CITY OF PARK RIDGE, ILLINOIS

PRELIMINARY STUDY AND ANALYSIS OF TOXIC AIR POLLUTANT EMISSIONS FROM O'HARE INTERNATIONAL AIRPORT AND THE RESULTING HEALTH RISKS CREATED BY THESE TOXIC EMISSIONS IN SURROUNDING RESIDENTIAL COMMUNITIES

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VOLUME IV

PRELIMINARY RISK EVALUATION OF MOSTARDI-PLATT PARK RIDGE PROJECT DATA MONITORING ADJACENT TO O'HARE AIRPORT

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Preliminary Risk Evaluation of Mostardi-Platt Park Ridge Project Data Monitoring Adjacent to O'Hare Airport

Prepared for:

City of Park Ridge, Illinois
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City of Des Plaines, Illinois
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I. INTRODUCTION AND SUMMARY

ENVIRON has reviewed the Park Ridge Project Data collected by Mostardi-Platt Associates (2000), and has conducted a preliminary evaluation of potential risks associated with inhalation exposures to toxic compounds measured in air near the O'Hare Airport. Based on the data collected by Mostardi-Platt (2000) and standard United States Environmental Protection Agency (USEPA) protocols for assessing exposure and risk (USEPA 1989, 1991, 1997a), ENVIRON's preliminary conclusions are as follows:

- Hypothetical lifetime incremental cancer risks associated with concentrations measured at the Airport fenceline are approximately five-fold higher than the cancer risks associated with "background" air quality in Naperville, Illinois. The lifetime incremental cancer risks for residential scenarios based on fenceline concentrations near Runways 27L and 27R range up to about 1 in 10,000 ($1x10^{-4}$), which is equivalent to about 100 in 1,000, 000 ($100x10^{-6}$).

- The potential for noncancer health effects posed by concentrations measured at one of the locations along the Airport fenceline is higher than for "background" air quality in Naperville, Illinois. The noncancer Hazard Index (HI) values calculated for residential scenarios based on concentrations measured at the fenceline range up to approximately 23. According to USEPA (1989), when an HI value is calculated to be greater than 1 "there may be concern for potential heath effects." By comparison, the noncancer HI calculated for "background" air quality in Naperville, Illinois is about 1.

- The chemicals that contribute most significantly to risks at the Airport fenceline are commonly detected in aircraft emissions (i.e., aldehydes, benzene, naphthalene), based on data reported by USEPA (1993).

- Calculated cancer and noncancer risks immediately west of the Airport in Bensenville are lower than the risks to the east of the airport, but somewhat higher than the risks associated with "background" air quality in Naperville, Illinois.

The results of the preliminary risk calculations are summarized in Table 1. In evaluating these results, the following should be considered:

- The risk calculations are based on the Mostardi-Platt (2000) data, which were collected over a relatively limited period of time, and thus may not reflect long-term average concentrations. Data collected over a longer duration would be more directly applicable to an assessment of chronic exposures, and could indicate higher or lower risks than those indicated above.

- Consistent with USEPA guidance, the exposure scenarios evaluated are conservative (i.e., more likely to lead to an overestimate than an underestimate of risk). For example, concentrations in residential areas may be lower than the fenceline concentrations evaluated in this assessment. Furthermore, consistent with USEPA recommendations for conducting screening-level exposure assessments for air contaminants, an exposure duration of 70 years was assumed.

- USEPA toxicity criteria are not available for more than half of the chemicals reported by Mostardi-Platt (2000); this could lead to an underestimate of risk.

- Mostardi-Platt (2000) did not report certain common constituents of aircraft emissions (e.g., 1,3-butadiene) which have been the focus of previous USEPA investigations due to their relative toxicity. According to Mostardi-Platt, the estimated detection limit for 1,3-butadiene in its analysis was approximately 1 microgram per cubic meter, which corresponds to a theoretical cancer risk of greater than 1 in 10,000 for a lifetime exposure. Thus, undetected levels of 1,3-butadiene may contribute significantly to risk but could not be accounted for in this evaluation, possibly leading to an underestimate of total risk.

- The risk calculations do not include potential pathways of exposure other than inhalation. Such pathways of exposure could be important for chemicals that adhere to particulate matter (e.g., metals and polycyclic aromatic hydrocarbons).

- The Mostardi-Platt (2000) data indicate that a "jet airport smell" is present at the end of Runway 27L. Air data can be compared to odor threshold levels published by the American Industrial Hygiene Association and in the scientific literature. Such a comparison was not part of the scope of work for this evaluation.

- On-site exposures of Airport workers were not included as part of the scope of work for this evaluation, and could not be conservatively assessed using the Park Ridge Project data.

Details regarding the risk evaluation are provided in the remainder of this report.

II. EXPOSURE SCENARIOS

Seven separate sets of air concentrations, representing different sampling locations or sampling events, were reported in the Park Ridge Project Data provided to ENVIRON (Mostardi-Platt 2000):

1. The average air concentrations from three samples collected over twenty-four hours in Naperville (40 miles southwest of the airport). These results are considered to represent background air concentrations for the purposes of this risk assessment;
2. The average air concentrations from five samples collected over eight hours in a field west of the airport, in Bensenville;
3. The average air concentrations from a sample collected over eight hours at the fenceline east of the airport at the end of Runway 27R;
4. The average air concentrations from a sample collected over eight hours at the fenceline east of the airport at the end of Runway 27L;
5. The average air concentrations from four grab samples collected over about 10 seconds at the fenceline east of the airport at the end of Runway 27L, when planes were lined up on the tarmac;
6. The air concentrations from one of the grab samples collected at the end of Runway 27L when no odor of "jet airport smell" was detected; and
7. The air concentrations from one of the grab samples collected at the end of Runway 27L when an odor of "jet airport smell" was detected.

Each of the first four data sets was evaluated independently using a residential scenario in the risk calculations. (The grab sample results were not included in the risk calculations given the very short sample collection period). In the adult resident scenario, exposure was assumed to occur for 350 days per year, for a period of 70 years. In the child (age 1 to 7) resident scenario, exposure was assumed to occur for 350 days per year for a period of 6 years.

III. EXPOSURE ASSESSMENT

Exposure parameters used in assessing potential risks to off-site residents are presented in Table 2. Potential inhalation risks are estimated by combining the inhalation toxicity values (in units of concentration) with the air concentration over the period of exposure. Exposure concentrations are calculated as shown below:

$$C_e = \frac{C_a \, x \, EF \, x \, ED}{AT}$$

where:

C_e	=	Exposure concentration; time-weighted concentration of chemical in air, $\mu g/m^3$
C_a	=	Concentration of chemical in air, $\mu g/m^3$
EF	=	Exposure frequency, days/year
ED	=	Exposure duration, years
AT	=	Averaging time, days.

The exposure parameters used to estimate the exposure concentrations for the adult and child residents are described below:

- Exposure Frequency (EF). An exposure frequency (EF) of 350 days per year was used for both the adult and child resident, based on USEPA (1991) guidance.

- Exposure Duration (ED). An exposure duration (ED) of 70 years was used for the adult, as recommended by USEPA (2000) for conducting screening-level assessments for air contaminants. This exposure duration is also consistent with USEPA (1999a) guidance for conducting screening-level evaluations of hazardous air pollutants. An exposure duration of 6 years was used for the child, based on the total number of years in the 1 to 7 year old age range for the child.

- Averaging Time (AT). For carcinogens, the averaging time (AT) is the number of days in a lifetime. A lifetime of 70 years was used for the adult and child residents, based on USEPA (1989) guidance. For noncarcinogens, the averaging time is the same as the exposure duration in units of days (USEPA 1989).

The equation for exposure concentration, as presented above, does not include body weight and inhalation rate, because the inhalation toxicity factors are already adjusted for these parameters. However, body weight and inhalation rate are defined for the residents in order to adjust the inhalation cancer unit risk factor values, which are applied in this analysis to calculate carcinogenic risk.

An inhalation rate of 20 m^3/day was assumed for both the adult and child resident, based on the inhalation rate presented in USEPA 1991. This is a conservative inhalation rate for a child, given that USEPA (1997a) recommends an inhalation rate of 8.3 m^3/day for children between the ages of 3 to 5 years and 10 m^3/day for children between the ages of 6 to 8 years.

A body weight of 70 kg was assumed for the adult resident, based on the mean adult body weight presented in USEPA (1991). A body weight of 15 kg was used for the child, based on the mean body weight for 6 year old children presented in USEPA (1991).

IV. TOXICITY EVALUATION

Toxicity values have been developed by USEPA for the evaluation of hazards posed by different types of chemical exposures. In this risk assessment, inhalation is the primary route of potential exposure for the off-site community. Relevant toxicity criteria for the chemicals of potential concern in this assessment are presented in Tables 3a (carcinogenic effects) and 3b (noncarcinogenic effects), and discussed below.

It should be noted that USEPA toxicity criteria are unavailable for many chemicals reported by Mostardi-Platt (2000). Of the over 70 compounds reported by Mostardi-Platt (2000), toxicity values were identified for only about half. Chemicals without adequate toxicity criteria could not be included in the quantitative risk assessment; this may result in an underestimate of the risks.

Toxicity Values for Evaluating Potential Cancer Risk

There are two steps involved in assessing carcinogenic potential; first, the evaluation of the likelihood that the substance is a human carcinogen (i.e., a weight-of-evidence assessment), and second, definition of the quantitative relationship between dose and carcinogenic response.

The USEPA classifies a chemical into one of five groups, based on the weight of evidence of carcinogenicity from human and animal investigations. These groups are as follows (USEPA 1989, 1997b):

- Group A: Human Carcinogen (sufficient evidence of carcinogenicity in humans)
- Group B: Probable Human Carcinogen (B1 - limited evidence of carcinogenicity in humans; B2 - sufficient evidence of carcinogenicity in animals with inadequate or lack of evidence in humans)
- Group C: Possible Human Carcinogen (limited evidence of carcinogenicity in animals and inadequate or lack of human data)
- Group D: Not Classifiable as to Human Carcinogenicity (inadequate or no evidence)
- Group E: Evidence of Noncarcinogenicity for Humans (no evidence of carcinogenicity in adequate studies).

The outcome of the second part of the evaluation for assessing carcinogenic risk is the derivation of a unit risk factor (URF) for each chemical in Groups A, B1 and B2. (USEPA estimates URFs for chemicals in Group C on a case-by-case basis.) The inhalation URF is an estimate of the upper-bound probability of an individual developing cancer from a lifetime of exposure to a unit concentration of a given chemical in air (USEPA 1989). The URF values used in this assessment are presented in Table 4. Where available, inhalation URFs for the chemicals at the site were obtained directly from the USEPA Integrated Risk Information System (IRIS) database and USEPA's Health Effects Assessment Summary Tables (HEAST). For some chemicals of potential concern, toxicity values published by USEPA's National Center for Environmental Assessment (NCEA) or USEPA Region III were used, due to a lack of toxicity values in IRIS and HEAST. For benzene, USEPA provides a range of URF values; given the preliminary nature of this evaluation, the high end of the range was used.

For those chemicals where an inhalation URF has not been published, but an inhalation slope factor (SF) is available from IRIS, HEAST, NCEA or USEPA Region III, the inhalation SF was converted to a URF using the following standard conversion methodology published in HEAST (USEPA 1997b):

$$URF\ (\mu g/m^3)^{-1} = \frac{SF\ (mg/kg\text{-}day)^{-1} \times 20\ m^3/day \times 10^{-3}\ (mg/\mu g)}{70\ kg}$$

This conversion was used for 1,4-dichlorobenzene.

Toxicity Values for Evaluating the Potential for Non-Cancer Health Effects

The inhalation reference concentration (RfC) is an estimate of the chemical concentration in air to which an individual in the general population may be exposed over a substantial portion of a lifetime without experiencing adverse noncarcinogenic effects. The RfC values used in this assessment are presented in Table 4. Chronic inhalation RfC values were taken directly from IRIS and HEAST where available. For some chemicals of potential concern, toxicity values published by USEPA's NCEA or USEPA Region III were used, due to a lack of toxicity values in IRIS and HEAST.

For those chemicals where a chronic RfC has not been published, but a chronic inhalation reference dose (RfD) is available from IRIS, HEAST, NCEA or USEPA Region III, the RfD was converted to an RfC using the following standard conversion methodology published in HEAST (USEPA 1997b):

$$RfC\ (mg/m^3) = RfD\ (mg/kg\text{-}day) \times \frac{70\ kg}{20\ m^3/day}$$

This conversion was used for chloromethane, 2-hexanone, and 1,2,4-trimethylbenzene. Route-specific toxicity values were used when available. As a conservative measure, oral RfD values were used for the inhalation pathway for those constituents that do not have inhalation RfCs or RfDs. The oral RfDs were converted to inhalation RfCs using the standard conversion methodology published in HEAST, as shown above (USEPA 1997b). Oral RfDs were used as surrogate RfC values for the following chemicals: acetone, acetophenone, benzaldehyde, 1-butanol, 2-methyl-1-propanol, 2-methylpropanal, alph-methylstyrene, tetrachloroethene, trichloroethene, o-xylene and m- & p-xylenes.

V. RISK CHARACTERIZATION

The theoretical risk of an individual developing cancer as a result of exposure to each potentially carcinogenic chemical reported by Mostardi-Platt (2000) was calculated as follows:

$$Risk = C_e \times URF$$

where:

Risk	=	the incremental risk of developing cancer over the course of a lifetime, (unitless);
C_e	=	exposure concentration in air (averaged over a 70-year lifetime), ($\mu g/m^3$); and
URF	=	unit cancer risk factor, $(\mu g/m^3)^{-1}$.

When estimating carcinogenic risk, care must be taken to ensure that the exposure parameters used to estimate the exposure concentration (C_e) are consistent with those used to develop the URF. The following exposure parameters have been traditionally used to develop URF values:

- inhalation rate = 20 m^3/day;
- body weight = 70 kg; and
- lifetime = 70 years.

When the exposure parameters used to develop the URF differ from the site-specific exposure factors used to develop the exposure concentration, the URF is adjusted as follows (USEPA 1997a):

$$adjusted\ URF_{inhalation}\ (\mu g/m^3)^{-1} = URF_{inhalation} \times (inhalation\ rate/20\ m^3/day) \times (70\ kg/body\ weight)^{2/3}$$

For this assessment, the adult resident was assumed to have standard exposure factors for inhalation rate (20 m^3/day) and body weight (70 kg), while the child resident was assumed to have a standard inhalation rate (20 m^3/day) and a body weight of 15 kg. Therefore, the URF values were adjusted using the equation above for the child resident (see Table 4).

The potential for noncancer health effects was evaluated by calculating separate Hazard Quotient (HQ) values for each chemical, as follows:

$$HQ = \frac{C_e}{RfC}$$

where:

HQ = Hazard Quotient, (unitless);

C_e = exposure concentration in air (averaged over the period of exposure), ($\mu g/m^3$); and

RfC = reference concentration, ($\mu g/m^3$).

Hazard Index (HI) values were calculated by summing HQ values, across all chemicals of potential concern.

VI. RESULTS

The results of the risk calculations are summarized in Table 1.

Potential Cancer Risks

As shown in Table 1, carcinogenic risks of 2×10^{-5} and 6×10^{-6} were calculated for an adult and child resident, respectively using the background air data from Naperville, Illinois. The carcinogenic risk calculated using the air data from the field west of the airport (Bensenville) was somewhat higher than the background risk. The carcinogenic risks calculated using the air data collected east of the airport at the end of Runway 27R were three to four fold higher than background, with carcinogenic risks of 8×10^{-5} and 2×10^{-5} calculated for an adult and child resident, respectively. Carcinogenic risks of 1×10^{-4} and 3×10^{-5} were calculated for an adult and child resident, respectively, using the air data collected over 8 hours from the end of Runway 27L, also to the east of the airport.

Potential Noncancer Health Effects

An HI of 1 was calculated for both the adult and child resident using the background air data from Naperville, Illinois. The HI values calculated using the air data from the field west of the airport (Bensenville) were approximately the same as the background HI. An HI of approximately 1.0 was calculated using the air data to the east of the airport from the end of Runway 27R. An HI of 23 was calculated using the air data from the sample collected over 8 hours at the end of Runway 27L, to the east of the airport. This HI is driven primarily by the presence of naphthalene. The naphthalene concentration in the sample collected over 8 hours at the end of Runway 27L is about 60-fold higher than the naphthalene concentration in the grab samples collected at the end of Runway 27L, and also about 60-fold higher than the naphthalene concentration in the sample collected over 8 hours at the end of Runway 27R.

VII. REFERENCES

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TABLES

TABLE 1 Risk Summary				
	Naperville [40 miles southwest of airport] Background Average	**Bensenville [in field west of airport] UPW Average**	**Runway 27R [fenceline east of airport] DWN Average**	**Runway 27L [fenceline east of airport] DWS Average**
Carcinogenic Risk Summary				
Adult Resident	**2.E-05**	**5.E-05**	**8.E-05**	**1.E-04**
Risk Drivers	Benzene Carbon Tetrachloride 1,4-Dichlorobenzene Formaldehyde	Benzene Carbon Tetrachloride 1,4-Dichlorobenzene Crotonaldehyde Formaldehyde	Benzene Carbon Tetrachloride 1,4-Dichlorobenzene Crotonaldehyde Formaldehyde	Benzene Carbon Tetrachloride 1,4-Dichlorobenzene Crotonaldehyde Formaldehyde
Child Resident	**6.E-06**	**1.E-05**	**2.E-05**	**3.E-05**
Risk Drivers	Benzene 1,4-Dichlorobenzene Formaldehyde	Benzene Carbon Tetrachloride Crotonaldehyde Formaldehyde	Benzene Carbon Tetrachloride Crotonaldehyde Formaldehyde	Benzene 1,4-Dichlorobenzene Crotonaldehyde Formaldehyde
Noncarcinogenic Risk Summary				
Adult Resident	**1**	**1**	**1**	**23**
Risk Drivers				Benzene Naphthalene
Child Resident	**1**	**1**	**1**	**23**
Risk Drivers				Benzene Naphthalene

TABLE 2 Exposure Parameters			
Parameter	**Units**	**Adult Resident**	**Child Resident (age 1 to 7)**
Exposure Frequency	days/year	350	350
Exposure Duration	years	70	6
Averaging Time, Carcinogenic	days	25550	25550
Averaging Time, Noncarcinogenic	days	25550	2190
Inhalation Rate	m^3/day	*20*	*20*
Body Weight	*kg*	*70*	*15*

TABLE 3a
Toxicity Values - Cancer

Chemical Name	CASRN	Chemical representing coeluted compound in quantitative risk assessment	Wt	Ref	Inhalation URF $(ug/m3)^{-1}$	Ref	Note	Inhalation SF $(mg/kg/d)^{-1}$	Ref
Acetone+IsoPentane	67-64-1 + 109-66-0	Acetone	D	1					
Acetonitrile	75-05-8		D	1					
Acetophenone+$C_{11}H_{24}$ Alkane	98-86-2 + Indeterminate	Acetophenone	D	1					
Benzaldehyde+2-Ethylhexanal	100-52-7 + 104-76-7	2-Ethylhexanal							
Benzene	71-43-2		A	1	7.80E-06	1	60		
Butanol, 1-	71-36-3		D	1					
Butanone, 2-	78-93-3		D	1					
Butoxyethanol, 2- +Hexylene glycol	111-76-2 + 107-41-5	2-n-butoxyethanol	C	1					
Carbon disulfide	75-15-0								
Carbon tetrachloride	56-23-5		B2	1	1.50E-05	1		5.30E-02	2
Chloromethane	74-87-3		C	2	1.80E-06	2		6.30E-03	2
Dichlorobenzene, 1,4-	106-46-7		C	2	6.29E-06		based on inhalation SF	2.20E-02	3
Dichlorodifluoromethane	75-71-8								
Ethylbenzene	100-41-4		D	1					
Hexane, n-	110-54-3								
Hexanone, 2-	591-78-6								
Isobutane+Acetaldehyde	106-97-8 + 75-07-0	Isobutane							

TABLE 3a Toxicity Values - Cancer									
Chemical Name	**CASRN**	**Chemical representing coeluted compound in quantitative risk assessment**	**Wt**	**Ref**	**Inhalation URF $(ug/m3)^{-1}$**	**Ref**	**Note**	**Inhalation SF $(mg/kg/d)^{-1}$**	**Ref**
Methyl-1-propanol, 2-	78-83-1								
Methyl-2-pentanone, 4-	108-10-1								
Methylene chloride	75-09-2		B2	1	4.70E-07	1			
Methylstyrene, alph-	98-83-9								
Naphthalene	91-20-3		C	1					
Tetrachloroethene	127-18-4		C-B2	51	5.80E-07	51		2.00E-03	51
Toluene	108-88-3		D	1					
Trichloroethene	79-01-6		C-B2	49	1.70E-06	49		6.00E-03	49
Trichlorofluoromethane	75-69-4								
Trimethylbenzene, 1,2,4-	95-63-6								
Xylene, o-	95-47-6		D	1					
Xylenes, m- & p-	1330-20-7		D	1					
Butanal	123-72-8								
Butane, n-	106-97-8								
Butene or Iso-Butane	106-98-9 (1-Butene), 107-01-7 (2-Butene) or 106-97-8 (Butane)								
$C_{10}H_{14}$ Aromatic	Indeterminate								
$C_{11}H_{24}$ Alkane	Indeterminate								

TABLE 3a Toxicity Values - Cancer									
Chemical Name	CASRN	Chemical representing coeluted compound in quantitative risk assessment	Wt	Ref	Inhalation URF $(ug/m3)^{-1}$	Ref	Note	Inhalation SF $(mg/kg/d)^{-1}$	Ref
C_5H_{10} Alkene	Indeterminate								
$C_8H_{14}O$ Aldehyde	Indeterminate								
$C_9H_{16}O$ Aldehyde	Indeterminate								
Decane, n-	124-18-5								
Dimethyl disulfide	624-92-0								
Dimethyl-3-pentanone, 2,4-	565-80-0								
Dimethylbutane, 2,3-	79-29-8								
Dodecane, n-	112-40-3								
Ethanol	64-17-5								
Ethyl-1-hexenol, 2-	104-76-7								
Heptanal	111-71-7								
Heptane, n-	142-82-5		D	1					
Hexamethylcyclotrialloxane	Indeterminate								
Hexanal	66-25-1								
Isooctane	540-84-1								
Isopropanol	67-63-0								
Methacrolain	78-85-3								
Methylcyclopentane	96-37-7								
Methylpentane, 2-	107-83-5								
Methylpentane, 3-	96-14-0								
Methylpropanal, 2-	78-84-2								
Nonanal	124-19-6								
Nonane, p-	111-84-2								
Octamethylcyclotetrasiloxane	556-67-2								
Octanol	111-87-5								
Pentane, n-	109-66-0								

TABLE 3a Toxicity Values - Cancer									
Chemical Name	**CASRN**	**Chemical representing coeluted compound in quantitative risk assessment**	**Wt**	**Ref**	**Inhalation URF $(ug/m3)^{-1}$**	**Ref**	**Note**	**Inhalation SF $(mg/kg/d)^{-1}$**	**Ref**
Pentanol+3-Methylhexane	71-41-0 (1-Pentanol), 6032-29-7 (2-Pentanol) or 584-02-1 (3-Pentanol) + 589-34-4 (3-Methylhexane)								
Propene+Propane	115-07-1 + 74-98-6								
Tetradecane, n-	629-59-4								
Trichlorofluoroethane	75-79-4								
Tridecane, n-	629-50-5								
Trimethylallanol	Indeterminate								
Undecane, n-	1120-21-4								
Acetaldehyde	75-07-0				2.20E-06	1			
Benzaldehyde	100-52-7								
Crotonaldehyde	123-73-9				5.40E-04	2	Based on Oral SF		
Formaldehyde	50-00-0				1.30E-05	1			
Unidentified Siloxane	Indeterminate								

TABLE 3b
Toxicity Values - Noncancer

Chemical Name	CASRN	Chemical representing coeluted compound in quantitative risk assessment	Inhalation RFC (mg/m3)	Ref	Note	Inhalation RFD (mg/kg/d)	Ref	Note	Oral RFD (mg/kg/d)	Ref	Note
Acetone+IsoPentane	67-64-1 + 109-66-0	Acetone	3.50E-01		based on oral RfD				1.00E-01	1	
Acetonitrile	75-05-8		6.00E-02	1							
Acetophenone+C11H24 Alkane	98-86-2 + Indeterminate	Acetophenone	3.50E-01		based on oral RfD				1.00E-01	1	
Benzaldehyde+2-Ethylhexanal	100-52-7 + 104-76-7	2-Ethylhexanal									
Benzene	71-43-2		6.00E-03	32	50,69	1.70E-03	3	50,69	3.00E-03	3	50,69
Butanol, 1-	71-36-3		3.50E-01		based on oral RfD				1.00E-01	1	
Butanone, 2-	78-93-3		1.00E+00	1					6.00E-01	1	
Butoxyethanol, 2- +Hexylene glycol	111-76-2 + 107-41-5	2-n-butoxyethanol	1.30E+01	1					5.00E-01	1	
Carbon disulfide	75-15-0		7.00E-01	1					1.00E-01	1	
Carbon tetrachloride	56-23-5		2.00E-03	33		5.71E-04	3		7.00E-04	1	
Chloromethane	74-87-3		3.01E-01		based on inhalation RfD	8.60E-02	3		4.00E-03	34	
Dichlorobenzene, 1,4-	106-46-7		8.00E-01	1					3.00E-02	3	
Dichlorodifluoromethane	75-71-8		2.00E-01	2					2.00E-01	1	
Ethylbenzene	100-41-4		1.00E+00	1					1.00E-01	1	
Hexane, n-	110-54-3		2.00E-01	1					6.00E-02	2	
Hexanone, 2-	591-78-6		4.90E-03		based on inhalation RfD	1.40E-03	3		4.00E-02	40	
Isobutane+Acetaldehyde	106-97-8 + 75-07-0	Isobutane									

TABLE 3b
Toxicity Values - Noncancer

Chemical Name	CASRN	Chemical representing coeluted compound in quantitative risk assessment	Inhalation RFC (mg/m3)	Ref	Note	Inhalation RFD (mg/kg/d)	Ref	Note	Oral RFD (mg/kg/d)	Ref	Note
C5H10 Alkene	Indeterminate										
C8H14O Aldehyde	Indeterminate										
C9H16O Aldehyde	Indeterminate										
Decane, n-	124-18-5										
Dimethyl disulfide	624-92-0										
Dimethyl-3-pentanone, 2,4-	565-80-0										
Dimethylbutane, 2,3-	79-29-8										
Dodecane, n-	112-40-3										
Ethanol	64-17-5										
Ethyl-1-hexenol, 2-	104-76-7										
Heptanal	111-71-7										
Heptane, n-	142-82-5										
Hexamethylcyclotrialloxane	Indeterminate										
Hexanal	66-25-1										
Isooctane	540-84-1										
Isopropanol	67-63-0										
Methacrolain	78-85-3										
Methylcyclopentane	96-37-7										
Methylpentane, 2-	107-83-5										
Methylpentane, 3-	96-14-0										
Methylpropanal, 2-	78-84-2										
Nonanal	124-19-6										
Nonane, p-	111-84-2										
Octamethylcyclotetrasiloxane	556-67-2										
Octanol	111-87-5										
Pentane, n-	109-66-0										

TABLE 3b
Toxicity Values - Noncancer

Chemical Name	CASRN	Chemical representing coeluted compound in quantitative risk assessment	Inhalation RFC (mg/m3)	Ref	Note	Inhalation RFD (mg/kg/d)	Ref	Note	Oral RFD (mg/kg/d)	Ref	Note
C5H10 Alkene	Indeterminate										
C8H14O Aldehyde	Indeterminate										
C9H16O Aldehyde	Indeterminate										
Decane, n-	124-18-5										
Dimethyl disulfide	624-92-0										
Dimethyl-3-pentanone, 2,4-	565-80-0										
Dimethylbutane, 2,3-	79-29-8										
Dodecane, n-	112-40-3										
Ethanol	64-17-5										
Ethyl-1-hexenol, 2-	104-76-7										
Heptanal	111-71-7										
Heptane, n-	142-82-5										
Hexamethylcyclotrialloxane	Indeterminate										
Hexanal	66-25-1										
Isooctane	540-84-1										
Isopropanol	67-63-0										
Methacrolain	78-85-3										
Methylcyclopentane	96-37-7										
Methylpentane, 2-	107-83-5										
Methylpentane, 3-	96-14-0										
Methylpropanal, 2-	78-84-2										
Nonanal	124-19-6										
Nonane, p-	111-84-2										
Octamethylcyclotetrasiloxane	556-67-2										
Octanol	111-87-5										
Pentane, n-	109-66-0										

TABLE 3b
Toxicity Values - Noncancer

Chemical Name	CASRN	Chemical representing coeluted compound in quantitative risk assessment	Inhalation RFC (mg/m3)	Ref	Note	Inhalation RFD (mg/kg/d)	Ref	Note	Oral RFD (mg/kg/d)	Ref	Note
Pentanol+3-Methylhexane	71-41-0 (1-Pentanol), 6032-29-7 (2-Pentanol) or 584-02-1 (3-Pentanol) + 589-34-4 (3-Methylhexane)										
Propene+Propane	115-07-1 + 74-98-6										
Tetradecane, n-	629-59-4										
Trichlorofluoroethane	75-79-4										
Tridecane, n-	629-50-5										
Trimethylallanol	Indeterminate										
Undecane, n-	1120-21-4										
Acetaldehyde	75-07-0		9.00E-03	1							
Benzaldehyde	100-52-7		3.50E-01	1	Based on Oral RfD				1.00E-01	1	
Crotonaldehyde	123-73-9										
Formaldehyde	50-00-0		7.00E-01	1	Based on Oral RfD				2.00E-01	1	
Unidentified Siloxane	Indeterminate										

TABLES 3a and 3b
References and Notes for Toxicity Values

Ref	Source
1	USEPA. 2000. Integrated Risk Information System (IRIS). On-line database.
2	USEPA. 1997. Health Effects Assessment Summary Tables (HEAST). FY-1997 Update. EPA 540/R-97-036. July.
3	USEPA. Region III. 1999. Risk-Based Concentration Table. October.
32	USEPA. NCEA. 1994. Risk Assessment Issue paper for: Derivation of a Provisional Chronic Inhalation RfC for Benzene [CASRN 71-43-2]. March 23.
33	USEPA. NCEA. 1994. Risk Assessment Issue paper for: Derivation of a Provisional Inhalation RfC for Carbon Tetrachloride [CASRN 56-23-5]. April 11.
34	USEPA. NCEA. 1994. Risk Assessment Issue paper for: Derivation of a Provisional RfD for Chloromethane [CASRN 74-87-3]. March 21.
40	USEPA. NCEA. 1993. Risk Assessment Issue paper for: Derivation of a Provisional RfD for 2-Hexanone (Methyl-n-butyl ketone) [CASRN 591-78-6]. June 24.
46	USEPA. NCEA. 1995. Risk Assessment Issue paper for: Provisional oral RfD for Trichloroethylene [CASRN 79-01-6].
49	USEPA. NCEA. 1995. Risk Assessment Issue paper for: Carcinogenicity Information for Trichloroethylene (TCE) [CASRN 79-01-6]. September 6.
51	USEPA. NCEA. 1995. Risk Assessment Issue paper for: Carcinogenicity Information for Tetrachloroethylene (perchloroethylene, PERC) [CASRN 127-18-4]. September 11.

Note	Comment
50	Personal communication with NCEA; indicated the supporting paper had been withdrawn.
60	IRIS provides a range of 2.2E-6 to 7.8E-6 (ug/m3)-1as the Inhalation Unit Risk Factor (URFI) for Benzene.
69	Personal communication with NCEA; indicated the withdrawn paper should be used until a new value is published in IRIS.

TABLE 4
Toxicity Values Used in Risk Assessment

Chemical Name	CASRN	Chemical representing coeluted compound in quantitative risk assessment	Inhalation URF $(ug/m^3)^{-1}$	Inhalation URF Adjusted for Child's Exposure $(ug/m^3)^{-1}$	Inhalation RfC (ug/m^3)
Acetone+IsoPentane	67-64-1 + 109-66-0	Acetone			3.50E+02
Acetonitrile	75-05-8				6.00E+01
Acetophenone+C11H24 Alkane	98-86-2 + Indeterminate	Acetophenone			3.50E+02
Benzaldehyde+2-Ethylhexanal	100-52-7 + 104-76-7	2-Ethylhexanal			
Benzene	71-43-2		7.80E-06	2.18E-05	6.00E+00
Butanol, 1-	71-36-3				3.50E+02
Butanone, 2-	78-93-3				1.00E+03
Butoxyethanol, 2- +Hexylene glycol	111-76-2 + 107-41-5	2-n-butoxyethanol			1.30E+04
Carbon disulfide	75-15-0				7.00E+02
Carbon tetrachloride	56-23-5		1.50E-05	4.19E-05	2.00E+00
Chloromethane	74-87-3		1.80E-06	5.03E-06	3.01E+02
Dichlorobenzene, 1,4-	106-46-7		6.29E-06	1.76E-05	8.00E+02
Dichlorodifluoromethane	75-71-8				2.00E+02
Ethylbenzene	100-41-4				1.00E+03
Hexane, n-	110-54-3				2.00E+02
Hexanone, 2-	591-78-6				4.90E+00
Isobutane+Acetaldehyde	106-97-8 + 75-07-0	Isobutane			
Methyl-1-propanol, 2-	78-83-1				1.05E+03
Methyl-2-pentanone, 4-	108-10-1				8.00E+01
Methylene chloride	75-09-2		4.70E-07	1.31E-06	3.00E+03
Methylstyrene, alph-	98-83-9				2.45E+02
Naphthalene	91-20-3				3.00E+00
Tetrachloroethene	127-18-4		5.80E-07	1.62E-06	3.50E+01
Toluene	108-88-3				4.00E+02
Trichloroethene	79-01-6		1.70E-06	4.75E-06	2.10E+01
Trichlorofluoromethane	75-69-4				7.00E+02
Trimethylbenzene, 1,2,4-	95-63-6				5.95E+00

TABLE 4
Toxicity Values Used in Risk Assessment

Chemical Name	CASRN	Chemical representing coeluted compound in quantitative risk assessment	Inhalation URF $(ug/m^3)^{-1}$	Inhalation URF Adjusted for Child's Exposure $(ug/m^3)^{-1}$	Inhalation RfC (ug/m^3)
Xylene, o-	95-47-6				7.00E+03
Xylenes, m- & p-	1330-20-7				7.00E+03
Butanal	123-72-8				
Butane, n-	106-97-8				
Butene or Iso-Butane	106-98-9 (1-Butene), 107-01-7 (2-Butene) or 106-97-8 (Butane)				
C10H14 Aromatic	Indeterminate				
C11H24 Alkane	Indeterminate				
C5H10 Alkene	Indeterminate				
C8H14O Aldehyde	Indeterminate				
C9H16O Aldehyde	Indeterminate				
Decane, n-	124-18-5				
Dimethyl disulfide	624-92-0				
Dimethyl-3-pentanone, 2,4-	565-80-0				
Dimethylbutane, 2,3-	79-29-8				
Dodecane, n-	112-40-3				
Ethanol	64-17-5				
Ethyl-1-hexenol, 2-	104-76-7				
Heptanal	111-71-7				
Heptane, n-	142-82-5				
Hexamethylcyclotrialloxane	Indeterminate				
Hexanal	66-25-1				
Isooctane	540-84-1				
Isopropanol	67-63-0				
Methacrolain	78-85-3				
Methylcyclopentane	96-37-7				
Methylpentane, 2-	107-83-5				
Methylpentane, 3-	96-14-0				

TABLE 4
Toxicity Values Used in Risk Assessment

Chemical Name	CASRN	Chemical representing coeluted compound in quantitative risk assessment	Inhalation URF $(ug/m^3)^{-1}$	Inhalation URF Adjusted for Child's Exposure $(ug/m^3)^{-1}$	Inhalation RfC (ug/m^3)
Methylpropanal, 2-	78-84-2				
Nonanal	124-19-6				
Nonane, p-	111-84-2				
Octamethylcyclotetrasiloxane	556-67-2				
Octanol	111-87-5				
Pentane, n-	109-66-0				
Pentanol+3-Methylhexane	71-41-0 (1-Pentanol), 6032-29-7 (2-Pentanol) or 584-02-1 (3-Pentanol) + 589-34-4 (3-Methylhexane)				
Propene+Propane	115-07-1 + 74-98-6				
Tetradecane, n-	629-59-4				
Trichlorofluoroethane	75-79-4				
Tridecane, n-	629-50-5				
Trimethylallanol	Indeterminate				
Undecane, n-	1120-21-4				
Acetaldehyde	75-07-0		2.20E-06	6.14E-06	9.00E+00
Benzaldehyde	100-52-7				3.50E+02
Crotonaldehyde	123-73-9		5.40E-04	1.51E-03	
Formaldehyde	50-00-0		1.30E-05	3.63E-05	7.00E+02
Unidentified Siloxane	Indeterminate				