Guidelines for Minimizing Toxic Air Contaminant (TAC) Emissions from Laboratories

1. Introduction

The University of California, Irvine (UCI) is committed to protecting the local community and the environment and to complying with the laws and regulations governing emissions of TACs. In response to the new requirements, Environmental, Health & Safety (EH&S) has developed a program to help laboratories comply with federal, state, and local TAC regulations and incorporate the following guidelines into their work. These guidelines are part of a program taken from the Bay Area Air Quality Management District (BAAQMD) Responsible Laboratory Management Program. The guidelines implemented for UCI are based on federal and state law, SCAQMD regulations, and on the procedures set forth in the National Research Council publication *Prudent Practices in the Laboratory: Handling and Disposal of Chemicals* (National Academy Press, Washington, DC, 1995).

2. What Are TACs?

TACs are those chemicals "that may cause or contribute to an increase in mortality or in serious illness, or may pose a present or potential hazard to human health" when they are present in the atmosphere (California Health and Safety Code SS39655). The California Air Resources Board (ARB) designates which chemicals are TACs. In the BAAQMD Responsible Laboratory Management Program, it estimates that the following laboratory TACs pose the greatest health hazards:

- benzene
- 1,3-butadiene
- carbon tetrachloride
- chloroform
- 1,4-dioxane
- ethylene glycol butyl ether (butyl cellosolve)
- ethylene glycol monoethyl ether (cellosolve)
- ethylene glycol methyl ether
- (methyl cellosolve)
- formaldehyde methanol
- methyl chloroform (1,1,1-TCA)
- methylene chloride
- perchloroethylene
- toluene
- trichloroethylene
- xylenes

Typical laboratory operations or conditions leading to TAC vapor emissions include:

- chromatography
- distillation

- refluxing
- heating solvents
- handling or pouring of chemicals
- untrapped rotovaps
- uncovered beakers
- any operation involving open containers of TACs

Most laboratory operations that use TACs are performed in fume hoods to protect people in the laboratory from exposure to hazardous vapors. TAC emissions are first diluted in the fume hood, then the fume hood exhaust is emitted and disperses into the atmosphere.

3. What Are the Dangers of TACs?

TAC emissions degrade overall air quality by contributing to increased cancer risk and to ground-level ozone formation (ozone is a regulated air pollutant). Children and people with respiratory diseases are particularly sensitive to any exposure to TACs. In addition, occupants of buildings where TACs are in use may be at special risk for exposure through the recapture of the building or fume hood exhaust into the building's air supply. Maintenance personnel working on or near fume hood or building exhaust vents are also at increased risk from exposure to TAC emissions.

4. SCAQMD "Screening Emission Levels"

To ensure good ambient air quality for local air quality, the SCAQMD has set screening emission levels for TACs (see Attachment 1). If the emissions from a source are less than the listed screening emission levels, it is assumed that the source would not fail a toxic risk assessment. If the emissions are equal or greater than one or more of the screening emission levels, a toxic risk assessment should be completed to determine the source's exemption status.

Regulating TAC emissions in the South Coast Area air basin (this basin covers a four county region: Los Angeles and Orange, parts of Riverside and San Bernardino) is the responsibility of the SCAQMD. To minimize emissions of TACS, UCI is requesting that laboratory facilities either demonstrate that the health risk resulting from emissions of TACs is less than one additional cancer risk in one million or follow the guidelines outlined below. Because of the varied nature of research, estimating TAC emissions and demonstrating low risk is difficult while following the guidelines are fairly straightforward.

5. Minimizing Emissions of TACs

Follow these guidelines when using, storing, or disposing of TACs to prevent air pollution and to ensure compliance with federal, state, and local requirements as well as campus policy.

Use and Storage of TACs

- Scale down experiments.
- Substitute less volatile chemicals for TACs where possible.
- Avoid experimental procedures using open containers of TACs.
- Trap vapors from any process that evaporates a solution containing TACs.
- Avoid storing open containers of TACs. Cap solvent containers such as beakers and unwanted solvent collection bottles (no open funnels).

Technological controls such as filters and scrubbers are available to abate emissions of toxic air contaminants and should be considered when designing experiments. However, if the design calls for any such technological controls, then potentially a permit to construct application would need to be submitted to the SCAQMD. If in doubt, please contact EH&S.

Disposal of TACs

Evaporating unwanted solvents is prohibited. Collect all unwanted TACs for pick-up by EH&S. See EH&S's Hazardous Waste Disposal Site for more information: Hazardous Waste Management Program.

Training

All laboratory employees who handle hazardous materials must be trained on minimizing TAC emissions, and should be covered under the Chemical Hygiene Plan training. These guidelines are designed to meet training requirements and should be provided to all laboratory staff, including incoming students and visiting scholars.

Fume Hood Labeling

Fume hoods should be inspected annually by EH&S to ensure that exposures to TACs will be kept to a minimum, and labeled accordingly.

Chemical Inventory Requirements

All hazardous chemicals, including TACs, must be inventoried both annually and when quantities change significantly. Include your estimated annual usage of TACs in the inventory. See EH&S's fact sheet **"Chemical Inventory"** for more information. Labels and inventory instructions are available from your School's EH&S Coordinator or EH&S website.

Attachment 1

TAC Screening Emission Levels A-X

Compound	CAS Number	Screening Emission Level (lb/year) 25 meters
Acetaldehyde	75070	12.25
Acetamide	60355	1.65
Acrolein	107028	1.98 **0.0001 lbs/hr**
Acrylamide	79061	0.03
Acrylic Acid	79107	**3.00 lbs/hr**
Acrylonitrile	107131	0.11
Allyl chloride	107051	5.51
Aminoanthraquinone, 2-	117793	0.28
Ammonia	7664417	6,610 **1.60 lbs/hr**
Aniline	62533	20.66
Arsenic and arsenic compounds (inorganic)	7440382*	0.004 **0.0001 lbs/hr**
Arsine	7784421	**0.08 lbs/hr**
Asbestos	1332214	0.0005
Benzene	71432	1.14 **0.739 lbs/hr**
Benzidine (and its salts)	92875*	**0.0002 lbs/hr**
Benzyl chloride (see chlorotoluenes)	100447	0.67 **0.12 lbs/hr**
Beryllium and beryllium compounds	7440417*	0.002
Bis(2-chloroethyl)ether (DCEE)	111444	0.05
Bis(chloromethyl)ether	542881	0.003
Bis(2-ethylhexyl)phthalate (DEHP)	117817	14
Bromine and bromine compounds (inorganic)	7726956*	3.28E+02
Butadiene, 1,3-	106990	0.19

Cadmium and cadmium compounds	7440439*	0.008
Carbon disulfide	75150	26,500 **3.52 lbs/hr**
Carbon tetrachloride	56235	0.79 **1.08 lbs/hr**
Chlorinated dibenzodioxins and dibenzofurans (TCDD equivalent)	1746016*	1.28E-06
Chlorine	7782505	6.61 **0.11 lbs/hr**
Chlorine dioxide	10049044	19.8
Chlorobenzene	108907	11,800
Chloro-o-phenylenediamine, 4-	95830	7.19
Chloro-o-toluidine, p-	95692	0.43
Chloroform	67663	6.24 **0.09 lbs/hr**
Chlorophenols Pentachlorophenol Trichlorophenol, 2,4,6-	96000 87865 88062	- 1.62 0.46
Chloropicrin	76062	13.2 **0.015 lbs/hr**
Chromium, hexavalent	18540299	0.0002
Chromic Trioxide (as chromic acid mist)	1333820	0.07
Copper and copper compounds	7440508*	**0.05 lbs/hr**
Cresidine, p-	120718	0.77
Cresol	1319773	19,800
Cupferron	135206	0.52
Diaminoanisole, 2,4- (sulfate)	615054	5.01
Diaminotolune, 2,4-	95807	0.03
Dibromo-3-chloropropane,1,2- (DBCP)	96128	0.02
Dichlorobenzene, 1,4- (orp-dichlorobenzene)	106467	0.75
Dichlorobenzidene, 3,3'-	91941	0.097
Dichloroethane, 1,1-	75343	21
Dichloroethylene, 1,1- (see vinylidene chloride)	73354	2,310
Diethanolamine	11422	99.2
Dimethylaminoazobenzene, p-	60117	0.03
Dimethylformamide N,N-	68122	2,650

Dinitrotolune, 2,4-	121142	0.37
Dioxane, 1,4-	123911	4.29 **1.5 lbs/hr**
Diphenylhydrazine (or hydrazobenzene)	122667	0.15
Epichlorohydrin	106898	1.44 **0.65 lbs/hr**
Epoxybutane (1,2-)	106887	661
Ethyl benzene	100414	66,100
Ethyl chloride	75003	992,000
Ethylene dibromide (1,2-dibromoethane)	106934	0.47
Ethylene dichloride (1,2-dichloroethane)	107062	1.50
Ethylene glycol	107211	13,200
Ethylene glycol ethyl ether	110805	2,310 **0.21 lbs/hr**
Ethylene glycol monobutyl ether	11762	**7.00 lbs/hr**
Ethylene glycol monoethyl ether acetate	111159	9,920 **0.08 lbs/hr**
Ethylene glycol monomethyl ether	109864	1,980 **0.05 lbs/hr**
Ethylene glycol monomethyl ether acetate	110496	2,980
Ethylene oxide	75218	0.38
Ethylene Thiourea	96457	2.54
Formaldehyde	50000	5.51 **0.05 lbs/hr**
Glutaraldehyde	111308	2.65
Hexachlorobenzene	118741	0.007
Hexachlorocyclohexanes gamma- (lindane)0	58899*	0.03
Hexachlorocyclohexanes technical grade	608731	0.008
Hexane, n-	110543	231,000
Hydrazine	302012	0.007
Hydrogen chloride	7647010	298 **1.05 lbs/hr**
Hydrogen cyanide	74908	298 **0.17 lbs/hr**
Hydrogen fluoride	7664393	**0.12 lbs/hr**
Hydrogen selenide	7783075	**0.003 lbs/hr**
Hydrogen sulfide	7783064	331

		0.021 lbs/hr
Isophorone	78591	66,100
Isocyanates:	--	--
Isopropyl Alcohol	67630	231,000 **1.6 lbs/hr**
Lead and Lead compounds Lead acetate Lead chromate Lead phosphate Lead subacetate	7439921 301042 7758976 7446277 1335326	2.76 1.20E-05 -- 1.20E-05 1.20E-05
Maleic anhydride	108316	23.1
Manganese and manganese compounds	7439965*	6.61
Mercury and mercury compounds (inorganic)	7439976*	1.86 **0.0009 lbs/hr**
Methyl alcohol (methanol)	67561	132,000 **14.00 lbs/hr**
Methyl bromide	74839	165 **1.95 lbs/hr**
Methyl chloroform (1,1,1-TCA)	71556	33,100 **34.00 lbs/hr**
Methyl ethyl ketone	78933	**6.50 lbs/hr**
Methyl isocyanate	624839	33.1
Methylene bis (2-chloroaniline), 4,4-(MOCA)	101144	0.08
Methylene chloride	75092	33.06 **7.00 lbs/hr**
Methylene dianiline, 4,4;- (and its dichloride)	101779	0.072
Methylene phenyl diisocyanate	101688	23.1
Methyl t-butyl ether	1634044	265000
Michler’s ketone	90948	0.13
Naphthalene	91203	298
Nickel and nickel compounds	7440020*	0.13 **0.003 lbs/hr**
Nitric acid	7697372	**0.04 lbs/hr**
n-Nitroso-n-ethylurea	759739	0.001
n-Nitroso-n-methylurea	684935	0.0003
n-Nitroso-n-butylamine	924163	0.0001
Nitrosodiethylamine, N-	55185	0.001

Nitrosodimethylamine, N-	62759	0.002
Nitrosodiphnylamine, N-	86306	3.18
Nitrosodiphenylamine,p,	156105	1.54
Nitrosodi-n-propylamine, N-	621647	0.004
Nitrosomethylethylamine, N-	10595956	0.001
Nitrosomorpholine, N-	59892	0.017
Nitrosopiperidine, N-	100754	0.012
Nitrosopyrrolidine, N-	930552	0.01
Paraffins, chlorinated (avg. chain length, c12; Approx. 60% c1 by weight)	108171262	1.32
Perchloroethylene	127184	5.60 **10.00 lbs/hr**
Phenol	108952	6,610 **2.90 lbs/hr**
Phosgene	75445	**0.002 lbs/hr**
Phosphoric acid	7664382	231
Phosphine	7803512	26.5
Phthalic anhydride	85449	661
PAHs (including but not limited to):	*	
Benz[a]anthracene Benzo[b]fluoroanthene Benzo[k]fluoroanthene Benzo[j]fluoroanthene Benzo[a]pyrene Chrysene Dibenz[a,h]acridine Dibenz[a,j]acridine Dibenzo[a,h]anthracene Dibenzo[a,e]pyrene Dibenzo[a,h]pyrene Dibenzo[a,i]pyrene Dibenzo[a,l]pyrene Dibenzo[c,g]carbozole, 7h- Dimethylbenz[a]anthracene, 7,12- Dinitropyrene, 1,6- Dinitropyrene, 1,8- Indenopyrene Methylcholanthrene, 3- Methylchrysene, 5- Nitroacenaphthene, 5- Nitrochrysene, 6-	56553 205992 207089 205823 50328 218019 226368 224420 53703 192654 189640 189559 191300 194592 59976 42397648 42397659 193395 56495 3697243 602879 7496028	0.024 0.024 0.024 0.024 0.002 0.24 0.24 0.24 0.002 0.002 0.0002 0.0002 0.0002 0.002 3.70E-05 0.0002 0.002 0.035 4.13E-04 0.002 0.063 0.0002

Nitrofluorene, 2- Nitropyrene, 1- Nitropyrene, 4-	607578 5522430 57835924	0.24 0.024 0.024
PCBs (polychlorinated biphenyls)	1336363*	0.002
Potassium bromate	7758012	0.24
Propane sultone, 1,3-	1120714	0.05
Propylene	115071	99,200
Propylene glycol monomethyl ether	107982	231,000
Propylene oxide	75569	8.94 **1.55 lbs/hr**
Selenium and selenium compounds	7782492*	661
Sodium hydroxide	1310732	**0.004 lbs/hr**
Styrene monomer	100425	29,800 **10.50 lbs/hr**
Sulfuric acid and oleum	7664939	**0.06 lbs/hr** 33.1
Tetrachloroethane 1,1,2,2-	79345	0.57
Thioacetamide	62555	0.02
Toluene	108883	9,920 **18.50 lbs/hr**
Toluene diisocyanate: Toluene-2,4-diisocyanate Toluene-2,6-diisocyanate	 584849 91087	 2.31 2.31
Trichloroethane, 1,1,2-	79005	2.07
Trichloroethylene	79016	16.53
Triethylamine	121448	6,610 **1.40 lbs/hr**
Urethane (ethyl carbamate)	51796	0.11
Vanadium pentoxide	1314621	**0.015 lbs/hr**
Vinyl acetate	108054	6,610
Vinyl chloride	75014	0.42 **90.00 lbs/hr**
Xylenes (isomers and mixtures) Xylene, m, o, p-	1330207* 108383,95476,106423	23,100 **11.00 lbs/hr**

*This is a chemical compound group. If a CAS number is listed, it represents only a single chemical within the chemical class (for metallic compounds, the CAS number of the elemental form is listed; for other compounds, the CAS number of a predominant compound in the group is given).

n/a - No CAS number is available for this compound or compound group.
If the emissions from a source are less than the listed trigger-levels, it is assumed that the source would not fail a risk screen. If the emissions are equal or greater than one or more of the trigger-levels, a risk screen should be completed to determine the source's exemption status.