A practical modification to ISO 8297:1994 for unattended sound power level measurement of land drilling rigs

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Abstract - Land drilling rigs are large, mobile machines operating continuously in Australia's gas fields. These rigs must comply with noise limits, some of which are determined by the calculated sound power level according to *ISO 8297:1994 Acoustics - Determination of sound power levels of multisource industrial plants for evaluation of sound pressure levels in the environment - Engineering method*. The standard involves surrounding a defined plant area with an array of microphones, and typically requires an attended measurement session. However, attended surveys at operational drilling rigs are impractical for various reasons, leading to a preference for unattended noise surveys. Furthermore, physical limitations often prevent placing microphones beyond the well pad perimeter, making strict adherence to ISO 8297:1994 unreliable due to mobile noise sources (such as front-end loaders and trucks) operating too close to the microphones. To address these challenges, a modification to the ISO 8297:1994 calculation procedure has been investigated. The goal is to provide accurate sound power level results even when noise sources approach closer to the microphones than the standard allows.

1 INTRODUCTION

ISO 8297:1994 specifies an engineering method for determining the sound power level of large multisource industrial plants and is relevant to land drilling rigs in the oil and gas industry. This standard is used by Shell's QGC (Queensland Gas Company) to assess noise levels from land drilling rigs, where limits are expressed as a sound power level. However, field conditions often make it difficult to adhere strictly to the standard's requirements, particularly during unattended noise measurements. As a result, a modification to the calculation method has been explored to improve the reliability of these measurements for operational land drilling rigs.

2 THE PROBLEM

The standard requires measuring sound pressure levels along a Measurement Contour surrounding a specified Plant Area. For accurate results, the relative distances between the Plant Area, Measurement Contour, and measurement points must meet specific criteria. However, physical and operational constraints at drilling sites often prevent placing microphones in ideal locations. A land drilling rig is typically located centrally on a 100m x 100m hardstand (the well pad), and due to land access and topographical issues, equipment cannot usually be placed beyond this area. This limitation results in mobile noise sources, such as front-end loaders and trucks, operating closer to microphones than anticipated by the standard, leading to an over-calculation of the sound power level. While additional microphones can be used to increase the Plant Area size, this solution is impractical due to the need for vehicle access to the site (i.e. moving between microphones), and the additional cost of equipment and setup. Based on experience, we have determined that ten (10) is the optimal number of measurement locations.

In summary, over-calculation of the sound power level occurs when mobile equipment moves outside the Plant Area and too close to individual microphones. Since it is impractical to change the physical measurement setup to encompass the entire well pad, a modified calculation method is needed to address this issue.

3 FINDING A SOLUTION

The over-calculation of sound power level occurs when noise sources operate outside the Plant Area, with one microphone disproportionately influencing the value of the average sound pressure level, $\overline{L_p}$. As defined by the standard, $\overline{L_p}$ is the logarithmic average of each sound pressure level (L_{pi}) measured in octaves and is used to identify outliers and limit their influence (the standard limits L_{pi} values to $\overline{L_p}$ plus 5 dB). However, when a significant noise source operates outside the Plant Area, the calculation becomes skewed, leading to an over-calculation of the sound power level.

To mitigate this, various modifications to the calculation method were considered. The most reliable solution was found to be calculating $\overline{L_p}$ as the median, rather than the logarithmic average, of the measured sound pressure levels (L_{pi}). This approach reduces the impact of outliers, providing more accurate results when noise sources operate outside the Plant Area. It is important to note that the modification only applies to the value $\overline{L_p}$ that is used to *check* for outliers in Step 1, and the resulting sound power level remains based on a logarithmic average of the corrected sound pressure levels (L_{pi}).

4 TESTING THE SOLUTION

To evaluate the proposed modification, a SoundPlan model was created, replicating a real-world measurement. The model featured a 92m x 72m Measurement Contour around a 59m x 39m Plant Area, with ten receiver points positioned along the Measurement Contour. Various scenarios were tested, with one or two 100 dB L_{WA} point sources positioned either within, on the edge, or outside the Plant Area. Sound pressure levels were calculated according to ISO 9613-2:1996, and sound power levels were then back-calculated using both the original ISO 8297:1994 method and the proposed modification. The results, shown in Table 1, demonstrate that the modified method provides more accurate sound power levels when sources are located outside the Plant Area.

Table 1 – Comparison of calculated sound power levels (deviation greater than ±2 of expected is highlighted).

Source Location(s)	ISO8297:1994 Method ($\overline{L_p}$ as logarithmic average of L_p)			Modified Method ($\overline{L_p}$ as median of L_p)		
	Calculated	**Expected**	**Deviation**	**Calculated**	**Expected**	**Deviation**
One Source:						
Centre of Plant Area	99.0	100.0	-1.0	99.0	100.0	-1.0
Edge of Plant Area	100.1	100.0	+0.1	99.1	100.0	-0.9
Outside Plant Area	110.5	100.0	+10.5	98.7	100.0	-1.3
Two Sources:						
Both within Plant Area	102.1	103.0	-0.9	102.1	103.0	-0.9
One at edge of Plant Area	102.9	103.0	-0.1	102.5	103.0	-0.5
Both at edge of Plant Area	104.3	103.0	+1.3	104.1	103.0	+1.1
One outside Plant Area	111.0	103.0	+8.0	102.3	103.0	-0.7
Both outside Plant Area	116.5	103.0	+13.5	103.7	103.0	+0.7

5 CONCLUSION

Modifying the sound power calculation method in ISO 8297:1994 to use the median rather than the logarithmic average for $\overline{L_p}$ provides more reliable results when noise sources operate outside the designated Plant Area. This modification is particularly useful for unattended measurements of land drilling rigs, where microphone placement is often restricted to the well pad perimeter. This conclusion is based on a limited set of scenarios, further testing and review is warranted.

REFERENCES

International Organization for Standardization. (1994). *ISO 8297:1994 Acoustics - Determination of sound power levels of multisource industrial plants for evaluation of sound pressure levels in the environment - Engineering method(Incorporating Amd.1:2021(E))*.