Noise Exposure Assessment for Extended Work Shifts – What Are the Options?

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Determining employee time-weighted average (TWA) noise exposures for facilities with 8-hour work shifts can be a fairly straightforward procedure. However, confusion often reigns when extended work shifts (i.e., 10-hour, 12-hour days) exist. To handle exposure data for workdays greater than 8 hours there are at least three viable options. The data may be normalized to an 8-hour day for direct comparison to the applicable regulation criteria, the average sound level may be compared to a sliding-scale criteria, or the full-shift projected dose may be utilized. Each option is described herein to help sound surveyors decide which approach may be best suited for their specific needs or management preferences.

Consider the following example. A pipe fitter works 12-hour days in a chemical plant. A personal noise dosimeter is used to measure the pipe fitter's daily noise exposure. The dosimeter is pre-set with an 80-dBA threshold level, a 90-dBA criterion level, and a 5-dBA exchange rate. Note: these criteria are set forth in both the Occupational Safety and Health Administration (OSHA) and the Mine Safety and Health Administration (MSHA) occupational noise exposure regulations. The dosimeter sample duration is 10 hours and 41 minutes, which is equal to 10.7 hours. The measured dose is 44.6%, and the average sound level (L_{AVG}) is 82.1 dBA. Based on the regulatory requirements, does this job activity warrant inclusion in a hearing conservation program (HCP)? Note: for demonstration purposes only data measured with the low-threshold (80 dBA) setting are used. For an explanation of the differences between low- and high-threshold (90 dBA) data, please refer to the author's article entitled *A Common Misunderstanding About Noise Exposure Assessment and the Regulations*, that appeared in the CAOHC Update Winter/Spring 2004 issue. In addition, this example assumes sufficient sampling time is used to make certain an adequate number of full-duty work cycles are captured during the partial-shift monitoring to ensure the results are representative of the full 12-hour workday.

Option 1 – Normalize the data to an 8-hour TWA:
From the author's experience, the most common approach to handling exposure data for extended work shifts is to normalize the results to an 8-hour average or TWA. This option permits direct comparison to the action level (85 dBA) for HCP inclusion. In fact, the MSHA regulation mandates this procedure and even designates the result as TWA_8. However, it is worth noting the subscript "8" is redundant as TWA used by itself is synonymous with an 8-hour average sound level. *In other words, it is technically incorrect to refer to a 10-hour or 12-hour average sound level as TWA_{10} or TWA_{12}. These 10-hour and 12-hour results should instead be referred to as L_{AVG} values.*

Both the OSHA and MSHA regulations use the following expression to calculate TWA:

$$TWA = 16.61 Log_{10} (D/100) + 90 \text{ dBA} \quad (1)$$

Where,
D = percent (%) dose for the whole shift.

Using the example results above, to find the TWA we first convert the measured dose for the partial-shift sample into a full-shift dose. Since the workday is 12-hours, and the pipe fitter is expected to continue the same activity for the balance of the day, we may extrapolate the measured dose to find the projected dose as follows:

$$\text{Projected Dose} = \text{Measured Dose} \times [(\text{Shift Length} / \text{Sample Time})] \ \% \quad (2)$$

Where,
Projected Dose and Measured Dose are in units of %, and Shift Length and Sample Time are both in units of Hours or Minutes.

Therefore, inputting the measured and known data into Equation 2:

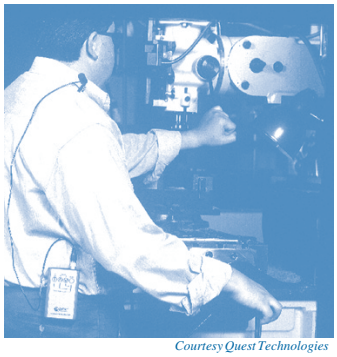
$$\text{Projected Dose} = 44.6 \ (\%) \times [12 \ (\text{Hrs}) / 10.7 \ (\text{Hrs})] = 50.0 \ \%$$

The TWA is now calculated using Equation 1:

$$TWA = 16.61 Log_{10} (50.0/100) + 90 = 85.0 \text{ dBA}$$

The resultant TWA represents the full-shift exposure normalized to 8 hours. Since the TWA equals the 85.0 dBA action level, this job activity must be included in an HCP.

A word of caution is warranted when using personal dosimeters. Most, if not all, noise dosimeters will provide a projected dose; however, the resultant value is based on an 8-hour work shift. In addition, dosimeters provide a TWA result, which typically is calculated using the measured dose and not the projected dose. Users need to review the dosimeter owner's manual or check with the manufacturer to ascertain how their particular instrument performs these internal calculations. For extended work shifts, to avoid potential misinterpretation or misuse of dosimetry data, users should take the dosimetry data for measured dose and sample run time, and then manually calculate the extended-shift projected dose using Equation 2, and the normalized TWA using Equation 1.



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Option 2 – Using L_{AVG} and the sliding-scale criteria:
As an alternative to using the dose and TWA results, L_{AVG} may be used to determine regulatory compliance. Herein, this option is referred to as the sliding-scale criteria. Under this option the user must identify the appropriate action level and permissible exposure limit (PEL)[1], based on the work-shift length. Table G16a in the OSHA regulation and Table 62-1 in the MSHA regulation present the allowable reference duration of exposure per sound level, or L_{AVG} under this option. Following the table the regulation includes an equation that provides the permitted duration for a given average level. In our case we need the permitted average level, given a specified duration. That relationship is given as Equation 3.

$$L = 16.61 Log_{10} (T_c / T_p) + 90 \text{ dBA} \quad (3)$$

Where,

T_c is the criterion sound duration. T_c = 8 hours for OSHA/MSHA purpose.

T_p is the permissible time of exposure at a stated A-weighted sound level that accumulates 100% noise dose (i.e., T_p = 12 hours for 12-hour shifts)

As an example, with 12-hour workdays, the allowable L_{AVG} is 87.1 dBA (calculated from Equation 3). This value now becomes the PEL for 12-hour work shifts. The HCP action level will always be 50% of the PEL, which is 5 dBA less using a 5-dBA exchange rate. So for 12-hour workdays the action level is 87.1 – 5 = 82.1 dBA under this option. Given the fact the measured L_{AVG} is 82.1 dBA, which equals the action level for a 12-hour shift, the pipe fitter must be included in the HCP.

It is important to keep in mind an average is an average is an average; irrespective of shift length. Assuming the L_{AVG} is representative of the full-shift exposure, the user may simply decide to apply the sliding-scale criteria to determine HCP inclusion, and all other requirements, as per the applicable regulation. An additional feature of the sliding-scale L_{AVG} approach is that it explicitly demonstrates that average sound levels lower than the specific action level or PEL, are not necessarily in compliance, when exposures exceed 8 hours.

Option 3 – Using the Projected Dose:
The final and third option is a shorter version of Option 1, as it only requires use of Equation 2 to calculate the full-shift projected dose. Instead of following the second step in Option 1 of converting the dose to a TWA, the percent dose is simply compared to the applicable regulatory criteria. Recall both the OSHA and MSHA occupational noise exposure regulations set the HCP inclusion at or above a TWA of 85 dBA, or equivalently, a dose of fifty percent. Therefore, in the pipe fitter example, the projected dose is 50.0% (see calculation under Option 1), which mandates HCP inclusion.

This noise exposure assessment option works the same regardless of the shift length. Keep in mind noise dose is a cumulative quantity. So once a fifty percent dose is reached or projected, all additional measurements and calculations are essentially unnecessary. Frankly, using the projected dose is the simplest option for handling extended work-shift data. The principal difficulty with this option is often worker and/or management perception. Over the past few decades we have simply been conditioned to think of, and work with, dBA values. As a result, most end users conceptually have difficultly relating to projected dose. To effectively apply this data assessment option, it will likely require reconditioning (re-training) of workers and management to think of noise exposure in terms of percent dose.

In conclusion, noise exposure assessment for extended work shifts needs to be managed with care. The most common evaluation procedure is to normalize all data to an 8-hour TWA. This approach requires the user to perform two fairly basic calculations. For assistance, use of a spreadsheet is recommended. The sliding-scale criteria option provides a simple data assessment procedure. However, this method can potentially lead to confusion and/or inadvertent misinterpretation of data when facilities have both 8-hour and extended workdays for different work groups, job activities, and/or departments. Therefore, the sliding-scale criteria option is only recommended for facilities with one shift length. The final option of using the projected dose is the simplest procedure, provided users can relate to percent dose. Hearing conservationists should review the details of all three options and consider the practical applications of each method before deciding which procedure is most suitable for their particular needs.[2]

(Footnotes)

[1] Note: the OSHA regulation uses the term Permissible Exposure Limit, while the MSHA regulation uses Permissible Exposure Level. Both quantities represent the same maximum allowable TWA of 90 dBA or equivalently a dose of 100%.

[2] For a more detailed discussion of the issues covered in this article see "Noise Surveys and Data Analysis," by L. H. Royster, E. H. Berger, and J. D. Royster in the *AIHA Noise Manual* 5th edition available at <https://www.aiha.org/webapps/commerce/product.aspx?id=ENOM03-619&cat=Books&subcat=>

References

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