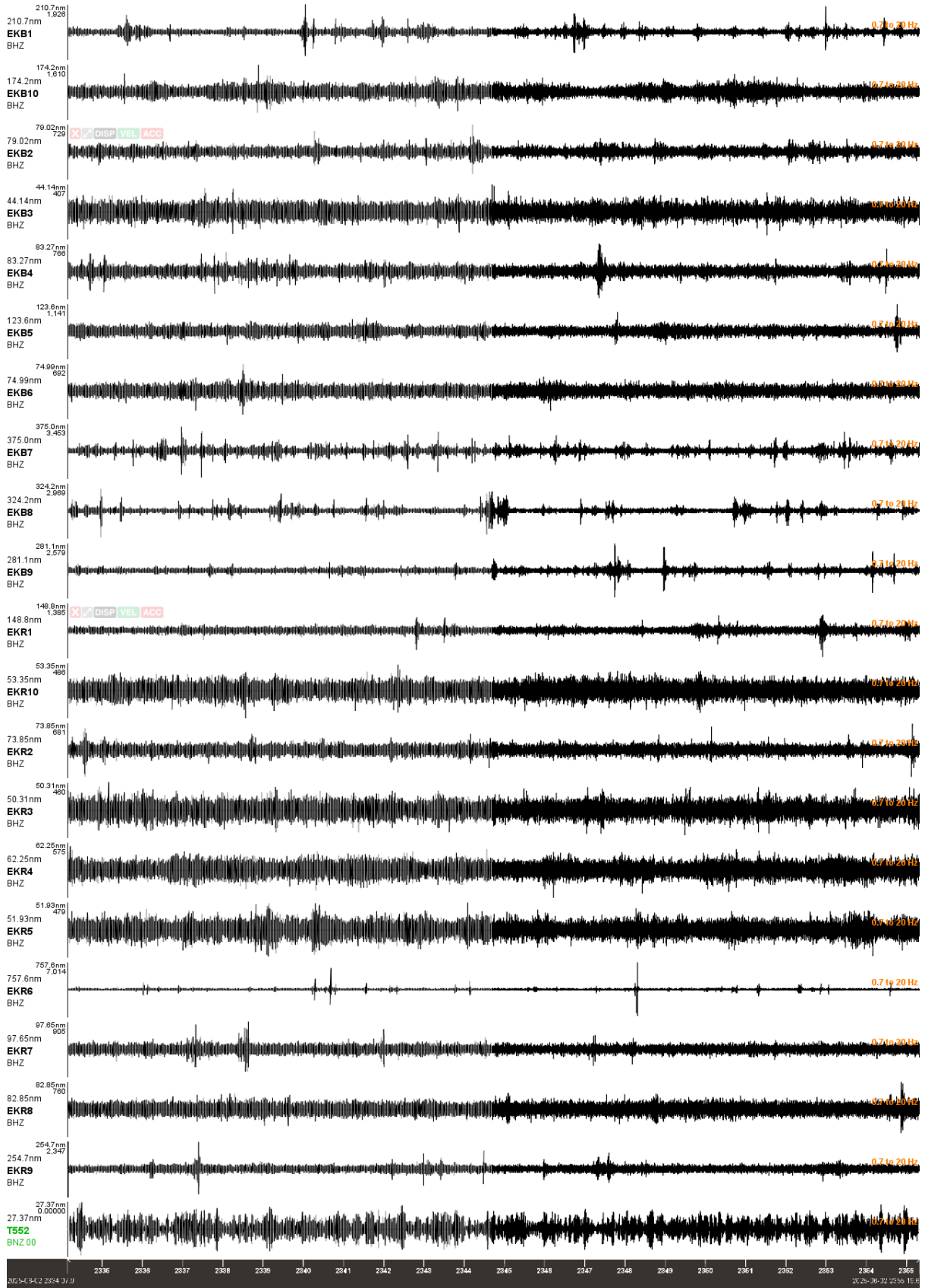


Figure 14, Data from AWE portal with BH on bottom, 12.5m/s winds, filtered from 0.7 to 20 Hz. Note BH is amplified 10X so as not to be a flat line.

As you know AWE uses a Root Mean Square (RMS) values for making their measurement. RMS is simply a set of values of the square root of the set's mean square data points, or:

$$x_{RMS} = \sqrt{\frac{1}{n} (x_1^2 + x_2^2 + \dots + x_n^2)}$$

So to measure the RMS, and not the Peak to Peak, we used 15 min of data, or 36,000 data points, from each element in the array and converted these to a CVS file, which was then imported into Excel. We then averaged the results using the method outlined above and compared these results to the borehole, using the same method. For the data in Table 1 we measured both 1-20Hz and 2-4Hz filtered data for the high wind day and only the 2-4Hz data for the calm wind day. The 1-20Hz filter was used to represent the basic "Raw" data above 1Hz and across AWE's area of interest and was used to check the results with the 2-4Hz data.

Each data point was squared, then averaged for each channel, and then the square root of the average was calculated to measure the RMS. As you can see in Table 1 these values show nearly the same noise reduction as simply using the Peak to Peak values. Using the 2-4Hz filtered data for 12.5m/s the results clearly shows a significant improvement in noise reduction between the array average and the borehole, as well as comparing the borehole to the quietest element of the array. The data shows that on windy days the RMS of the surface array was over 1.9nm while the borehole sensor was only at 0.26nm. Figure 15 shows bar graphs on the same scale for both the Calm and 12.5m/s RMS data for reference.

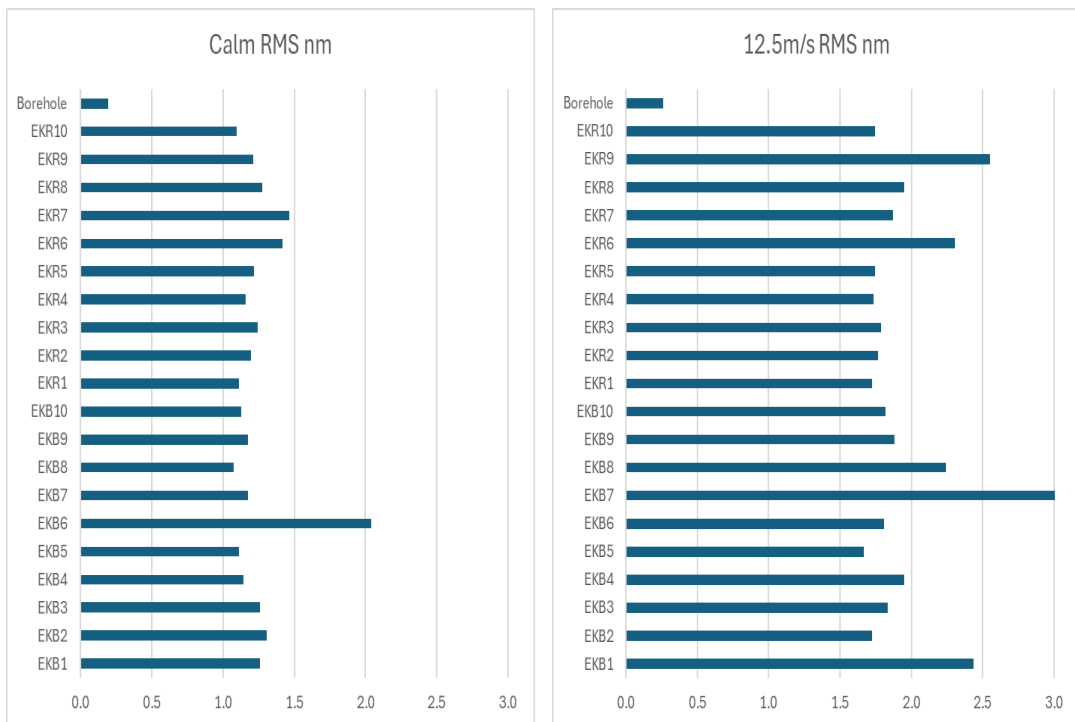


Figure 15, RMS plots Calm Vs 12.5m/s, note EKB7 is off scale at 12.5m/s wind speeds.