Beyond Science and Decisions: From Problem Formulation to Dose-Response Assessment

Case Study 1: Instantaneous Comparison Values (ICVs) & Acute Action Levels (AALs) for Use During In-Motion Monitoring & Emergency Events

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1. **Provide a few sentences summarizing the method illustrated by the case study.**

This case study describes methods for the derivation of ICVs and AALs to be used by the Texas Commission of Environmental Quality (TCEQ) during in-motion monitoring and emergency events. These methods may be used by the Toxicology, Risk Assessment, and Research Division (TD) of the TCEQ to derive instantaneous comparison values (ICVs) and acute action levels (AALs) for chemicals that have already gone through the TCEQ Development Support Document (DSD) process for derivation of an acute toxicity factor (TCEQ 2015). Considerations in the methodology include:

- TCEQ short-term, health-based air monitoring comparison values (AMCVs);
- American Conference of Governmental Industrial Hygienists (ACGIH) occupational 8-hour Threshold Limit Values (TLVs are a conservative policy-based consideration because these values are frequently based on chronic toxicity);
- ACGIH occupational 15-minute Short-Term Exposure Limits (STELs); and
- Statistical relationships between instantaneous concentrations and those for longer durations.

United States Environmental Protection Agency (USEPA) acute exposure guideline levels (AEGLs), which are derived to be threshold exposure limits (10 minutes to 8 hours) for the general public for emergency situations, can provide some additional context for TCEQ AAL values. **Appendix A** describes the detailed methods used to derive ICVs, 5-10 minute AALs, and 45-60 minute AALs.

As mentioned below, these values may be considered as criteria for triggering further investigation (e.g., emissions sources) and/or assist field workers (non-first responders) in taking or developing exposure avoidance strategies to mitigate the potential for adverse health effects in those impacted in emergency response situations. As such, the ICVs will be used for comparison to incoming instantaneous air monitoring data on a continuous basis. Furthermore, it is envisioned that short-term averages will be automatically and continuously calculated for comparison to 5-10 minute and 45-60 minute AALs. As needed or requested, the potential for adverse health effects to occur will be assessed based on comparison of health-based criteria (e.g., 45-60 minute AALs) to exposure concentrations of similar duration, margin of exposure (MOE) analyses that also consider similarity in duration, etc.

From a risk communication perspective, ICVs are viewed as indicators that a longer-term average might exceed an applicable health-based value. If a longer-term average is indeed found to exceed an applicable health-based value, the potential for adverse health effects to occur will depend upon the magnitude of the exceedance, etc. As discussed below, 5-10 minute and 45-60 minute AALs are set based on consideration of various health-based values, the exceedance of which could result in the potential for adverse health effects depending upon the basis for the underlying health-based value and the magnitude of exceedance.

2. **Describe the problem formulation(s) the case study is designed to address. How is the method described in the case useful for addressing the problem formulation?**

   The TCEQ has acquired instrumentation (e.g., DUVAS and SIFT-MS) capable of reporting low to high chemical concentrations in ambient air on an instantaneous basis (e.g., 1-30 second concentrations) while in a moving vehicle. This necessitates the consideration of possible bases for appropriate and useful ICVs, and AAL values for somewhat longer averages (i.e., 5-10 minute and 45-60 minute), for the evaluation of incoming instantaneous monitoring technology data in the field. ICVs, for example, may be considered by TCEQ staff as potential criteria for triggering the need for further investigation (e.g., the characterization of longer-term air concentrations, investigation of source(s), etc.). Furthermore, while not derived to be representative of levels that are immediately dangerous to life or health, ICVs may also assist field workers (non-first responders) and perhaps others in taking or developing exposure avoidance strategies. The strategies may include, depending upon the magnitude and duration of an ICV exceedance, action(s) deemed necessary to mitigate the potential for adverse human health effects to those impacted in an emergency response situation.

   However, ICVs (for comparison to 1-30 second exposures) have not historically been derived by the TCEQ or other regulatory agencies for a variety of reasons, including: 1-30 seconds is a historically irrelevant exposure duration both environmentally and occupationally when considering typical historical air sampling durations (e.g., 24-hour, 8-hour), hence a lack of historical regulatory need; and a lack of relevant toxicity studies with exposure durations of no more than a minute or two. Health-based values have historically been based on a chronic exposure duration (e.g., USEPA reference concentrations (RfCs) and reference doses (RfDs)), with some agencies such as the TCEQ also developing short-term/acute (e.g., 1-hour) health-based comparison values. In addition to the challenge of a general lack of ICVs and other very short-term (e.g., 5-10 minute) health-based comparison values, the continuous review of incoming instantaneous air monitoring data and short-term rolling averages presents its own technical and public risk communication challenges.

   The methods described in this case study are useful for addressing this relatively new problem (e.g., the lack of ICVs) since they allow for the setting of ICVs and AALs. Because the intended use of the values by TCEQ staff includes emergency situations (e.g., after an industrial accident), these approaches are not designed to be as conservative as those used to derive health-based comparison values for everyday public exposure. Neither are the methods designed to derive much less conservative threshold values for adverse health effects for use in emergency situations (e.g., USEPA AEGLs). Rather, the methods are designed to: (1) recognize health protectiveness as an important consideration and goal within the context of circumstances that may include monitoring non-routine, increased emissions like those that may be encountered during an emergency situation; and (2) help the TCEQ focus attention and efforts on emissions that may be amongst those representing a more significant environmental issue given the situation/ circumstances (e.g., following an industrial accident, receptor presence/density in the area monitored), potentially requiring further investigation and/or exposure avoidance strategies.

3. **Comment on whether the method is general enough to be used directly, or if it can be extrapolated, for application to other chemicals and/or problem formulations. Please explain why or why not.**

This method can be used by others who need to develop screening values such as ICVs and AALs for the evaluation of incoming instantaneous monitoring technology data in the field for chemicals that have the relevant considerations:

- Can be monitored using instantaneous monitoring and data reporting technology;
- Prior derived acute/short-term health-protective air concentrations for the general public, including potentially sensitive subpopulations;
- Occupational 8-hour time-weighted average (TWA) values;
- Occupational STEL values; and
- The ability (at some point in time) to evaluate statistical relationships between instantaneous concentrations and those for longer durations (the ongoing re-evaluation of such relationships may result in revised AALs).

Since this method was developed to be fit-for-purpose, other problem formulations to which the method may be applied are not abundantly clear. Generally, the method could be used anytime there is a need for the evaluation of incoming instantaneous monitoring technology data in the field utilizing health-based criteria with a focus on identifying emissions that may represent a more significant environmental issue and may require further investigation and/or exposure avoidance strategies.

4. **Discuss the overall strengths and limitations of the methodology.**

There are several overall strengths to this methodology. First, for the consideration of health-protection, this methodology draws upon various previously-derived, health-based criteria (i.e., existing acute/short-term health-protective air concentrations and occupational TWA and STEL values). Additionally, the method draws upon observed relationships between instantaneous and longer-term air concentrations, the statistical analysis of which allows for realism in quantitatively determining adjustment factors between temporal durations, which could also be chemical specific. The method's reliance on existing health-based criteria may also be viewed as a limitation since all chemicals of interest may not have the relevant values. In such cases, a search could be conducted for the relevant values from national and international sources to help mitigate the effect(s) of this limitation. Implementation of the values in the field can also be challenging since the appropriate consideration of the longer-term AALs require monitoring of rolling averages as the instantaneous data continuously become available. However, if the monitoring of both the instantaneous concentrations and rolling averages by staff is too burdensome, such monitoring could be implemented with the aid of a computer program/software.

5. **Outline the minimum data requirements and describe the types of data needed.**

In addition to the availability of instantaneous monitoring equipment and data reporting technology, complete data needed for the method include:

- Previously-derived acute health-protective air concentrations for the general public;
- Occupational 8-hour TWA values;
- Occupational STEL values; and
- Data from which to evaluate the statistical relationships between instantaneous concentrations and those for longer durations (e.g., hourly).

However, 5-10-minute AALs may still be derived in the absence of a 15-minute STEL since the 8-hour TWA value will also be protective of the types of effects the STEL protects against.

6. **Questions for the panel.**

Following review of the methods in **Appendix A**, in addition to requesting comments generally, the TCEQ poses the following questions for the panel.

In regard to ICVs:

a. Does this method entail reasonable considerations and bases for the setting of ICVs?
b. Can you suggest any alternate considerations/bases for ICV derivation that would address our problem formulation?
c. Does the panel have specific recommendations concerning:
    - Type and amount of instantaneous data that should be collected for statistical analyses across durations (e.g., instant vs. hourly)?
    - Type of statistical analyses that should be performed with these data?

In regard to both 5-10- and 45-60-minute AALs:

a. Do the methods entail reasonable considerations and bases for the setting of AALs?
b. Can you suggest any alternate considerations/bases for AAL derivation that would address our problem formulation?
c. Does the panel have any specific recommendations concerning 5-10 minute or 45-60 minute AALs?
d. How are the public risk communication challenges of continuous review of instantaneous data and rolling averages best addressed?

Does your case study:

A. Describe the dose-response relationship in the dose range relevant to human exposure?

Yes, insofar as the health-based criteria relied upon are designed/intended to be applied to the range of human exposure. Additionally, in regard to the exposure component, the monitored air concentrations to be evaluated will represent actual (or at least potential) human exposure levels.

B. Address human variability and sensitive populations?

Yes, insofar as the health-based criteria relied upon are designed/intended to address human variability and potentially sensitive subpopulations. That is, the case study indirectly includes consideration of human variability and potentially sensitive subpopulations through the inclusion of health-based criteria such as TCEQ short-term AMCVs that are derived using methods that consider the same.

C. Address background exposures or responses?

This case study does not directly address background exposures or responses.

D. Address incorporation of existing biological understanding of the likely mode of action?

This case study does not directly incorporate existing biological understanding of the likely mode of action (MOA) and does so indirectly only to the extent that MOA was considered previously in the derivation of relevant health-based criteria.

E. Address other extrapolations, if relevant – insufficient data, including duration extrapolations, interspecies extrapolation?

The current case study is only meant to incorporate the quantitative evaluation of the relationships between instantaneous concentrations and durations of 5-10 minutes and 45-60 minutes. The case study does not directly address other extrapolations, although other durations could easily be considered through the statistical evaluation of the relationships between instantaneous concentrations and the other durations of interest.

F. Address uncertainty?

This case study does not directly address uncertainty and does so indirectly only to the extent that uncertainty was considered previously in the derivation of relevant health-based criteria (e.g., through the use of uncertainty factors).

G. Allow the calculation of risk (probability of response for the endpoint of interest) in the exposed human population?

This case study is not amenable to the calculation of risk in an exposed human population as it incorporates more of an acute hazard-based evaluation (e.g., potential or actual acute exposure concentrations versus acute health-based criteria not associated with a specific probability of response).

H. Work practically? If the method still requires development, how close is it to practical implementation?

Yes, the values are intended to be practical and implementable in the field given currently available technology. The TCEQ's mobile monitoring team will practice using these values in the near future.

Reference:

TCEQ. 2015. Guidelines to develop toxicity factors. RG-442: Texas Commission on Environmental Quality (TCEQ).

Appendix A: Method Details for Derivation of Instantaneous Comparison Values (ICVs) & Acute Action Level (AALs)

1.0 Instantaneous Comparison Values (ICVs)

One possible basis for 1-30 second ICVs is that of preventing the exceedance of longer-duration, health-based screening levels such as TCEQ short-term Air Monitoring Comparison Values (AMCVs). There is historical agency precedence for such a derivation; e.g., a modeled maximum ground-level hourly concentration for the year that is no more than 10-times a desired annual concentration helps ensure compliance with the desired annual concentration due to meteorological variability. In the case of ICVs, such a basis would entail deriving a 1-30 second duration concentration that, if not exceeded, may be expected to help ensure compliance with the short-term (e.g., 1-hour) AMCV. Conversely, an ICV may be viewed as a 1-30 second value that if exceeded might indicate the potential for, or likelihood of, exceedance of a short-term AMCV. While TCEQ does not currently have data to directly inform the statistical relationship(s) between 1-30 second and hourly concentrations, in the interim, evaluating such relationships for temporal periods with similar or greater differences between them (e.g., hourly vs. annual) may initially help inform the magnitude(s) by which the concentrations may be expected to differ (e.g., instantaneous vs. hourly). *Later, after the TCEQ has collected ample 1-30 second and longer-term data contemporaneously, the relationship(s) between 1-30 second and hourly concentrations can be more directly and definitively evaluated and determined.* Furthermore, based on expert panel review and experience in the field (e.g., background data, frequency of exceedances), the utility of interim ICVs may be reassessed and the values revised accordingly.

1.1 Hourly vs. Annual Data

The relative temporal difference between 1 hour and 1 year is 8,760 fold. This is larger than the temporal difference between 1-30 seconds and an hour (120-3,600 fold). Using 1-hour autoGC data from different monitoring sites for 2016 (Table 1), the distribution of 1-hour values around the annual mean can be assessed to understand the relative concentration differences for these very different temporal periods.

Table 1. Ratio of 95th Percentile Hourly Averages to Annual Means for 1,3-Butadiene, Benzene, and Styrene Hourly AutoGC Data from Six Ambient Air Monitoring sites (2016).

Site Name	1,3-Butadiene 95th percentile hourly / annual mean (unitless)	Benzene 95th percentile hourly / annual mean (unitless)	Styrene 95th percentile hourly / annual mean (unitless)
Cesar Chavez	3.9	3.3	3.6
Channelview	4.1	3.1	4.0
Clinton	3.9	3.5	5.3
Galena Park	3.7	3.6	4.1
Houston Deer Park #2	3.4	4.0	4.8
Lake Jackson	3.4	3.1	8.4
Min	3.4	3.1	3.6
Max	4.1	4.0	8.4
Average Ratio	3.7	3.4	5.0

One-hour concentrations above the 95th percentile might be considered abnormal. On average, such concentrations are 3-5 times the annual means across these three chemicals and six sites. *If the* *distribution of 1-30 second values around the short-term AMCV (as a triggering 1-hour mean) were the same*, this would suggest that 3-5 times the short-term AMCV concentration would be representative of a 1-30 second 95th percentile value at a stationary point where the hourly average may approximate the short-term, health-based AMCV. *Accordingly, with the above caveat, greater than 3-5 times the short-term AMCV concentration could be assumed to be a 1-30 second value (i.e., an ICV) that might suggest the hourly average could be greater than the short-term AMCV.*

1.2 5-Minute vs. Hourly Data

Data collected at continuous monitors are averaged in increments of 5-minute data, allowing the opportunity to observe the relationship between 5-minute data and hourly data. The difference between 5-minute and hourly data is much smaller at a 12-fold difference. Despite this, a comparison between the 95th percentile 5-minute hydrogen sulfide (H_2S) concentration and the average hourly H_2S concentration shows a 4-fold difference on average (Table 2) and the same range discussed above (≈3-5) for relationship between hourly 95th percentile VOC levels/annual means.

Table 2. H_2S 5-Minute and 1-Hour Average Data (in ppb) for the El Paso Lower Valley Sounder Monitoring Site (2009-2018).

	2018	**2017**	**2016**	**2015**	**2014**	**2013**	**2012**	**2011**	**2010**	**2009**
5-min Av	2.97	3.36	3.01	3.27	2.41	2.47	2.52	3.37	3.54	2.85
5-min 95%	11.58	12.79	12.13	11.94	9.17	8.57	9.56	13.76	15.52	13.14
5-min MAX	446.29	559.82	660.73	824.43	236.32	342.46	205.81	407.96	565.82	866.27
1-hr Av	3.02	3.37	3.02	3.28	2.42	2.51	2.53	3.40	3.58	2.85
1-hr 95%	12.04	13.51	13.04	12.57	9.36	9.08	9.70	14.26	15.43	13.42
1-hr MAX	161.95	273.67	134.65	269.05	117.56	149.42	81.71	123.58	173.64	255.20
95th 5-min/1-hr av	3.84	3.79	4.02	3.64	3.79	3.41	3.77	4.05	4.34	4.61
95th 5-min/95th 1-hr	0.96	0.95	0.93	0.95	0.98	0.94	0.99	0.97	1.01	0.98

Thus, similarly, these data suggest that if you have a certain triggering 1-hour concentration, if a 5-minute concentration is over approximately 4 times greater than that, then the 1-hour triggering value might be exceeded.

1.3 Conclusions

We do not have data to examine the relationship(s) between 1-30 second concentrations and concentrations of longer duration such as 1 hour. The temporal differences in sampling data examined above (from 12-fold to 8,760-fold) encompass the temporal difference in sampling between 1-30 seconds and a 1-hour duration (120-3,600 fold), which is often used to set short-term AMCVs. However, it is not known how differences in meteorology during these short time periods will impact the relationship between 1-30 second concentrations and 1-hour concentrations. Until TCEQ can determine those relationships, the observed concentration relationships discussed above will be considered in setting chemical-specific ICVs that might indicate that the associated 1-hour mean could exceed its respective short-term, health-based AMCV.

Conservatively, based on the data above, a 1-30 second concentration that is greater than 3 times the hourly short-term AMCV concentration might suggest the hourly average could be greater than the short-term AMCV. This would also be conservative from the perspective that it is the potential exceedance of one times the short-term AMCV that triggers further investigation, when such an exceedance may have been permitted (e.g., considering land use, the margin of exposure (MOE) built into AMCVs, etc.).

Essentially, this approach is based on the assumption that an instantaneous concentration equal to 3 times the AMCV represents the 95th percentile hourly air concentration. Therefore, an instantaneous air concentration *greater* than 3 times the short-term (e.g., 1 -hour) AMCV is: (1) Assumed to be greater than the 95th percentile of the distribution associated with the AMCV; (2) Given 1, considered an abnormally high value for a distribution associated with an air concentration equal to the short-term, 1-hour AMCV; and (3) Given 2, assumed to actually be part of a distribution associated with a short-term, 1-hour concentration that exceeds the short-term, health-based AMCV.

It is important to note that ICVs are based on the consideration of chemical-specific, direct health effects and do not consider potential odors. Strong and persistent odors have the potential to cause indirect health effects like headache and nausea, regardless of the chemical causing them or how the reported levels of the chemicals being analyzed compare to conventional health-based values. As always, in all circumstances, personnel are encouraged to use their best judgment in determining whether to leave the area, shelter in place, or otherwise mitigate exposure (e.g., reports of headaches, feeling faint, etc.). In the future, odor-based, short-term AMCVs may be considered as a basis for ICVs.

1.3.1 ICV Calculation

ICVs are conservatively calculated to be three times the current AMCV for a given chemical. Examples of ICVs can be found in Table 3.

Table 3. ICVs Calculated for 9 Chemicals for Comparison to Samples Collected for a Duration of 1-30-Seconds.

Chemical	CAS No.	Short-Term Health-Based AMCV (ppm)	ICV (ppm)
Ammonia	7664-41-7	0.83	**2.5**
Benzene	71-43-2	0.18	**0.54**
1,3-Butadiene	106-99-0	1.7	**5.1**
Chlorine	7782-50-5	0.05	**0.15**
Ethylbenzene	100-41-4	20	**60**
Formaldehyde	50-00-0	0.041	**0.12**
Styrene	100-42-5	5.1	**15**
Toluene	108-88-3	4	**12**
Xylene	1330-20-7	1.7	**5.1**

2.0 Acute Action Levels (AALs)

Acute action level (AAL) values are intended to help inform actions (e.g., triggering investigations) in emergency situations. As discussed in Section 1.0 for ICVs, AALs may be considered by TCEQ staff as potential criteria for triggering the need for further investigation (e.g., the characterization of longer-term air concentrations, investigation of source(s), etc.). Furthermore, while not representative of levels that are immediately dangerous to life or health, these AALs may also assist field workers (non-first responders) and perhaps others in taking or developing exposure avoidance strategies. The strategies may include, depending upon the magnitude and duration of an AAL exceedance, action(s) deemed necessary to mitigate the potential for adverse human health effects to those impacted in an emergency response situation. AALs are also designed to be more conservative than USEPA acute emergency guideline levels (AEGLs). AAL values assume a short-term/acute exposure duration and are derived based on TCEQ short-term health-based AMCVs, occupational 8-hour American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Values (TLVs), and occupational 15-minute Short-Term Exposure Limits (ACGIH STELs). The use of occupational 8-hour values is conservative for this purpose as these values are frequently based on the potential health effects associated with chronic exposure, and consequently are frequently lower than short-term/acute, health-based comparison values for the general public (e.g., TCEQ short-term AMCVs).

It is important to note that the values provided below are based on the consideration of chemical-specific, direct health effects and do not consider potential odors. Strong and persistent odors have the potential to cause indirect health effects like headache and nausea, regardless of the chemical causing them or how the reported levels of the chemicals being analyzed compare to conventional health-based values. As always, in all circumstances, personnel are encouraged to use their best judgment in determining whether to leave the area, shelter in place, or otherwise mitigate the potential for exposure-related adverse health effects (e.g., reports of headaches, feeling faint, etc.). In the future, odor-based, short-term AMCVs may be considered as a basis for these values.

2.1 5-10 Minute Acute Action Levels

These 5-10-minute values are intended to help inform actions (e.g., triggering investigations) in emergency situations and may be set as the *lowest* of the following values:

- 3 times the short-term, health-based AMCV[1];
- Occupational ACGIH 8-hour TLV (conservative policy-based consideration because these values are frequently based on chronic toxicity); and
- Occupational ACGIH 15-minute STEL divided by 2 (to help ensure that the STEL is not exceeded).

The lowest of these three values is used as the 5-10-minute acute action level. Examples of 5-10-minute AALs can be found in Table 4.

Table 4. AALs Calculated for 9 Chemicals for Comparison to Samples Collected for a Duration of 5-10 minutes.

Chemical	CAS No.	3x Short-Term Health-Based AMCV (ppm)	TLV (ppm)	½ STEL (ppm)	5-10 Minute AAL (ppm)
Ammonia	7664-41-7	2.5	25	17.5	**2.5**
Benzene	71-43-2	0.54	0.5	1.25	**0.5**
1,3-Butadiene	106-99-0	5.1	2	--	**2**
Chlorine	7782-50-5	0.15	0.1	0.2	**0.1**
Ethylbenzene	100-41-4	60	20	--	**20**

[1] Using this calculation, the value will somewhat exceed a 1-hour value extrapolated to 5-10minutes using Haber's law with n=3 under the TCEQ (2015) Guidelines to Develop Toxicity Factors, but is still conservative given that generally there is an MOE ≥3 even for a 1-hour exposure. A person who chooses to leave an area or otherwise mitigate exposure based on an exceedance of the 5-10-minute AAL may or may not be exposed to concentrations that meet/exceed the hourly AMCV, depending upon the magnitude of exceedance and the promptness of leaving or otherwise mitigating exposure. This calculation generates a concentration that is consistent with the interim ICV concentration.

Formaldehyde	50-00-0	0.12	0.1	0.15	**0.1**
Styrene	100-42-5	15	20	20	**15**
Toluene	108-88-3	12	20	--	**12**
Xylene	1330-20-7	5.1	100	75	**5.1**

"--" no STEL values available for the chemical

2.2 Hourly Acute Action Levels

These 45-60-minute values are intended to help inform actions (e.g., triggering investigations) in emergency situations and may be set as the *lowest* of the following values:

- 2 times the short-term, health-based AMCV (conservative in that generally there is an MOE ≥3 for a 1-hour exposure and such an exceedance may have been permitted depending upon various considerations, at the same time the 45-60 minute concentration that triggers this action level will be > 2 times the health-based AMCV); and
- Occupational ACGIH 8-hour TLV (conservative policy-based consideration because these values are frequently based on chronic toxicity).

The lowest of these two values is used as the 45-60-minute action level. Examples of 45-60-minute AALs can be found in Table 5.

Table 5. AALs Calculated for 9 Chemicals for Comparison to Samples Collected for a Duration of 45-60 minutes.

Chemical	CAS No.	2x Short-Term Health-Based AMCV (ppm)	TLV (ppm)	45-60 Minute AAL (ppm)
Ammonia	7664-41-7	1.7	25	**1.7**
Benzene	71-43-2	0.36	0.5	**0.36**
1,3-Butadiene	106-99-0	3.4	2	**2**
Chlorine	7782-50-5	0.1	0.1	**0.1**
Ethylbenzene	100-41-4	40	20	**20**
Formaldehyde	50-00-0	0.082	0.1	**0.082**
Styrene	100-42-5	10	20	**10**
Toluene	108-88-3	8	20	**8**
Xylene	1330-20-7	3.4	100	**3.4**

3.0 Summary of Calculated ICVs and AALs

Table provides the 1-hour AMCV and a summary of the calculated ICVs and AALs from this document for the nine chemicals with acute toxicity factors developed through the DSD process.

Table 6. Summary of Calculated ICVs and AALs for Chemicals in This Document, Including the 1-Hour AMCV for Comparison.

Chemical	CAS No.	1-hour AMCV (ppm)	ICV (ppm)	5-10 Minute AAL (ppm)	45-60 Minute AAL (ppm)
Ammonia	7664-41-7	0.83	2.5	2.5	1.7
Benzene	71-43-2	0.180	0.54	0.5	0.36
1,3-Butadiene	106-99-0	1.7	5.1	2	2
Chlorine	7782-50-5	0.05	0.15	0.1	0.1
Ethylbenzene	100-41-4	20	60	20	20
Formaldehyde	50-00-0	0.041	0.12	0.1	0.082
Styrene	100-42-5	5.1	15	15	10
Toluene	108-88-3	4	12	12	8
Xylene	1330-20-7	1.7	5.1	5.1	3.4

4.0 Comparison of ICVs and AALs to Federal AEGLs

The USEPA has developed threshold exposure limits for airborne chemicals for the general public that are applicable to emergency exposure periods ranging from 10 minutes to 8 hours. These thresholds, called Acute Exposure Guideline Levels (AEGLs), are intended for use for once-in-a-lifetime, or rare, exposures to airborne chemicals. These values are used by emergency responders when dealing with chemical spills or other catastrophic exposures.

There are three AEGL levels, depending on the severity of effects; AEGL-1, AEGL-2, and AEGL-3. The levels present the airborne concentration of a substance above which it is predicted that the general population, including susceptible individuals, could experience:

- AEGL-1 – notable discomfort, irritation, or certain asymptomatic, non-sensory effects. These effects are not disabling and are transient and reversible upon cessation of exposure.
- AEGL-2 – irreversible or other serious, long-lasting adverse health effects or an impaired ability to escape.
- AEGL-3 – life-threatening health effects or death.

AEGLs are intended to represent concentrations and durations above which the general population, including susceptible individuals, could experience health effects. While AEGL values represent threshold levels for the general public, including susceptible subpopulations (e.g., infants, children, the elderly, persons with asthma, and those with other illnesses), it is recognized that individuals, subject to unique or idiosyncratic responses, could experience the effects described at concentrations below the corresponding AEGL.

As shown in Table 7, the TCEQ ICVs and AALs are designed to be more conservative and health protective than AEGLs; that is, they are set below levels at which health effects are expected to occur.

Table 7. Comparison of Calculated ICVs and AALs to USEPA AEGLs with Similar Durations.

Chemical	CAS No.	ICV (ppm)	5-10 Minute AAL (ppm)	10 Minute AEGL-1 (ppm)	10 Minute AEGL -2 (ppm)	10 Minute AEGL-3 (ppm)	45-60 Minute AAL (ppm)	60 Minute AEGL-1 (ppm)	60 Minute AEGL -2 (ppm)	60 Minute AEGL-3 (ppm)
Ammonia	7664-41-7	2.5	2.5	30	220	2700	1.7	30	160	1100
Benzene	71-43-2	0.54	0.5	130	2000	9700	0.36	52	800	4000
1,3-Butadiene	106-99-0	5.1	2	670	6700	27000	2	670	5300	22000
Chlorine	7782-50-5	0.15	0.1	0.5	2.8	50	0.1	0.5	2	20
Ethylbenzene	100-41-4	60	20	33	2900	4700	20	33	1100	1800
Formaldehyde	50-00-0	0.12	0.1	0.9	14	100	0.082	0.9	14	56
Styrene	100-42-5	15	15	20	230	1900	10	20	130	1100
Toluene	108-88-3	12	12	67	1400	10000	8	67	560	3700
Xylene	1330-20-7	5.1	5.1	130	2500	7200	3.4	130	920	2500