Application of the NIOSH occupational exposure banding process to Bisphenol A: A case study

Supplemental Tables

Table S1. Draft NIOSH Tier 1 Banding Criteria: GHS Hazard Codes and Categories

Endpoint	Endpoint Band		
	C	D	E
Acute Toxicity	H301, Cat. 3 H302, Cat. 4 H331, Cat. 3 H332, Cat. 4 H311, Cat. 3 H312, Cat. 4	H300, Cat. 2 H330, Cat.2 H310, Cat.2	H300, Cat. 1 H330, Cat. 1 H310, Cat. 1
Skin Corrosion/Irritation	H315, Cat. 2	none	H314, Cat. 1, 1A, 1B or 1C
Eye Damage/Irritation	H319, Cat. 2, 2A, or 2B	none	H318, Cat. 1
Respiratory and Skin Sensitization	Skin: H317, Cat. 1B	Skin: H317, Cat. 1 or 1A Respiratory: H334, Cat. 1B	Skin: none Respiratory: H334, Cat. 1 or 1A
Germ Cell Mutagenicity	none	H341, Cat. 2	H340, Cat. 1, 1A or 1B
Carcinogenicity	none	None	H350, Cat. 1, 1A or 1B H351, Cat. 2
Reproductive Toxicity	H361 (excluding H361f, H361d, and H361fd), Cat. 2	H360 (including H360f, H360d, and H360fd), Cat. 1B	H360 (including H360f, H360d, and H360 fd), Cat. 1 or 1A
Specific Target Organ Toxicity – Repeated Exposure	H371, Cat. 2 H373, Cat. 2	None	H370, Cat. 1 H372, Cat. 1

Cat: Category; **GHS:** Globally Harmonized System of Classification and Labelling;

Table S2. Draft NIOSH Tier 2 Banding Criteria: Acute Toxicity

Exposure/Dosing Route	Endpoint Band				
	A	B	C	D	E
Oral (LD_{50}), mg/kg-bw	>2000	>300 to ≤2000	>50 to ≤300	>5 to ≤50	≤5
Dermal (LD_{50}), mg/kg-bw	>2000	>1000 to ≤2000	>200 to ≤1000	>50 to ≤200	≤50
Inhalation, gases (LC_{50}), ppmv/4 h	>20,000	>2,500 to ≤20,000	>500 to ≤2,500	>100 to ≤500	≤100
Inhalation, vapors (LC_{50}), mg/L/4 h	>20	>10 to ≤20	>2 to ≤10	>0.5 to ≤2.0	≤0.5
Inhalation, dusts and mists (LC_{50})	>5	>1 to ≤5	>0.5 to ≤1	>0.05 to ≤0.5	≤0.05

bw: body weight; **LD_{50}:** lethal dose 50%; **LC_{50}:** lethal concentration 50%;

Table S3. Draft NIOSH Tier 2 Banding Criteria: Skin Corrosion/Irritation

	Endpoint Band			
	A	B	C	E
Skin Corrosion/Irritation Results	Non-irritating	Mild to moderate irritation	Moderate to severe irritation; reversible direct effects OR	Skin corrosion; irreversible effects pH ≤2 or >11.5

			Mixed results or irritant potential with unspecified severity	

Table S4. Draft NIOSH Tier 2 Banding Criteria: Eye Damage/Irritation

	Endpoint Band		
	A	C	E
Eye Damage/Irritation Results	Mild to moderate irritation	Severe irritation; moderate to severe irritation OR Irritant with unspecified severity, no conclusion, or mixed results	Irreversible eye damage

Table S5. Draft NIOSH Tier 2 Banding Criteria: Respiratory Sensitization

	Endpoint Band		
	A	C	D
Respiratory Sensitization Results	No evidence	Mixed	Positive

Table S6. Draft NIOSH Tier 2 Banding Criteria: Skin Sensitization

Test Type	Endpoint Band		
	A	C	E
LLNA EC3 (%)	Non-skin sensitizer	>2.0 to ≤100 (weak to moderate skin sensitizer)	≤2.0 (strong to extreme skin sensitizer)
GPMT	No positive response or low incidence	30-60% of test animals respond at >0.1% intradermal induction concentration OR ≥30% of test animals respond at >1% intradermal induction concentration	≥30% of test animals respong at ≤0.1% intradermal induction concentration OR ≥60% of test animals respond at >0.1% to ≤1% intradermal induction concentration
Buehler	No positive response or low incidence	≥60% of test animals respond at >0.2 to ≤20% topical induction concentration OR ≥15% of test animals respond at >20% topical induction concentration	≥15% of test animals respond at ≤0.2% topical induction concentration OR ≥60% respond at any topical induction concentration

GPMT: guinea pig maximization test; **LLNA EC3:** local lymph node assay effective concentration required to produce a three-fold increase in the stimulation index compared to vehicle-treated controls

Table S7. Draft NIOSH Tier 2 Banding Criteria: Genotoxicity

	Endpoint Band		
	A	C	D
Genotoxicity Results	Negative	Mixed	Positive

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Table S8. Draft NIOSH Tier 2 Banding Criteria: Carcinogenicity

Quantitative	Endpoint Band			
Potency Factor	A	C	D	E
Slope Factor, $(mg/kg\text{-}day)^{-1}$	NA	<0.01	≥0.01 to <10	≥10
Inhalation risk unit, $(\mu g/m^3)^{-1}$	NA	$<3x10^{-6}$	$\geq 3x10^{-6}$ to <0.01	≥0.01
TD_{05}, mg/kg-day	NA	>5	>0.005 to ≤5	≤0.005
TC_{05} ($\mu g/m^3$)	NA	>16,700	>5 to 16,700	≤5
Qualitative				
NTP Report on Carcinogens	NA	NA	NA	1) Known to be a human carcinogen 2) Reasonably anticipated to be a human carcinogen
EPA IRIS[A]	1) Group E (evidence of non-carcinogenicity for humans) 2) Not likely to be carcinogenic to humans	NA	1) Group C 2) Suggestive evidence of carcinogenic potential	1) Group A 2) Carcinogenic to humans 3) Group B1 4) Group B2 5) Likely to be carcinogenic to humans
IARC[B]	Group 4	NA	NA	1) Group 1 2) Group 2A 3) Group 2B
State of California OEHHA	NA	NA	NA	Type of toxicity=cancer

Group 1: carcinogenic to humans; **Group 2A:** probably carcinogenic to humans; **Group A:** human carcinogen; **Group 2B:** possibly carcinogenic to humans; **Group 4:** probably not carcinogenic to humans; **Group B1:** probable human carcinogen; **Group B2:** probable human carcinogen; **Group C:** possible human carcinogen; **IARC:** International Agency for Research on Cancer; **NA:** not applicable; **NTP:** National Toxicology Program; **OEHHA:** Office of Environmental Health Hazard Assessment; **TD:** tumorigenic dose

[A]Group D (not classifiable as to human carcinogenicity) and category "data are inadequate for an assessment of carcinogenic potential", no band assigned.

[B]Group 3 (no classifiable as to its carcinogenicity to humans), no band assigned.

Table S9. Draft NIOSH Tier 2 Banding Criteria: Reproductive Toxicity

Exposure/Dosing Route	Endpoint Band				
	A	B	C	D	E
Oral, Dermal, mg/kg-day	>300	>30 to ≤300	>3 to ≤30	>0.3 to ≤3	≤0.3
Inhalation, gases and vapors, ppm	>10,000	>1,000 to ≤10,000	>100 to ≤,1000	>10 to ≤100	≤10
Inhalation, dusts and mists, $\mu g/m^3$	>10,000	>1,000 to ≤10,000	>100 to ≤1,000	>10 to ≤100	≤10

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Table S10. Draft NIOSH Tier 2 Banding Criteria: Specific Target Organ Toxicity-Repeated Exposure

Exposure/Dosing Route	Endpoint Band				
	A	B	C	D	E
Oral, Dermal, mg/kg-day	>1,000	>100 to ≤1,000	>10 to ≤100	>1 to ≤10	≤1
Inhalation, gases and vapors, ppm	>30,000	>3,000 to ≤30,000	>300 to ≤3,000	>30 to ≤300	≤30
Inhalation, dusts and mists, $\mu g/m^3$	>30,000	>3,000 to ≤30,000	>300 to ≤3,000	>30 to ≤300	≤30

Table S11. Endpoint Determinant Scores (EDS) Associated with Health Effect Endpoints under Draft NIOSH Tier 2

Endpoint	EDS if Adequate Data Available[A]
Acute Toxicity	5
Skin Corrosion/Irritation	5
Eye Damage/Irritation	5
Respiratory Sensitization	10
Skin Sensitization	5
Genotoxicity	5
Carcinogenicity	
Quantitative	30
Qualitative	20 or 30[B]
Reproductive Toxicity	30
Specific Target Organ Toxicity – Repeated Exposure	30

[A]If adequate data are not available, endpoint determinant score is 0.

[B]See Table 3-7 in: National Institute for Occupational Safety and Health (NIOSH): The NIOSH Occupational Exposure Banding Process: Guidance for the Evaluation of Chemical Hazards, External Review Draft. March 8, 2017. Available at: https://www.regulations.gov/document?D=CDC-2017-0028-0002 (accessed 17 Aug 2018).