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# Cooling tower noise control audit

The **Industrial Noise and Vibration Centre (INVC)** was requested by Darren Bolton to carry out an environmental noise control audit of the site in Runcorn. The assessment was performed during a site visit on Tuesday and Wednesday 23 and 24 April 2024 and is a follow-up of a previous visit performed in August 2022.

## 1.0 Audit objective

The audit objective is to identify and rank the significant noise sources and any specific noise characteristics that are the potential cause of complaints - even when conventional noise specifications have been met. Best practice in noise control is then defined for the site as the basis for planning the most practical and cost effective noise control programme possible.

Since the previous assessment, a noise control programme has been implemented. Depending on the effectiveness of the program, it is likely that different sources are now the main noise contributors.

## 2.0 Methodology

Measurements were performed at 1.6m height during the night time at position A (Clarks Terrace, about 110m away from the cooling towers) and B (Mersey View, about 185m away from the cooling towers) as shown in Figure 1. During the night time assessment, the weather was dry, with a light breeze (measured locally between 2 m/s and 3 m/s) from the north and a temperature of 7ºC . Measurements were also performed during the day around the cooling towers and other external noise sources on site.

Each measurements was performed for a long enough duration to obtain a stable equivalent level, which was typically reached after 1 minute.

The audit was carried out using calibrated instrumentation conforming to BS EN 60651:1994 and BS EN 60804:1994 Type 1 to measure sound pressure levels. The equipment was calibrated and battery checks were made at regular intervals during the survey to confirm the equipment was performing to specification. Details of the noise measurement equipment used for this assessment are listed in Table 1.

**Table 1. Equipment used**

| | | | |
|---|---|---|---|
| Sound level meter | NTI | XL2 | s/n A2A-23797-E1 |
| Sound level calibrator | Larson Davis | CAL200 | s/n 31327 |

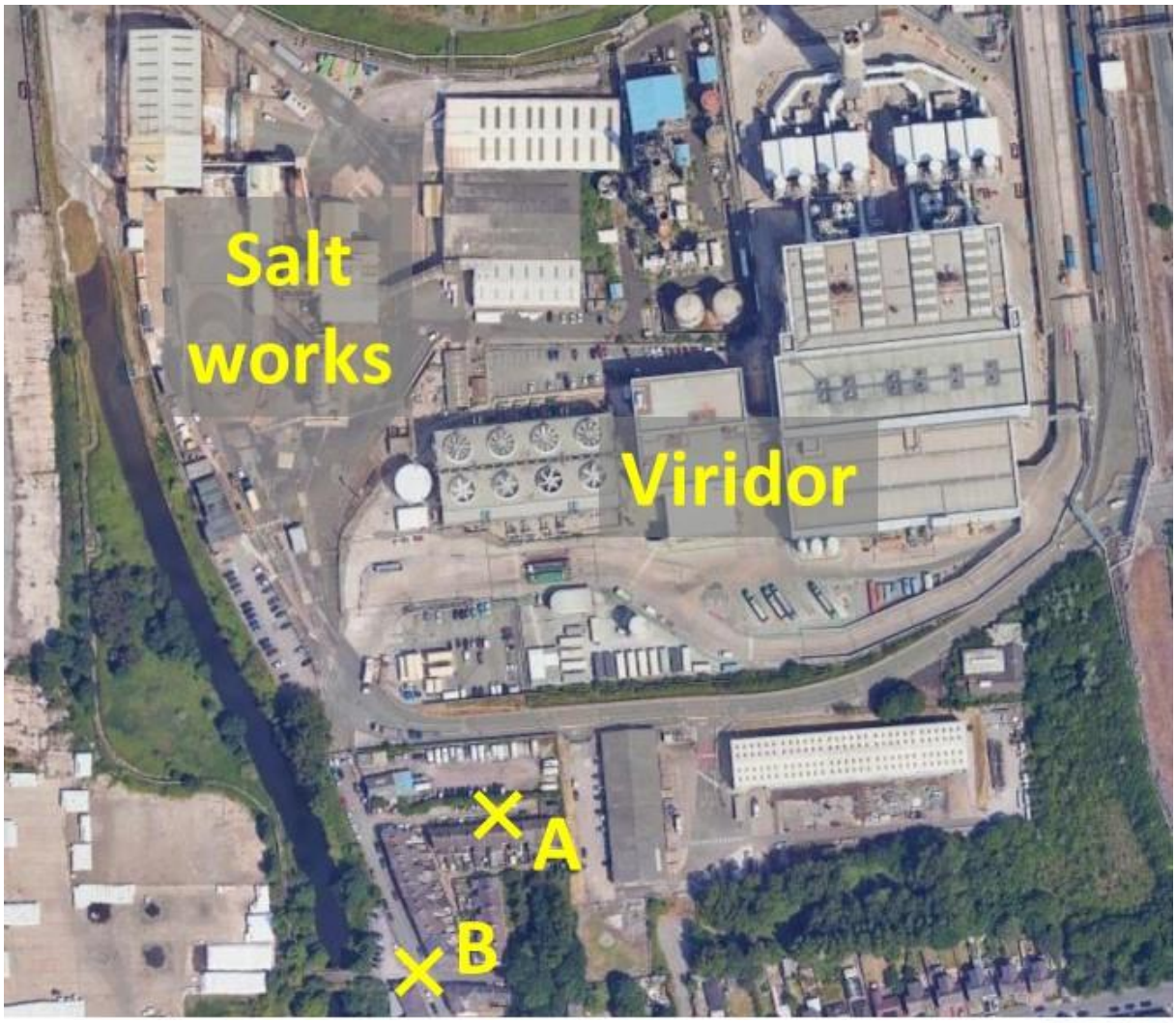


**Figure 1 Aerial view**

Several configurations were assessed at position A, detailed in Table 2. For all tests, the cooling tower fans were set at their maximum operational speed.

**Table 2. Tested configurations**

| Test number | Plant operation | | |
|---|---|---|---|
| | **Turbine hall ventilation fans (all)** | **Phase I , cooling tower fans 1 and 2 Phase II, cooling tower fans 1 and 2 (four cooling tower fans in total)** | **Phase I , cooling tower fans 3 and 4 Phase II, cooling tower fans 3 and 4 (four cooling tower fans in total)** |
| 1 | on | on | on |
| 2 | on | off | on |
| 3 | off | off | on |
| 4 | off | on | off |
| 5 | on | on | off |

At position B, the noise levels were only measured with all the plant on site operating (Test 1).

# 3.0 Measurements

## 3.1 Overall levels

The obtained overall levels, measured between 22.30 hours and 23.15 hours, and are shown in Table 3.

**Table 3. Measured overall levels**

| Test number | Position | Measured levels | |
|---|---|---|---|
| | | $L_{Aeq}$ [dB] | $L_{A90}$ [dB] |
| 1 | A | 51 | 51 |
| 2 | | 52 | 52 |
| 3 | | 52 | 51 |
| 4 | | 51 | 51 |
| 5 | | 52 | 52 |
| 1 | B | 51 | 47 |

Subjectively, broadband and tonal noise are both equally noticeable at position A.

## 3.2 Frequency signature at location A

An overview of the frequency signature at position A during the night time at approximately 23.00 hours on Tuesday 23 April is shown in Figure 2. The most significant tones identified on the signature are at 140Hz, 280Hz, and 560Hz. They are related to an unknown source on the salt works site.

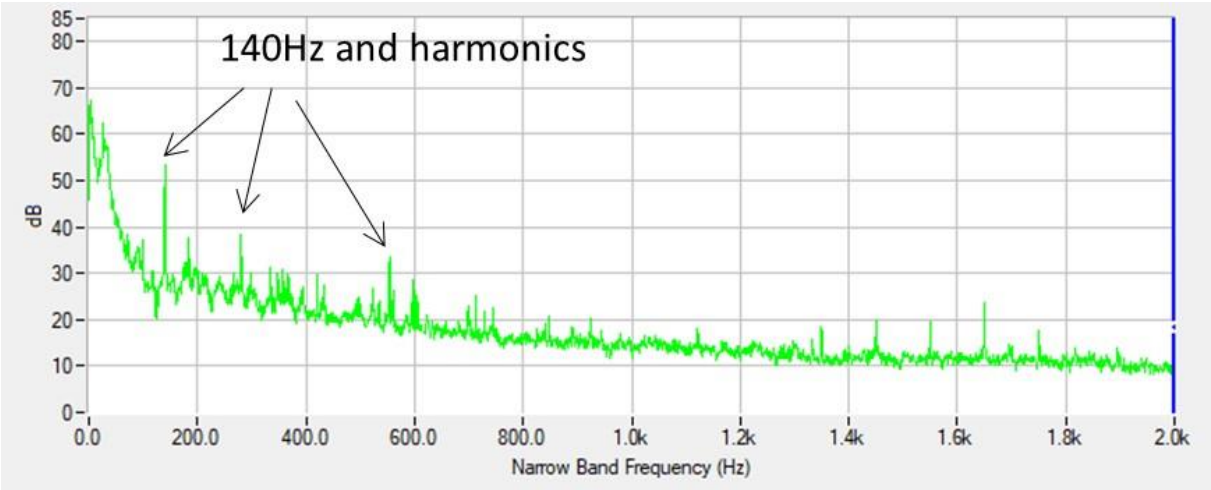


**Figure 2. Noise frequency signature at Clarks Terrace**

# 4.0 Analysis and comments

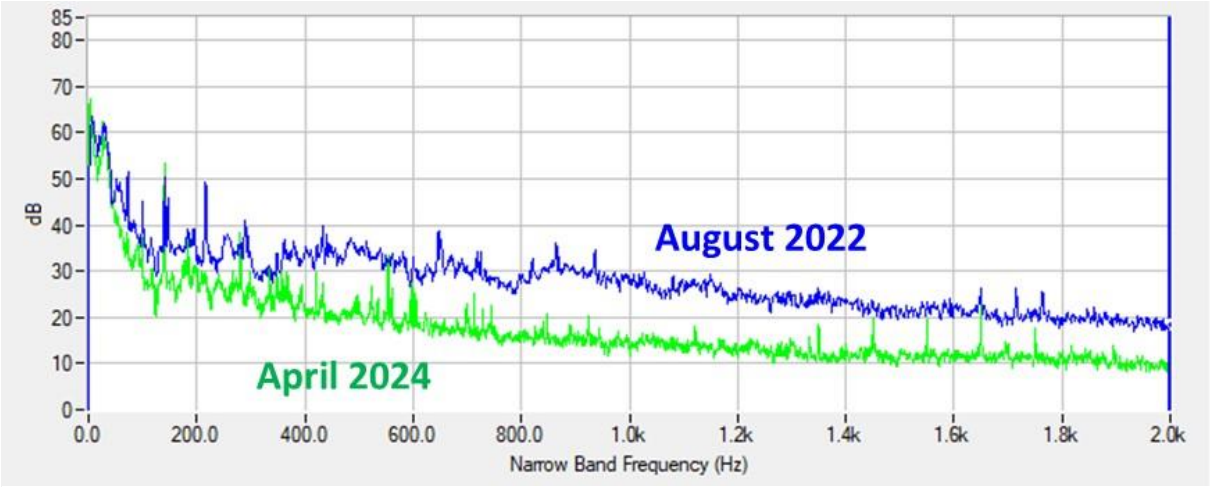


**Figure 3. Noise frequency signatures in August 2022 (blue) and April 2024 (green)**

The comparison with the previous assessment, Figure 3, shows a significant improvement. Tonal and broadband noise have been reduced by 10-15dB. Regarding overall levels, the $L_{Aeq}$, previously measured at 59dB, has been reduced by 8dB.

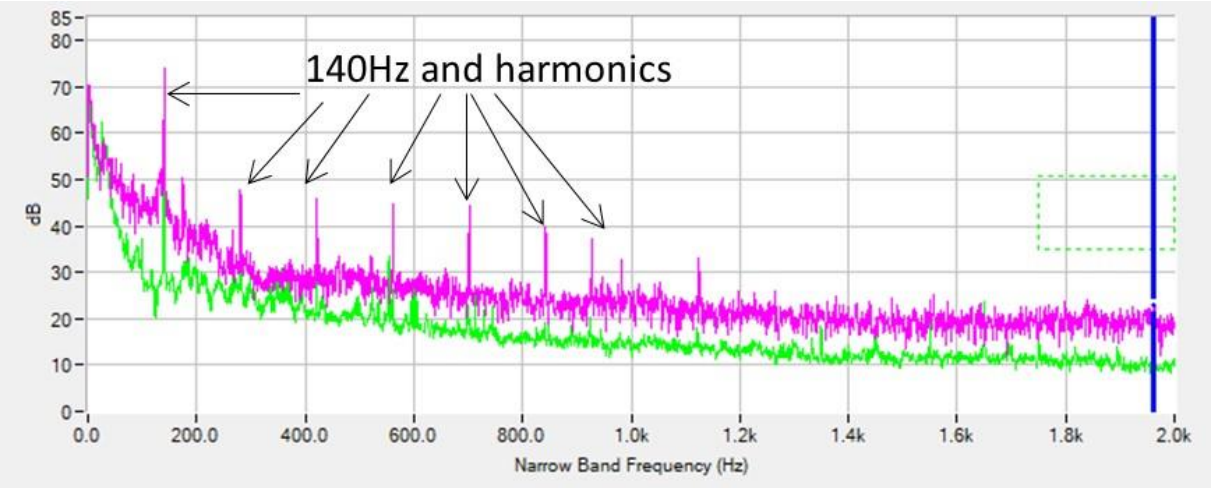


**Figure 4. Noise frequency signatures at the boundary with the salt works (magnolia) and at Clarks Terrace (green)**

The 140Hz tone and its harmonics, Figure 4 , is present in the signature taken at the boundary between Viridor and the salt works site. Subjectively, the source of this tone is originated from the salt works, and it could not be identified on any of the signatures obtained on the Viridor site.

The Viridor site only contributes to the broadband noise, not to the tonal noise. There is very little difference between the overall levels measured for the different tests in Table 3. The main contributors are therefore not the cooling tower fans, nor the ventilation fans.

Indeed, the main broadband sources have been reviewed. They are listed and ranked in Table 4, with an estimation of their partial level at position A. Plant mentioned in the table is detailed in section 5.0, and the details of the calculations are available on request.

**Table 4. Estimated partial level for the main broadband contributors**

| Rank (Highest to lowest contributor) | Plant details | Estimated partial level contribution at location A [dB(A)] |
|---|---|---|
| 1 | Phase I cooling tower air inlet | 48 |
| 2 | Steam return valve 10BLB10GH010 | 48 |
| 3 | Phase I water pumps, by air inlets | 44 |
| 4 | Valve 10PAR10AA001X | 39 |

# 5.0 Noise control options

## 5.1 Phase I cooling tower air inlets

Estimated partial level at location A: 48dB(A)

Some noise control measures are already integrated to the plant. In particular, vertical silencer baffles are installed all across the inlet area, Figure 5. In addition, **INVC** has been notified that some waterfall noise reducers, Figure 6, have also been installed internally. These measures are effective, as it is estimated that the noise from the inlet has been reduced locally by 6-9dB since 2022.

Additional noise reduction measures would require very significant and expensive modifications, of a similar scale in size to the cooling towers, for only a modest 1 dB estimated level reduction at Location A. For this particular source, the Best Practical Means not exceeding excessive cost are achieved.


**Figure 5. Silencer baffles in front of Phase I cooling tower air inlet**

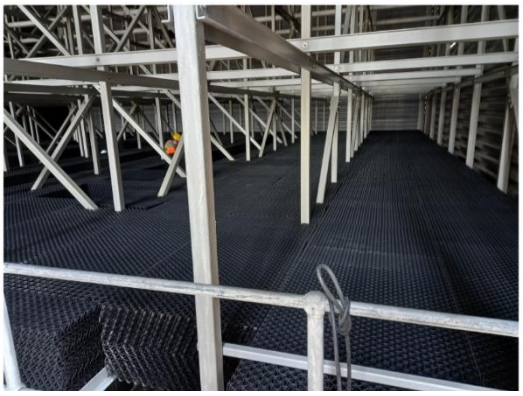

**Figure 6. Waterfall noise reducers**

## 5.2 Steam return valve 10BLB10GH010

Estimated partial level at location A: 48dB(A)

The first step is to inspect the valve for leaks or missing seals, and to provide any required maintenance.

Local acoustic panels placed at a strategic location will help to reduce the noise level of the valve. In addition, depending on the valve type, a quiet version might be available.


**Figure 7. Steam return valve 10BLB10GH010, behind polished water storage tank 1**

## 5.3 Phase I water pumps

Estimated partial level at location A: 44dB(A)

During the visit, only 3 of the 4 pumps were operating. Noise is radiated from several surfaces: inlet, pump body, motor pedestal. Local acoustic shields, in addition to the introduction of damping, are required.

Note that introducing a simple acoustic cover over the motor is not likely to provide a significant noise reduction, as it is not the only surface radiating noise.


**Figure 8. Phase I water pumps overview**

## 5.4 Valve 10PAR10AA001X

Estimated partial level at location A: 39dB(A)

In a similar way to the steam return valve , the first step is to inspect the valve for leaks or missing seals, and to provide any required maintenance. In particular, some of the lagging is missing on the valve body and should be replaced.

Local acoustic panels placed at a strategic location will help to reduce the noise level of the valve. Moreover, depending on the valve type, a quiet version might be available.


**Figure 9. Valve 10PAR10AA001X (yellow box)**

It is recommended to introduce control measures to the other sources first before considering significant changes to the valve (apart from replacing the lagging) as it is not the dominant source at location A.

## 5.5 Recommendations

The Best Practical Means not exceeding excessive costs are achieved for the Phase I cooling tower air inlets. Since it is also one of the two main contributors at Location A, equally with the 10BLB10GH010 steam return valve, this limits the achievable attenuation at that location.

Reducing the noise emissions of the valves detailed in sections 5.2 and 5.4, on the other hand, is relatively straightforward. The level can be reduced locally around the valves significantly, by an estimated 3-8dB, which would in turn translate in a 1-2dB attenuation in the far field at Location A.

The Phase I water pumps are not the dominant source at Location A, and although technically feasible, the Best Practicable Means not exceeding excessive costs are nearly achieved for this source. Whether they are reached or not depends on how much the noise from the valves is reduced.

It is therefore recommended to proceed with a stepped approach:

1. Introduce noise control measures to the 10BLB10GH010 and 10PAR10AA001X valves
2. Review the noise reduction achieved at Location A
3. Reassess the noise source ranking to establish the benefit of extending the noise control programme to the pumps

All the sources on the Viridor site are producing broadband noise. Once the broadband noise level is reduced, the 140Hz tone and its harmonics will become more prominent, making them more noticeable.

# 6.0 Conclusion

The main source of tonal noise at 140Hz and harmonics at position A is related to the salt works. However, the Viridor site does contribute to the broadband noise at that location.

The noise level from the Viridor site has been significantly reduced since **INVC**'s assessment in August 2022, with reductions of 10-15 dB for tonal noise and 8dB for the overall level.

The current main contributors to the overall level at Clarks Terrace are the Phase I cooling tower air inlets and the steam return valve 10BLB10GH010.

Some noise reduction measures are already into place to reduce the noise emissions from the Phase I cooling tower air inlets. Significant and onerous changes are required to reduce their contribution even further, to the point that the Best Practicable Means without exceeding excessive costs are reached for this source. This therefore limits the amount of possible noise reduction at Location A to 1-2 dB for the overall level.

It is recommended to introduce noise control measures for the steam return valve 10BLB10GH010. Although the second valve, 10PAR10AA001X, is the fourth contributor at Location A, the two are similar and the measures are likely to be easily replicated to this valve.

Once this is performed, it is then also recommended to reassess the ranking to determine whether it is beneficial to introduce some noise control measure to the Phase I water pumps.

A few potential measures have been identified: some of them can be directly implemented by Viridor. For the most technical steps, **INVC** can provide detailed recommendations.

Please contact **INVC** if you need any additional information or would like to discuss any of the above in more detail.

Matthieu Folzan

| Revision | Date | Revision History | Prepared | Checked |
|---|---|---|---|---|
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| 1 | 11/06/2024 | First amendment | MF | MF |
| 2 | 14/06/2024 | Second amendment | MF | MF |
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