

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

Revised (May 2010)

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 introduces “air monitoring comparison values” or AMCVs as a new term. 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 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 their *Guidelines to Develop Effects Screening Levels, Reference Values, and Unit Risk Factors* (RG-442) (referred to as Guidelines).

Please refer to the following attachments for 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 2009) 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 instantaneous 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 *Guidelines to Develop Effects Screening Levels, Reference Values, and Unit Risk Factors*, 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 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 Guidelines are 70% lower than the respective acute and chronic ReV.
- If the 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 1×10^{-5} risk (one in one hundred thousand) is used to calculate cancer-based air concentrations from URFs (refer to 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 has begun using 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-, vegetative-, 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. The ESL Published List used by regulated entities and the Air Permits Division during an air permit review only provide the short- and long-term ESLs. Go to [Toxicology ESL Webpage](#) to download previous and current ESL lists for Air Permitting.

However, for air monitoring, the AMCV Published List should be used. Go to [Toxicology Air Toxics Webpage](#) to download the list of the odor-, vegetative-, and health-based AMCVs.

The TD has prepared these two separate lists 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 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.”

AMCVs: Air monitoring comparison values - AMCVs are chemical-specific air concentrations set to protect human health and welfare. Exposure to an air concentration at or below the AMCVs 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. AMCVs are a collective term that refer to all values used by TD staff to review ambient air monitoring data.

odor	${}^{\text{acute}}\text{ESL}_{\text{odor}}$
short-term vegetation	${}^{\text{acute}}\text{ESL}_{\text{veg}}$
long-term vegetation	${}^{\text{chronic}}\text{ESL}_{\text{veg}}$
short-term health	Acute ReV or ${}^{\text{acute}}\text{ESL}_{\text{generic}}$ or interim ESL
long-term health	lowest value of the chronic ReV [nonlinear(c)], chronic ReV [nonlinear(nc)], ${}^{\text{chronic}}\text{ESL}_{\text{linear(c)}}$, or ${}^{\text{chronic}}\text{ESL}_{\text{linear(nc)}}$

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.

${}^{\text{acute}}\text{ESL}$: 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_{linear(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_{linear(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_{nonlinear(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_{nonlinear(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 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_{linear(c)} or ^{chronic}ESL_{linear(nc)} or ^{chronic}ESL_{nonlinear(c)} or ^{chronic}ESL_{nonlinear(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 [nonlinear(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 [nonlinear(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 $\mu\text{g}/\text{L}$ in water, or 1 $\mu\text{g}/\text{m}^3$ in air. The interpretation of unit risk would be as follows: if unit risk = $1.5 \times 10^{-6} \mu\text{g}/\text{m}^3$, 1.5 excess tumors are expected to develop per 1,000,000 people if exposed daily for a lifetime to 1 $\mu\text{g}/\text{m}^3$ of the chemical in air.

Attachment B

Table 1 Differences between Air Permitting and Air Monitoring

Air Permitting	Air Monitoring
ESLs are developed for thousands of chemicals.	A limited number of chemicals can be monitored (approximately 120).
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).
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.
If predicted maximum 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.	The TD routinely evaluates all TCEQ air monitoring data and performs a health effects evaluation.
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 instantaneous or up to 1-hour, which represent a point in time for a specific location.
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 multiple points in time for a specific locations.

Air Permitting	Air Monitoring
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.
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 comparison values (i.e., odor-, vegetative-, and health-based values).
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 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 vegetative effects, whereas long-term ESLs are developed to be protective of chronic noncancer and cancer health effects and vegetative 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 facilities seeking to permit emissions.

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, vegetative effects), AMCVs are based on odor- or vegetation-based ESLs. The values derived by TD that are not appropriate for evaluating ambient air monitoring data are the ^{acute}ESL and ^{chronic}ESL for threshold health effects.

Table 2 Uses of ESLs and AMCVs in Air Permitting and Air Monitoring 1

	Air Permitting ESLs	Air Monitoring² AMCVs
Short-term Exposure	<p>Short-Term ESL is defined as the lowest value of: ^{acute}ESL_{generic}, ^{acute}ESL, ^{acute}ESL_{odor}, or ^{acute}ESL_{veg} (Figure 1-1 of Guidelines)</p>	<p>Short-Term health = Acute ReV or ^{acute}ESL_{generic} or interim ESL 3 Odor = ^{acute}ESL_{odor} Short-Term vegetation = ^{acute}ESL_{veg}</p>
Long-term Exposure	<p>Long-Term ESL is defined as the lowest value of: ^{chronic}ESL_{linear(c)}, ^{chronic}ESL_{linear(nc)}, ^{chronic}ESL_{nonlinear(c)}, ^{chronic}ESL_{nonlinear(nc)} or ^{chronic}ESL_{veg} (Figure 1-2 of the Guidelines)</p>	<p>Long-Term health is the lowest value of: Chronic ReV [nonlinear(c)], Chronic ReV [nonlinear(nc)], ^{chronic}ESL_{linear(c)}, or ^{chronic}ESL_{linear(nc)} Long-Term vegetation = ^{chronic}ESL_{veg}</p>

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 Guidelines have not yet been used to develop a health-based ReV, original ESLs are used in both program areas