Technical Guidelines
for Air Management Regulation VI

By

Air Management Services

Department of Public Health

City of Philadelphia

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I. Toxic Air Contaminants and Reporting Thresholds

Toxic air contaminants, also known as air toxics, are man-made or natural pollutants that when emitted into the air may have adverse health effects as determined from human and animal exposure studies. Air Management Regulation (AMR) VI, as amended, incorporates a list of two hundred and seventeen (217) air pollutants and pollutant groups that are designated as air toxics by the Air Pollution Control Board pursuant to Phila. Code Sec. 3-201(3). This list incorporates nearly all one hundred eighty-eight (188) pollutants that are classified as hazardous air pollutants (HAPs) by U.S. EPA pursuant to Section 112 of the Clean Air Act, and includes additional air pollutants that have been determined to have adverse health effects by Air Management Service (AMS), Department of Public Health (the Department), City of Philadelphia.

As per AMR VI Sec. III.C.(2), AMS is required to establish a reporting threshold for each of the designated air toxics. The reporting threshold is the annual emission rate level (tons per year or pounds per year), that when exceeded, a health risk analysis is necessary. The reporting thresholds for all the designated air toxics are provided in Table 1 below. The *Health Risk Assessment Technical Support Document for Air Management Regulation VI Amendment* describes how these reporting thresholds were established.

Table 1. List of Toxic Air Contaminants (Air Toxics) and Reporting Thresholds

No.	CAS Number	Toxic Air Contaminant / HAP	Reporting Threshold (pounds/year)
1	75070	Acetaldehyde	24
2	60355	Acetamide	2.7
3	75058	Acetonitrile	2000
4	98862	Acetophenone	1
5	53963	2-Acetylaminofluorene	0.04
6	107028	Acrolein	1
7	79061	Acrylamide	0.5
8	79107	Acrylic acid	53
9	107131	Acrylonitrile	1
10	107051	Allyl chloride	9
11	92671	4-Aminobiphenyl	0.01
12	62533	Aniline	33
13	90040	o-Anisidine	1.3
14	140578	Aramite	7.5
15	1332214	Asbestos (1)	0.007
16	71432	Benzene	7
17	92875	Benzidine (4,4’-Biphenyldiamine)	0.001

18	98077	Benzotrichloride	0.015
19	100447	Benzyl chloride (Chloromethyl benzene)	1
20	92524	Biphenyl	21
21	117817	Bis(2-ethylhexyl) phthalate (DEHP)	22
22	542881	Bis(chloromethyl)ether	0.001
23	75252	Bromoform	48
24	106945	1-Bromopropane	2000
25	106990	1,3-Butadiene	1.8
26	156627	Calcium cyanamide	2000
27	133062	Captan	80
28	63252	Carbaryl	2000
29	75150	Carbon disulfide	2000
30	56235	Carbon tetrachloride (Tetrachloromethane)	9
31	463581	Carbonyl sulfide	530
32	120809	Catechol	1000
33	133904	Chloramben	200
34	57749	Chlordane	0.5
35	7782505	Chlorine	10
36	79118	Chloroacetic acid	20
37	532274	2-Chloroacetophenone	1.6
38	108907	Chlorobenzene	2000
39	510156	Chlorobenzilate (Ethyl-4,4’-dichlorobenzilate)	1.7
40	67663	Chloroform (Trichloromethane)	2.3
41	107302	Chloromethyl methyl ether (CMME)	0.08
42	126998	Chloroprene (2-Chloro-1,3-butadiene)	0.12
43		Cresols (Cresylic acid, Cresol mixers)	2000
44	95487	o-Cresol	2000
45	108394	m-Cresol	2000
46	106445	p-Cresol	2000
47	98828	Cumene	2000
48	72559	DDE (Dichlorodiphenyldichloroethylene)	0.5
49	50293	DDT/DDD	0.5
50	334883	Diazomethane	200
51	132649	Dibenzofurans	1000

52	96128	1,2-Dibromo-3-chloropropane	0.03
53	84742	Dibutylphthalate	2000
54	106467	1,4-Dichlorobenzene	4.8
55	91941	3,3-Dichlorobenzidine	0.16
56	111444	Dichloroethyl ether (Bis(2-chloroethyl) ether)	0.16
57	542756	1,3-Dichloropropene	13
58	62737	Dichlorvos	0.6
59	60571	Dieldrin	0.012
60	111422	Diethanolamine	160
61	121697	N,N-Dimethylaniline	200
62	64675	Diethyl sulfate	200
63	119904	3,3-Dimethoxybenzidine	20
64	60117	4-Dimethyl aminoazobenzene	0.04
65	119937	3,3′-Dimethyl benzidine (o-Tolidine)	2
66	79447	Dimethyl carbamoyl chloride	0.014
67	68122	Dimethyl formamide	1600
68	57147	1,1-Dimethyl hydrazine (Asymmetric dimethyl hydrazine)	0.1
69	131113	Dimethyl phthalate	2000
70	77781	Dimethyl sulfate	0.013
71	534521	4,6-Dinitro-o-cresol	20
72	51285	2,4-Dinitrophenol	200
73	121142	2,4-Dinitrotoluene	0.6
74	123911	1,4-Dioxane (1,4-Diethyleneoxide)	11
75	122667	1,2-Diphenylhydrazine	0.25
76	106898	Epichlorohydrin (1-Chloro-2,3-epoxypropane)	44
77	106887	1,2-Epoxybutane	1060
78	140885	Ethyl acrylate	425
79	100414	Ethyl benzene	21
80	51796	Ethyl carbamate (Urethane)	0.18
81	75003	Ethyl chloride (Chloroethane)	2000
82	106934	Ethylene dibromide (1,2-Dibromoethane)	0.09
83	107062	Ethylene dichloride (1,2-Dichloroethane)	2
84	107211	Ethylene glycol	2000

85	151564	Ethylene imine (Aziridine)	0.003
86	75218	Ethylene oxide	0.01
87	96457	Ethylene thiourea (1,3-Ethylene-2-thiourea)	4
88	75343	Ethylidene dichloride (1,1-Dichloroethane)	33
89	50000	Formaldehyde	4
90	76448	Heptachlor	0.04
91	118741	Hexachlorobenzene	0.12
92	87683	Hexachlorobutadiene (Hexachloro-1,3-butadiene)	2.4
93	608731	Hexachlorocyclohexane [technical grade]	0.1
94	58899	*gamma*-Hexachlorocyclohexane (Lindane)	0.17
95	77474	Hexachlorocyclopentadiene	11
96	67721	Hexachloroethane	4.8
97	822060	Hexamethylene-1,6-diisocyanate	0.5
98	680319	Hexamethylphosphoramide	2
99	110543	Hexane	2000
100	302012	Hydrazine (Diamine)	0.01
101	7647010	Hydrogen chloride (Hydrochloric acid)	1060
102	7664393	Hydrogen fluoride (Hydrofluoric acid)	200
103	123319	Hydroquinone	200
104	78591	Isophorone	2000
105	108316	Maleic anhydride	37
106	67561	Methanol	2000
107	72435	Methoxychlor	2000
108	74839	Methyl bromide (Bromomethane)	265
109	74873	Methyl chloride (Chloromethane)	29
110	71556	Methyl chloroform (1,1,1-Trichloroethane)	2000
111	60344	Methyl hydrazine	0.05
112	74884	Methyl iodide (Iodomethane)	200
113	108101	Methyl isobutyl ketone (MIBK; Hexone)	2000
114	624839	Methyl isocyanate	53
115	80626	Methyl methacrylate	2000
116	1634044	Methyl tert butyl ether (MTBE)	200

117	101144	4,4-Methylene bis(2-chloraniline)	0.12
118	75092	Methylene chloride (Dichloromethane)	2000
119	101779	4,4'-Methylene dianiline	0.12
120	101688	4,4-Methylene diphenyl diisocyanate (MDI)	4.5
121	91203	Naphthalene	1.6
122	98953	Nitrobenzene	1.3
123	92933	4-Nitrobiphenyl	200
124	100027	4-Nitrophenol	1000
125	79469	2-Nitropropane	0.02
126	55185	N-Nitrosodiethylamine	0.001
127	62759	N-Nitrosodimethylamine	0.004
128	59892	N-Nitrosomorpholine	0.03
129	684935	N-Nitroso-N-methylurea	0.002
130	56382	Parathion	20
131	82688	Pentachloronitrobenzene (Quintobenzene)	60
132	87865	Pentachlorophenol	10
133	108952	Phenol	2000
134	106503	p-Phenylenediamine	2000
135	75445	Phosgene	16
136	7803512	Phosphine	16
137	7723140	Phosphorus	3.7
138	85449	Phthalic anhydride	1060
139	1336363	Polychlorinated biphenyls (PCBs; Aroclors)	0.5
140	1120714	1,3-Propane sultone (3-Hydroxyl-1-propane sulfonic acid sulfone)	0.08
141	57578	*beta*-Propiolactone (3-Hydroxypropanoic acid lactone)	0.01
142	123386	Propionaldehyde	425
143	114261	Propoxur (Baygon)	2000
144	78875	Propylene dichloride (1,2-Dichloropropane)	5.3
145	75569	Propylene oxide (1,2-Epoxypropane)	14
146	75558	1,2-Propylenimine (2-Methyl aziridine)	0.6
147	91225	Quinoline	0.05

148	106514	Quinone	1000
149	100425	Styrene	93
150	96093	Styrene oxide	1.2
151	2699798	Sulfuryl fluoride	2000
152	1746016	2,3,7,8-Tetrachlorodibenzo(p)dioxin (2,3,7,8-TCDD; Dioxin)	0.0000014
153	79345	1,1,2,2-Tetrachloroethane	0.9
154	127184	Tetrachloroethylene (Perchloroethylene)	9
155	7550450	Titanium tetrachloride	5.3
156	108883	Toluene	2000
157	95807	2,4-Toluene diamine (2,4-Diaminotoluene)	0.05
158	584849	2,4-Toluene diisocyanate	3.7
159	95534	o-Toluidine	1
160	8001352	Toxaphene	0.17
161	120821	1,2,4-Trichlorobenzene	106
162	79005	1,1,2-Trichloroethane	3.3
163	79016	Trichloroethylene	10
164	95954	2,4,5-Trichlorophenol	200
165	88062	2,4,6-Trichlorophenol	17
166	121448	Triethylamine	370
167	1582098	Trifluralin	24
168	540841	2,2,4-Trimethylpentane	1000
169	108054	Vinyl acetate	2000
170	593602	Vinyl bromide (Bromoethene)	1.7
171	75014	Vinyl chloride	6
172	75354	Vinylidene chloride (1,1-Dichloroethylene)	2000
173		Xylenes (mixed isomers)	2000
174	95476	o-Xylenes	2000
175	108383	m-Xylenes	2000
176	106423	p-Xylenes	2000
		Chemical Compound Groups	
177		Antimony compounds (2)	1000
178	7783702	Antimony pentafluoride	20
179	1309644	Antimony trioxide	11
180	1345046	Antimony trisulfide	20

181		Arsenic compounds (2)	0.01
182	7784421	Arsine	0.01
183		Beryllium compounds (2)	0.02
184		Cadmium compounds (2)	0.01
185	130618	Cadmium oxide	0.01
186		Chromium VI (Total) (2)	0.0045
187	744084	Cobalt metal and compounds (2)	0.006
188	10210681	Cobalt carbonyl	0.006
189	62207765	Fluomine	0.006
190		Coke oven emissions (2)	0.09
191		Cyanide compounds (including Hydrogen cyanide) (2)	42
192	94757	2,4-D, salts and esters (2)	2000
193		Glycol ethers (2)	2000
194	111762	Ethylene glycol monobutyl ether (2-Butoxyethanol; EGBE)	2000
195	110805	Ethylene glycol monoethyl ether (2-Ethoxy ethanol)	1800
196	111159	Ethylene glycol monoethyl ether acetate	685
197	109864	Ethylene glycol monomethyl ether (2-Methoxy ethanol)	455
198		Lead and compounds (2)	2
199	78002	Tetraethyl lead	2
200	7439965	Manganese and compounds (2)	0.8
201	12108133	Methylcyclopentadienyl manganese	0.8
202		Mercury compounds (2)	2
203	7439976	Mercury (inorganic)	1.6
204		Nickel compounds (2)	0.2
205	13463393	Nickel carbonyl	0.2
206	1313991	Nickel oxide	0.2
207		Polycyclic organic matter (POM) & Polycyclic aromatic hydrocarbons (PAHs) (2)	2
208	56553	Benz(a)anthracene	0.4
209	225514	Benz(c)acridine	2
210	50328	Benzo(a)pyrene (3,4-benzopyrene)	0.05
211	205992	Benzo(b)fluoranthene	0.4
212		Selenium compounds (2)	1060

213	7783075	Hydrogen selenide	25
214	7488564	Selenium sulfide (mono- and di-)	20
215	13410010	Sodium selenate	20
216	10102188	Sodium selenite	20
217		Total dioxin and furans (3)	0.00012

(1) Also see Philadelphia Department of Public Health Asbestos Control Regulation.
(2) Indicating a chemical compound group; some compounds or subgroups included in this group may also be individually named in this table.
(3) As defined in Interim Procedures for Estimating Risks Associated with Exposures to Mixtures of Chlorinated Dibenzo-p-Dioxins and Dibenzofurans (CDDs and CDFs), March 1989 update, EPA-625/3-89/016, available from www.epa.gov/nscep; https://archive.epa.gov/raf/web/html/cdd-cdf.html

II. Overview – Toxic Air Contaminants Health Risk Assessment

A health risk assessment is a scientific process used to estimate the probability of adverse health effects resulting from human exposure to a hazardous substance or hazardous substances. AMS utilizes health risk assessments to evaluate any remaining health risk, known as residual health risk, posed by air toxic emissions from certain air pollution sources that have otherwise implemented emission controls, work practices, and other requirements specified by applicable City, Commonwealth, and Federal authorities.

As per AMR VI. Secs. II and III, a health risk assessment may be required along with any Installation Permit application[1] or Plan Approval application received on and after January 1, 2024, for the construction / modification of air pollution sources where the emission of air toxics will exceed specified reporting thresholds. A facility-wide health risk assessment is also required for any initial or renewal Title V operating permit application received on and after January 1, 2024, if the facility-wide potential emission of at least one toxic air contaminate is above the reporting threshold. A Title V operating permit modification application only requires a risk assessment if the potential emissions of at least one toxic air contaminant due to the modification increases above the reporting threshold. See AMR VI. Secs. II, III.

Instructions on how to perform the required health risk assessment; calculate the cancer risks and non-cancer health quotients; and interpret the results of the assessments are provided in Section III of the Guidelines below, and in Appendix A. Appendix B contains a glossary of the various terms used in these Guidelines.

[1] Note: As per AMR VI. Sec. II.C., no air toxics notice and health risk assessment is required for the following Installation Permits Applications: Complex Source Permits, Mechanical Ventilation System for Automotive Facilities Permits, and Dust Control Permits.

III. Health Risk Assessment

A. Risk Screening

An initial risk screening analysis must be performed for any new or modified air pollution source that will emit air toxics in excess of the reporting thresholds provided in Table I in Section I. This risk screening analysis can be performed by using: 1) AMS's Risk Screening Workbook; 2) EPA's air quality screening model, AERSCREEN; or (3) an alternative air screening model approved by the Department on a case-by-case basis.

Note: Risk screening is required for new or modified sources where an applicant seeks Installation Permits or Plan Approvals from AMS. Applicants seeking an initial or renewal Title V permit should proceed to Section III.D.

A.1. Risk Screening – Using the Risk Screening Workbook

The Risk Screening Workbook is a Microsoft Excel workbook that calculates the worst-case cancer risks and non-cancer health hazard quotients from a source's air toxics emissions, based on applicant-inputted data. The Risk Screening Workbook incorporates assumptions derived from air quality dispersion modeling and dose response factors to produce conservative risk assessment estimates for a particular emission point. It is an easy-to-use tool that simplifies the risk assessment screening process for the permit applicants. **The risk screening workbook should not be used for the following sources:** (1) sources without an exhaust stack or release point, (2) sources with stacks with a horizontal or downward discharge direction, or (3) sources with stack heights less than 15 feet (above grade). For these sources, applicants must use either the EPA air quality screening model AERSCREEN or another screening model approved by the Department, as described in III.A.2 below.

The Risk Screening Workbook consists of three separate worksheets, as indicated by the tabs at the bottom of the workbook. The first worksheet contains instructions. The second worksheet, called the Risk worksheet, handles the risk screening data input and calculations. The third worksheet, called the CAS Index, contains a numerical listing of all the Chemical Abstracts Service (CAS) numbers for the designated air toxics. The CAS Index worksheet also contains synonyms for certain air toxics. The applicant must complete a Risk Screening Workbook for each exhaust stack or emissions point to be included in the newly constructed or modified air pollution source.

For a particular exhaust stack or emission point, the applicants must enter the stack height (ft), the distance from the stack to the closest facility property line (ft), the pollutant-specific annual emission rate Q (tons/year) and the pollutant-specific maximum short-term emission rate Q_h (lbs/hr) in the risk worksheet. All source-specific information entered by the applicant must be consistent with the information provided in the attendant Installation Permit, Plan Approval, or Title V permit application. Screening results will be calculated automatically and displayed in the risk worksheet.

The screening results provided for each exhaust stack or emission point will indicate whether any further risk assessment will be required. If the screening results for any air toxic emitted by a particular stack is "Negl" (Negligible), no further evaluation is needed[2]. If the screening result shows

[2] A "Negl" result means the cancer risk from the emission of an air toxic from a particular stack or emission point is ≤ 1 in a million (1×10^{-6}) and the non-cancer hazard quotient is ≤ 1.

"FER," further evaluation in the form of a refined risk assessment as described in Section III.B. below is required.

A.2. Risk Screening – Air Quality Modeling

In the event where the Risk Screening Workbook cannot be used, the required risk screening must be performed via AERSCREEN or another Department-approved screening model. The latest AERSCREEN modeling program and attendant instructions for running the modeling program can be found on U.S. EPA's website:

https://www.epa.gov/scram/air-quality-dispersion-modeling-screening-models

Applicants must use AERSCREEN or another Department-approved screening model to estimate the worst-case, ambient air concentrations of air toxics that will be emitted from the source, and then calculate the attendant cancer risk and non-cancer hazard quotients. All source-specific information entered into AERSCREEN by the applicant to perform this analysis must be consistent with the information provided in the attendant Installation Permit or Plan Approval application. Formulas for the cancer health risk and non-cancer hazard quotients calculation are provided in Appendix A, Step 4, Equations 1, 2 and 3. Unit Risk Factor **(**URF) and Reference Concentration (RfC) values needed to perform these calculations are found in the Risk Screening Workbook, Risk worksheet.

Note: In the event that an air toxic has both long-term and short-term non-cancer RfCs listed in the risk worksheet, then –

1) An annual pollutant emission rate should be used to model the maximum annual (long-term) ambient concentration, and calculate the long-term hazard quotient using the long-term RfC; and
2) A short-term, hourly pollutant emission rate should be used to model the maximum short-term ambient concentration and calculate the short-term hazard quotient using the short-term RfC.

If the cancer risk for each air toxic emitted from the source is $\leq$ 1 in a million (1×10^{-6}) AND the applicable non-cancer hazard quotient is $\leq$ 1, the health risk for the source is considered negligible and no further evaluation is necessary. In the event that cancer risks for any air toxic emitted is > 1 in a million (1×10^{-6}) AND / OR the applicable non-cancer hazard quotient is > 1, then a refined risk assessment must be performed as specified in Section B of these Guidelines.

B. Refined Risk Assessment

Note: Refined Risk Assessment is required for new or modified sources where an applicant seeks Installation Permits or Plan Approvals from AMS and: 1) received an "FER" result in the risk screening step using the Risk Screening Workbook, or 2) cancer risks for any air toxic is > 1 in a million (1×10^{-6}) and/or the applicable non-cancer hazard quotient is > 1 using the AERSCREEN model or other Department-approved screening model. Applicants seeking an initial or renewal Title V permit should proceed to Section III.D.

The refined risk assessment consists of a refined atmospheric dispersion modeling analysis for air pollution sources that estimates ambient air concentrations of emitted air toxics more accurately than the methods described in Section III.A. This analysis relies on using stack- and source-specific data as well as representative meteorological data, as input into U.S. EPA's AERMOD

air quality dispersion model. All source-specific information inputted into the model for this analysis must be consistent with the information provided by the applicant in the attendant Installation Permit or Plan Approval application.

The refined risk assessment process evaluates cancer risk, as well as short- and long-term non-carcinogenic risks, and must be calculated in accordance with Appendix A for each air toxic emitted from a source. These health risks must be determined:

1) at the modeling receptor with the highest predicted air concentration based on 5 years of meteorological data (AERMOD modeling); and
2) at sensitive or vulnerable receptors (such as nearest residence, daycare centers, hospitals, nursing homes, playgrounds, etc.) located within the defined modeling grid.

All applicants must submit an atmospheric dispersion modeling protocol in accordance with procedures outlined by U.S. EPA for AERMOD air quality dispersion modeling. Program files and instructions for performing AERMOD modeling can be found on U.S. EPA's website:
https://www.epa.gov/scram/air-quality-dispersion-modeling

Note: Other air quality dispersion models (for example, EPA's AERSCREEN model if it was not used in the risk screening step) or use of source-specific ambient air monitoring / fenceline monitoring data, may only be used in the refined risk assessment evaluation if first approved by the Department.

C. Risk Management Guidelines – New and Modified Sources (Installation Permits / Plan Approvals)

AMS's risk management guidelines for individual new or modified sources, pursuant to AMR VI, are summarized below in Tables 2 and 3.

Table 2. Cancer Risk Guidelines for New or Modified Sources

Risk Level	Outcome
Risk ≤ 1 in a million ($1x10^{-6}$)	Negligible risk.
1 in a million < Risk < 50 in a million	Case-by-case review (See Section IV).
Risk ≥ 50 in a million ($5x10^{-5}$)	Unacceptable risk; source poses an undue health hazard

Table 3. Long-and Short-Term Non-Cancer Hazard Quotient Guidelines for New or Modified Sources

Risk Level	Outcome
Hazard Quotient ≤ 1	Negligible risk.
Hazard Quotient > 1	Risk Mitigation Plan required (See Section IV).

If all cancer risk and non-cancer hazard quotients calculated for all the air toxics emitted are deemed “negligible” pursuant to Tables 2 and 3, no further action is required. See Appendix A, Step 4 for rounding of the hazard quotient value.

Figure 1 illustrates the workflow of health risk assessment for individual sources in Installation Permit and Plan Approval applications.

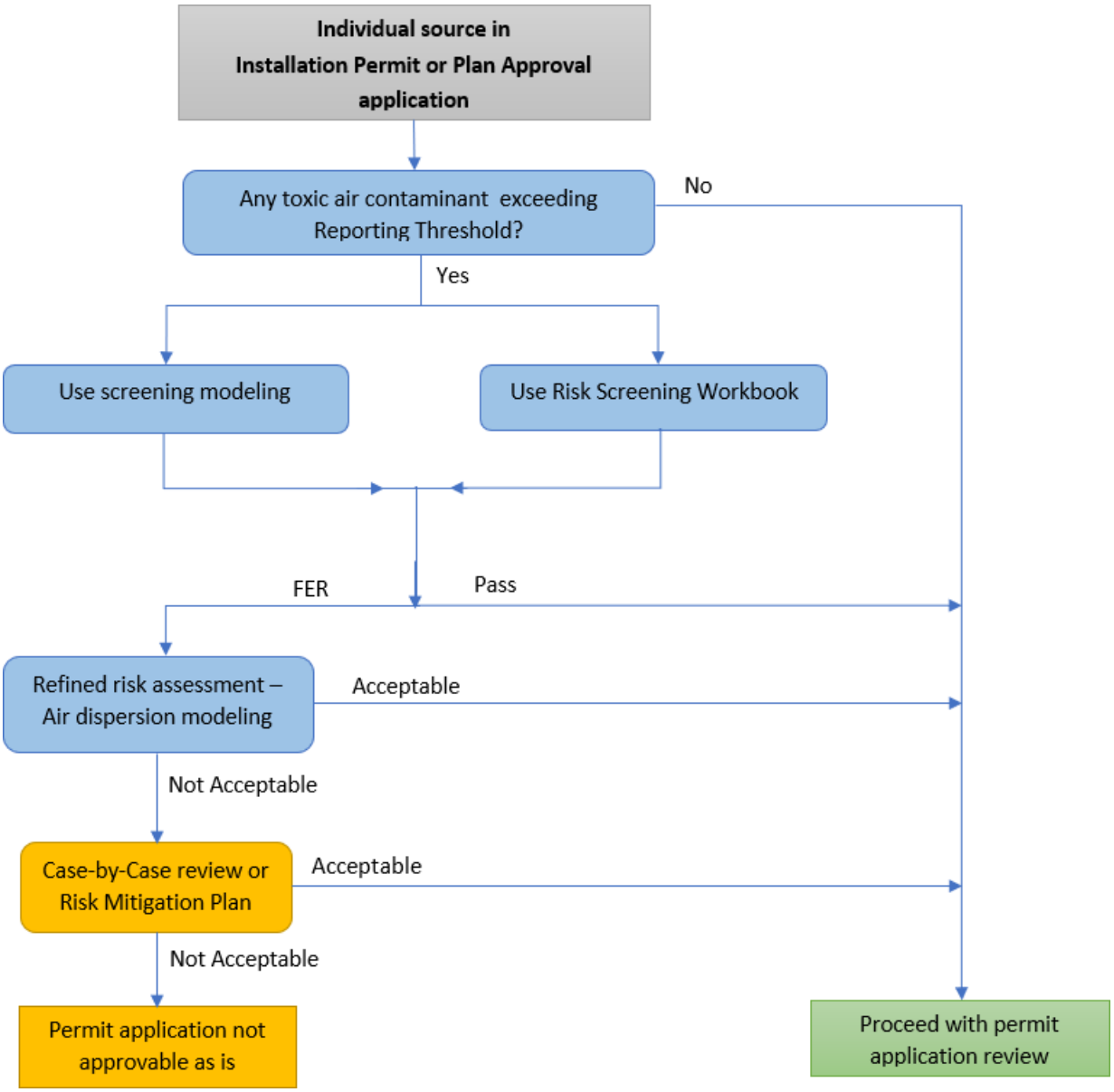

Figure 1. Workflow of air toxics health risk assessment for individual sources in Installation Permit and Plan Approval applications

D. Title V Facility-Wide Risk Assessment

A facility-wide heath risk assessment is required for all air toxics emitted from all air pollution sources operated as part of a Title V facility. This analysis must be performed anytime an applicant seeks an initial Title V permit for a facility or seeks to renew a Title V permit for an existing facility where air toxics will be emitted in excess of the reporting thresholds.

Applicants performing a facility-wide risk assessment must submit an atmospheric dispersion modeling protocol to AMS that is in accordance with procedures outlined in the U.S. EPA's air quality dispersion modeling guidelines available at https://www.epa.gov/scram/air-quality-dispersion-modeling. This modeling protocol must estimate the impact of each toxic air contaminant that will be emitted from all stacks / emission points within the facility in accordance with the cancer risk and non-cancer hazard quotient methodology provided in Appendix A to these Guidelines.

All source-specific information entered by the applicant to perform the facility-wide health risk assessment must be consistent with the information provided in the attendant Title V permit application. Applicants may opt to use Risk Screening Workbook discussed in Section III.A.1 when applicable, as a preliminary tool to conduct screening for facility-wide risk assessment of air toxic emissions.

Note: The atmospheric dispersion modeling protocol required by this section must be approved by AMS before the facility-wide health risk assessment is performed.

D.1. Title V Facility-Wide Risk Assessment Guidelines

AMS's risk management guidelines for Title V facilities are summarized below in Tables 4 and 5.

Table 4. Title V Facility-Wide Cancer Risk Guidelines

Risk Level	Outcome
Risk ≤ 10 in a million ($1x10^{-6}$)	Negligible risk.
10 in a million < Risk < 50 in a million	Risk Mitigation Plan required (see Section IV).
Risk ≥ 50 in a million ($5x10^{-5}$)	Unacceptable risk; facility poses an undue health hazard

Table 5. Title V Facility-Wide Long- and Short-Term Non-Cancer Risk Guidelines

Risk Level	Outcome
Hazard Quotient ≤ 1	Negligible risk.
Hazard Quotient > 1	Risk Mitigation Plan required (see Section IV).

If all cancer risk and non-cancer hazard quotients calculated for all the air toxics emitted are deemed "negligible" pursuant to Tables 4 and 5, no further action is required. Figure 2 illustrates

the workflow of facility wide risk assessment. See Appendix A, Step 4 for rounding of the hazard quotient value.

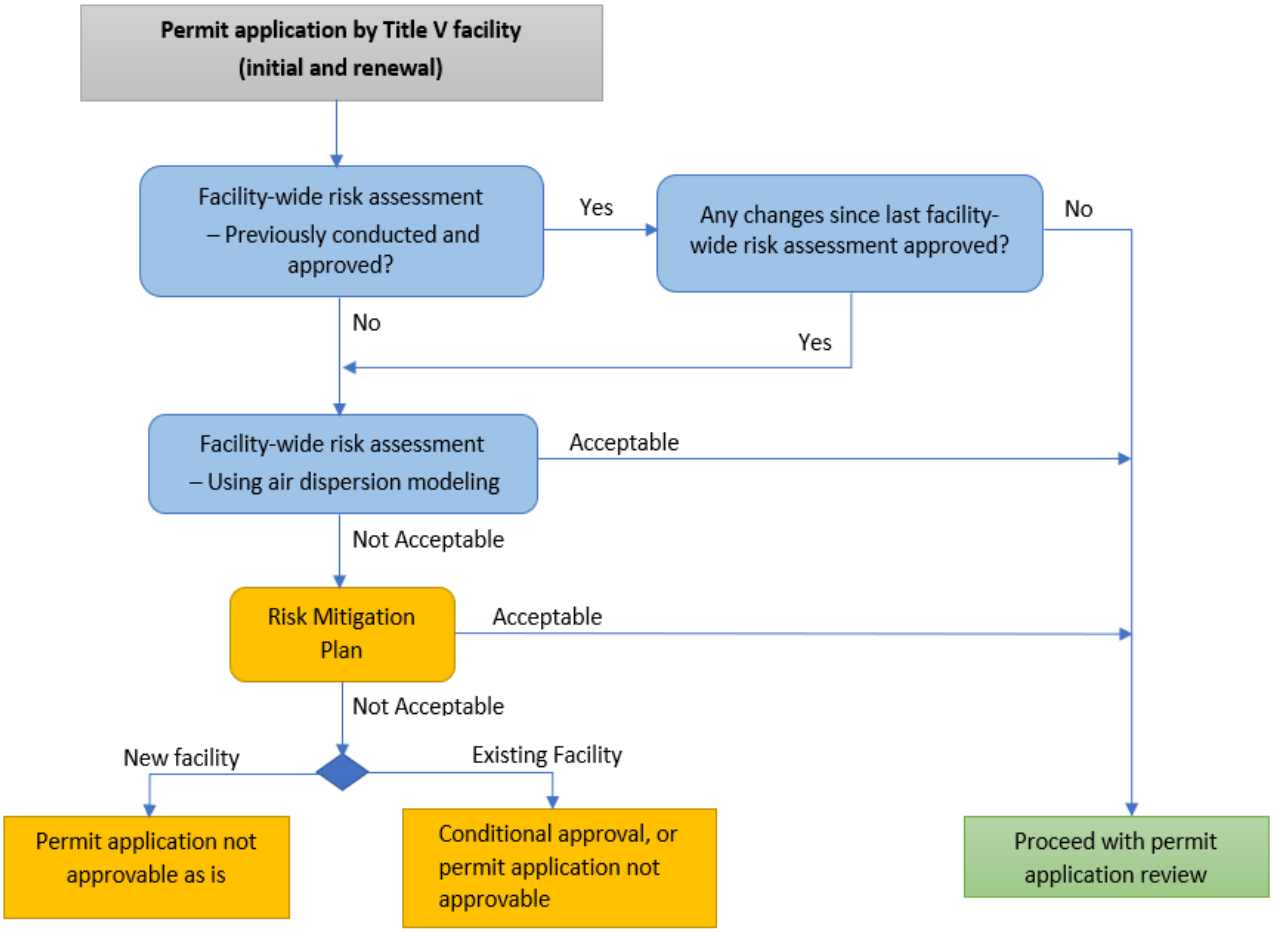

Figure 2. Workflow of facility-wide air toxics health risk assessment for Title V permit applications

D.2. Determining Total Risk Including Background

The Department will determine the Total Risk by combining the Background Risk (by ambient air pollutant concentrations) and the Incremental Risk from the facility, as below:

$$\underline{\textbf{Total Risk} = \textbf{Background Risk}_{\text{ambient air}} + \textbf{Incremental Risk}_{\text{facility}}}$$

The Department will measure the Background Risk by measuring the ambient air concentrations surrounding the facility. The Department will use EPA approved methods to capture and analyze

24-hour grab air samples. The sample analysis will produce a 24-hour average concentration, and the Department will use the 24-hour average to estimate an annual average concentration for TACs in the ambient air surrounding the facility.

The Department will calculate cancer and noncancer Background Risk for each TAC using the estimated annual air concentration, cancer URFs, and noncancer RfCs. Formulas for the cancer health risk and non-cancer hazard quotients calculation are provided in Appendix A, Step 4, Equations 1, 2 and 3.

When calculating a facility's Incremental Risk, the Department will only consider sources that are not captured in the existing Background Risk at the facility. Therefore, Incremental Risk would only encompass newly planned sources at the facility for TVOP renewals and applications.

A permit application is unacceptable if the total cancer risk is above 100 in a million, based on EPA cancer risk upper limit guidelines, unless the facility reduces the total cancer risk to no more than 100 in a million using mitigation measures (see Section IV). See III.D.1 for facility incremental risk.

As the technology and EPA guidance evolve, AMS may adopt new methods to determine the background risk.

IV. Risk Mitigation Plan

A risk mitigation plan is required when the risk analysis for the application is higher than a negligible risk and lower than an unacceptable risk. Risk mitigation plans will be submitted by the facility owners and/or operators and are subject to Department review and approval. The risk mitigation plan must be well-defined and result in health risk reductions. This is a case-by-case determination because the situations can vary drastically, so there is no "one-size-fits-all" solution. Both an installation permit (for example, for a new small boiler at a school) and a Title V operating permit application for a large chemical plant can require risk mitigation. The primary goal of a mitigation plan is to reduce emissions and health risks; the emission and risk reductions should be quantified.

In the event that Risk Mitigation Plan is called for, the applicant must develop a plan that documents and describes how the health risks posed by air toxics emissions from a new / modified air pollution source, or Title V facility, will be minimized and managed. This Risk Mitigation Plan must account for locations where the modeled, maximum air toxic(s) concentrations occur as demonstrated by the refined risk assessment / Title V facility-wide risk assessment, the presence of overburdened communities, and the overall impact of such emissions on the sensitive receptor population. The Risk Mitigation Plan must also account for the uncertainties associated with the health risk assessment procedures; applicant's / operator's compliance history if any; and include a cost benefit analysis of any adopted health risk mitigation measures. Such risk mitigation measures can include, but are not limited to –

- Adoption of additional air pollution controls to lower air toxic emissions that are not otherwise required by other air pollution authorities;

- Adoption of changes in operation hours and schedules to reduce short-term maximum pollutant concentration;

- Modifying stack / emission point parameters to increase dispersion (for example, increase the stack height); and / or

- Adoption of changes in operation in a manner to eliminate or reduce the inhalation pathway for sensitive receptors.

If approved by AMS, the relevant details of the Risk Mitigation Plan will be incorporated into the respective Installation Permit, Plan Approval, or Title V permit. AMS may require changes to the Risk Mitigation Plan if AMS believes it is not sufficient. Failure to develop an acceptable Risk Mitigation Plan will result in the denial of the respective Installation Permit, Plan Approval, or Title V permit.

When reviewing Risk Mitigation Plans, AMS will consider information such as the following:

- How high is the cancer risk level? For example, AMS will push harder for changes if the risk level is 95-in-a-million than if it is 5-in-a-million.

- What is near the facility, particularly near the area with the highest projected risk? Are there residences or sensitive sources like hospitals and day care centers nearby? AMS will be more concerned if the highest risk is projected to be near a residence than if it is in the middle of a street.

- How difficult is it to improve the risk level? AMS is more likely to push for the raising of a stack that will lead to a small improvement than the installation of an expensive control device that will only lead to a small improvement.

When preparing a Risk Mitigation Plan, the facility should consider the following:

- Can the emission rate be lowered through the installation of a control device?

- Can the potential emissions be reduced by accepting a throughput limit (i.e. limit operation of the process to 4,000 hours per year instead of 8,760 hours per year)?

- Can the risk level be improved by changing the location or exhaust? Raising the stack, increasing the stack exhaust velocity, or locating the process further from the property line may lower the risk level.

APPENDIX A

THE RISK ASSESSMENT PROCESS

In 1986, the U.S. EPA established risk assessment guidelines in order to provide consistency and technical support between U.S. EPA and other regulatory agencies. The guidelines were based on recommendations from the National Research Council (NRC 1983). NRC divided the risk assessment process into four steps, which are described below.

Step 1 - <u>Hazard Identification</u>

Hazard identification is the process used to determine the potential human health effects from exposure to an air toxic. This is based on information provided by the scientific literature. For air toxics sources, hazard identification involves identifying whether a hazard exists, and if so, identifying the exact pollutants of concern. Hazard identification takes into consideration whether a pollutant is a potential human carcinogen or is associated with other types of adverse health effects. For hazard identification in relation to an air permit, the following are considered:

A. Which contaminants will be emitted from the source;
B. Which of these contaminants have known health effects; and
C. The specific toxicological effects of these air toxics.

Step 2 - <u>Dose-Response Assessment</u>

Dose-response assessment is the characterization of the relationship between a chemical (air toxic) exposure, or dose, and the incidence and severity of an adverse health effect. It takes into consideration factors that influence this relationship, including intensity and pattern of exposure, and age and lifestyle variables that may affect susceptibility. It may also involve extrapolation from high-dose to low-dose responses, and from animal to human responses. This information is gathered from epidemiological or laboratory studies done by federal or state agencies, health organizations, academic institutions, and others.

Dose-response assessment as utilized in the air permitting process involves the quantification (in terms of severity or likelihood) of toxicological effects of individual chemicals on humans. The dose-response relationship is evaluated differently for carcinogenic (cancer-causing) and non-carcinogenic substances.

For carcinogens, it is assumed that there is a linear relationship between an increase in dose or exposure concentration and an increase in cancer risk. This is expressed as a **potency slope** or **slope factor** (SF), in units “per milligram (of chemical) per kilogram (of body weight) per day” or (/mg/kg/day).

To evaluate health risks from inhalation of carcinogenic substances, U.S. EPA and other regulatory agencies use potency slopes to develop **unit risk factors** (URFs). A URF can be

defined as the upper-bound excess probability of contracting cancer as the result of a lifetime of exposure to a carcinogen at a concentration of 1 $\mu g/m^3$ in air. URF units are "per microgram (of chemical) per cubic meter (of air)" or $(\mu g/m^3)^{-1}$.

For inhalation effects from non-carcinogens, dose-response data are used to develop **reference concentrations** (RfCs), for both long-term (chronic) and short-term exposures. Unlike carcinogens, non-carcinogens are assumed to have thresholds for adverse effects, meaning that injury does not occur until exposure has reached or exceeded some concentration (a threshold). An RfC is derived from a no-observed adverse effect level (NOAEL) or lowest-observed adverse effect level (LOAEL) determined through human or animal exposure studies. Since actual thresholds for the general population cannot be precisely determined, uncertainty or safety factors are applied to the NOAEL or LOAEL. This assures that the RfC is set at a level that is expected to be protective of sensitive populations (the elderly, infirm, or very young). Short-term RfCs are developed to prevent health effects from exposure periods of 24 hours or less. RfCs are expressed in units of $\mu g/m^3$ (Note: California's air program refers to these values as "Reference Exposure Levels (RELs)," while U.S. EPA uses the term RfC.).

To establish URFs, RfCs, and SFs, toxicological studies are evaluated by groups assigned for this purpose within U.S. EPA and other agencies. These risk values are then usually peer- reviewed and gathered into databases. U.S. EPA maintains the Integrated Risk Information System (IRIS), which is available on-line at http://www.epa.gov/iris. Another primary source of risk data is the California Office of Environmental Health Hazard Assessment (OEHHA). Their data is available on-line at http://www.oehha.ca.gov/.

Step 3 - Exposure Assessment

The exposure assessment step determines the extent (intensity, frequency, and duration, or dose) of human exposure to a chemical in the environment. There are three components to the exposure assessment:

A. Estimation of the maximum quantity of each pollutant emitted from the source of concern (based on data from previously existing sources or engineering estimates);

B. For each contaminant emitted from a source, estimation of the resulting maximum annual average and (where applicable) maximum short-term average ambient air concentrations, using dispersion models, or air impact values based on dispersion models; and

C. Estimation of the amount of contaminant taken in by a human

Step 4 - Risk Characterization

Risk characterization is the final step in risk assessment. At this step, human health risk is calculated and described based on the information gathered in the first three steps. The risk characterization also includes some consideration of uncertainty, scientific judgment, and the major assumptions that were made, especially regarding exposure.

Human health risk estimates for inhalation of a carcinogen are based on the following

calculation:

Cancer Risk = C x URF - Equation 1

where:

C = Annual maximum ambient air concentration of the pollutant ($\mu g/m^3$), based on annual emission rate;

URF = pollutant-specific inhalation unit risk factor $(\mu g/m^3)^{-1}$

Human health risk estimates for inhalation of a non-carcinogen are based on the following calculations:

For long-term non-cancer risk:

Hazard Quotient = C/RfC - Equation 2

where:

C = Annual maximum ambient air concentration of the pollutant ($\mu g/m^3$), based on annual emission rate;

RfC = Long-term pollutant-specific reference concentration ($\mu g/m^3$).

For short-term non-cancer risk:

Hazard Quotient $_{(ST)}$ = C_{st}/RfC_{st} - Equation 3

where:

C_{st} = Short-term maximum ambient air concentration of the pollutant ($\mu g/m^3$), based on short-term emission rate;

RfC_{st} = Short-term pollutant-specific reference concentration ($\mu g/m^3$).

The averaging time for non-carcinogen concentrations can be long-term (annual) and/or short-term (a specific number of hours), depending on the basis of the reference dose. Both a long-term and a short-term non-cancer hazard quotient should be evaluated for an air toxic if it has both long-term and short-term RfC values established.

The hazard quotient is commonly rounded to one significant figure. The rounding should be done only in the final results, not in the intermediate calculations (see U.S. EPA reference). However, AMS may require that the first decimal place in the value be kept (for example, 1.4) when health risks at sensitive or vulnerable receptors (such as nearest residence, daycare centers, hospitals, nursing homes, playgrounds, etc.) are evaluated.

APPENDIX B

ACRONYMS & GLOSSARY

Air Toxics: Also known as toxic air pollutants, toxic air contaminants, or hazardous air pollutants. These are chemicals that cause or may cause serious effects in humans and may be emitted into the air in quantities that are large enough to cause adverse health effects. These effects cover a wide range of conditions from lung irritation to birth defects to cancer. Health concerns may be associated with both short and long-term exposures to these pollutants. Many are known to have respiratory, neurological, immune or reproductive effects, particularly for more susceptible sensitive populations such as children.

Background Risk: The sum of the risks to which the public is exposed, excluding the risk of additional activities being evaluated.

Carcinogen: A chemical for which there is some evidence (either in animals or humans) that it may cause cancer.

CAS Number: A unique number used to identify a particular chemical substance, established by the Chemical Abstracts Service of the American Chemical Society.

Department: City of Philadelphia Department of Public Health.

Exposure: Contact with a substance through inhalation, ingestion, or some other means for a specific period of time.

Hazardous Air Pollutant (HAP): In general, a hazardous air pollutant is an "air toxic." Specifically, this also refers to any of the 188 air toxic pollutants listed in the 1990 federal Clean Air Act amendments.

Hazard Quotient: An estimate of the potential for a detrimental non-cancer health effect from exposure to a chemical.

Non-carcinogen: A pollutant that can cause adverse health effects other than cancer.

Reference Concentration (RfC): An estimate (with uncertainty spanning perhaps an order of magnitude) of a continuous inhalation exposure (expressed as an air pollutant concentration) to the human population (including sensitive subgroups) that is likely to be without an appreciable risk of harmful effects during a lifetime. It can be derived from various types of human or animal data, with uncertainty factors generally applied to reflect limitations of the data used.

Slope Factor (SF): An upper-bound, approximating a 95% confidence limit, on the increased cancer

risk from a lifetime exposure to an agent. This estimate is usually expressed in units of proportion (of a population) affected per mg/kg-day.

Unit Risk Factor (URF): The upper-bound excess lifetime cancer risk estimated to result from continuous exposure to a chemical at a concentration of 1 µg/m^3 in air. For example, if a chemical's URF is 2 x 10^{-6} (per µg/m^3), then a person exposed daily for a lifetime to 1 µg of the chemical in 1 cubic meter of air would have an increased risk of cancer equal to 2 in a million.

U.S. EPA: The United States Environmental Protection Agency.