Gary Palcisko

TOXICITY EQUIVALENCE (TEQ) & RELATIVE POTENCY

Oct. 10, 2018

Toxicity Equivalence & Relative Potency

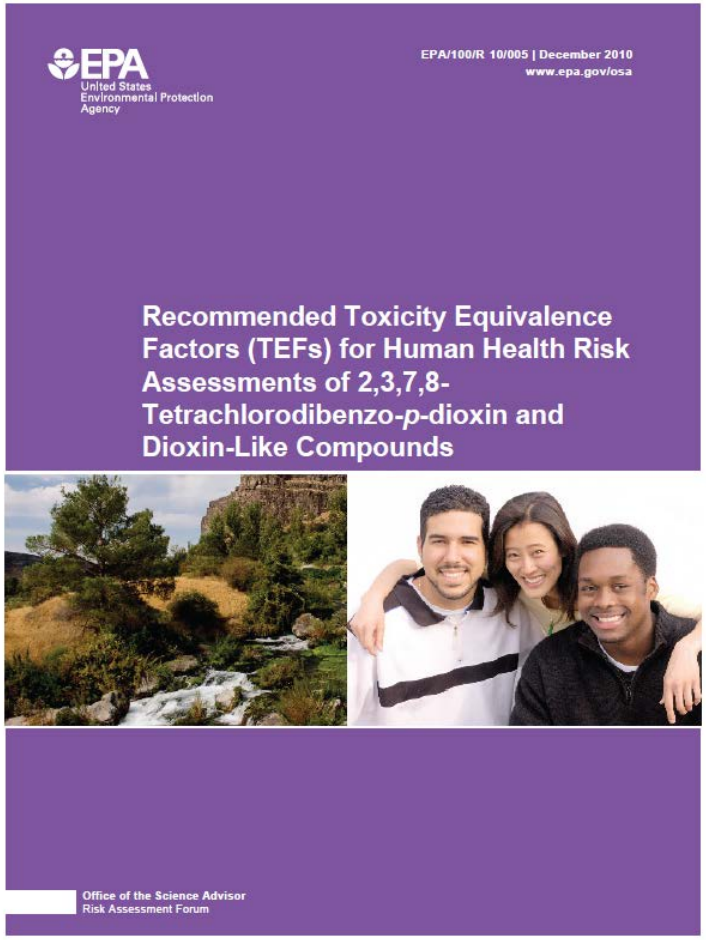
- Commonly used to estimate risks for mixtures of pollutants that cause toxicity through similar mechanisms
  - Toxicity Equivalence – applied to all health endpoints, exposure routes, and exposure durations
    - Dioxin-like compounds: 2,3,7,8-tetrachlorodibenzo(p)dioxin
  - Relative Potency – limited to specific health endpoints, exposure routes, and exposure durations
    - PAHs: benzo(a)pyrene

Toxicity Equivalence (TEQ)

Pollutant	Concentration	Toxicity Equivalence Factor (TEF) or Relative Potency Factor (RPF)	Toxic Equivalent Concentration
A	2	1	2
B	1	0.5	0.5
C	10	0.1	1
		TEQ Concentration	**3.5**

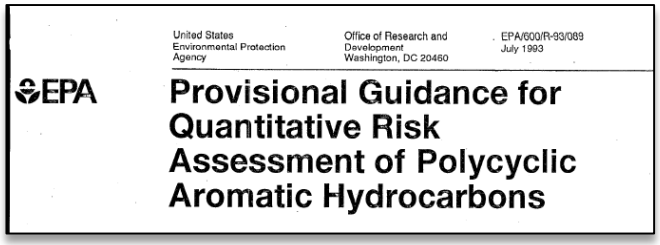
$$TEQ = \sum_{i=1}^{n} (C_i \times TEF_i)$$

Dioxin-like compounds



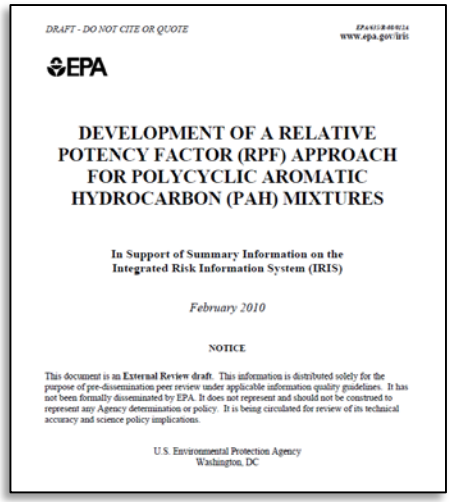
Compound	CAS	TEF
Polychlorinated dibenzo-p-dioxins (PCDDs)		
2,3,7,8-Tetrachlorodibenzo-p-dioxin	1746-01-6	1
1,2,3,7,8-Pentachlorodibenzo-p-dioxin	40321-76-4	1
1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin	39227-28-6	0.1
1,2,3,6,7,8 Hexachlorodibenzo-p-dioxin	57653-85-7	0.1
1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin	19408-74-3	0.1
1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin	35822-46-9	0.01
1,2,3,4,6,7,8,9-Octachlorodibenzo-p-Dioxin	3268-87-9	0.0003
Polychlorinated dibenzofurans (PCDFs)		
2,3,7,8-Tetrachlorodibenzofuran	51207-31-9	0.1
1,2,3,7,8-Pentachlorodibenzofuran	57117-41-6	0.03
2,3,4,7,8-Pentachlorodibenzofuran	57117-31-4	0.3
1,2,3,4,7,8-Hexachlorodibenzofuran	70648-26-9	0.1
1,2,3,6,7,8-Hexachlorodibenzofuran	57117-44-9	0.1
1,2,3,7,8,9-Hexachlorodibenzofuran	72918-21-9	0.1
2,3,4,6,7,8-Hexachlorodibenzofuran	60851-34-5	0.1
1,2,3,4,6,7,8-Heptachlorodibenzofuran	67562-39-4	0.01
1,2,3,4,7,8,9-Heptachlorodibenzofuran	55673-89-7	0.01
1,2,3,4,6,7,8,9-Octachlorodibenzofuran	39001-02-0	0.0003
Polychlorinated biphenyls* (PCBs)		
3,3',4,4'-Tetrachlorobiphenyl	32598-13-3	0.0001
3,4,4',5-Tetrachlorobiphenyl	70362-50-4	0.0003
2,3,3',4,4'-Pentachlorobiphenyl	32598-14-4	0.1
2,3,4,4',5-Pentachlorobiphenyl	74472-37-0	0.03
2,3',4,4',5-Pentachlorobiphenyl	31508-00-6	0.00003
2',3,4,4',5-Pentachlorobiphenyl	65510-44-3	0.00003
3,3',4,4',5-Pentachlorobiphenyl	57465-28-8	0.00003
2,3,3',4,4',5-Hexachlorobiphenyl	38380-08-4	0.00003
2,3,3',4,4',5'-Hexachlorobiphenyl	69782-90-7	0.00003
2,3',4,4',5,5'-Hexachlorobiphenyl	52663-72-6	0.00003
3,3',4,4',5,5'-Hexachlorobiphenyl	32774-16-6	0.00003
2,3,3',4,4',5,5'-Heptachlorobiphenyl	39635-31-9	0.00003

PAHs


United States Environmental Protection Agency | Office of Research and Development Washington, DC 20460 | EPA/600/R-93/089 July 1993

EPA

Provisional Guidance for Quantitative Risk Assessment of Polycyclic Aromatic Hydrocarbons


DRAFT - DO NOT CITE OR QUOTE

www.epa.gov/iris

EPA

DEVELOPMENT OF A RELATIVE POTENCY FACTOR (RPF) APPROACH FOR POLYCYCLIC AROMATIC HYDROCARBON (PAH) MIXTURES

In Support of Summary Information on the Integrated Risk Information System (IRIS)

February 2010

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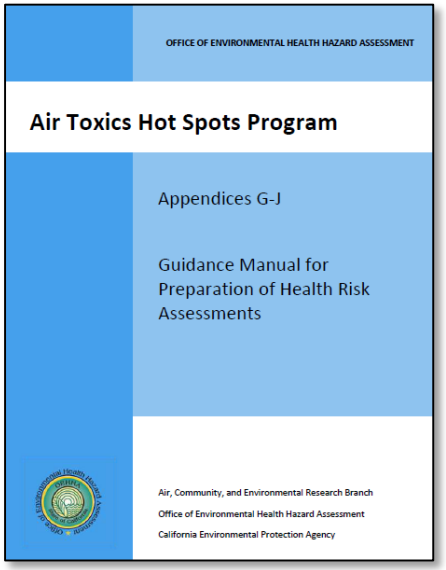
U.S. Environmental Protection Agency
Washington, DC


OFFICE OF ENVIRONMENTAL HEALTH HAZARD ASSESSMENT

Air Toxics Hot Spots Program

Appendices G-J

Guidance Manual for Preparation of Health Risk Assessments

Air, Community, and Environmental Research Branch
Office of Environmental Health Hazard Assessment
California Environmental Protection Agency

Common Name	EPA 1993	EPA 2010 RPF	OEHHA 2015 PEF
1,6-Dinitropyrene			0.1
1,8-Dinitropyrene			1.0
1-Nitropyrene			0.1
2-Nitrofluorene			0.01
3-Methylcholanthrene			5.7
4-Nitropyrene			0.1
5-Methylchrysene			1.0
5-Nitroacenaphthene			0.03
6-Nitrochrysene			10
7,12-Dimethylbenz[a]anthracene			64.5
7h-Dibenzo[c,g]carbazole			1.0
Benz[a]anthracene	0.1	0.2	0.1
Benzo[a]pyrene	1.0	1.0	1.0
Benzo[b]fluoranthene	0.1	0.8	0.1
Benzo[j]fluoranthene		0.3	0.1
Benzo[k]fluoranthene	0.01	0.03	0.1
Chrysene	0.001	0.1	0.01
Dibenz[a,h]acridine			0.1
Dibenz[a,h]anthracene	1.0	10	0.1
Dibenz[a,j]acridine			0.1
Dibenzo[a,e]pyrene		0.4	1.0
Dibenzo[a,h]pyrene		0.9	10
Dibenzo[a,i]pyrene		0.6	10
Dibenzo[a,l]pyrene		30	10
Indeno[1,2,3-cd]pyrene	0.1	0.07	0.1
Naphtho[2,3-e]pyrene			0.3
Anthanthrene		0.4	
Benz[b,c]aceanthrylene, 11H-		0.05	
Benzo[c]fluorene		20	
Benz[e]aceanthrylene		0.8	
Benzo[g,h,i]perylene		0.009	
Benz[j]aceanthrylene		60	
Benz[l]aceanthrylene		5.0	
Cyclopenta[c,d]pyrene		0.4	
Cyclopenta[d,e,f]chrysene, 4H-		0.3	
Dibenz[a,c]anthracene		4.0	
Dibenzo[a,e]fluoranthene		0.9	
Dibenzo[a,e]pyrene		0.4	
Fluoranthene		0.08	

ASIL for Dioxin TEQ and PAH mixtures

- Propose to establish an ASIL for the mixture of these chemicals
  - Example

Chemical Name	Averging Period	ASIL (ug/m3)
2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD) - TEQ	year	2.6E-08
2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD)	year	2.6E-08
2,3,4,7,8-Pentachlorodibenzofuran (PeCDF)	year	9.1E-08
1,2,3,4,7,8-Hexachlorodibenzofuran (HxCDF)	year	2.6E-07
1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin (HxCDD)	year	2.6E-07
1,2,3,6,7,8-Hexachlorodibenzofuran (HxCDF)	year	2.6E-07
1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin (HxCDD)	year	2.6E-07
1,2,3,7,8,9-Hexachlorodibenzofuran (HxCDF)	year	2.6E-07
1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin (HxCDD)	year	2.6E-07
2,3,4,6,7,8-Hexachlorodibenzofuran (HxCDF)	year	2.6E-07
2,3,7,8-Tetrachlorodibenzofuran (TcDF)	year	2.6E-07
PCB 126 [3,3',4,4',5-pentachlorobiphenyl]	year	2.6E-07
…	…	…

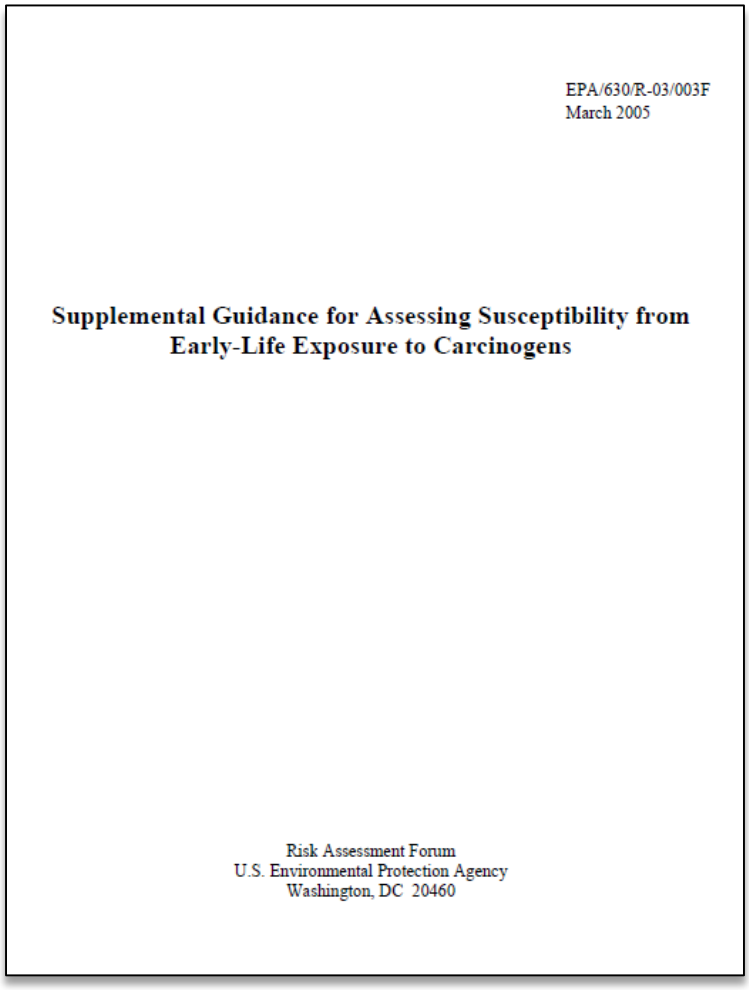
ASIL for mixture of chemicals

ASIL for each chemical

Gary Palcisko

EARLY-LIFE ADJUSTMENT FACTORS

Early-Life Adjustment Factors



EPA/630/R-03/003F
March 2005

Supplemental Guidance for Assessing Susceptibility from Early-Life Exposure to Carcinogens

Risk Assessment Forum
U.S. Environmental Protection Agency
Washington, DC 20460

- Applies to cancer causing chemicals that act through a mutagenic mode of action

URF Early-Life Adjustment Factors

Age Range	Early-life adjustment factor
0 to < 2	10
2 to < 16	3
> 16	1

- Used if:
  - Chemical determined to cause cancer through mutagenic mode of action
  - Study that forms the basis of the URF did not include children or juvenile animals
- For lifetime exposure scenario (70 years):
  - Increases risk estimate by a factor of about 1.7

$$10 \times \frac{2}{70} + 3 \times \frac{14}{70} + 1 \times \frac{54}{70} = \mathbf{1.66}$$

Chemicals –Mutagenic Mode of Action

Chemical	CASRN	Reference
Acrylamide	79-06-1	IRIS
Benz[a]anthracene	56-55-3	Benzo[a]pyrene*
Benzidine	92-87-5	Supplemental Guidance
Benzo[a]pyrene	50-32-8	Supplemental Guidance
Benzo[b]fluoranthene	205-99-2	Benzo[a]pyrene*
Benzo[k]fluoranthene	207-08-9	Benzo[a]pyrene*
Chromium(VI)	18540-29-9	CalEPA and OPP
Chrysene	218-01-9	Benzo[a]pyrene*
Coke Oven Emissions	8007-45-2	70 Federal Register 19992
Dibenz[a,h]anthracene	53-70-3	Supplemental Guidance
Dibromo-3-chloropropane, 1,2-	96-12-8	PPRTV
Dimethylbenz(a)anthracene, 7,12-	57-97-6	Supplemental Guidance
Ethylene Oxide	75-21-8	IRIS
Indeno[1,2,3-cd]pyrene	193-39-5	Benzo[a]pyrene*
Methylcholanthrene, 3-	56-49-5	Supplemental Guidance
Methylene Chloride	75-09-2	IRIS
Methylene-bis(2-chloroaniline), 4,4'-	101-14-4	PPRTV
Nitrosodiethylamine, N-	55-18-5	Supplemental Guidance
Nitrosodimethylamine, N-	62-75-9	Supplemental Guidance
Nitroso-N-ethylurea, N-	759-73-9	Supplemental Guidance
Nitroso-N-methylurea, N-	684-93-5	Supplemental Guidance
Safrole	94-59-7	Supplemental Guidance
Trichloroethylene	79-01-6	IRIS
Trichloropropane, 1,2,3-	96-18-4	IRIS
Urethane	51-79-6	Supplemental Guidance
Vinyl Chloride	75-01-4	Supplemental Guidance
Chloroprene	129-99-8	IRIS

Red color

These chemicals not considered mutagenic in EPA's latest National Air Toxics Assessment:

- Chromium VI
- Dibromo-3-chloropropane, 1,2-
- Methylene-bis(2-chloroaniline), 4,4'-