# Uses of Effects Screening Levels (ESLs) and Air Monitoring Comparison Values (AMCVs)

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## Background

This document summarizes the differences in the way ESLs, inhalation reference values (ReVs), and unit risk factors (URFs) are used in air permitting and air monitoring, as well as explains air monitoring comparison values (AMCVs) and how they are used in air monitoring. Historically, the same short- and long-term ESLs have been used for both air permitting and air monitoring. However, there are significant differences between the procedures used for performing health effect reviews for air permitting and for the various forms of ambient air monitoring data. Based on these differences, changes were made to toxicity values that were used in these distinctly different program areas when the Toxicology Division (TD) published the first *TCEQ Guidelines to Develop Toxicity Factors* (RG-442) (hereafter referred to as Toxicity Factor Guidelines). The Toxicity Factor Guidelines document the procedures used to develop ESLs, ReVs, and URFs: https://www.tceq.texas.gov/downloads/toxicology/publications/rg-442.pdf.

Please refer to the following attachments for further background information:

- Attachment A *Glossary*
- Attachment B *Differences between Air Permitting and Air Monitoring*
- Attachment C *ESLs, ReVs, and URFs in Air Permitting and Air Monitoring*

## Original Uses of ESLs in Air Permitting and Air Monitoring

ESLs are chemical-specific air concentrations set to protect human health and welfare. Short-term ESLs are based on data concerning acute health effects, the potential for odors to be a nuisance, and effects on vegetation, while long-term ESLs are based on data concerning chronic health and vegetation effects. Health-based ESLs are set below levels where health effects would occur whereas welfare-based ESLs (odor and vegetation) are set based on effect threshold concentrations. The ESLs are screening levels, not ambient air standards.

The TD derives ESLs for thousands of chemicals for air permitting while the number of compounds that can be monitored in ambient air is smaller (approximately 120 chemicals). Health-based ESLs for about 800 chemicals have typically been set based on occupational exposure limits divided by safety factors to protect the general population. If occupational exposure limits were not available, chemical-specific ESLs derived using standard toxicity methods or based on structural similarity to chemicals with existing ESLs could be used. These procedures were conservative and resulted in health-protective screening levels.

ESLs are used in the air permitting process to assess the protectiveness of chemical-specific emission rate limits for facilities undergoing air permit reviews. Evaluations of modeled worst-case ground-level air concentrations on a chemical-by-chemical basis are conducted to determine the potential for adverse effects to occur due to the operation of a proposed facility. If predicted airborne levels of a chemical do not exceed its ESL, no further review from the TD is necessary. If predicted airborne levels of a chemical exceed its ESL, then a more in-depth review by TD staff, as described in Air Permits Division Guidance (APDG) 5874, *Modeling and Effects Review Applicability: How to Determine the Scope of Modeling and Effects Review for Air Permits* (APDG 2018), is triggered to determine if adverse health or welfare effects could be expected to result.

Short-term and long-term ESLs have also been used in the review of air monitoring data. Although a snapshot in time, air monitoring data is a measured concentration of a chemical in ambient air. All TCEQ air monitoring data is reviewed by TD staff on a routine basis. Short-term ESLs were typically used to evaluate 30 minutes to 1-hour reported air concentrations and long-term ESLs were used to evaluate annual average concentrations. Because the ESLs are conservative, there have been numerous occasions when the measured concentration for a chemical was above the ESL, however, the TD's review of the toxicity information on the chemical concluded that health effects were not likely to occur at the measured concentration. This broad conservative application of the ESLs has resulted in misunderstandings among the public because the ESLs did not represent the predictive toxicity of the chemical. ESLs continue to be useful screening values for air permitting, but more realistic, predictive values are needed for use in the review of ambient air monitoring data.

## Opportunity for Change

In drafting the Toxicity Factor Guidelines, and in subsequent updates, the TD used the latest scientific methods to derive toxicity values and incorporated changes to how short-term and long-term ESLs were used in the review of air monitoring data. One new value that was introduced in the original Toxicity Factor Guidelines is the health-based ReV. The ReV is a health-protective air concentration, developed for chemicals with thresholds (*i.e.,* a concentration can be determined where adverse health effects do not occur), that is similar to protective air concentrations developed by federal and state agencies. The majority of chemicals evaluated in air monitoring and in air permitting have thresholds. The main difference between values used in air monitoring and air permitting involve the use of the ReV. The ReV is used for air monitoring whereas the health-based ESL, which is 70% lower than the ReV, is used in air permitting. The reasons for the change are as follows:

- Air concentrations of chemicals collected in air monitoring samples represent emissions from multiple chemicals and from different facilities and sources (i.e., can be both cumulative across chemicals and aggregate across sources and time). For review of air monitoring data, the health-based ReV is appropriate.

- For review of air permit applications, site-wide modeled concentrations for one chemical at a time are evaluated. The impacts from multiple chemicals or from different sites are not

included. Therefore, for air permitting, an additional buffer is applied to the acute or chronic ReV to calculate the acute and chronic ESLs. The final acute and chronic ESLs developed using the Toxicity Factor Guidelines are 70% lower than the respective acute and chronic ReV.

- If the Toxicity Factor Guidelines have not yet been used to develop a health-based ReV for a chemical, the original short-term and long-term ESLs are used in both program areas.
- Welfare based ESLs (odor and vegetation) are set based on effect threshold concentrations, so the same level or ESL is used in both program areas (i.e., a higher value is not used in air monitoring).
- For chemicals with cancer-based long-term values, the same level of conservatism is used in both air monitoring and air permitting because of the concern for cancer. The no significant risk level of $1 \times 10^{-5}$ risk (one in one hundred thousand) is used to calculate cancer-based air concentrations from URFs (refer to the Toxicity Factor Guidelines for additional information).

Since there are significant differences between performing health effect reviews of air permits and the various forms of ambient air monitoring data, the TD uses the term “air monitoring comparison values” (AMCVs) in evaluations of air monitoring data. The term “AMCVs” is a collective term and refers to all odor-, vegetation-, and health-based values used in reviewing air monitoring data. Similar to ESLs, AMCVs are chemical-specific air concentrations set to protect human health and welfare. The use of different values and different terminology is appropriate because the air monitoring and air permitting programs perform different functions in the protection of human health and welfare.

The terms “short-term ESL” and “long-term ESL” have specific meanings and uses in the air permitting program and regulatory guidance. The short-term ESL is the lowest value of odor-, vegetation-, and health-based ESLs derived for evaluation of acute exposures. The long-term ESL is defined as the lowest value of vegetation- or health-based ESLs derived for evaluation of chronic exposures. A list of ESLs may be downloaded through the Toxicity Factor Database. There are two ESL reports that can be downloaded: the Tox ESL-Detail and the Tox ESL-Summary reports. The summary report is most similar to the old ESL published lists, providing only the ESLs that are used in air permitting. The detail report provides ESLs used in air permitting, as well as other ESLs associated with a chemical. For more information on how to access the Toxicity Factor Database, please see the Toxicology Webpage: Toxicity Factor Database (https://www.tceq.texas.gov/toxicology/database/tox).

For air monitoring, a list of AMCVs may also be downloaded through the Toxicity Factor Database; the Tox AMCV Report.

These lists are separate so that interested parties can obtain the most appropriate values to be used in these different program areas.

## Attachment A: Glossary

**Acute Exposure**: Exposure by the oral, dermal, or inhalation route for 24 hours or less.

**Aggregate**: Exposure to a single airborne chemical multiple times or from multiple sources. Aggregate exposure has also been defined as the combined exposure of an individual (or defined population) to a specific agent or stressor via multiple relevant routes, pathways, and sources.

**Chronic Exposure**: Repeated exposure by the oral, dermal, or inhalation route for more than approximately 10% of the life span in humans. This time period corresponds to 90 days to 2 years in commonly used mammalian laboratory species.

**Cumulative:** Exposure to multiple airborne chemicals. Cumulative has been used to describe various combinations of exposure or risk. The USEPA defines cumulative risk as "the combined risks from aggregate exposures to multiple agents or stressors."

**AMCV**: Air monitoring comparison value - AMCVs are chemical-specific air concentrations set to protect human health and welfare. Exposure to an air concentration at or below the AMCV is not likely to cause adverse health effects in the general public, including sensitive subgroups such as children, the elderly, pregnant women, and people with preexisting health conditions. AMCV is a collective term that refers to all values used by TD staff to review ambient air monitoring data.

| *AMCV Type* | *AMCV Notation* |
|---|---|
| *odor* | $^{acute}ESL_{odor}$ |
| *short-term vegetation* | $^{acute}ESL_{veg}$ |
| *long-term vegetation* | $^{chronic}ESL_{veg}$ |
| *short-term health* | Acute ReV or $^{acute}ESL_{generic}$ or interim ESL |
| *long-term health* | lowest value of the chronic ReV [threshold(c)], chronic ReV [threshold(nc)], $^{chronic}ESL_{nonthreshold(c)}$, or $^{chronic}ESL_{nonthreshold(nc)}$ |

**ESL**: Effects Screening Level - ESLs are chemical-specific air concentrations set to protect human health and welfare. Exposure to an air concentration at or below the ESL is not likely to cause an adverse health effect in the general public, including sensitive subgroups such as children, the elderly, pregnant women, and people with preexisting health conditions.

**$^{acute}$ESL**: acute health-based Effects Screening Level for chemicals meeting minimum database requirements.

**$^{acute}ESL_{generic}$**: acute health-based Effects Screening Level for chemicals not meeting minimum database requirements.

**$^{acute}ESL_{odor}$:** acute odor-based Effects Screening Level.

**$^{acute}ESL_{veg}$:** acute vegetation-based Effects Screening Level.

**$^{chronic}ESL_{nonthreshold(c)}$**: chronic health-based Effects Screening Level for linear dose response cancer effect. A chemical with a linear dose response does not exhibit a threshold.

**$^{chronic}ESL_{nonthreshold(nc)}$**: chronic health-based Effects Screening Level for linear dose response noncancer effects. A chemical with a linear dose response does not exhibit a threshold.

**$^{chronic}ESL_{threshold(c)}$**: chronic health-based Effects Screening Level for nonlinear dose response cancer effects. A chemical with a nonlinear dose response is considered to have a threshold.

**$^{chronic}ESL_{threshold(nc)}$**: chronic health-based Effects Screening Level for nonlinear dose response noncancer effects. A chemical with a nonlinear dose response is considered to have a threshold.

**$^{chronic}ESL_{veg}$:** chronic vegetation-based Effects Screening Level.

**interim ESL**: ESLs where the RG-442 Toxicity Factor Guidelines have not yet been used to develop updated values.

**Short-term ESL**: A short-term ESL is determined by choosing the lowest value of the following acute health- and welfare-based ESLs (as available): $^{acute}ESL_{generic}$ or $^{acute}ESL$ or $^{acute}ESL_{odor}$ or $acuteESL_{veg}$.

**Long-term ESL**: A long-term ESL is determined by choosing the lowest value of the following chronic health- and welfare-based ESLs (as available): $^{chronic}ESL_{nonthreshold(c)}$ or $^{chronic}ESL_{nonthreshold(nc)}$ or $^{chronic}ESL_{threshold(c)}$ or $^{chronic}ESL_{threshold(nc)}$ or $^{chronic}ESL_{veg}$.

**ReV**: Reference Value - An inhalation ReV is defined as an estimate of an inhalation exposure concentration for a given duration to the human population (including susceptible subgroups) that is likely to be without an appreciable risk of adverse effects. ReVs are based on the most sensitive adverse health effect relevant for humans reported in the literature.

**Chronic ReV [threshold(c)]**: chronic health-based reference value for nonlinear dose response cancer effects. A chemical with a nonlinear dose response is considered to have a threshold.

**Chronic ReV [threshold(nc)]**: chronic health-based reference value for nonlinear dose response noncancer effects. A chemical with a nonlinear dose response is considered to have a threshold.

**Threshold**: The dose or exposure below which no adverse health effect is expected to occur.

**Unit risk factor**: The upper-bound excess lifetime cancer risk estimated to result from continuous exposure to an agent at a concentration of 1 µg/L in water, or 1 $\mu g/m^3$ in air. The interpretation of unit risk would be as follows: if unit risk = $1.5 \times 10^{-6}$ $\mu g/m^3$, 1.5 excess tumors are expected to develop per 1,000,000 people if exposed daily for a lifetime to 1 $\mu g/m^3$ of the chemical in air.

## Attachment B: Some Differences between Air Permitting and Air Monitoring

| | Air Permitting | Air Monitoring |
|---|---|---|
| **Number of chemicals evaluated** | Thousands of chemicals are regulated via air permitting. ESLs are derived for many of those chemicals. | A limited number of chemicals can be monitored (approximately 120). |
| **Consideration of multiple pollutant sources in concentration data** | Site-wide modeled concentrations are evaluated on a case-by-case and chemical-by-chemical basis. The impacts from multiple chemicals or from different sites are not included in the review. | Air concentrations of chemicals collected in air monitoring samples reflect multiple chemicals or emissions from different facilities and sources (i.e., can be both cumulative across chemicals and aggregate across sources and time). |
| **Type of data evaluated** | The maximum ground level concentration ($GLC_{max}$) is predicted under the worst-case scenario by air dispersion models. | Chemical concentrations in air are analytically determined. They represent a snapshot in time that provides insight into ambient air concentrations of targeted compounds during the sampling event. |
| **Review of data by Toxicology Division** | If predicted $GLC_{max}$ is equal to or below the short-term or long-term ESL, the TD does not evaluate the impacts. However, if the $GLC_{max}$ > ESLs, then the TD will review according to the 3-Tiered Effects Evaluation Procedure (TCEQ MERA Guidance 2018). | The TD routinely evaluates all TCEQ air monitoring data (for non-criteria pollutants) and performs health effects evaluations. |
| **Evaluation of short-term concentrations** | The short-term ESL, based on acute exposure health and welfare data, is compared to the modeled 1-hour $GLC_{max}$, unless otherwise specified. | The short-term AMCV, based on acute exposure health and welfare data, is compared to monitored concentrations that can be 30 minutes to 1-hour, which represent air quality for a point in time for a specific location. |
| **Evaluation of long-term concentrations** | The long-term ESL, based on chronic or lifetime exposure health and welfare data, is compared to the worst-case annual $GLC_{max}$. | The long-term AMCV, based on chronic health and welfare data, is used to evaluate annual averaged monitored concentrations or annual concentrations averaged over multiple years (if available), which represent air quality for multiple points in time for a specific location. |

| | Air Permitting | Air Monitoring |
|---|---|---|
| **Consideration of multiple pollutant sources in toxicity factor** | Multiple sources of one chemical and exposure to multiple chemicals (i.e., to account for cumulative risks) need to be accounted for. If a ReV has been developed for a chemical, an extra buffer is used to calculate health-based ESLs that are 70% lower than the ReV. | For chemicals for which a ReV has been calculated, an extra buffer is not needed to account for cumulative risk for air monitoring samples. The ReV, a health-protective concentration, is appropriate. |
| **Applicable toxicity factors** | The terms “short-term ESL” and “long-term ESL” have specific meanings and uses in the air permitting program and regulatory guidance. | TD staff uses all available comparison values (i.e., odor-, vegetation-, and health-based values) for evaluation of air monitoring data. |
| **Terminology** | ESLs are the terminology used for air permitting. | AMCVs are the terminology used for ambient air monitoring because of the significant differences from the air permitting program. This term was introduced because the ReV is a “reference” value. |

# Attachment C: ESLs, ReVs, and URFs in Air Permitting and Air Monitoring

## Air Permitting: Effects Screening Levels (ESLs)

ESLs are screening levels specifically derived for use in TCEQ's air permitting process. They are compared to results of predicted impacts from air dispersion modeling. For chemicals where the Toxicity Factor Guidelines have been used to develop toxicity values, inhalation ReVs and/or URFs for carcinogens are the basis for calculating health-based ESLs. The TD derives short-term ESLs to be protective of acute health effects, odor potential, and vegetation effects, whereas long-term ESLs are developed to be protective of chronic noncancer and cancer health effects and vegetation effects. The $^{acute}$ESL and $^{chronic}$ESL (refer to Appendix A Glossary) for threshold health effects are 70% lower than their respective ReVs in order to account for cumulative and aggregate effects of multiple facilities seeking to permit emissions of the same chemical. See Table 1 below for a summary of uses of ESLs and AMCVs in Air Permitting and Air Monitoring.

## Air Monitoring: Air Monitoring Comparison Values (AMCVs)

AMCVs are comparison values used in TCEQ's evaluation of ambient air monitoring results. To assess the potential for measured concentrations of specific chemicals to cause health effects, health-based AMCVs are based on ReVs and/or URFs (for carcinogens). To assess the potential for measured concentrations of specific chemicals to cause welfare effects (i.e., nuisance odors, vegetation effects), AMCVs are based on odor- or vegetation-based ESLs. The values derived by TD that are <u>not</u> appropriate for evaluating ambient air monitoring data are the $^{acute}$ESL and $^{chronic}$ESL for threshold health effects, if a ReV exists for the chemical. See Table 1 below for a summary of uses of ESLs and AMCVs in Air Permitting and Air Monitoring.

Table 1. **Uses of ESLs and AMCVs in Air Permitting and Air Monitoring** [1]

| EXPOSURE | AIR PERMITTING ESLS | AIR MONITORING [2] AMCVS |
|---|---|---|
| **SHORT-TERM** | Defined as the lowest value of:<br><br>$^{acute}ESL_{generic}$, $^{acute}ESL$, $^{acute}ESL_{odor}$, or $^{acute}ESL_{veg}$<br><br>(Figure 1-1 of Toxicity Factor Guidelines) | **Health**: Acute ReV, $^{acute}ESL_{generic}$, or interim ESL [3]<br><br>**Odor**: $^{acute}ESL_{odor}$<br><br>**Vegetation**: $^{acute}ESL_{veg}$ |
| **LONG-TERM** | Defined as the lowest value of:<br><br>$^{chronic}ESL_{nonthreshold(c)}$, $^{chronic}ESL_{nonthreshold(nc)}$, $^{chronic}ESL_{threshold(c)}$, $^{chronic}ESL_{threshold(nc)}$, or $^{chronic}ESL_{veg}$<br><br>(Figure 1-2 of Toxicity Factor Guidelines) | **Health**: lowest value of<br><br>Chronic ReV [threshold(c)], Chronic ReV [threshold(nc)], $^{chronic}ESL_{nonthreshold(c)}$, or $^{chronic}ESL_{nonthreshold(nc)}$<br><br>**Vegetation**: $^{chronic}ESL_{veg}$ |

[1] Refer to Appendix A Glossary for definition of terms

[2] All values are used in the review of measured analytical concentrations for air monitoring data

[3] If the Toxicity Factor Guidelines have not yet been used to develop a health-based ReV, ESLs are used in both program areas