United States
Environmental Protection Agency

Office of Chemical Safety and
Pollution Prevention

Summary of External Peer Review and Public Comments and Disposition for Perchloroethylene (PCE)

Response to Support Risk Evaluation of Perchloroethylene (PCE)

December 2020

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This document summarizes the public and external peer review comments that the EPA's Office of Pollution Prevention and Toxics (OPPT) received for the risk evaluation of perchloroethylene (PCE). It also provides EPA/OPPT's response to the comments received from the public and the peer review panel.

EPA/OPPT appreciates the valuable input provided by the public and peer review panel. The input resulted in numerous revisions to the hazard summary.

Peer review charge questions[1] were used to categorize the peer review and public comments into specific issues related to the seven main themes.

1. Environmental Fate
2. Environmental Exposure and Releases
3. Environmental Hazard
4. Occupational and Consumer Exposure
5. Human Health Hazard
6. Risk Characterization
7. Overall Content and Organization

All peer review comments for the seven charge questions are presented first, organized by charge question in the following section. These are followed by the public comments. For each theme, general comments pertaining to all chemicals are presented first, and then additional comments pertaining to only one or several chemicals follows.

[1] These are the questions that EPA/OPPT submitted to the panel to guide the peer review process.

ABBREVIATIONS

1-BP	1-Bromopropane
AC	Acute Concentration
ACA	American Coatings Association
ACC	American Chemistry Council
ACGIH	American Conference of Governmental Industrial Hygienists
ACP	AC Products
ACS	American Chemical Society
ADC	Average Daily Concentration
ADME	Absorption, distribution, metabolism, and elimination
AEGL	Acute Exposure Guideline Levels
AF	Assessment Factor
AFL-CIO	American Federation of Labor and Congress of Industrial Organizations
AFPM	American Fuel and Petrochemical Manufacturers
AI/AN	American Indian/Alaska Native
AIHA	American Industrial Hygiene Association
AIRFA	American Indian Religious Freedom Act
AMWA	Association of Metropolitan Water Agencies
APF	Assigned protection factor
ATSDR	Agency for Toxic Substances and Disease Registry
AUC	Area under the curve
AWWA	American Water Works Association
BAEP	Brainstem auditory evoked potential
BCF	Bioconcentration factors
BLS	Bureau of Labor Statistics
BMA	Bayesian model averaging
BMD	Benchmark dose
BMDL	Benchmark dose lower bound
CAA	Clean Air Act
CalEPA	California Environmental Protection Agency
CARB	California Air Resources Board
CBI	Confidential business information
CCI	Color confusion index
CDC	Centers for Disease Control and Prevention
CDR	Chemical data reporting
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFC	Chlorofluorocarbon
CFR	Code of Federal Regulations
CI	Confidence interval
CISWI	Commercial/Industrial Solid Waste Incineration
CNS	Central nervous system

COC	Concentration of Concern
COU	Conditions of Use
COVID-19	Coronavirus disease of 2019
CRC	CRC Industries
CTE	Central tendency estimate
CWA	Clean Water Act
CYP	cytochrome P450
CYP2E1	Cytochrome P450 2E1
DCVC	S-(1,2-dichlorovinyl)L-cysteine
DHHS	Department of Health and Human Services
DMCF	Dimethylcyano-foramide
DMR	Discharge Monitoring Report
EC50	Effect Concentration at which 50% of test organisms exhibit the effect
ECB	European Chemical Bureau
ECETOC	European Centre for Ecotoxicology and Toxicology of Chemicals
EDC	Endocrine-disrupting chemical
EDC	Ethylene dichloride
EDC/VCM	Ethylene dichloride/vinyl chloride monomer
E-FAST	Exposure and Fate Assessment Screening Tool
ELAP	Environmental Laboratory Approval Program
EPA	United States Environmental Protection Agency
EPI Suite™	Estimation Programs Interface suite of models
EPN	Environmental Protection Network
ERG	Eastern Research Group
ESD	Emission Scenario Documents
FF	Far-field
FRN	Federal Register Notice
GSD	Generic scenario documents
GSH	Glutathione
GST	Glutathione S-transferase
HAP	Hazardous Air Pollutants
HBCD	Hexabromocyclododecane
HEC	Human Equivalent Concentrations
HED	Human Equivalent Dose
HHE	Health Hazard Evaluation
HQ	Hazard Quotient
HSIA	Halogenated Solvents Industry Alliance
HUC	Hydraulic unit code
IARC	International Agency for Research on Cancer
IL-4	Interleukin 4
IMDS	International Material Data System

IOM	Institute of Medicine
IRIS	Integrated Risk Information System
IUR	Inhalation Unit Risk
JEM	Job Exposure Matrix
JISA	Japan Information Technology Service
KOC	Organic carbon-water partition coefficient
KOW	n-Octanol-water partition coefficient
LADC	Lifetime Average Daily Concentration
LC50	Lethal concentration at which 50% of test organisms die
LDPFA	Land Disposal Program Flexibility Act
LOAEC	Lowest observed adverse effect concentration
LOAEL	Lowest observed adverse effect level
LOD	Limit of detection
LOEC	Lowest observed effect concentration
MACT	Maximum Achievable Control Technology
MCI	Molecular connectivity index
MCL	Maximum Contaminant Level
MCMC	Markov Chain Monte Carlo
MDH	Minnesota Department of Health
MM	Multiple myeloma
MOA	Mode of Action
MOE	Margin of Exposure
MPCA	Minnesota Pollution Control Agency
NAFLD	Non-alcoholic fatty liver disease
NAICS	North American Industry Classification System
NAS	National Academies of Sciences
NASEM	National Academies of Sciences, Engineering, and Medicine
NCA	National Cleaners Association
NCHS	National Center for Health Statistics
NEI	National Emission Inventory
NESHAP	National Emission Standards for Hazardous Air Pollutants
NF	Near-field
NHANES	National Health and Nutritional Examination Survey
NHL	Non-Hodgkin's lymphoma
NHW	non-Hispanic white
NIEHS	National Institute of Environmental Health Sciences
NIH	National Institutes of Health
NIOSH	National Institute of Occupational Safety and Health
NOAEC	No observed adverse effect concentration
NOAEL	No observed adverse effect level
NOEC	No observed effect concentration

Non-POTW	Non-publicly owned treatment works
NPDES	National Pollutant Discharge Elimination System
NPL	National Priorities List
NRC	National Research Council
NRDC	Natural Resources Defense Council
NTP	National Toxicology Program
NTTC	National Tribal Toxics Council
NYSDEC	New York Department of Environmental Conservation
NYSDOH	New York State Department of Health
OCPSF	Organic Chemicals, Plastics, and Synthetic Fibers
OECD	Organization for Economic Cooperation and Development
OEHHA	Office of Environmental Health Hazard Assessment
OES	Occupational exposure scenario
OHAT	Office of Health Assessment and Translation
OLEM	Office of Land and Emergency Management
ONU	Occupational Non-User
OPPT	Office of Pollution Prevention and Toxics
OR	Odds Ratio
OSHA	Occupational Safety and Health Administration
OSWI	Other Solid Waste Incineration
PBPK	Physiologically-based pharmacokinetic
PBZ	Personal Breathing Zone
PCE	Perchloroethylene
PDM	Probabilistic dilution model
PEL	Permissible Exposure Limit
PERC	Tetrachloroethene
PESS	Potentially exposed or susceptible subpopulations
PF	Protection factor
POD	Point of departure
POTW	Publicly Owned Treatment Works
PPAR	Peroxisome proliferator-activated receptor
PPE	Personal Protective Equipment
RAGS	Risk Assessment Guidance for Superfund
RBC	Red blood cell
RCRA	Resource Conservation and Recovery Act
RE	Risk Evaluation
RPS	Respiratory Protection Standard
RQ	Risk Quotient
RR	Relative risk
RTF	Rich text format
SACC	Science Advisory Committee on Chemicals

SCHF	Safer Chemicals Healthy Families
SDS	Safety Data Sheet
SDWA	Safe Drinking Water Act
SEG	Similar exposure group
SIC	Standard Industrial Classification
SR	Systematic Review
SSD	Species sensitivity distributions
STEL	Short-term exposure limit
STP	Sewage treatment plant
STROBE	Strengthening the Reporting of Observational Studies in Epidemiology
TCA	Trichloroacetate
TCDD	2,3,7,8-tetrachlorodibenzo-p-dioxin
TCE	Trichloroethylene
TCVC	S-(1,2,2-trichlorovinyl)-L-cysteine
TRA	Targeted risk assessment
TRI	Toxics Release Inventory
TSCA	Toxic Substances Control Act
TURI	Toxics Use Reduction Institute
TWA	Time weighted average
UF	Uncertainty factor
UFA	Interspecies uncertainty/variability factor
UFH	Intraspecies uncertainty/variability factor
US	United States
USGS	U.S. Geological Survey
VEP	Visual Evoked Potential
VOC	Volatile organic compound
WHO	World Health Organization
WOE	Weight-of-evidence
WQP	Water Quality Portal
WQX	Water Quality Exchange

List of Comments		
#	**Docket File**	**Submitter**
26	EPA-HQ-OPPT-2019-0502-0026	Michelle Roos, Environmental Protection Network (EPN)
27	EPA-HQ-OPPT-2019-0502-0027	Andrew Maier, Senior Managing Health Scientist, Cardno ChemRisk
28	EPA-HQ-OPPT-2019-0502-0028	Suzanne Hartigan, Senior Director, Regulatory and Technical Affairs, American Chemistry Council (ACC)
29	EPA-HQ-OPPT-2019-0502-0029	Liz Hitchcock, Director, Safer Chemicals Healthy Families (SCHF) et al.
30	EPA-HQ-OPPT-2019-0502-0030	Jennifer Sass, Senior Scientist, Natural Resources Defense Council (NRDC)
31	EPA-HQ-OPPT-2019-0502-0031	Jon Meijer, Director of Membership, Drycleaning & Laundry Institute (DLI)
33	EPA-HQ-OPPT-2019-0502-0033	Diane VanDe Hei, Chief Executive Officer, Association of Metropolitan Water Agencies (AMWA)
34	EPA-HQ-OPPT-2019-0502-0034	Catherine Neuschler, Manager, Water Assessment Section, Environmental Analysis and Outcomes Division, Minnesota Pollution Control Agency (MPCA) and James Kelly, Manager, Environmental Surveillance & Assessment, Environmental Health Division Minnesota Department of Health (MDH)
35	EPA-HQ-OPPT-2019-0502-0035	G. Tracy Mehan III, Executive Director- Government Affairs, American Water Works Association (AWWA)
36	EPA-HQ-OPPT-2019-0502-0036	Gary D. Hammer, President, Endocrine Society
37	EPA-HQ-OPPT-2019-0502-0037	Eric Berg, Deputy Chief, Research and Standards, California Division of Occupational Safety and Health (Cal/OSHA)
38	EPA-HQ-OPPT-2019-0502-0038	Julia M. Rege, Vice President, Energy & Environment, Alliance for Automotive Innovation
39	EPA-HQ-OPPT-2019-0502-0039	Nora Nealis, Executive Director, National Cleaners Association (NCA)
40	EPA-HQ-OPPT-2019-0502-0040	Liz Hitchcock, Director, SCHF et al.
41	EPA-HQ-OPPT-2019-0502-0041	Jared Blumenfeld, Secretary for Environmental Protection, California Environmental Protection Agency (CalEPA) et al.
42	EPA-HQ-OPPT-2019-0502-0042	Suzanne Hartigan, Senior Director, Regulatory and Technical Affairs, ACC
43	EPA-HQ-OPPT-2019-0502-0043	Riaz Zaman, Counsel, Government Affairs and Scott Braithwaite, Director of Product Stewardship, Science and Technology, American Coatings Association (ACA)
44	EPA-HQ-OPPT-2019-0502-0044	Richard Krock, Senior Vice President, Regulatory and Technical Affairs, Vinyl Institute (VI)

45	EPA-HQ-OPPT-2019-0502-0045	James Cooper, Senior Petrochemical Advisor, American Fuel & Petrochemical Manufacturers (AFPM)
46	EPA-HQ-OPPT-2019-0502-0046	Jonathan Kalmuss-Katz, Staff Attorney, Earthjustice and Randy Rabinowitz, Executive Director, Occupational Safety & Health Law Project on behalf of American Federation of Labor and Congress of Industrial Organizations (AFL-CIO) et al.
47	EPA-HQ-OPPT-2019-0502-0047	Dianne C. Barton, Chair, National Tribal Toxics Council (NTTC)
48	EPA-HQ-OPPT-2019-0502-0048	Peter Weissman, Global Aerospace Coatings Director, AC Products (ACP)
49	EPA-HQ-OPPT-2019-0502-0049	W. Chiu
50	EPA-HQ-OPPT-2019-0502-0050	Letitia James, Attorney General of New York et al.
51	EPA-HQ-OPPT-2019-0502-0051	Gail Saunders, Senior Counsel and Amy Chyao, Assistant Corporation Counsel, Environmental Law Division, The City of New York
52	EPA-HQ-OPPT-2019-0502-0052	Swati Rayasam, Science Associate, Program on Reproductive Health and the Environment, University of California, San Francisco (UCSF)
53	EPA-HQ-OPPT-2019-0502-0053	Christopher Bevan, Director, Scientific Programs, Halogenated Solvents Industry Alliance, Inc. (HSIA)
54	EPA-HQ-OPPT-2019-0502-0054	John McAleese, Counsel, McCarter & English, LLP on behalf of Chris Ladwig, Director, Environment, Health, Safety, and Security, Spirit AeroSystems, Inc.
SACC	EPA-HQ-OPPT-2019-0502-0055	Science Advisory Committee on Chemicals (SACC)

1. Environmental Fate and Exposure

Environmental Fate and Exposure		
Charge Question 1.1: Please comment on EPA's qualitative analysis of pathways based on physical/chemical and fate properties. **Charge Question 1.2:** Please comment on the data, approaches and/or methods used to characterize exposure to aquatic receptors.		
#	**Summary of Comments for Specific Issues Related to Charge Question 1**	**EPA/OPPT Response**
Selection of fate values/models		
SACC	**SACC COMMENTS:** Recommendation: Provide additional discussion on the rationale used to determine the quality of physical-chemical properties listed in Tables 1-1 and 2-1. It is difficult to determine how physical-chemical properties are selected in terms of quality (low, medium, or high) via the systematic review process. There are many experimental physical-chemical properties for PCE reported in the literature. It is not clear in the evaluation how the physical-chemical properties, were selected over other experimental values in the literature (many of which are listed in the supplemental data). • The properties listed in Tables 1-1 and 2-1 are generally obtained from compilations or literature reviews that are not always available through the U.S. Environmental Protection Agency (EPA) Health and Environmental Research Online (HERO) database.	The data quality for physical and chemical properties was determined using the metrics described in *Application of Systematic Review in TSCA Risk Evaluations* (US EPA, 2018). Physical and chemical property values were obtained from the publicly accessible Reaxys, ChemSpider, STN/CAS, and PhysProp (integrated into EPI Suite™) databases, and from data submitted to EPA under the authority of various TSCA sections. Property values were selected based on their data quality and whether similar values were reported in multiple sources.
SACC	**SACC COMMENTS:** Recommendation: Summarize how the physical-chemical and environmental fate properties of PCE contribute to its widespread environmental contamination. PCE continues to be detected in outdoor and indoor air, groundwaters, surface waters, and drinking waters. It is considered one of the most prevalent chemical contaminants in the U.S. groundwaters and indoor air.	EPA discussed the widespread contamination by PCE in the scope and problem formulation documents and included information in the risk evaluation that was most relevant to the scope of the evaluation. Widespread detection of PCE in the environment is due to its potential persistence (ranging from rapid to negligible biodegradation in aerobic conditions and ranging from rapid to very slow for anaerobic conditions; see Table 2-1 and Section 2.1.2) and environmental mobility based on its water solubility (206

	• Additional discussion of the widespread and persistent environmental contamination by PCE is needed, as is additional discussion of the likely routes of introduction into the environment. These additions would help the reader better appreciate the overall fate and transport of this compound in the environmental systems relative to its physical-chemical properties.	mg/L at 20°C), evaporation potential (vapor pressure of 18.5 mmHG at 25°C and Henry's law constant of 0.0177 atm-m3/mole at 25°C), as well as its widespread releases as described in Section 2.1.2. EPA has also added a mass balance to Section 1.4.1 to better describe the routes by which PCE enters the environment.
SACC	**SACC COMMENTS:** The draft risk evaluation states that environmental fate properties not adequately reported in the literature were estimated using EPI Suite™ models. • It was uncertain why a single estimated value was used for log K_{oc} instead of a range of acceptable experimental values. It was also not specified in Table 2-1, which of the two EPI Suite™ estimation methods were used to estimate the log K_{oc} value. • There seems to be an over-reliance on the database of physical-chemical properties within EPI Suite™. Typically, only a single value for each physical-chemical property is listed within the EPI Suite™ database even though many seemingly high-quality experimental values can be found in the literature. Estimates of physical-chemical or fate properties obtained from experimental study findings are generally considered more reliable unless there are some obvious procedural or analytical issues with the study. The alternative, using property estimates computed via models or property relationships are less desirable. The accuracy/precision of an estimated property value depends on the estimation method used and how well the chemical/substance being measured fits the method's domain of applicability. • When more than one estimation method is available within EPI Suite™, the rationale for selecting one	There are two K_{OC}-estimation methods included in the EPI Suite™ KOCWIN module. The value produced by regression from log K_{OW} was presented in the draft risk evaluation and is somewhat greater than the value estimated using the molecular connectivity index (MCI) method (log K_{OC} = 2.95 by log K_{OW} and 1.98 by MCI). Table 2-1 has been edited to present both estimated log K_{OC} values, in addition to the measured value reported in the PhysProp database. Although the physical and chemical properties selected for use in the PCE risk evaluation were primarily drawn from the PhysProp database in EPI Suite™, those data were selected from among the values collected from the publicly-accessible Reaxys, ChemSpider, STN/CAS, and PhysProp (integrated into EPI Suite™) databases and from data submitted to EPA under the authority of various TSCA sections. EPA appreciates the comment on assigning separate data quality ratings to each module within EPI Suite™. EPA will include this suggestion when data quality evaluation processes and metrics are revised based on the peer review of TSCA systematic literature review processes by the

	estimation method over another should be provided. Instead of assigning high quality to all values estimated within EPI Suite™, the Committee recommended that it is more appropriate to rank the values based on the reliability of the estimation method. For example, quantitative property-property relationships (QPPRs) are generally more reliable than quantitative structure property relationships (QSPRs).	National Academies of Sciences, Engineering, and Medicine (NASEM) TSCA Committee.
SACC	**SACC COMMENTS:** Many of the references listed in Table 2-1 are from the 1980s, suggesting that the physical-chemical property database within EPI Suite™ has not been recently updated. Some description of how frequently EPI Suite™ has been updated since its peer review in 2007 should be added.	The environmental fate characteristics presented in Table 2-1 of the draft risk evaluation (*i.e.*, prior to the inclusion of several physical and chemical properties in response to another comment) were obtained via searches of peer-reviewed literature as described in *Application of Systematic Review in TSCA Risk Evaluations* (US EPA, 2018). Measured data for the environmental fate properties in Table 2-1 of the draft risk evaluation are not included in the EPI Suite™ PhysProp database. Most of the fate data collected from peer-reviewed literature was published between the mid-1970s and the early 1990s, thus most of the selected values presented in Table 2-1 are from the 1980s. Since the 2007 SAB review of EPI Suite™, the bioaccumulation factor (BAF) and log K_{OC} models were updated in 2015-2017 to improve predictions for silicon-containing substances. The physical and chemical properties reported in the EPI Suite™ PhysProp database are updated periodically, most recently on April 6, 2015.
SACC	**SACC COMMENTS:** Recommendation: Remove or reword any direct inference of environmental transport rates being derived from equilibrium properties. Kinetics or rates of flux from one phase to another cannot be directly inferred from equilibrium properties. For example,	The risk evaluation document has been revised to avoid implying rates from Henry's Law constants. However, it is noted that volatilization rates are controlled by resistances to mass transfer. In two-film theory, the mass-transfer coefficient associated with volatilization is directly related to the Henry's law constant.

	the rate of volatilization depends on environmental conditions such as temperature, wind speed, and differences in chemical concentration between the environmental phases of interest (*e.g.*, air, water, soil). Sorption coefficients like K_{oc} are also assumed to reflect equilibrium partitioning into the organic matter of the environmental solid, while sorption kinetics depend on chemical and sorbent combination.	
SACC, 42	**SACC COMMENTS:** Recommendation: Use actual emissions of PCE to all environmental compartments as inputs to an EPI Suite™ fugacity model capable of displaying concentrations in compartments. The use of default model inputs in Fugacity Level 3 and Sewage Treatment Plant (STP) models within EPI Suite™ are not appropriate especially when release data or reasonable estimates are available. • EPA should use a Fugacity Level 3 model to report predicted concentrations not just percentages. The percentage distribution obtained from any fugacity model depends on the size of the compartments, making percentages misleading. For example, since the default size of the air compartment is much larger than all others, the percentage of total releases in the air may still be relatively large even when air concentrations are relatively low. • In the PCE Problem Formulation document, EPA provides estimates of PCE releases to the atmosphere, water, and soil. Using those release estimates as inputs into the EPI Suite™ fugacity model instead of the defaults used to produce the values reported in the draft risk evaluation demonstrates that PCE released from the COUs assessed in this evaluation will partition from air into water. The EPI Suite™ fugacity model predicts an	The Level III fugacity model in EPI Suite™ was not used to determine any specific environmental concentrations of PCE. The model was only used to qualitatively assess how PCE will behave in specific media (*i.e.*, setting the model to 100% emission to a single medium) in order to inform development of Figure 2-1. The predicted environmental concentrations presented in the risk evaluation were estimated using E-FAST, which accounts for the relative distribution of releases among media.

	aqueous PCE concentration that is almost 300 times larger than the concentration directly discharged into the water. This may be a reasonable estimate for surface water bodies near COUs assuming a continuous release of PCE into the atmosphere. **PUBLIC COMMENTS:** Several peer reviewers commented that modeling using the Level III fugacity model seemed to indicate that PCE emissions to the air could ultimately result in higher concentrations in the water. However, there are a number of assumptions and limitations to the model. EPA should clarify these assumptions and limitations in its final risk evaluation of PCE to more fully explain why EPA's approach was appropriate.	
42	**PUBLIC COMMENTS:** Fugacity modeling is an important tool that can be used to inform expected distribution in the environment. However, fugacity models require detailed understanding of the inputs in order to appropriately interpret the model outputs. This is particularly challenging for the EPI Suite™ model due to the setup of the interface. • Fugacity modeling should be conducted as a tiered process. Multimedia models associated with the Mackay group of Trent University are available via the Chemical Properties Research Group website, including Level I and Level II models, that can provide access to the various inputs. Also, these models create a graphical output that helps to put the fugacity information and related processes into perspective. For example, advection is particularly important to consider for PCE due to the high volatility.	The Mackay Level III fugacity model (https://www.trentu.ca/cemc/resources-and-models/level-iii-model) was used in development of the qualitative fate diagram (Figure 2-1) but was not used for quantitative exposure assessments. The inputs to the model were releases to air, land, and water scaled PCE release rates as reported in Table 2-7 of the PCE problem formulation document (US EPA, 2018); physical and chemical properties as presented in Table 1-1 of the risk evaluation; and slow aerobic and anaerobic biodegradation and metabolism (half-life = 1000 hours).

	• EPA should provide more detail regarding the inputs for fugacity modeling and explain limitations associated with this information risk assessment.	
SACC	**SACC COMMENTS:** The assumption of no discharges to water due to volatility are erroneous as pointed out in the trichloroethylene (TCE) dialogue.	EPA agrees with this comment. As the Mass Balance in Figure 1-2 shows, wastewater discharges of PCE are very low in comparison to air emissions but are not zero. Estimates of wastewater discharges for the various conditions of use of PCE are presented in Section 2.2 Releases to the Environment.
SACC	**SACC COMMENTS:** Recommendation: Increase the emphasis on using the bioaccumulation factor, which considers water and food contributions, in describing the likelihood that PCE accumulates in organisms. Given the log K_{ow} value is near 3, it is likely that PCE accumulates in organisms with limited biotransformation such as algae, having bioconcentration factors (BCFs) of 111-300, and invertebrates. A BCF of 312 or an estimated BCF of 46 should not be considered low.	Quantitative modeling of dietary exposure is done using E-FAST, for which bioconcentration factor (not bioaccumulation factor) is an input. Bioconcentration factors below 1000 are generally considered to be associated with "low" or "limited" bioconcentration potential. The risk evaluation has been revised to describe the bioconcentration potential for PCE as "limited" (Section 2.1.2, pg. 76).
SACC, 26, 29, 40	**SACC COMMENTS:** Recommendation: Expand the discussion on metabolic pathways and impact of transformation products and co-solvent contaminants that occur in drinking waters. The Committee recommended expansion of the discussion of the potential formation and the environmental fate of the hazardous transformation products and co-solvent contaminants including TCE, cis-1,2-dichloroethene, and vinyl chloride. Several of these are commonly detected together in drinking waters throughout the U.S. **PUBLIC COMMENTS:** EPA acknowledges that "PCE biodegradation products include potentially hazardous substances including	The impact of other chemicals is outside of the scope of the risk evaluation for PCE. The purpose of the risk evaluation under TSCA is to determine whether a chemical substance presents an unreasonable risk of injury to health or the environment, under the conditions of use. EPA acknowledges in Section 3.2.5.3.1 that "co-exposure to other pollutants and drugs may also have either an activating or inhibitory effect on PCE-metabolizing enzymes." As part of the problem formulation for PCE, EPA identified exposure pathways under the jurisdiction of other environmental statutes administered by EPA, including the Clean Air Act (CAA), the Safe Drinking Water Act (SDWA), the Clean Water Act (CWA), Comprehensive

	trichloroethylene, cis-1,2-dichloroethene and vinyl chloride." This statement presents a persuasive argument for incorporating PCE along with reviews of the other relevant chlorinated compounds in the top 10/top 20 priority chemicals. However, EPA fails to consider the known risks associated with PCE degradation in its draft risk evaluation. This oversight is particularly striking given that EPA recently conducted a TSCA risk evaluation for one of those degradation products (TCE), and it failed to consider PCE degradation as a source of TCE in that risk evaluation as well. EPA pretends as if those exposures and risks – which are directly attributable to PCE's known, intended, and reasonable foreseen use and disposal – do not exist. EPA should account for these risks in the final PCE risk evaluation.	Environmental Response, Compensation, and Liability Act (CERCLA) and the Resource Conservation and Recovery Act (RCRA). As explained in more detail in Section 1.4.2 of the Final Risk Evaluation, EPA believes it is both reasonable and prudent to tailor TSCA Risk Evaluations when other EPA offices have expertise and experience to address specific environmental media, rather than attempt to evaluate and regulate potential exposures and risks from those media under TSCA. Therefore, general population exposure via drinking water was not assessed in this risk evaluation. EPA did however consider the effects of metabolites within the context of human exposure via either occupational or consumer scenarios. Metabolism of PCE is discussed in Section 3.2.2.1.3 and 3.2.3.3.
Presentation of physical-chemical and fate properties		
SACC	**SACC COMMENTS:** Recommendation: Include the octanol-air partition coefficient (Koa) and dermal penetration properties in Table 1-1 or in a separate table. The dermal penetration properties recommended in the previous SACC reviews should be included in the PCE evaluation.	The K_{OA} value reported in the PhysProp database in EPI Suite™ has been added to the physical chemical properties table (Table 1-1).
SACC	**SACC COMMENTS:** Recommendation: Consider deleting properties listed in Table 1-1 that are not discussed or used in the evaluation. Flash point, auto-flammability, viscosity, refractive index, and dielectric constant are not discussed further or used in the draft risk evaluation. If the properties are not going to be used or discussed in the evaluation, they should be deleted from the table.	A consistent set of physical and chemical properties are presented across all of the risk evaluations, although some properties are used in only a subset of risk evaluations. The properties not used in this risk evaluation have not been removed from Table 1-1.

SACC	**SACC COMMENTS:** Recommendation: The estimates of water solubility, vapor pressure, and log K_{ow} should be moved to or repeated in Table 2-1. Water solubility, vapor pressure, and log K_{ow} have importance in assessing environmental fate and should be moved to or repeated in Table 2-1 to support this discussion.	The water solubility, vapor pressure, log K_{OW}, and Henry's law constant have been added to Table 2-1
SACC	**SACC COMMENTS:** Recommendation: Report Henry's law values as dimensionless air-water partition coefficients. Partition coefficients directly show the relationship between chemical concentrations in the two phases that are in equilibrium; Henry's law constants should be reported as dimensionless air-water partition coefficients.	The Henry's law constant with the units atm-m3 /mol was converted to the dimensionless (concentration/concentration) value and added to the physical and chemical properties table (Table 1-1).
SACC	**SACC COMMENTS:** Recommendation: Add arrows to Figure 2-1 indicating the estimated quantities of all significant emissions into the environment and showing intercompartmental transport as equilibria not as one-way transport. • Several Committee members found the Conceptual Environmental Fate Diagram helpful and improved relative to that provided in previous TSCA chemical draft risk evaluations. • Other Committee members indicated that the improved figure continues to provide a misleading or inaccurate picture of PCE fate. The draft risk evaluation states: "Although transport and partitioning processes (green arrows) can occur in both directions, the image illustrates the primary direction of transport indicated by partition coefficients." • Some Committee members found this an oversimplification of a complex process. The primary direction of transport also depends on the environmental	Figure 2-1 qualitatively illustrates the expected environmental transport and degradation of PCE. It is based on the results of the Mackay Level III fugacity model (https://www.trentu.ca/cemc/resources-and-models/level-iii-model), which considers physical-chemical properties, release rates, and environmental conditions, and estimates transport kinetics. Figure 2-1 has been revised to include arrows pointing in both directions across interfaces where partitioning and transport occur, and the narrative has been revised to more thoroughly explain that partitioning and transport can occur in both directions. The revised narrative reads, "Because transport and partitioning processes (green arrows) can occur in both directions across an interface, the transport and partitioning pathways are illustrated with arrows pointing in both directions. For interfaces where one direction of transport and partitioning is expected to prevail based on release rates and partition coefficients, the primary

	compartment (*i.e.*, air, water, soil) into which the chemical is being introduced, rate of chemical introduction into the environment, rates of degradation, and chemical concentrations within the compartments. • An appropriate model along with kinetics information are needed to determine direction of interphase transfer. Arrows representing equilibrium partition coefficients should not be presented as unidirectional unless removal rates in one of the compartments is rapid compared to transport. Arrows indicating all significant emissions into the environment should also be added to the conceptual figure. For PCE, the draft risk evaluation estimates fugitive emissions to the atmosphere as the largest input. • These emissions are critical to understanding direction of the transport arrows. For example, if the concentration of PCE in the water is zero, PCE will move from the air into the water until Henry's law constant is attained. Figure 2-1 should also include the formation of hazardous intermediates.	direction of transport is indicated by a wider arrow. However, the direction of transport in a given locality depends on the site-specific properties of environmental media, weather conditions, PCE release rates, degradation and transformation rates, and PCE concentrations within environmental compartments." Because intermediates and transformation products are not in the scope of this risk evaluation, they were not added to Figure 2-1.
SACC	**SACC COMMENTS:** Recommendation: Refine the mass balance assessment associated with PCE life cycle analysis diagram in Figure 1-1. The Committee generally agreed that the PCE life cycle diagram in Figure 1-1 was helpful in understanding how much PCE is used, where it ends up, and clarifying which conditions of use (COUs) would be evaluated in this draft risk evaluation. However, Committee members indicated that it would help clarify how these COUs fit into the overall PCE exposure if EPA would highlight that most (80-85%) PCE produced and not used as feedstock for	EPA has completed a mass balance for PCE using reasonably available data. An overview of the mass balance has been added to Section 1.4.1 and a new Appendix C has been added to provide the details of the mass balance.

	producing other chemicals is ultimately emitted into the atmosphere.	
Uncertainty associated with fate values		
SACC	**SACC COMMENTS:** Recommendation: Report the variability in estimates across quality studies associated for each of the physical-chemical properties. • Including low and high estimates of property values allows for better optimization of hazard assessments and better understanding of the sources of uncertainties in the risk estimates. The only values showing ranges in Table 1-1 and Table 2-1 are for degradation properties (*e.g.*, biodegradation, hydrolysis, photolysis). • Include the additional physical-chemical properties suggested by Committee members in Table 1-1. • All physical-chemical properties have variability associated with them even if standard or high-quality measurement methods were used. Recommendation: Confidence intervals (CIs) should be provided for the physical-chemical and environmental fate properties used in the evaluation. The experimental values obtained from the database contained within EPA's EPI Suite™ program and the estimated values derived from routines within the program are rated in the quality review process to be high quality. • Several Committee members expressed concern that the estimates lack information regarding uncertainty. Both property variability and estimate uncertainty can impact the significance of some of the conceptual pathways. • The Committee recommended that the discussion on data quality assessment and variability for the properties obtained from EPI Suite™ and other references be expanded. The Committee noted that the procedures	Physical-chemical and fate property information were evaluated for data quality as described in *Application of Systematic Review in TSCA Risk Evaluations* (US EPA, 2018). EPA examined the available evidence and selected values for use in the risk evaluation. Due to the differences among study conditions, generating confidence intervals for each physical-chemical and fate property would be very complex or even impossible, because EPA does not have a full extracted dataset of physical-chemical properties and there are broad differences in fate study conditions. However, the range and quality of reasonably available data were considered in the fate and exposure assessment of PCE. Full systematic review was not completed for PCE physical-chemical properties, rather, following a standard process EPA identified physical-chemical property values from high-quality databases and indexes. Thus, EPA does not have the fuller extracted dataset needed to present statistics such as variability and minimum/maximum.

	used for assessing acceptability are much more well defined for toxicology studies than the fate studies. It would be helpful if there was a better description of how the quality of the physical-chemical and fate properties are assessed. In addition, several Committee members recommended providing CIs around each property estimated.	
SACC	**SACC COMMENTS:** It is not clear how variability in estimates of physical-chemical properties impact the conceptual model for environmental releases and the environmental fate models (*i.e.*, E-FAST, fugacity) used to provide environmental exposure concentration estimations. Estimates of variability across methods and CIs within methods can support the sensitivity analysis needed to determine which properties have higher influence on the outcome of the qualitative pathway analysis.	The E-FAST model uses several physical-chemical and fate properties as inputs (vapor pressure, bioconcentration factor, removal in wastewater treatment, sorption to sludge, groundwater migration). The inputs for the Mackay Level III fugacity model (https://www.trentu.ca/cemc/resources-and-models/level-iii-model) include degradation half-lives in environmental media, emission rates, organic carbon partition coefficient (K_{OC}), melting point, vapor pressure, Henry's law constant, and octanol-water partition coefficient (K_{OW}).
SACC	**SACC COMMENTS:** Recommendation: Clarify how uncertainty in biodegradation rates are accounted for in assessing persistence and estimates of removal from wastewater. • PCE contamination of groundwater is widespread and the Committee agreed that complete biodegradation to carbon dioxide and chloride is unlikely to take place except under specific environmental conditions. • The draft risk evaluation states: "PCE biodegradation rates in the environment may vary based on factors including level of oxygenation, microorganisms present, and microorganisms' previous exposure and adaptation to PCE. This uncertainty in biodegradation rates was considered in the assessment of persistence in aerobic and anaerobic environments and estimates of removal from wastewater." One Committee member could not	The rate of aerobic biodegradation is the key area of uncertainty in the fate assessment for PCE, as described in Section 2.1.3. Clarification of how uncertainties were handled was added to Section 2.1.3: "The full range of reported biodegradation rates was used in qualitative assessments (*e.g.*, sediment assessment, Section 4.1.2). The most conservative ends of the data distributions (*i.e.*, longer half-lives) were used in quantitative assessments, including estimated removal in wastewater treatment (Section 2.3.1.1.3)." The uncertainty in biodegradation rates was not quantitatively assessed, as differences in study methods complicate direct comparisons.

	find a description of how uncertainty in degradation rates are incorporated when estimating persistence and removal from wastewater. Simply acknowledging an uncertainty is inadequate. Where there are significant uncertainties, the potential that unacceptable risks are allowed to pass undetected should be minimized with adjustment factors, uncertainty factors (UFs), or estimates from conservative ends of data distributions.	

2. Environmental Exposure and Releases

Environmental Exposure and Releases		
Charge Question 2.1: Please comment on the data and approaches used to estimate the amounts of wastewater discharge for the different scenarios. **Charge Question 2.2:** Please comment on the approaches, models, and data used in the water release assessment including comparison to monitored data. **Charge Question 2.3:** Please provide any specific suggestions or recommendations for alternative data or estimation methods, including modeling approaches, that could be considered by the Agency for conducting or refining the water release assessment and relation to monitored data.		
#	**Summary of Comments for Specific Issues Related to Charge Question 2**	**EPA/OPPT Response**
Exposure pathways included in the environmental exposure assessment		
SACC	**SACC COMMENTS:** Recommendation: The potential impact of PCE contaminated groundwater infiltrating into surface water should be discussed and included in the conceptual environmental fate diagram (Figure 2-1 of the draft risk evaluation). The potential for PCE contaminated groundwater infiltration into surface water (or conversely surface to groundwater) is not discussed in the draft risk evaluation. Even if contaminated groundwater is subject to other regulatory jurisdictions, the potential infiltrations of PCE contaminated groundwater into surface waters should be discussed along with its potential to increase exposures to aquatic organisms.	Figure 2-1 and Section 2.1.2 were revised to reflect the potential for transport between surface and groundwater. A double-headed arrow was added between the groundwater and surface water compartments in Figure 2-1. The following sentence was added to Section 2.1.2: "Because it has moderate mobility through soil and sediment, PCE may be transported between groundwater and surface water where local hydrologic conditions permit." Exposures to aquatic organisms in surface water were assessed in the risk evaluation.
SACC	**SACC COMMENTS:** Recommendation: Include discussion of the potential of surface runoff and storm water runoff as sources of environmental release of PCE. The PDM is an appropriate tool for evaluating downstream concentrations of toxicants. However, PDM was developed to support analysis of non-point source run-off, not the point source discharges that are the focus of the draft risk evaluation. • Several Committee members considered use of the PDM model as further support of the inappropriate exclusion of releases from	Wherever possible, EPA used site specific 7Q10 flow metrics to estimate flows at waterbodies receiving known facility releases based on COUs. EPA did not assess surface and storm runoff as environmental releases. For still water bodies, a dilution factor approach is applied since no available 7Q10 metric is available. If neither of these metrics are available a flow associated with the industry sector of the discharging facility was

	surface runoff to water bodies in the analysis reported in the draft risk evaluation. Two of three discussants recommended including surface runoff and storm water runoff as environmental releases of PCE.	chosen to approximate the instream flow. This approach is consistent across all risk evaluations. EPA used the best available science to evaluate discharges of PCE and its environmental concentrations.
SACC, 26	**SACC COMMENTS:** Recommendation: Include land application of biosolids and associated groundwater contamination as environmental releases of PCE. • The Committee agreed that omitting land application of biosolids following wastewater treatment in the discharge discussion leaves a gap in the exposure data for environmental receptors and in potential groundwater exposures for humans. Surface application of biosolids should be included in this TSCA evaluation, at least for releases that originate from the COUs being considered. • Considering all landfills out of scope means that releases from landfills that specifically receive PCE from TSCA-covered sources are not included in the assessment of environment impacts. These landfills are likely to be active and potentially contribute to surface and groundwater releases. The assumption that these landfills do not contribute PCE to aquatic environments should be assessed by examining levels in neighboring water systems. Since active landfills are also likely to have active groundwater monitoring, the link between groundwater contamination and contamination of neighboring water sources can be quantified. **PUBLIC COMMENTS:** EPA did not analyze PCE for other releases to land during risk evaluation, including biosolids application to soil as indicated in the Problem Formulation. However, we agree, in general, with EPA's decision not to conduct risk estimations for land applied biosolids pathways.	Clarifying language about what pathways are under the jurisdiction of other EPA-administered statutes, including pathways involving biosolids and landfills, has been added to Section 1.4.2 of the Risk Evaluation. As explained in more detail there, EPA believes it is both reasonable and prudent to tailor TSCA risk evaluations when other EPA offices have expertise and experience to address specific environmental media, rather than attempt to evaluate and regulate potential exposures and risks from those media under TSCA. EPA believes that coordinated action on exposure pathways and risks addressed by other EPA-administered statutes and regulatory programs is consistent with statutory text and legislative history, particularly as they pertain to TSCA's function as a "gap-filling" statute, and also furthers EPA aims to efficiently use Agency resources, avoid duplicating efforts taken pursuant to other Agency programs, and meet the statutory deadline for completing Risk Evaluations. EPA has therefore tailored the scope of the Risk Evaluation for PCE using authorities in TSCA Sections 6(b) and 9(b)(1).

46	**PUBLIC COMMENTS:** EPA does not evaluate occupational exposures from spills and other accidental releases of PCE. Such exposures are not only reasonably foreseen but are virtually inevitable in an industrial workplace. There have been documented spills of PCE, both within the workplace and to the environment, and ATSDR warns that "[PCE] may also be inhaled from accidental spills." Moreover, there are thousands of spills and accidental chemical releases each year, making such exposures a reasonably foreseen occupational hazard. There have been documented spills of PCE to the environment, and accidental releases are considered to be "reasonably . . . expected" under the Clean Water Act (CWA), the National Environmental Policy Act, and other environmental laws. Under TSCA, as well, EPA must evaluate the risks posed by reasonably foreseen spills and other occupational releases of PCE.	Spills and leaks generally are not included within the scope of a TSCA risk evaluation because in general they are not considered to be circumstances under which a chemical substance is intended, known or reasonably foreseen to be manufactured, processed, distributed, used, or disposed of. To the extent there may be potential exposure from spills and leaks, EPA is also declining to evaluate environmental exposure pathways addressed by other EPA-administered statutes and associated regulatory programs. First, EPA does not identify PCE spills or leaks as "conditions of use." EPA does not consider PCE spills or leaks to constitute circumstances under which PCE is manufactured, processed, distributed, used, or disposed of, within TSCA's definition of "conditions of use." Congress specifically listed discrete, routine chemical lifecycle stages within the statutory definition of "conditions of use" and EPA does not believe it is reasonable to interpret "circumstances" under which PCE is manufactured, processed, distributed, used, or disposed of to include uncommon and unconfined spills or leaks for purposes of the statutory definition. Further, EPA does not generally consider spills and leaks to constitute "disposal" of a chemical for purposes of identifying a COU in the conduct of a risk evaluation. In addition, even if spills or leaks of PCE could be considered part of the listed lifecycle stages of

		PCE, EPA has "determined" that spills and leaks are not circumstances under which PCE is intended, known or reasonably foreseen to be manufactured, processed, distributed, used, or disposed of, as provided by TSCA's definition of "conditions of use," and EPA is therefore exercising its discretionary authority under TSCA section 3(4) to exclude PCE spills and leaks from the scope of the PCE risk evaluation. The exercise of that authority is informed by EPA's experience in developing scoping documents and risk evaluations, and on various TSCA provisions indicating the intent for EPA to have some discretion on how best to address the demands associated with implementation of the full TSCA risk evaluation process. Specifically, since the publication of the Risk Evaluation Rule, EPA has gained experience by conducting ten risk evaluations and designating forty chemical substances as low- and high priority substances. These processes have required EPA to determine whether the case-specific facts and the reasonably available information justify identifying a particular activity as a "condition of use." With the experience EPA has gained, it is better situated to discern circumstances that are appropriately considered to be outside the bounds of "circumstances… under which a chemical substance is intended, known, or reasonably foreseen to be manufactured, processed, distributed in commerce, used, or disposed of" and to thereby meaningfully limit circumstances subject to evaluation. Because of the expansive

		and potentially boundless impacts that could result from including spills and leaks as part of the risk evaluation (*e.g.*, due to the unpredictable and irregular scenarios that would need to be accounted for, including variability in volume, frequency, and geographic location of spills and leaks; potential application across multiple exposure routes and pathways affecting myriad ecological and human receptors; and far-reaching analyses that would be needed to support assessments that account for uncertainties but are based on best available science), which could make the conduct of the risk evaluation untenable within the applicable deadlines, spills and leaks are determined not to be circumstances under which PCE is intended, known or reasonably foreseen to be manufactured, processed, distributed, used, or disposed of, as provided by TSCA's definition of "conditions of use." Exercising the discretion to not identify spills and leaks of PCE as a COU is consistent with the discretion Congress provided in a variety of provisions to manage the challenges presented in implementing TSCA risk evaluation. See *e.g.*, TSCA sections 3(4), 3(12), 6(b)(4)(D), 6(b)(4)(F). In particular, TSCA section 6(b)(4)(F)(iv) instructs EPA to factor into TSCA risk evaluations "the likely duration, intensity, frequency, and number of exposures under the conditions of use…," suggesting that activities for which duration, intensity, frequency, and number of exposures cannot be accurately predicted or

		calculated based on reasonably available information, including spills and leaks, were not intended to be the focus of TSCA risk evaluations. And, as noted in the preamble to the Risk Evaluation Rule, EPA believes that Congress intended there to be some reasonable limitation on TSCA risk evaluations, expressly indicated by the direction in TSCA section 2(c) to "carry out [TSCA] in a reasonable and prudent manner." For these reasons, EPA is exercising this discretion to not consider spills and leaks of PCE to be COUs. Second, even if PCE spills or leaks could be identified as exposures from a COU in some cases, these are generally not forms of exposure that EPA expects to consider in risk evaluation. TSCA section 6(b)(4)(D) requires EPA, in developing the scope of a risk evaluation, to identify the hazards, exposures, conditions of use, and potentially exposed or susceptible subpopulations the Agency "expects to consider" in a risk evaluation. This language suggests that EPA is not required to consider all conditions of use, hazards, or exposure pathways in risk evaluations. EPA has chosen to tailor the scope of the risk evaluation to exclude spills and leaks in order to focus analytical efforts on those exposures that present the greatest potential for risk.

		In the problem formulation documents for many of the first 10 chemicals undergoing risk evaluation, EPA applied the same authority and rationale to certain exposure pathways, explaining that "EPA is planning to exercise its discretion under TSCA 6(b)(4)(D) to focus its analytical efforts on exposures that are likely to present the greatest concern and consequently merit a risk evaluation under TSCA...." This approach is informed by the legislative history of the amended TSCA, which supports the Agency's exercise of discretion to focus the risk evaluation on areas that raise the greatest potential for risk. See June 7, 2016 Cong. Rec., S3519-S3520. In addition to TSCA section 6(b)(4)(D), the Agency also has discretionary authority under the first sentence of TSCA section 9(b)(1) to "coordinate actions taken under [TSCA] with actions taken under other Federal laws administered in whole or in part by the Administrator." TSCA section 9(b)(1) provides EPA authority to coordinate actions with other EPA offices, including coordination on tailoring the scope of TSCA risk evaluations to focus on areas of greatest concern rather than exposure pathways addressed by other EPA-administered statutes and regulatory programs, which does not involve a risk determination or public interest finding under TSCA section 9(b)(2). EPA has already tailored the scope of this risk evaluation using such discretionary authorities with respect to exposure pathways covered under the jurisdiction

		of other EPA-administered statutes and associated regulatory programs (see section 1.4.2). Following coordination with EPA's Office of Land and Emergency Management (OLEM), EPA has found that exposures of PCE from spills and leaks fall under the jurisdiction of RCRA. See 40 CFR 261.33(d) (defining in part a hazardous waste as "any residue or contaminated soil, water or other debris resulting from the cleanup of a spill into or on any land or water of any commercial chemical product or manufacturing chemical intermediate having the generic name listed [40 CFR 261.33(e) or (f)], or any residue or contaminated soil, water or other debris resulting from the cleanup of a spill, into or on any land or water, of any off-specification chemical product and manufacturing chemical intermediate which, if it met specifications, would have the generic name listed in [40 CFR 261.33(e) or (f)]"); 40 CFR 261.33(f) (listing tetrachloroethylene as hazardous waste no. U210). As a result, EPA believes it is both reasonable and prudent to tailor the TSCA risk evaluation for PCE by declining to evaluate potential exposures from spills and leaks, rather than attempt to evaluate and regulate potential exposures from spills and leaks under TSCA.
SACC, 29, 40, 42, 44	**SACC COMMENTS:** • Recommendation: Provide additional information about prevalence of exposures outside of the COUs in the draft risk evaluation, including from contaminated drinking water and air, and from soil vapor. As an example of the high frequency of	As part of the problem formulation for PCE, EPA identified exposure pathways under the jurisdiction of other environmental statutes administered by EPA, including the Clean Air Act (CAA), the Safe Drinking Water Act (SDWA),

	background exposures, a Committee member noted that USGS and California state drinking water records (California Water Boards, 2020) show that PCE is a common drinking water contaminant (~13% of sources have detects) and that areas with septic systems and urban areas have a greater likelihood for detects, suggesting non-point sources – those most easily addressed by TSCA – are important. In addition, the most common co-contaminant is TCE, and 13% of California drinking water sources have both PCE and TCE detected. Committee members suggested that the draft risk evaluation clarify how common is drinking water and groundwater contamination with PCE, perhaps by indicating what fraction produced is ultimately released to air or water. A mass balance analysis would be helpful along with a discussion on groundwater contamination and soil vapor impact on indoor air as an important source of PCE exposure. • Recommendation: Conduct exposure assessment for sediments and compare to the WHO and IRIS data. WHO (2006) clearly shows sediment values of 1-50 µg/kg in Germany and <5 µg/kg wet weight in the U.S. Sediment quality guidelines are also available in California for PCE. **PUBLIC COMMENTS: other sources of exposure should be included** PCE air emissions and contaminated groundwater, drinking water and soil are pervasive across the U.S. and contribute significantly to overall PCE exposure. • Because of PCE's volatility and widespread use in open processes, air emissions are a major source of exposure. ATSDR indicates that, "in general, the average concentration of PCE in outdoor air is <1 µg/m3 (0.15 ppb) for the majority of the locations sampled; however, several 24-hour average values exceeded 1 µg/m3." Although indoor and outdoor PCE levels vary over a wide range,	the Clean Water Act (CWA), the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), the Resource Conservation and Recovery Act (RCRA). As explained in more detail in Section 1.4.2 of the Final Risk Evaluation, EPA believes it is both reasonable and prudent to tailor TSCA Risk Evaluations when other EPA offices have expertise and experience to address specific environmental media, rather than attempt to evaluate and regulate potential exposures and risks from those media under TSCA. EPA believes that coordinated action on exposure pathways and risks addressed by other EPA-administered statutes and regulatory programs is consistent with statutory text and legislative history, particularly as they pertain to TSCA's function as a "gap-filling" statute, and also furthers EPA aims to efficiently use Agency resources, avoid duplicating efforts taken pursuant to other Agency programs, and meet the statutory deadline for completing Risk Evaluations. EPA has therefore tailored the scope of the Risk Evaluation for PCE using authorities in TSCA Sections 6(b) and 9(b)(1). As stated in Section 2.5.3.1 of the Problem Formulation for PCE, there are no national recommended water quality criteria for the protection of aquatic life for perchloroethylene. The water quality criteria for perchloroethylene developed by EPA under the Clean Water Act is for the protection of human health not for aquatic

	the higher concentrations reported by ATSDR present lifetime cancer risks – without considering other sources of exposure – that exceed EPA's 1x10-6 threshold for unreasonable cancer risk to the general population under TSCA. • PCE is a significant concern at contaminated sites within the purview of the EPA Superfund program. ATSDR reports that PCE is "in at least 949 of the 1,854 hazardous waste sites that have been proposed for inclusion on the EPA National Priorities List (NPL)." There are undoubtedly far more sites with PCE contamination. Contaminated sites are often the result of spills and leaks from dry-cleaning facilities and industrial operations such as degreasing. **PUBLIC COMMENTS: air and wastewater are already regulated** • EDC and VCM facilities are regulated under the Clean Air Act (CAA) by EPA's Hazardous Organics National Emission Standards for Hazardous Air Pollutants (NESHAP) rule, which established maximum achievable control technology (MACT) standards to regulate the emissions of hazardous air pollutants from major source facilities. PCE is regulated as a hazardous air pollutant (HAP) under section 112 of the CAA. Under the Hazardous Organics NESHAP rule, emissions of the HAPs at EDC/VCM facilities are highly controlled, including leak detection and repair requirements to prevent occupational exposure. As a result, all HAPs produced from this source category including PCE have been controlled. • EPA's evaluation of environmental discharges to wastewater notes that OCPSF Effluent Guidelines and Standards exist for PCE for several industries, which are national regulatory standards set by EPA for wastewater discharges to surface water and municipal sewage treatment plants. It is unclear why further evaluation of these discharges are necessary as the Effluent Guidelines and Standards appear to be sufficient for that purpose.	life. Therefore, the developed Effluent Guidelines may not be sufficient to protect aquatic organisms from unreasonable risks presented by perchloroethylene in waterways. EPA considered discharges from regulated sites with respect to their risks to aquatic organisms. To accurately characterize PCE exposure, EPA took a conservative approach that included identifying and reviewing national scale monitoring data which included PCE effluent discharges. EPA conducted a qualitative assessment of sediments (Section 4.1.3) which acknowledges that PCE may be retained in sediments or may undergo biodegradation. The upper limit of sediment concentrations reported in Germany (50 ug/kg) aligns with the chronic concentration of concern (COC) for aquatic organisms (50 ug/kg). On-site releases to the environment of PCE at Superfund sites and subsequent exposure of the general population or non-human species do not fall under the scope of this TSCA evaluation. Spills and leaks generally are not included within the scope of a TSCA risk evaluation because they are not considered to be circumstances under which a chemical substance is intended, known or reasonably foreseen to be manufactured, processed, distributed, used, or disposed of. Clarifying language on exposure pathways and risks under the jurisdiction of other EPA-administered statutes, including CERCLA, has been added to section 1.4.2 of the final risk

		evaluation document. An analysis of the 2016 cleansed dataset was also conducted to determine if any monitoring station may be associated with Superfund sites that could be contributing to PCE releases, and thus would not fall under the scope of this TSCA evaluation. The EFAST modeling program used in this assessment does not offer the ability to model multiple releases within the same hydrologic unit or stream reach.
SACC	**SACC COMMENTS:** Recommendation: The impact of similar co-contaminants being discharged in wastewaters and commonly detected together in drinking water at the same time as PCE should be evaluated or at least discussed within the evaluation. Wastewater loadings associated with PCE likely contain similar chlorinated co-contaminants (other chlorinated solvents having similar toxicologic impacts) or PCE anaerobic biodegradation products (TCE, cis-1,2-dichloroethene, and vinyl chloride).	Co-contaminants are not in the scope of this risk evaluation. EPA will separately evaluate any co-contaminants that may be discharged together with PCE or biodegradation products of PCE when evaluating those chemical substances.
45	**PUBLIC COMMENTS:** Wastewater discharges were estimated using data from TRI and DMR, which were assigned a low-quality score by EPA for methodology, accessibility/clarity, and variability/uncertainty, while the overall quality of data was scored as medium. Neither TRI nor DMR include data on how each reporter estimated their releases; contain metadata (*e.g.*, release frequency, process/unit operation that is the source of the release) other than the media of release (accessibility/clarity); or address variability/uncertainty in the reported estimates. EPA guidance in these programs, such as using one-half the laboratory detection limit, rather than "non-detect" when reporting emissions,	While these datasets scored low in some metrics, they scored high in other metrics so the overall data quality rating for each dataset is medium. Uncertainties around the data are captured in the overall confidence in results. EPA acknowledges that while reporting guidance on non-detects may artificially inflate reported releases, such guidance may also artificially lower reported releases (where concentrations are less than the detection limit but greater than one-half the detection limit). EPA also does not have reasonably available data to indicate when reported releases are based on

	can artificially inflate reported releases, creating the illusion of emissions where none exist.	such a methodology to further capture uncertainties in the estimates. EPA acknowledges the uncertainties of the E-Fast model in section 2.3.4.4. The DMR, TRI and CDR databases represent comprehensive sources of environmental release data for the US; however, there are limitations and assumptions involved. These data are self-reported by facilities and subject to minimum reporting thresholds; therefore, they may not capture releases from smaller facilities (*i.e.*, environmental releases may be underestimated). Some of the reported information may be inaccurate because it reflects approximations rather than actual emissions or release data. TRI is based on mass balances and emission factors, whereas DMR is based on representative pollutant monitoring data at facility outfalls (mg/L) and corresponding wastewater discharge (million gallons per day). The assumed maximum days per year of release from each facility is uncertain and may in some cases lead to underestimation of daily release rates. Use of release information from facility data used to estimate environmental exposures is constrained by a number of uncertainties including: the heterogeneity of processes and releases among facilities grouped within a given sector; assumptions made regarding sector definitions used to select facilities covered under the scope; and fluctuations in the level of production and associated environmental releases

		incurred as a result of changes in standard operating procedures. Uncertainty may also arise from omissions in the reporting data, such as sectors that are not required to report, facilities that fall below the reporting threshold, or facilities for which forms simply are not filed.
Consideration of specific industry releases in the environmental exposure assessment		
SACC	**SACC COMMENTS:** Recommendation: Add a table to the draft risk evaluation showing the distribution of PCE releases to the environment by OES category and proportionally allocate any uncategorized releases to OES categories. The Problem Formulation document provided the categorization of releases to COU Categories. In the problem formulation, 28.7% of all PCE releases to the environment are not categorized. • One Committee member recommended that a categorization table (like Problem Formulation Table 2-7) should be presented in the draft risk evaluation, and information should be obtained to properly allocate the un-categorized release amount. If this cannot be done, the un-categorized release amount should be proportionally allocated to the OES categories. This would reduce (one source of) uncertainty associated with excluding from consideration these uncategorized releases.	EPA categorized all direct and indirect wastewater discharges reported in TRI and assessed them in the appropriate OES. EPA also added a mass balance to the RE that further describes the end-of-life (including releases) of PCE in the U.S. No attempt was made to categorize additional releases as they were not in scope of the risk evaluation. EPA acknowledges comment and will consider this and other approaches for improving the presentation of this information in future REs.
SACC	**SACC COMMENTS:** Table 2-5, Maskant for milling: One Committee member remarked that the uncertainty discussion for maskants for milling illustrates the limitations of assessing discharge by facilities when there are no data for the industries. The use of average production volume to represent volume for non-reporting facilities is not protective of the environment or of human health. High centiles of production volumes should be assumed in the absence of data. Also, in the absence of data on releases, the conservative approach is to assume 100% discharge to	Public comments received for the draft risk evaluation have provided further breakdown on the use-rates for 65 of the expected 71 sites using PCE-based maskants. These have been updated in the Supplemental Occupational Exposure and Environmental Release report. EPA believes an assumption of 100% release to water is unreasonable given the volatility of PCE, the limited opportunity for PCE to come into contact

	water. This should be used for each COU and facility for which there are no data on releases to environmental media. When there is high uncertainty associated with the number of facilities engaged in the COU and/or the extent of releases, when the estimated hazard quotient (HQ) is <1, the risk determination should conclude that "unreasonable risks cannot be ruled out" rather than "unreasonable risks are not found."	with water in maskant operations, and because facilities performing maskant operations are regulated by the Metal Finishing Effluent Guidelines which would limit the concentration of PCE present in wastewater discharges from these facilities. Furthermore, public comments indicate 93-95% of the PCE-based maskants are recaptured and returned to the manufacturer for production of new maskant. Therefore, the total release to any environmental media is expected to be less than 5-7% of the total use volume for the OES. EPA considers the uncertainties associated with each condition of use, and how the uncertainties may result in a risk estimate that overestimates or underestimates the risk. Based on such analysis, EPA determines whether or not the identified risks are unreasonable. EPA has revised the unreasonable risk determinations for all conditions of use for risk to the environment (aquatic organisms) based on revised aquatic hazard values for acute exposures to fish, amphibian, and invertebrates, an updated acute COC, an updated algae end point and COC, and updates to the days of exceedance for the sites assessed.
SACC	**SACC COMMENTS:** Table 2-5, Adhesives, Sealants, Paints, and Coatings: One Committee member noted that while it is true that the evaporation is not accounted for, neither is the partitioning of PCE vapor back into surface waters. That uncertainty must also be captured for this COU. This is also true for all others where EPA down-plays wastewater releases due to lack of evaporation estimates (wipe cleaning, etc.).	In Table 2-5 and Section 2.2.1 in general, EPA is discussing PCE that enters wastewater streams within the facility fence line and then crosses the fence line in the wastewater stream. Discussions of PCE that crosses the fence line through other pathways, such as air emissions, that subsequently partition back into waterways or other environmental media are related to fate and

		transport of the PCE not operations within a facility.
SACC	**SACC COMMENTS:** Recommendation: Further justify/document the exclusion of septic tank discharges, which can contaminate groundwaters and ultimately surface waters. Only indirect (released to environment after wastewater treatment) or direct releases into surface waters are considered in the PCE evaluation. There are over 20 million septic tank users in the U.S. Septic tank discharges into the environment is a pathway that should be considered in this draft risk evaluation or, at a minimum, the draft risk evaluation should provide sufficient discussion to document why this is excluded. • EPA indicated that local boards of health have regulatory control over PCE discharges from septic tanks. The Committee concluded that this is not an adequate justification for exclusion. Committee members expressed concerns that it is virtually impossible for local boards of health to address PCE contamination of groundwater via disposal of consumer products into septic systems. • For this reason, introduction of PCE from septic systems into groundwater and surface water, with resulting exposure via drinking water, soil vapor, and indoor air contamination, are additional exposures that should be addressed in order to understand risks associated with the COUs.	As explained in more detail in section 1.4.2 of the final risk evaluation, EPA believes that coordinated action on exposure pathways and risks addressed by other EPA-administered statutes and regulatory programs is consistent with statutory text and legislative history, particularly as they pertain to TSCA's function as a "gap-filling" statute, and also furthers EPA aims to efficiently use Agency resources, avoid duplicating efforts taken pursuant to other Agency programs, and meet the statutory deadline for completing Risk Evaluations. EPA has therefore tailored the scope of the Risk Evaluation for PCE using authorities in TSCA Sections 6(b) and 9(b)(1).
SACC	**SACC COMMENTS:** Recommendation: Consider soliciting public comment on the decision to not consider discharges from septic systems because local boards of health regulate them. The "regulatory nexus" decision not to consider discharges from septic systems because local boards of health can regulate them is worthy of public comment and SACC review.	EPA is not considering soliciting public comment for not assessing discharges from septic systems. EPA believes that coordinated action on exposure pathways and risks addressed by other EPA-administered statutes and regulatory programs is consistent with statutory text and legislative history, particularly as they pertain to TSCA's function as a "gap-filling" statute, and also

		furthers EPA aims to efficiently use Agency resources, avoid duplicating efforts taken pursuant to other Agency programs, and meet the statutory deadline for completing Risk Evaluations. EPA has therefore tailored the scope of the Risk Evaluation for PCE using authorities in TSCA Sections 6(b) and 9(b)(1).
SACC, 26, 42	**SACC COMMENTS:** One Committee member noted that the draft risk evaluation reports some PCE facilities that did not appear to have an NPDES permit, or it was not clear where releases from those facilities were going. In these cases, it would seem reasonable for EPA to follow up with those facilities to clarify. **PUBLIC COMMENTS: facilities without NPDES permits should receive EPA follow-up** EPA identified elevated acute and chronic risk to aquatic organisms from direct release of PCE to surface water from the Incorporation into Formulation COU at a single facility. The facility showing risk has a NPDES permit. However, one of the facilities that was not identified with risk lacked an NPDES permit. EPA should follow up on any facility that lacks an NPDES permit and is suspected of releasing PCE to surface waters. **PUBLIC COMMENTS: facilities with NPDES permits are already regulated** The risk characterization identifies several OESs with RQs greater than 1.0 for a number of discharging days. EPA should correct the flaws in these risk characterizations, including the duplicative evaluation of industries and facilities that are currently regulated for their discharges of the chemical (*e.g.*, NPDES permit).	Compliance/non-compliance with statutory requirements outside of TSCA is not a component to consider when conducting Risk Evaluations under TSCA. Compliance/non-compliance issues are addressed under separate enforcement authorities for each statute along with settlement of identified non-compliance issues.

42	**PUBLIC COMMENTS:** EPA identifies 12,822 commercial dry-cleaning establishments anticipated to discharge PCE. EPA indicates that these facilities are likely discharging to local sewer systems that are serviced by domestic POTWs. Moreover, EPA states, "[v]arious states may have regulations on permissible disposal and treatment options for produced separator water containing PCE," and provides example calculations of particular POTWs receiving effluent from commercial dry-cleaning establishments. It is unclear whether this analysis is necessary given the dilution that will occur within the system, the volatilization during wastewater treatment, and the existing local regulations for these establishments	EPA acknowledged that some states may regulate discharges from dry cleaners; however, such regulations are not expected to be universal across states and it is unclear if existing regulations by states adequately address risks assessed under TSCA. Removal during treatment, including via volatilization, were considered in the E-FAST modeling for dry cleaning sites. EPA uses all reasonably available supporting data to inform its risk evaluations.
26, 41, 47, 51	**PUBLIC COMMENTS:** TSCA requires EPA to evaluate "legacy uses," which EPA has characterized as referring to "circumstances associated with activities that do not reflect ongoing or prospective manufacturing, processing, or distribution." However, legacy uses do not appear in EPA's draft risk assessment for PCE. This could result in an underestimation of the exposure risks of PCE. • The court decision in Safer Chemicals Healthy Families v. EPA (9th Cir. 2019) obligates EPA to consider legacy uses and disposal when conducting assessments in the Existing Chemicals Risk Evaluation program. EPA must include a discussion of this topic in the final PCE risk evaluation, providing either documentation of the absence of any legacy uses or identifying and then assessing them to the fullest degree for both environmental and human health consequences. • To fulfill its statutory mandate to "[address] the risks of injury to health or the environment" posed by PCE, EPA must consider all forms of PCE's use and disposal. Failure to do so results in an incomplete accounting of the risks of injury that PCE presents. • Legacy exposure contributes to the rate of background exposure to individuals and may result when people live or work in	EPA did not identify any "legacy uses" (*i.e.*, circumstances associated with activities that do not reflect ongoing or prospective manufacturing, processing, or distribution) or "associated disposal" (*i.e.*, future disposal from legacy uses) of PCE, as those terms are described in EPA's Risk Evaluation Rule, 82 FR 33726, 33729 (July 20, 2017). Therefore, no such uses or disposals were added to the scope of the risk evaluation for PCE following the issuance of the opinion in *Safer Chemicals, Healthy Families v. EPA*, 943 F.3d 397 (9th Cir. 2019). EPA did not evaluate "legacy disposal" (*i.e.*, disposals that have already occurred) in the risk evaluation, because legacy disposal is not a "condition of use" under *Safer Chemicals*, 943 F.3d 397. EPA described background exposures in the uncertainty sections (2.4.2.6, 4.2.5.4), acknowledging that the risk estimations in the Risk Evaluation may be underestimations,

	environments that contain legacy chemicals as well as when legacy disposals cause individuals to come into contact with a chemical substance through the air, water, or another exposure pathway. Not evaluating background exposure from legacy uses in assessing risk is contrary to EPA's mandate to "address risks of injury to health or the environment" by PCE. • Legacy exposures to PCE are of particular concern in New York City due to the presence of PCE in detectable quantities in soil vapor in many locations. Of 539 brownfield sites in New York City tested between 2013 and 2020, 497 (92%) had detectable concentrations of PCE in the soil vapor. Many of these sites had no prior site history of PCE use. Testing for concentrations of PCE in soil vapor or groundwater is not routinely conducted for most construction projects in New York City or throughout the U.S., so safety measures may not be implemented. The extent of exposure is poorly understood. Nearly half of the concentrations in the soil vapor from those 497 sites exceed EPA's reference concentration (RfC), and 86.5% exceed the concentrations corresponding to a 1-in-100,000 risk of cancer. While concentrations in soil vapor do not directly correspond to indoor air concentrations, the frequent detection of high concentrations in this small sample is indicative of a widespread and generally disregarded problem. Legacy exposures to PCE are of concern in New York City, and likely elsewhere in the country, and should be considered by EPA. • Not evaluating background exposure from legacy uses in assessing the risk a chemical substance would result in inadequate protections for residents of New York City and other jurisdictions. In order to accurately address the risks PCE may pose to human health and the environment, the use and unsafe disposal of consumer products containing it needs to be evaluated.	because background exposures are not incorporated to the risk estimations for each COU. Additional discussion of aggregate exposure is provided in Section 4.3.2. EPA did not consider background PCE exposure that workers might be exposed to in addition to exposures from TSCA conditions of use. EPA does not have methods to reliably predict background exposure from legacy disposal. This may result in an underestimation of risk, and additional discussion of this underestimation has been added to the document in the Key Assumptions and Uncertainties section.

Monitoring estimates of media concentrations		
SACC	**SACC COMMENTS:** Recommendation: Better justify use of 2016 monitoring data in lieu of more recent or averaged data. The draft risk evaluation implies that only monitored data for 2016 are used instead of the most recent 2017 data or the average for 2013 to 2017. The Committee questioned why the 2016 data were selected, especially since 2016 appears to report lower PCE concentrations and frequencies of detection compared than other years.	EPA performed a comparative trend analysis of environmental releases from 2015 to 2017 to assess the differences in environmental releases between each year. EPA determined that 2016 (the selected data year) had a total of 137 reported environmental releases which approximatethe calculated average number of releases (approximately 139) within this 3-year period. In 2016, there were 130 unique sites compared to 121 unique sites in 2015 and 148 unique sites in 2017. The number of sites with exceedance for 20 days of release did not differ significantly and was 36 in 2016 compared to 38 in 2015 and 2017. The number of sites with exceedance for 250 days of release did not differ significantly and was 25 in 2016 compared to 23 in 2015 and 26 in 2017. In general, EPA determined that the environmental release data points did not differ significantly from 2015 and 2017, and in some cases 2016 data was close to the median or mean data points from 2015 to 2017. As a result, 2016 was selected as the data year for environmental releases of PCE.
SACC	**SACC COMMENTS:** Recommendation: Carefully review data presented in Table 2-9 and present that information more clearly. • Table 2-9 is appended in the SACC report. Specific data that are unlikely to be correct are circled. For example, the "Concentration in All Samples" column of the first row (Year 2013) contains an average of 0.23 μg/L, which is larger than the upper bound of the range (0.092 μg/L). It does not make sense that an average value is larger than the upper bound of values in a range, unless most	EPA acknowledges comment and will consider ways to improve clarity of the way this information is presented in future REs.

	reported data points have reporting limits that exceed the maximum measured concentration. • Mean values are of little, if any, use. It would be better to utilize the reported upper bound from among the wide-ranging limits of detection. Also, in the column of "Concentrations (ug/L) in Only Samples Above the Detection Limit," again for Year 2013, there were 2 of 366 total samples that had concentrations higher than the detection limit, and the average value of these two samples is presented. A mean based on these two samples is not representative of the entire 366 samples. The average of the two samples above the detection limit is 0.082 μg/L, whereas the average of all samples assuming non-detects recorded with values at half the detection limit is 0.23 μg/L. The factor driving the conclusions from this table is the actual detection limit. With some detection limit values as high as 5 μg/L, it is no wonder this happens. • One Committee member wondered what would happen if in the quality review samples with the highest detection limits were rated as being of low quality and removed from consideration in this table. These comments apply to tabulated data from other years.	
SACC	**SACC COMMENTS:** Recommendation: Provide estimates of ambient PCE concentrations for only those releasing facilities with monitoring data from downstream sites that are close enough that the Probabilistic Dilution Model (PDM) would predict concentrations above background. • Ambient aqueous PCE concentrations reported in aggregate or by HUC are only relevant to this evaluation if the monitoring site is a short distance downstream from the discharge point. The distance that monitoring stations are downstream from releasing facilities must be determined for each facility to appropriately evaluate river miles or lake volumes that separate releasing facilities from ambient monitoring sites. That is the only way to understand the extent to which releases from an assessed COU might influence surface water concentrations of PCE at monitoring sites.	EPA used the reasonably available data concerning known releases of PCE. EPA's analysis uses TRI and DMR to estimate the highest local per site water releases of PCE. The assumptions and uncertainties associated with using these data sources, such as limitations on required reporters, are discussed in Section 4.3. EPA acknowledges that there are some uncertainties concerning our monitoring data. A key limitation pertains to the lack of monitoring data for every facility for each respective condition of use.

	• Table 2-11 contains a Euclidian distance downstream, which is assumed to be a simple linear distance between the release point and the monitoring station and not the actual distance down the river channel. This must be clarified and "river miles" should be used to describe distances between releasing facilities and monitoring sites. If monitoring data are not downstream, the water quality exchange (WQX)/WQP data are inappropriate for use in that way in the evaluation. • Downstream monitoring data could, however, be used to estimate impacted river miles or lake volumes for each facility for which there are no downstream monitoring data. Concentrations above background could be used in conjunction with river discharge and river distance to determine how far downstream impacts could be expected. Getting this process correct is particularly important since ambient monitoring data are a key input to the draft risk evaluation concluding no unreasonable risks to environmental receptors. • In Section 4.3.1, the draft risk evaluation statements mislead the reader to assume that ambient environmental concentrations of PCE rarely exceed COCs. This and all similar statements should be removed or significantly qualified. The draft risk evaluation should better describe the data from monitoring sites that could conceivably have received water from releasing facilities. If the monitoring data are not both downstream and near releasing facilities the data are only useful in establishing background concentrations.	Modeled data was used due to the limitations of monitoring data as explained above and in section 2.3.4.4. Specifically, monitoring data at sampling sites don't always predict concentrations of PCE that are released by a facility into surface water bodies because sampling sites are not at the point of release into the environment. Therefore, EPA used modeled concentration data to reflect near-site (facility) estimates at the point of release. Modeled and monitoring data were used in conjunction to determine if there was a correlation between the observed surface water concentrations and the modeled facility releases so that EPA could estimate the potential exposure of PCE in the environment. The corresponding section to this comment is Section 4.1.1. As is currently written, for this iteration of the PERC draft risk evaluation, the data in this section has been reported in a clear and straightforward manner.
SACC	**SACC COMMENTS:** Ambient aqueous concentrations of PCE are measured by USGS and presented in the landscape level evaluation organized within the HUCs. The best use of these HUC evaluations is to situate new monitoring stations for collection of chemical occurrence data. The Committee suggested that data from new monitoring stations would better inform this draft risk evaluation or be useful in future TSCA risk evaluations.	EPA used best quality of data and methods available to measure PCE concentrations in ambient water.

SACC	**SACC COMMENTS:** Recommendation: Consider monitoring for environmental media at all large use facilities and those facilities where discharges are large portions of total receiving water volumes. The draft risk evaluation does not contain non-human biomonitoring data, and there are no systematic measurements of PCE for determination of commercial releases to or effects on any environmental media. • Several Committee members noted that The American Chemical Society (ACS) supports better understanding of critical risk assessment science in specific areas such as: (1) exposure assessment, following best practices for modeling and assessment, including robust exposure data, and (2) biomonitoring, measuring a wide range of chemicals and transformation products. • The Committee recommended that the National Research Council (NRC) and ACS recommendations to obtain environmental monitoring data for environmental media be considered. Monitoring near large use facilities and those facilities where discharges are large portions of total receiving water volumes are considered essential to reduce uncertainty and improve confidence in release estimates.	EPA used reasonably available monitoring data and measured release data, as well as modeled data in its analysis.
42	**PUBLIC COMMENTS:** The geospatial analysis of monitored environmental concentrations from the WQP found a maximum surface water concentration of 1.69 ppb. EPA has maintained that PCE is not likely to be found in surface waters at high levels as a result of industrial, commercial, or municipal discharges due to its low vapor pressure and these data appear to support that assertion.	EPA acknowledges your comment.
Modeled estimates of media concentrations		
SACC	**SACC COMMENTS:** Table 2-5, Manufacturing: One Committee member challenged the assumption that manufacturing facilities release 350 days/year. The Committee member observed that other evaluations for chlorinated	EPA consistently applied 350 days/yr for manufacturing for other chlorinated solvents (MeCl and TCE). This assumption is based on EPA's professional judgement and understanding

	solvents assume that manufacturers operate 270 days/year. This is far lower than the 350 used for the PCE draft risk evaluation. It is also much closer to the more conservative 250-day estimate, derived by assuming a 5-day work week with a 2-week turnaround. The Committee member concluded that the discussion in Table 2-5 on uncertainty in the daily discharge estimates is misleading. Operational data should be readily available from industrial manufacturers and other significant commercial users to better estimate this value rather than rely on an assumption. Data would allow estimating the distribution of operating days per year. If no data are available, then assuming 250-270 days of operation is more conservative. Processing as reactant (p. 76), formulation (p. 78), and industrial processing (p. 83) also assume PCE discharge days in excess of 250-270 with no supporting data.	on how facilities manufacturing chlorinated solvents, such as PCE, operate. They are generally manufactured in continuous processes that are not expected to have frequent shutdowns or discontinuations of production. Other chemicals may have used fewer days per year based on specific data or EPA's understanding of the manufacturing process. For example, chemicals manufactured in batch processes may be more likely to occur in set campaigns throughout the year rather than every day making assumptions for lower days per year appropriate. The processing as a reactant assumption is based on the same logic as manufacturing whereas formulation and industrial processing aids days/yr are based on information provided in Specific Environmental Release Categories (SpERCs) developed by the European Solvents Industry Group for such operations.
SACC	**SACC COMMENTS:** The draft risk evaluation reports that E-FAST 2014 "accounts for dilution by incorporating an acute or chronic dilution factor for the water body of interest instead of stream flows." For surface water concentrations in static water bodies, the range of dilution factors used in E-FAST 2014 is very broad, reported to be in the range of 1-200. • It was unclear to the Committee what dilution factor was used for each waterbody, or if that is part of the E-FAST 2014 site-specific data. If these dilution factors are uniform for river or standing water bodies then the two dilution factors should be noted in the explanation of surface water concentration equations in this section. If dilution factors are not standard for each water body type, the dilution factors should be listed in the tables where RQs are presented.	Wherever possible, EPA used site specific 7Q10 flow metrics to estimate flows at waterbodies receiving known facility releases. For still water bodies, a dilution factor approach is applied since no available 7Q10 metric is available. If neither of these metrics are available a flow associated with the industry sector of the discharging facility was chosen to approximate the instream flow.

SACC	**SACC COMMENTS:** Recommendation: When estimating stream flow or dilution factor, in the absence of site monitoring data or acceptable surrogate site data, the 10th centile 7Q10 data for the stream should be used. Section 2.3.1.1.4.1 discusses the selection of surrogate NPDES data for sites having stream flow or dilution factor information. One Committee member suggested that the surrogate NPDES should be chosen to maximize release to maintain conservatism. Having the actual data from the streams in question is preferred. Facility location could be determined and used to locate stream flow data for nearest or most similar sites with U.S. Geological Survey (USGS) gauging data.	EPA appreciates the suggestion to do modeling across similar classes of chemicals to evaluate model performance and predictive ability and will entertain those suggestions for future risk evaluations. However, absent monitoring programs designed to measure these concentrations proximal to discharging facilities, the co-location of monitoring information with known facility releases is expected to be small thereby limiting model verification with actual monitored values.
SACC	**SACC COMMENTS:** Recommendation: Consider using the direct discharge input of E-FAST without the WWTP module to estimate discharge. Wastewater dominated streams have not been considered as a worst-case scenario. Due to climate change and water re-use practices in arid regions, there is limited dilution of effluent discharges. Consequently, effluent values should be used for risk quotient (RQ) values as a "worst-case" scenario. In addition, estimates of discharge were primarily through direct non-publicly owned treatment works (non-POTW) discharge rather than wastewater treatment. It is unclear why the analysis uses a WWTP module in E-FAST.	EPA in scenarios where PCE was discharged indirectly through a WWTP or POTW, the removal percentage was used. When PCE was directly discharged, a WWT% of zero was used for direct releasing facilities because the release reported in TRI and DMR already accounts for any wastewater treatment which may have occurred.
SACC	**SACC COMMENTS:** Care needs to be taken to ensure that more than one facility (regardless of COU) does not discharge to a common WWTP or to similar areas of a waterbody.	As discussed in the Environmental Exposure section 2.3.4.2.5, EPA conducted an analysis concerning the co-location of PCE releasing facilities and monitoring stations. Figure 2-12 illustrates a map of two pairs of facilities which were collocated or where their discharges may. EPA also states that for these collocated facilities there were few samples collected and their measured PCE concentrations were below the detection limit (<0.1 ppb).

SACC	**SACC COMMENTS:** The treatment of facilities that have no designation of release to WWTP or directly to water bodies is described in Section 2.3.1.1.4; one Committee member commented that this is the correct way to handle this problem, and points to the proper approach for all non-reported PCE releases.	If a facility NPDES was not available in the E-FAST-2014 database (U.S. EPA, 2014b), the release was modeled using water body data for a surrogate NPDES (preferred) or an industry sector, as described below. Thank you for the comment.
42	**PUBLIC COMMENTS:** EPA assumes a 20-day release scenario occurring during a 7Q10 surface water flow condition, which results in high concentration estimates. While such an approach may be appropriate for the purposes of screening-level risk assessment, EPA should have additional higher tier tools available for instances where the maximum exposure exceeds the hazard threshold. Given the maximum condition only occurs for a subset of OESs, EPA should further refine these to more accurately estimate environmental exposures.	The assumptions were made that each facility would release their total volume of PCE to surface water over 20 days and over a maximum number of days (depending on the exposure scenario). Because EPA does not know the exact number of days over which the environmental release occurs, EPA found it essential to assess acute environmental risk. The 20-day risk criterion is derived from partial life cycle tests (*e.g.*, daphnid chronic and fish early life stage tests) that typically range from 21 to 28 days in duration. The use of the 7Q10 flow value is intended to represent a protective evaluation of low flow conditions where environmental and human populations may be most affected. The predicted concentrations associated with different flow metrics are available in supplementary materials, but the modeling with EFAST does not allow for evaluation of days of exceedance outside use of the 7Q10 flow metric.
26	**PUBLIC COMMENTS:** Environmental releases of PCE to the environment are based on wastewater discharges for COU, as defined by the EPA Administrator, and as understood to be within the life cycle for PCE. EPA estimated daily wastewater discharges and, for each of the 22 occupational exposure scenarios (OES), integrated a summary of release days,	For direct discharges, a WWT% of zero was used for direct releasing facilities. These releases are typically those identified through the OCSPF EGL data source and are from facilities that are not in DMR or TRI. This approach is consistent with

	number of facilities and daily wastewater discharges. These estimates represent both direct discharges to surface water and indirect discharges to public and non-public wastewater treatment works. • Surface water concentrations resulting from wastewater releases of PCE from facilities that manufacture, process, or use PCE related to TSCA COUs were modeled using E-FAST. The modeling assumed that the percentage of PCE removed from wastewater during treatment before discharge to a body of water was 80%. Facilities that directly release effluent to surface water do not treat PCE prior to discharge; therefore, EPA did not account for removing any PCE. E-FAST was used to estimate site-specific surface water concentrations for discharges to both free-flowing water bodies and for still water bodies (*i.e.*, bays, lakes, estuaries).	other risk evaluations from the first ten risk evaluations.
Uncertainty associated with release and concentration estimates		
SACC	**SACC COMMENTS:** Recommendation: Ensure that phrasing regarding environmental releases or environmental assessments is specified as being constrained or limited to surface waters. • The language regarding exposure characterization (line 1956) should be refined to state that the characterization is "constrained" to aquatic releases, not that it "focuses on" aquatic releases. The current terminology suggests that PCE releases to compartments other than water are covered in this evaluation, and they are not. • PCE releases to air (714,600 pounds/year) far exceed releases into water (10,390 pounds/year). When coupling these relative releases with the pseudo-persistent nature of PCE in the vicinity of discharge points (to air and water), fugacity modeling output shows PCE partitioning from air to water. This demonstrates a fundamental scientific flaw in the assumption inherent in the PCE draft risk evaluation that releases into various environmental compartments can be segregated through simple exclusion of COU or discharge types as being outside the scope of the evaluation.	Assuming releases of 715 kg/hr to air, 10 kg/hr to water, and 79 kg/hr to soil (*i.e.*, releases scaled to the total reported releases), and slow aerobic or anaerobic biodegradation and metabolism, the Mackay Level III fugacity model (https://www.trentu.ca/cemc/resources-and-models/level-iii-model) predicts 99% of PCE to be present in air, 1% in water, and negligible concentrations in soil or sediment. Assuming 1 kg/hr released to air and zero emissions to other media to simulate sites emitting only to air, the model estimates 79% of PCE will be in air and 21% in water. Because the model assumes continuous releases, the fraction in water increases as the rate of release to air decreases (*e.g.*, it estimates 8% of PCE in water with 10 kg/hr released to air and 24% in water with 0.1 kg/hr released to air). However, even at very low release rates ($<1x10^{-9}$ kg/hr), the fraction of PCE

	• Omission of land applied PCE contaminated biosolids (78,800 pounds/year) leaves a further gap in the evaluation and compounds the flaw of assuming intercompartmental discontinuity within the environment. Data from only 27 facilities of over 100,000 facilities that may release PCE were represented. These estimates likely represent a small fraction of the total PCE released. These data omissions demonstrate the high uncertainty that environmental releases are occurring at concentrations that are sufficiently low to protect environmental and human health.	in water does not exceed 25%. Thus, even in locations where the releases are only to air, the majority of PCE is expected to remain in air. Similarly, setting the Level III fugacity model to 1 kg/hr released to soil and zero emissions to other media to simulate sites with land-applied biosolids, an estimated 79% of PCE partitions to air and 21% partitions to water, with negligible fractions in soil or sediment. Depending on the rate of release to soil, approximately 75-100% of PCE is estimated to partition to air and 0-25% is expected to partition to water.
SACC	**SACC COMMENTS:** Table 2-5 provides a precise summary of assumptions, uncertainties and overall confidence of release estimates by OES. The Committee welcomed this addition to the structure of TSCA draft risk evaluations since it provides a concise way to summarize strengths of this key component.	EPA appreciates SACC's comment and will attempt to include similar tables in future risk evaluations.
SACC	**SACC COMMENTS:** Recommendation: Consider the impact of assuming other release scenarios, including alternate assumed operating days and expected discharges for non-reporting facilities, and describe associated uncertainties. One Committee member suggested that there was significant uncertainty associated with the limited TRI reporting requirements that were not addressed, maintaining that all of the discharge estimates should be rated as having low data quality. TRI allows up to 25,000 pounds of PCE per site to go unreported. This results in substantial (or significant) uncertainty in the assessment of releases when estimated total aggregate PCE production is around 325,000,000 pounds annually. If one assumes that 1,200 facilities are producing/using just under this limit, total use for this group would constitute over 10% of the total use.	EPA considered the impact of alternate assumed operating days for direct discharges by estimating environmental exposures from both the maximum number of release days assumed in the risk evaluation and at a low-end of 20 release days per year. EPA did not consider low-end release days for indirect dischargers because surface water discharges occur at the WWTP which typically operate every day of the year. The TRI threshold for PCE is 25,000 lbs for sites manufacturing or processing PCE and 10,000 lbs for sites otherwise using PCE. Where EPA expects there is a possibility that a large

	This may seem like a lot of businesses, but the estimated number of dry-cleaning facilities in the U.S. exceeds 32,0006 and the estimated auto repair shops exceed 230,0007, making 1,200 less than 5% of these two business categories.	percentage of sites within an OES that operate below these thresholds, EPA has attempted to model or estimate releases from those sites. Based on market data, the four largest uses of PCE include reactant uses (70% of PV), dry cleaning (10% of PV), aerosol degreasing (10% of PV), and vapor degreasing (7% of the PV). Based on the types of products being made, EPA expects the majority of sites using PCE as a reactant to meet the reporting requirements for either TRI or DMR; therefore, EPA made no attempt to model additional sites. For dry cleaning, EPA modeled release for the over 12,000 dry-cleaning sites that are not in TRI/DMR using PCE using the *Solvent Release in Water Discharge from Dry Cleaning Machines Model*. For aerosol degreasing, EPA does not expect any water releases. For vapor degreasing, EPA has added modeling for sites that are not in TRI/DMR using the *EPA/OPPT Water Saturation Model*. Furthermore, EPA also provided water release estimates for sites using PCE-based adhesives and coatings. However, EPA does not have reasonably available data to determine how many sites for which this release may occur.
SACC	**SACC COMMENTS:** Recommendation: Describe how the potential for missing discharge sites in the DMR is incorporated into the uncertainty of wastewater discharge estimates. The definition of major versus minor dischargers is set by each state, often based on discharge volume or facility size. This suggests that some sites that discharge PCE may not be included in the DMR dataset.	EPA used the best available science and reasonably available data concerning known releases of PCE. EPA's analysis uses TRI and DMR to estimate the highest local per site water releases of PCE. The assumptions and uncertainties associated with using these data sources, such as limitations on required reporters, are discussed in Section 2.2.1.3.

	It was not clear how the uncertainty associated with these discharges is accounted for in the draft risk evaluation.	
SACC	**SACC COMMENTS:** Recommendation: Alter language about uncertainty to clearly reflect that uncertainty in the release and toxicity data could result in situations where the potential for unacceptable risk is higher than predicted by the RQs determined in this evaluation. The STP model within the EPI Suite™ program was developed by Clark et al. (1995) and is used to evaluate the removal of PCE during wastewater treatment. EPA used this model's default input wastewater treatment plant parameters in its predictions. One Committee member questioned why the more recent version of the model (STP-EX, Seth et al., 2008) was not used in place of the older STP model in EPI Suite™.	To address uncertainties, the most conservative ends of the data distributions (*i.e.*, longer half-lives) were used in quantitative assessments, including estimated removal in wastewater treatment (Section 2.3.1.1.3). In addition, E-FAST does not consider volatilization. Both of these default setting result in a more conservative result, *i.e.*, higher modeled surface water concentration. The conservative approach makes it less likely that risks are underestimated.
SACC	**SACC COMMENTS:** Recommendation: Discuss how the environmental exposure characterization would change if every facility under an OES for which no release data are available were assigned an estimated daily release value that represented a likely high-end percentile (specified *a priori*). • Wastewater discharge data are available from TRI and DMR for only some facilities. Estimates for the facilities for which no discharge data are available are not provided. While average observed discharges from the reporting facilities may represent a high-end estimate, total discharge cannot be estimated without incorporating values for the missing facilities. • Several Committee members indicated that some assessment of the excluded facilities, and their likely discharges should be made. The fact that there are no data for most facilities results in high uncertainty in release estimates.	EPA used the best available science and reasonably available data concerning known releases of PCE. EPA's analysis uses TRI and DMR to estimate the highest local per site water releases of PCE. The assumptions and uncertainties associated with using these data sources, such as limitations on required reporters, are discussed in Section 2.2.1.3. EPA acknowledges that some facilities were not captured from data obtained from TRI and DMR. Therefore, to fill in the gaps of missing data, EPA also conducted a full systematic review of reasonably available surface water literature to identify other peer-reviewed or grey literature sources of measured surface water concentrations in the US. Predicted surface water concentrations were modeled for facility releases in the EPA Lifecycle Release Analysis conducted for

		reporting year 2016, as determined from TRI, and DMR; through EPA's Water Pollutant Loading Tool), and EPA's Chemical Data Reporting (CDR). EPA also used aquatic modeling with EPA's Exposure and Fate Assessment Screening Tool, version 2014 using reported annual release/loading amounts (kg/yr) and estimates of the number of days per year that the annual load is released.
SACC	**SACC COMMENTS:** Recommendation: Provide other estimates of the higher centile of discharges than the average maximum. Table 2-2 of the draft risk evaluation provides estimated releases by industry type. The number of days of discharge for each facility type is not specified in this table. Are these estimates simply annual totals divided by 365? This is an important consideration given the multiple assumptions made in the Hazard Assessment section of this evaluation. The maximum daily release data represented only the 50th to 80th centile of facilities for 7 of 12 COUs and represent the 86th centile for two others. Thus, the average maximum daily values are conservative estimates for only 25% of the selected COUs, which leave much uncertainty that predicted concentrations are not exceeded too frequently to be of concern.	The daily releases in Table 2-2 are generally annual releases divided by the number of operating days provided in Table 2-4. The estimates are not necessarily divided by 365 days. EPA referenced ESDs, NEI data, SpERCs, or needed to make assumptions when estimating operating days for each OES. A summary along with a brief explanation is presented in Table 2-4 of the Risk Evaluation Document.
SACC	**SACC COMMENTS:** E-FAST considers neither volatilization from water for cases where concentrations in water exceed those in air by over 33% nor partitioning into water for cases where concentrations in water exceed those in air by less than 33%. This must be captured in the text to avoid the perception of bias in the draft risk evaluation.	EPA acknowledges this limitation and it is included in section 2.3.3.4 of the risk evaluation.

SACC	**SACC COMMENTS:** Recommendation: For discharges to municipal waste facilities compare observed PCE concentrations in wastewaters to model predictions. The draft risk evaluation states that 7,661 samples were initially identified in the Water Quality Portal (WQP). This was reduced to 1,604 samples after "filtering and cleansing," with 94% of the excluded samples considered "off-topic media (*i.e.*, groundwater, artificial, bulk deposition, leachate, municipal waste, or stormwater) or location type (*i.e.*, landfill, subsurface, spring, or well)." • The Committee expressed concern with the exclusion of municipal waste, since these are often blended with industrial wastes. Since municipal waste are monitored under NPDES, PCE concentrations can be obtained and compared to modeled predictions when discharge is transported to a treatment facility.	EPA used the samples most relevant to the scope of the risk evaluation. Samples in WQP were excluded if they were covered under existing regulatory statutes. EPA tagged these as "off-topic media" including Municipal waste which is covered the Research Conservation and Recovery Act. Therefore, data associated with this meadia and exposure pathway was not evaluated in the risk evaluation of PCE.
SACC	**SACC COMMENTS:** Recommendations: (1) National Pollutant Discharge Elimination System (NPDES) monitoring data for perchloroethylene (PCE) should be compared to Exposure and Fate Assessment Screening Tool (E-FAST predictions for effluent and receiving streams. (2) E-FAST estimates should be ranked according to discharge input from the Toxics Release Inventory (TRI), these values should be compared to NPDES monitoring data to confirm TRI E-FAST estimates. • The surface water data do not appear to be consistently taken from discharge data, which are readily available from NPDES (*e.g.*, Discharge Monitoring Report [DMR] database). The PCE Problem Formulation document states that NDPES monitors PCE discharges to surface waters, presumably receiving waters, from top dischargers, and reports an average concentration of 19 µg/L from 70 samples with average maximum discharge values of 50 µg/L. It is unclear why these data were not compared to E-FAST estimates to determine model efficacy.	Modeled data is used due to the limitations of monitoring data. Monitoring data used does not accurately reflect a facility releasing PCE into the environment therefore the use modeled concentration data is needed to reflect near-site (facility) estimates at the point of release. The use of modeled data in conjunction with monitoring data was to show/identify if there was any correlation of any observed surface water concentration to modeled facility releases so that EPA could estimate the potential exposure of PCE in the environment. In the problem formulation, EPA stated that Discharge Monitoring data (measured) were reported in EPA's Discharge Monitoring Report (DMR) Pollutant Loading Tool (https://cfpub.epa.gov/dmr/ez_search.cfm). The

	• The PCE Problem Formulation states that NPDES "would only report the discharge to stream based on permits and would not report the actual stream concentrations." This statement is incorrect since NPDES permits require measurements (*i.e.,* stream concentrations) of priority pollutants in receiving waters downstream of discharge.	tool uses discharge monitoring report (DMR) data from ICIS-NPDES to calculate pollutant discharge amounts. This tool includes the top facility discharges for 2017. This information was used as a screening tool to evaluate some preliminary water concentrations in the problem formulation. In the risk evaluation, EPA used release information from TRI and DMR. The DMR releases are based on NPDES reporting. These releases were used as input for the EFAST modeling, not the summary data from the problem formulation.
SACC	**SACC COMMENTS:** Recommendation: Compare E-FAST data with global monitoring data from the World Health Organization (WHO) and Integrated Risk Information System (IRIS) data as reported in the Problem Formulation document. While it may be useful to determine overall surface water concentrations of PCE throughout North America, without source identification, it is unclear how these data can be related to industrial or commercial use categories for the Toxic Substances Control Act (TSCA). In addition, there are no comparisons between E-FAST predicted values or global monitoring values with those provided from the literature in the Problem Formulation (*e.g.,* Europe, U.S., and Canada). • It was unclear to some Committee members why surface water data that in some cases is 20 miles downstream from any wastewater treatment plant (WWTP) discharge is used for this assessment. Overall, this aspect of the assessment has too much uncertainty to support a finding of acceptable risk.	EPA acknowledges your comment and addressed the concerns regarding source identification of PCE concentrations in the final risk evaluation. EPA did not compare EFAST with the global data, however this data is summarized in the final risk evaluation. In the absence of monitoring data at the site of release, EPA used the reasonably available surface water data. The monitoring data represent PCE concentration in surface water at specific sites, some which were located far downstream. The limitations of the available monitored data include that it only was collected at specific sites and during specified timeframes. EPA found no measurements at the site of release from facilities releasing to surface water. Therefore, EPA mapped the sites in conjunction with modeled estimates in the exposure analysis, utilizing releases of PCE to surface water from facilities.

3. Environmental Hazard

Environmental Hazard		
Charge Question 3.1: Please comment on EPA's approach for characterizing environmental hazard for each risk scenario (*e.g.*, acute aquatic, chronic aquatic). What other additional information, if any, should be considered?		
#	**Summary of Comments for Specific Issues Related to Charge Question 3**	**EPA/OPPT Response**
Selection of pathways and species for inclusion in risk evaluation		
SACC, 26, 41	**SACC COMMENTS:** Recommendations: (1) The Committee disagreed with excluding discussion of terrestrial pathways. The terrestrial exposure pathway for PCE should be assessed. (2) Improve the justifications/documentation for excluding consideration of terrestrial organisms. Recommendation: Provide a better justification as to why inhalation exposures to terrestrial vertebrates were not considered. • There is a disconnect between the Problem Formulation and the draft risk evaluation in assumptions that drive the environmental risk assessment. While the Problem Formulation appears to state conservative assumptions regarding fate and receptor identification, the draft risk evaluation simply states that certain receptors (*i.e.*, terrestrial) and media (*i.e.*, sediments) will not be considered. The PCE Problem Formulation (p. 43) states that "Terrestrial species populations living near industrial and commercial facilities using PCE may be exposed via multiple routes such as ingestion of surface waters and inhalation of outdoor air." The draft risk evaluation does not address the volatilization pathway to inhalation exposures to small burrowing mammals in biosolids (acknowledged in Section 4.1.4). The draft risk evaluation justifies this exclusion by setting terrestrial pathways as out of scope by arguing that their exposures are covered by other regulations (*e.g.*, CWA). The Committee recommended that EPA take a more scientific approach to justify this exclusion, by citing research where these exposures are studied and found not to be significant (Spring et al., 2009).	Environmental exposure pathways and risks covered under the jurisdiction of other EPA-administered statutes and regulatory programs are not within the scope of the risk evaluation. As explained in more detail in section 1.4.2 of the risk evaluation, EPA believes it is both reasonable and prudent to tailor TSCA risk evaluations when other EPA offices have expertise and experience to address specific environmental media, rather than attempt to evaluate and regulate potential exposures and risks from those media under TSCA. EPA believes that coordinated action on exposure pathways and risks addressed by other EPA-administered statutes and regulatory programs is consistent with statutory text and legislative history, particularly as they pertain to TSCA's function as a "gap-filling" statute, and also furthers EPA aims to efficiently use Agency resources, avoid duplicating efforts taken pursuant to other Agency programs, and meet the statutory deadline for completing Risk Evaluations. EPA has therefore tailored the scope of the Risk Evaluation for PCE using authorities in TSCA Sections 6(b) and 9(b)(1). Clarifying

	• Several Committee members questioned the justification for excluding consideration of exposure to terrestrial organisms (*e.g.*, burrowing animals). They suggested that soil discharges are at least as likely as discharges to surface water. At a minimum, the risk evaluation should clarify in the regulatory discussion under which regulatory program these exposures are evaluated. The Committee also noted that Canada, as part of its PCE risk assessment, included consideration of vapor exposures to burrowing mammals. • In addition, fish-feeding birds might be impacted by PCE volatilizing from surface waters near points of discharge due to volatilization of PCE from surface water, which is a major fate mechanism in the draft risk evaluation. This pathway should be discussed, and risk assessed. The review article by Gobas et al. (2016) discusses the need for terrestrial bioaccumulation monitoring and modeling. • Table 2.9 of the PCE problem formulation document clearly shows that terrestrial organisms (birds, aquatic mammals) would be exposed not only through ingestion of water, but also by inhalation. If the E-FAST models are predicting volatilization from discharge, then terrestrial organisms will be receptors. Transfer of PCE from air to water is potentially significant when released to the air from landfills, land application, or stack emissions. • In Section 5.1.3 (p. 457), the first sentence is incorrect as written, in that the PCE draft risk evaluation does not evaluate hazards to terrestrial and sediment dwelling organisms. **PUBLIC COMMENTS: terrestrial species should be included** TSCA requires a risk evaluation to consider whether a chemical substance presents "an unreasonable risk of injury to… *the environment*." TSCA does not allow EPA to limit its evaluation only to particular parts of the environment. In its problem formulation for PCE, EPA discussed the extent of PCE contamination in different environmental media, including air, soil, surface water, salt water,	language about what pathways are addressed under other statutes has been added to Section 1.4.2 of the Risk Evaluation. As noted in Section 1.4.2, terrestrial exposure pathway is not in scope or the risk evaluation. In addition, based on the estimated bioconcentration factor and bioaccumulation potential described in Section 2.1, PCE is not expected to bioaccumulate in tissues, and concentrations does not increase from prey to predator in either aquatic or terrestrial food webs. Lastly, based on the Guidance for Ecological Soil Screening Levels (EPA, 2003) document, for terrestrial wildlife, relative exposures associated with inhalation and dermal exposure pathways are negligible, even for volatile substances, compared to direct soil ingestion and ingestion of food (by approximately 1,000-fold). Therefore, volatilization from surface water and biosolids to air of PCE is not a concern for wildlife. EPA has added language to the final risk evaluation document in Section 4.1.4 explaining this rationale. EPA has updated Section 5 to state that EPA considered the effects on aquatic organisms and has removed the reference to an evaluation of hazards to terrestrial and sediment dwelling organisms.

	drinking water, and groundwater, and also in both aquatic and terrestrial organisms. In spite of these known and recognized risks, the PCE draft risk evaluation considers risks only for one environmental medium – aquatic species. It fails to consider risks to air, soil, surface water quality, groundwater, or terrestrial animals. In disregard of TSCA obligations, EPA attempts to justify this failure by contending that it need not consider pathways that fall under other environmental statutes. EPA is urged to comply with TSCA by considering the risk of injury to all applicable environmental media. **PUBLIC COMMENTS: terrestrial species should not be included** EPA did not analyze exposure of terrestrial organisms through soil, land-applied biosolids, or ambient air, because PCE has moderate potential to partition to, or accumulate in, soil, but it is primarily expected to volatilize to air or migrate through soil into groundwater based on its physical-chemical properties. Therefore, physical-chemical properties do not support an exposure pathway through water and soil pathways to terrestrial organisms. EPA did not include PCE toxicity to terrestrial mammals in the risk evaluation because observed effects in laboratory mammals have been reported mostly at much higher concentrations than have been measured or are predicted to occur in the environment. Additionally, the BCF and bioaccumulation potential of PCE are low. Therefore, it is unlikely that adverse effects will occur in the terrestrial mammalian exposure pathway. We agree with EPA's decision to not conduct risk estimations for terrestrial mammalian exposure pathways.	
SACC, 26	**SACC COMMENTS:** Recommendation: Estimate risks to sediment dwelling invertebrates by PCE exposures. Section 4.1.3 (p. 331, lines 8621-8623) states: "While no ecotoxicity studies were available for sediment-dwelling organisms (*e.g.*,	EPA acknowledges that data gaps in the sediment environmental data exist. The uncertainty that PCE concentrations in sediment may be lower or somewhat greater than concentrations in overlying water is included in Section 4.1.2.

	Lumbriculus variegatus, *Hyalella azteca*, *Chironomus riparius*), the toxicity of PCE to sediment invertebrates is expected to be similar to the toxicity to aquatic invertebrates because of the similarities in PCE concentrations." One Committee member could find no data to support this statement and suggests that it should be justified in the draft risk evaluation. The member further noted that there are no data to suggest that PCE concentrations will be the same in sediments and water. This member concluded that the draft risk evaluation is incomplete until toxicity data are included for sediment dwelling organisms. **PUBLIC COMMENTS:** EPA conducted acute and chronic assessments and provided risk estimations for aquatic species but did not develop quantitative assessments for sediment organisms. EPA states that toxicity of PCE to sediment-dwelling invertebrates is expected to be similar to toxicity to aquatic invertebrates because of the similarities in PCE concentrations. • We disagree with the logic employed where EPA infers sediment-dwelling organisms and organisms living in the water column would exhibit similar toxicities "…because of the similarities in PCE concentrations…;" that logic does not equate to similarities in sensitivity of different organisms to toxicant concentrations in the environment, *i.e.*, water column versus pore water in sediments. • EPA should conduct testing toxicity of PCE using sediment-dwelling organisms (*e.g.*, *Chironomus dilutus*, *H. azteca*) to provide data to resolve this issue.	
Selection of the environmental COC: available database and evidence integration		
SACC	**SACC Comments:** Recommendations: (1) Use as much data as are reasonably available from studies of comparable quality to support a COC if an SSD approach cannot be used. If the current approach is retained, discuss all study findings as collaborative support for the final estimate of toxicity to fish and invertebrates. (2) Provide justification for why information from other relevant studies found were not used. (3) Gather needed	EPA agrees that the SSDs are a useful probabilistic method for integrating data across species; however, PCE did not have enough reasonably available data that was comparable (*e.g.*, comparing LC50s to LC50s or EC50s to EC50s) to create an SSD.

	toxicity data to fill gaps identified in the Problem Formulation document or require that regulated businesses generate needed data. (4) support generation of additional data on the toxicity of different environmental receptors (aquatic plants, etc.) to exposures to PCE. • The COC values derived in the draft risk evaluation seem reasonable given the spread of available information. However, the development and derivation of the values for acute and chronic exposures to fish and invertebrates (Section 3.1.2) is not well supported. It is difficult to believe that no new environmental health hazard data for PCE have been generated in the last 14 years. The evaluation states that only 30 studies were considered acceptable and only 10 were considered relevant for risk assessment. The draft risk evaluation mentions only 4 of these 10 were carried forward but does not indicate why the remaining 6 studies were not considered further. A cursory review of the ECOTOX database identified 374 records discussing effects of PCE. • Developmental studies examining effects on four amphibian species estimated EC_{50} values for developmental deformities produced by PCE exposures to wood frogs and green frogs are 12 and 40 mg/L, respectively (McDaniel et al., 2004). Developmental effects are also shown in Japanese medaka at 1.5 mg/L (Spencer et al., 2002). These studies appear to get an acceptable quality rating, but do not appear in the draft risk evaluation. Only a single study is used to develop a chronic value for fish. The Committee recommends providing more detail on why these studies are not used and recommends that they be used to develop an SSD. • Consider other plant data (*e.g.*, diatoms) or support collection of additional plant toxicity data for PCE and use other algal data to derive a COC and display the ranges of those data in a scatter diagram.	The McDaniel et al. 2004 study for amphibians, and the Spencer et al., 2002 study for Japanese medaka have been added to the risk evaluation (Table 3-1, and Section 3.1.2. EPA acknowledges that data gaps exist and has taken steps fill data gaps in upcoming risk evaluations. In addition, EPA completed additional analysis by qualitatively comparing the algal species in the PCE RE to the algal SSD in the TCE RE. The algae COC has been revised with the EC_{50} of *Chlamydomonas reinhartdtii* (Brack and Rottler, 1994).

SACC, 28, 42	**SACC Comments:** Recommendation: Review the literature on algal toxicity to PCE and either better justify the use of a single study or utilize the broader algal toxicity study data to create a more representative COC. The Committee expressed concern that the finding of unreasonable environmental risk stems from a single algae study. The selection of a single study risks allowing subjective professional judgment to potentially introduce biases into the selection process. A cursory ECOTOX search for PCE found 77 results for algae toxicity. The draft risk evaluation should increase its discussion of the quality of the algal studies and better justify its reliance on a single study. If possible, EPA should develop an SSD for aquatic plants using acute data and use the EC_{05} if data for adequate numbers of species are available. If not, use the most sensitive non-lethal EC_{20} value and apply an appropriate assessment factor. Display spread of the endpoint data on a scatter diagram to help support the utility of the value in protection of environmental receptors. Recommendation: One committee member suggested examining correlations made in a read-across manner with estimates of PCE toxicity to different environmental receptors for other similar compounds (*e.g.,* TCE). The draft risk evaluation notes that data are only available from three species of algae, raising the question of how representative these three species are of the total algae population. While the draft risk evaluation clearly acknowledges this uncertainty, it remains unclear to the reader if this is a real concern. The various species of algae can vary quite substantially in their sensitivity to environmental toxicants. Although data for PCE exposures may not be available for more than the three species of algae noted, read-across comparisons could be made with algae exposures to other similar compounds (*e.g.,* TCE) for which data from many more species are available. This would allow a qualitative assessment of the representativeness of the responses of the three species of algae to PCE and could enhance confidence in the risk conclusions.	The rationale for selecting the studies used for algal exposure to PCE is provided in Section 3.1.3 Weight of Scientific Evidence. To assess the toxicity of PCE to algae, data from three species were available from studies that EPA assigned an overall quality level of high (Brack and Rottler, 1994; Hollister et al., 1968) and medium (Labra et al., 2010). EPA revised the risk to algae from PCE exposure by leveraging existing data and analyses from the toxicity data of two species from the same studies that tested the effects of exposure to TCE and PCE exposure. EPA qualitatively compared the algal species in the PCE RE to the algal SSD in the TCE RE. The algae COC has been revised with the EC_{50} of *Chlamydomonas reinhartdtii* (Brack and Rottler, 1994). From Section 3.1.3: "…The Brack and Rottler (1994) study was also used in the risk evaluation for trichloroethylene with the same species (*C. reinhartdtii*). For the TCE risk evaluation, nine species of algae were available to perform a species sensitivity distribution (SSD) using EC_{50}s that included *C. reinhartdtii* from Brack and Rottler (1994). Because of the chemical similarities between trichloroethylene and PCE, EPA expects the distribution of species sensitivities from exposure to either chemical to be similar. In the trichloroethylene SSD, *C. reinhartdtii* was below the calculated HC_{05} (hazardous concentration threshold for 5% of species). Therefore, EPA expects the EC_{50} from

	PUBLIC COMMENTS: The SACC should comment on EPA's use of the algal ecotoxicity data among all other available ecotoxicity data and EPA's decision to treat it uniquely. Similarly, the SACC should comment on the appropriateness of the key algal study (Labra et al., 2010) in the determination of an ecotoxicological threshold. EPA identified 10 aquatic toxicity studies as the most relevant for quantitative environmental hazard assessment and summarized those studies in Table 3-1 (p. 250). The acute toxicity endpoint data including EC_{50} values for algae ranged from 2.49 to >500 mg/L. For chronic endpoints, the range of hazard values were 0.37-1.4 mg/L for fish and aquatic invertebrates. However, for algae, the chronic endpoint (no-observed-effect concentration [NOEC]/lowest-observed-effect concentration [LOEC]) was 182-50,000 times lower than the acute (EC_{50}) endpoint based on a single study (Labra et al., 2010). The algal study by Labra et al. (2010) should be viewed as an outlier and disqualified from consideration as a key study for the following reasons: • The general acute:chronic ratio for algae is typically in the realm of 3-5 and in large data reviews, it is about 4 (Mayo-Bean et al., 2012). • *Raphidocelis subcapitata* (aka *Pseudokirchneriella subcapitata*) is nearly always equivalent in sensitivity to *Desmodesmus subspicatus*. According to the algal interspecies correlation estimation models in Brill et al. (2016), one would expect these taxa to be within a factor of 2 of each other. The TCE risk evaluation contained a number of algal ecotoxicity studies reporting a roughly 50-fold difference between the results for *R. subcapitata* (*i.e.,* Labra et al., 2010) and the other algal species. In addition, the variance estimates of the algal cell density data for Labra et al. (2010) are incredibly small, while a coefficient of variation of 5-15% is expected. The inoculum density to terminal cell density should be at least 16-fold, where in this case, it is about 8-fold and would not meet standard test validity criteria.	exposure of PCE to *C. reinhartdtii* to also be protective of 95% of algal species. The EC_{50} from one high quality algae study (Brack and Rottler 1994), was used to derive an algae COC in Section 3.1.4."

	• There is additional evidence to support a chronic algae hazard endpoint that is more consistent with the chronic fish and aquatic invertebrate endpoints. In the TCE draft risk evaluation, the range of acute EC_{50} values for algae was 26.24-820 mg/L. In addition, an EC_{10} of 12.3 mg/L was reported for TCE based on the same high-quality study (Brack and Rottler, 1994) for which the chronic EC_{10} was identified in the methylene chloride final risk evaluation. Brack and Rottler (1994) was also the source of an EC_{50} among the ecotoxicity data for PCE. The evidence suggests that these chlorinated solvents (methylene chloride, TCE, and PCE) have similar ecotoxicological profiles for fish, aquatic invertebrates, and algae. If PCE and TCE are so much more toxic to algae than methylene chloride, and to fish and aquatic invertebrates, EPA should explain how the weight of the scientific evidence is so demonstrated. • EPA's risk characterization identifies several OESs with RQs >1.0 for a number of discharging days. In every case where a risk was identified, it was based on "risk to algae" that is driven by an unjustifiably low COC determined using the flawed Labra et al. (2010) study. EPA should provide more detail in the ecological hazard assessment section, specifically addressing the impact of the multiple COCs that were calculated.	
SACC	**SACC COMMENTS:** The NOEC and no-observed-effect level (NOEL) for invertebrates (Section 3.1.3, p. 252, lines 6148-6150) do not seem to have been used in the assessment. Even though the evaluation reports them to be the same as for algae (line 6154), that appears to have resulted from an erroneously low adjustment factor being used for the invertebrate toxicity data.	The chronic COC for aquatic organisms was calculated from NOEC and LOEC values to derive the chronic toxicity value of 0.5 mg/L (Hollister et al., 1968). The algae COC has been revised.

SACC	**SACC COMMENTS:** Recommendation: Report how findings/data from studies of lower quality corroborate final estimates or otherwise inform the extent to which the estimates may or may not be representative. • EPA chose to take a critical study approach in deriving acute and chronic values for environmental hazard where no specific rationale is provided for their selection over many studies that are available. Other studies that were excluded (likely due to data quality issues) could still provide useful information that could support the magnitude of the point of departure (POD) or COC. For example, though inadequate for COC derivation, that amphibian species were evaluated at levels where the COC was derived would be protective for those species is important corroborative information. The use of a data from a single study to develop a POD or COC on its face appears to ignore the body of evidence that is available. • EPA should take a more holistic approach to the evaluation of study data and results beyond what was done in assessing study quality and use as much data/information as possible to support the derivation of ecotoxicological benchmarks. EPA should consider use of data from other studies, even those considered "unacceptable" and irrelevant (*e.g.,* laboratory rodent data, adverse outcome pathway information) as corroborative support for study selection. When adverse effects are suggested from other data for conserved biological pathways that could be relevant to aquatic invertebrates, vertebrates, or plants, use that information to justify further data collection for the endpoint in the organism of interest OR use it as justification to adjust the assessment factor accordingly. EPA should pay particular attention to data outside the reasonable range of other similar data where issues of false positives or methodological or other attributes may explain large discrepancies in results (*e.g.,* ±1 SD). • Evaluation of multiple studies (including laboratory rodent information) can provide multiple lines of evidence, where	EPA appreciates the suggestions and is continuing to refine its Systematic Review protocol. Section 3.1.3 contains the weight of scientific evidence for environmental hazards. Additional narrative has been added to this section. EPA is developing and implementing a more formal and structured data integration strategies for the next set of TSCA chemical risk evaluations. In addition, EPA is seeking feedback from the NASEM TSCA Committee on its Systematic Review process, including data evaluation criteria and data quality rating methods used in TSCA Risk Evaluations. The NASEM webinars took place from June through August 2020. EPA will consider all comments and feedback received in updating its protocol.

	assessment of plausibility, coherence, and corroboration (of patterns) across study observations can inform variability and further reduce the influence of biases and perceived subjectivity in benchmark derivation. Together, these provide support for cause and effect relationships with the final estimated COC being less sensitive to influences of study design, statistical error, and other quality issues. Recommendations: (1) Include weight-of-evidence (WOE) arguments in the section on environmental hazards and factor WOE into the risk characterization. (2) Add to the WOE narrative summaries of the quality and quantity of studies reviewed.	
26	**PUBLIC COMMENTS:** In general, the databases from which aquatic hazard values were identified and characterized were considered adequate for deriving the relevant aquatic COCs. However, one recommendation that would help improve the hazard component of EPA's aquatic risk evaluation would be to conduct further algal testing using additional species, given that only two named algal species (*Pseudokirchneriella subcapitata, Chlamydomonas reinhardtii*) were incorporated into the risk evaluation of PCE.	EPA used the best available science and the reasonably available information during the data integration process. EPA leveraged existing data and analyses by analyzing the toxicity data from two species from the same studies correlated between TCE and PCE exposure. EPA qualitatively compared the algal species in the PCE RE to the algal SSD in the TCE RE. The algae COC has been revised with the EC_{50} of *Chlamydomonas reinhartdtii* (Brack and Rottler, 1994).
Selection of the environmental COC: accounting for cross-species variability		
SACC, 29, 40	**SACC Comments:** Recommendation: Refrain from averaging LC and EC (lethal and sublethal) refined median values and instead use lowest lethal dose or an EC_{20} (EC_{50}) with an adjustment factor. The use of mean values to develop criteria from variable data between assays (Section 3.1.2, p. 250) comprised of different species and methods is not generally considered appropriate. It is also not reasonable to calculate a geometric mean from both lethal and non-lethal (LC versus EC_{50}) median values, particularly when the case can be made that some species are more sensitive to exposures than others.	• The aquatic invertebrate hazard has been revised removing the EC50/LC50 geometric mean. EC_{50} from the most sensitive species is now used to derive the acute COC. • For acute fish the (Spencer et al., 2002) study for Japanese medaka has been added to the risk evaluation (Table 3-1, and Section 3.1.2). Of the three LC_{50} studies, rainbow trout was the most sensitive with an LC_{50} of 4.82 mg/L.

	The goal should be to estimate the level of exposure that would not adversely impact ~95% of the aquatic species from acute exposures to PCE. Some of the reported variation in toxicity is due to differences between methods and some is likely due to differences in sensitivities between species. • The Committee recommends calculating the EC_{05} or EC_{10} (depending upon the relevance of the endpoint) from the non-lethal data to be protective for other aquatic organisms or use the non-lethal data from the most sensitive species. If data from too few species are represented, a refinement to the adjustment factor is recommended. There are studies that describe the expected variation in response for time and concentration benchmarks that inform how the magnitude of the adjustment factor can be established (see Kienzler et al., 2017). • However, when attempting to bound a threshold from a no-observed-adverse-effect concentration (NOAEC) and a lowest-observed-adverse-effect concentration (LOAEC), calculation of a geometric mean value between those values is reasonable as the threshold for toxicity likely lies between those two values. **<u>PUBLIC COMMENTS:</u>** EPA selects ecological COCs that, according to EPA's own calculations, leave the most sensitive species subject to unreasonable risk. Instead of using the no-observed-adverse-effect level (NOAEL) or LC_{50} from the most sensitive species, EPA averages NOAELs and LC_{50} values across studies of different species and uses the geometric mean as the COC. For acute impacts to fish, EPA reports an LC_{50} of 4.82 mg/L for *Oncorhynchus mykiss* (rainbow trout) but selects a COC of 12 mg/L because some other fish species are more tolerant of PCE. In its comments on the methylene chloride risk evaluation, the SACC advised EPA that "dose response curves differ from species-to-species hence small changes in dose may be more impactful for one species than another. As such, it is incorrect to use the geometric mean of LC_{50}	However, the statistic used for the LC_{50} was not reported creating some uncertainty associated with the LC_{50} result. The other two studies included Japanese medaka (LC_{50} of 26.8 mg/L) and inland silverside (LC_{50} of 28.1) both used Probit for determining the LC_{50}. The geometric mean is used for the three studies resulting in an LC_{50} of 15.3 mg/L and addresses the uncertainty associated with the rainbow trout LC_{50} result. EPA prefers this approach over an alternative, and less protective, approach that would be to use the next most sensitive species (Japanese medaka) with an LC_{50} of 26.8 mg/L. • EPA agrees with the SACC comment that the geometric mean of the NOAEC/LOAEC (or NOAEL/LOAEL) is a reasonable approach.

	values from multiple species as the measure of lethality … The Committee suggests calculating LC_{01} values for all species and using the lowest value as the POD." Likewise, EPA should use the LC_{01} for the most sensitive species to determine the PODs for PCE. • To measure chronic aquatic toxicity, EPA relies on a 32-day toxicity study on exposure of *Pimphales promelas* (fathead minnow). The study reported "NOAEL-LOAEL values of 0.5-1.4 mg/l, respectively, based on growth and mortality of exposure to PCE." Instead of relying on the lowest NOAEL, however, EPA took the geometric mean of those values, without evidence that COC is protective of the most sensitive effect.	
SACC	**SACC Comments:** Recommendation: Develop SSDs of lethal and sublethal endpoints for aquatic organisms and use the EC_{05} of those data as toxicity benchmarks for this risk assessment. • SSDs employ effective concentrations of contaminants in aqueous media for multiple species from which a 5% effect concentration value is developed that is intended to be protective for 95% of the impacted populations. SSDs can be constructed using lethal (LC_{50}) or sub-lethal (EC_{50}) endpoints, but generally should not be mixed. When the SSD approach is used and their data requirements adequately fulfilled, no further adjustment factors are considered necessary (Belanger and Carr, 2019). • The critical study approach should only be used when data are insufficient to develop an SSD. In the critical study approach, quality ratings must factor into choice of data used to derive the COC. The derived COC value should be below central tendency estimates (CTEs), but not more than 2 standard deviations (SDs) below CTEs estimated across all available studies. When this happens, the Committee recommends much greater scrutiny of those data to defend their use in deriving benchmarks. The criteria that EPA currently has in place for assessing study quality should be	EPA agrees that the SSDs are a useful probabilistic method for integrating data across species; however, PCE did not have enough reasonably available data that was comparable (*e.g.*, comparing LC50s to LC50s or EC50s to EC50s) to create an SSD.

	sufficient to determine this use of data. Scatter diagrams would provide the transparent support for the critical study approach.	
SACC, 29, 40	**SACC COMMENTS:** Recommendation: Consider using an adjustment factor of 100 instead of 5 to derive the aquatic invertebrate COC and discuss the impact of this change on the environmental risk characterization. The adjustment factor of 5 for *Daphnia* is inappropriately low. If the Committee's recommendation of using an SSD based to derive an EC_{05} is not followed, a much higher adjustment factor should be used. With the limited number of species, an adjustment factor of 100 seems more appropriate to protect aquatic organisms (see Kienzler et al., 2017). An adjustment factor of 100 would produce an acute COC of 67 µg/L for aquatic invertebrates and a chronic COC of 5 µg/L. The chronic fish COC will be 8.4 µg/L. This will drastically alter the HQs calculated in this draft risk evaluation and would place the aquatic invertebrate COC as the risk driver. The risk would be further amplified if adjustment factors were applied to data as evaluated in the problem formulation. This would likely indicate that fish would be at risk near certain facilities. Recommendation: Consider differences in metabolism between species and use such as a rationale to set adjustment factors. An uncertainty that has not been discussed in the draft risk evaluation the Committee has reviewed is variation of metabolism and the impact of metabolites in the manifestation of toxicity relevant to various aquatic receptors. PCE has a log K_{ow} of approximately 3.0, suggesting that there is 1,000 times more likelihood of bioaccumulation into biota from exposure to contamination within aqueous media. PCE is quickly metabolized, which is likely the reason why bioaccumulation does not occur in fish. However, organisms of limited biotransformation/ metabolism would likely accumulate PCE. Estimates of bioaccumulation in algae were reported to be 100-300 in the Problem Formulation. Given the likelihood of accumulation within prey items of	EPA is in the process of evaluating the body of reasonably available literature on the subject in order to determine whether to revise standards for application of AF and the acute to chronic ratio for the next 20 high-priority substances undergoing risk evaluation. EPA will consider the (Kienzler, 2017) study in future assessments. Until the body of scientific evidence for assessment factors is evaluated, EPA will continue to use standard OPPT methodology as described in the risk evaluation (U.S. EPA, 2013, 2012b) and apply an AF of 5 for acute and 10 for chronic aquatic invertebrate data. EPA considers these AFs to be protective of aquatic invertebrates from acute and chronic exposures to neutral organic substances such as PCE, which produce toxicity from simple narcosis. Discussion of potential trophic transfer or trophic magnification has been added to the fate and transport uncertainties in Section 2.1.3.

	invertebrates, trophic transfer is likely and the uncertainty of this should be discussed. **PUBLIC COMMENTS:** EPA fails to adequately account for uncertainty and inter- and intra-species variability in its ecological risk evaluation. EPA used an assessment factor in its calculations of acute aquatic risks, and an assessment factor of 10 in its calculations of chronic risks and risks to algae. However, EPA does not establish that these assessment factors are sufficient to address the uncertainty in its environmental risk evaluation. EPA acknowledges that "algae species tend to vary widely in their sensitivity to chemical pollutants, and data were only available for three algal species and may not represent the most sensitive species at a given site." Moreover, EPA's use of the geometric mean of different LC_{50} values increases the likelihood that its COCs are not adequately protective of all species, and thus warrants a greater assessment factor than the default value used by EPA. In its report on the methylene chloride risk evaluation, the SACC recommended that EPA "[d]evelop LC_{01} values for test species and select the lowest value for use in hazard quotient (HQ) determination" or, if that is not deemed feasible, to "apply an assessment factor of 100." That recommendation is equally applicable to PCE.	
SACC	**SACC COMMENTS:** Recommendation: Provide further justification for the change in the estimated invertebrate acute COC from the value provided in the PCE Problem Formulation. The SACC noted that the acute COC for invertebrates in the Problem Formulation was estimated at 570 µg/L. In the draft risk evaluation, this value increases to 1342 µg/L (p. 253, line 6203). This change should be explained. Recommendation: Clarify discrepancies in the evaluation and problem formulation documents and provide greater discussion as to why other studies were neglected or rejected. It remains unclear why studies found acceptable in the Problem Formulation document have been excluded or	For the Problem Formulation the most sensitive end point was used. This was a saltwater invertebrate (mysid shrimp) LC_{50} study by (Hollister et al., 1968). Saltwater aquatic invertebrates are less representative of PCE exposure from releases than freshwater invertebrates. Acute aquatic invertebrate COC has been revised using EC_{50} of midge larvae. The McDaniel et al. 2004 study for amphibians, and the Spencer et al., 2002 study for Japanese medaka have been added to the risk evaluation

	ignored in the draft risk evaluation. An example is the study by Spencer et al. (2002).	(Table 3-1, and Section 3.1.2). The exclusion of these two studies from the draft risk evaluation was an error.
28, 42	**PUBLIC COMMENTS:** EPA derived an acute COC, a chronic COC (with algal ecotoxicity data excluded), and an algal COC (using only algal ecotoxicity data). The importance of each of these is unclear. EPA continues to use these COCs in comparison to all of the exposure COUs but does not distinguish acute exposures from chronic exposures and does not explain the importance of algae among other aquatic ecological receptors (fish and aquatic invertebrates). EPA should better explain the purpose of these hazard characteristics and their use in characterizing the risk of particular exposures. EPA should clarify and justify the role for unique acute and algal COCs in risk characterization. A single COC should be developed and applied for chronic aquatic environmental exposures.	Acute, chronic and algal exceedances are discussed in Section 4.1 *Environmental Risk*. Algae was assessed separately and not incorporated into acute or chronic COCs, because durations normally considered acute for other species (*e.g.*, 48, 72 hours) can encompass several generations of algae (see Section 3.1.4).
45	**PUBLIC COMMENTS:** EPA is proposing a finding of unreasonable risk to algae for the use of PCE as a catalyst regenerator. According to the draft evaluation, algae species vary widely with respect to chemical sensitivity. The COC for algae is based on only one study and EPA assigned a quality value of medium for that study. EPA estimated the COC as $1.4x10^{-2}$ µg/L, then added a 10X assessment factor, so the threshold used in the draft evaluation was $1.4x10^{-3}$ µg/L or 1.4 ppb. Rather than using its tools under TSCA Section 4 or 8 to collect more pertinent information on the effects of PCE on algae, EPA instead simply added a 10X factor, which dramatically reduced the COC. Despite various uncertainties and discrepancies, EPA assigns a quality ranking of medium to the E-FAST model outputs, algal COC, and overall environmental risk for the use of PCE as a catalyst regenerator.	EPA used the best available science and the reasonably available information during the data integration process. EPA has revised the risk calculation for algae exposed to PCE. The rationale for selecting the studies used for algal exposure to PCE is provided in Section 3.1.3 Weight of Scientific Evidence. From Section 3.1.3: "…The (Brack and Rottler, 1994) study was also used in the risk evaluation for trichloroethylene with the same species (*C. reinhartdtii*). For the TCE risk evaluation, nine species of algae were available to perform a species sensitivity distribution (SSD) using EC50s that included *C. reinhartdtii* from (Brack and Rottler, 1994). Because of the chemical similarities between these two chlorinated

		solvents, trichloroethylene and PCE, EPA expects the distribution of species sensitivities from exposure to either chemical to be similar. In the trichloroethylene SSD, *C. reinhartdtii* was below the calculated HC05 (hazardous concentration threshold for 5% of species). Therefore, EPA expects the EC50 from exposure of PCE to C. reinhartdtii to also be protective of 95% of algal species. The EC50 from one high quality algae study (Brack and Rottler, 1994) was used to derive an algae COC in Section 3.1.4."

4. Occupational and Consumer Exposure

Occupational and Consumer Exposure
Charge Question 4.1: Please comment on the approaches and estimation methods, models, and data used in the occupational exposure assessment. **Charge Question 4.2:** Specifically, please comment on the Occupational Near-Field/Far-Field models and their input parameters. **Charge Question 4.3:** Please provide any specific suggestions or recommendations for alternative data or estimation methods that could be considered by the Agency for conducting the occupational exposure assessment. **Charge Question 4.4:** Please comment on the assumptions and uncertainties of this approach. **Charge Question 4.5:** Are there other approaches or methods for assessing ONU exposure for the specific condition of use? **Charge Question 4.6:** Please comment on this and provide any suggestions and/or data for assessing dermal exposure to ONUs. **Charge Question 4.7:** Please comment on the approaches, models, exposure or use information and overall characterization of consumer inhalation exposure for users and bystanders for each of the identified conditions of use. What other additional information, if any, should be considered? **Charge Question 4.8:** Please comment on the approaches, models, exposure or use information and overall characterization of consumer dermal exposure for each of the identified conditions of use. **Charge Question 4.9:** Please comment on whether there are dermal models which would be appropriate to address evaporation during use and/or the amount of product absorbed into the skin during use when evaporation is not hindered. What other additional information or modeling approaches, if any, should be considered? **Charge Question 4.10:** Please provide any other suggestions or recommendations for alternative approaches, dermal methods, models or other information which may guide EPA in developing and refining the dermal exposure estimates.

#	Summary of Comments for Specific Issues Related to Charge Question 4	EPA/OPPT Response
Comments for specific conditions of use		
SACC, 29, 40, 50	**SACC COMMENTS:** Recommendation: Discuss and assess PCE exposures to dry-cleaner bystanders. The Committee discussed EPA's decision to assess dry-cleaning COU exposures, and to exclude assessment of exposures to 'bystanders.' Bystanders are people living and/or working near a dry cleaner that uses PCE. These include workers in co-located businesses who are likely exposed to fugitive PCE emissions. Also included are residents of apartments that are co-located (above or aside) the dry-cleaning	Stationary source emissions of PCE to ambient air (including dry cleaners) are under the jurisdiction of the Clean Air Act. EPA has promulgated National Perchloroethylene Air Emission Standards for Dry Cleaning Facilities under the authority of the CAA. See 40 CFR part 63, subpart M; 73 FR 39871 (July 11, 2008); 71 FR 42724 (July 27, 2006). As explained in more detail in section 1.4.2 of the final risk evaluation, EPA believes it is both reasonable and prudent to tailor TSCA risk evaluations when other EPA offices have

	business. • One Committee member cited published studies in New York that examined PCE exposures to residents in co-located apartments. The 2008 ruling by EPA directed a phasing out (closing down) of PCE dry cleaners that are co-located in [mixed use] residential buildings. This ruling does not address other dry cleaner bystander exposures, such as people working in nearby businesses and food service establishments which cater to adults, children and infants. However, EPA utilized that directive to justify its exclusion of that population in the draft risk evaluation. • One Committee member mentioned the 2010 King County (Washington) survey of dry cleaners which noted (p. 23 of the report): "Seventy-seven percent of respondents said their facility is part of a larger building (149 total respondents)" and "Sixty-nine percent of all respondents indicated that there are businesses that sell or serve food where their dry cleaning facility is located (112 total respondents)." Schreiber et al. (2002) examined apartment buildings in New York City that contained both an active dry-cleaning facility and a daycare center. In those surveys, it was also mentioned that children often go to the family dry cleaner after school where they are also exposed. • Table 2-40 (p. 147, line 3619) lists the estimated numbers of ONUs potentially exposed to PCE associated with each dry-cleaning facility as 1. This is equivalent to assuming 14,000 ONUs for the whole of the U.S. This value underestimates substantially the numbers of actual ONUs by an unknown amount (perhaps by 2 or more orders of magnitude) given that in New York City alone, 2,780 apartments are located in buildings with dry cleaners affected by confirmed or potential fugitive PCE emissions (McDermott et al., 2005). For the whole of New York State, there are 600 operating	expertise and experience to address specific environmental media, rather than attempt to evaluate and regulate potential exposures and risks from those media under TSCA. EPA believes that coordinated action on exposure pathways and risks addressed by other EPA-administered statutes and regulatory programs is consistent with the statutory text and legislative history, particularly as they pertain to TSCA's function as a "gap-filling" statute, and also furthers EPA aims to efficiently use Agency resources, avoid duplicating efforts taken pursuant to other Agency programs, and meet the statutory deadlines for completing risk evaluations. EPA has therefore tailored the scope of the risk evaluations for perchloroethylene using authorities in TSCA sections 6(b) and 9(b)(1). See section 1.4.2 of the Risk Evaluation. Additionally, children of employees present at dry cleaners were assessed as a PESS group within the PCE risk evaluation that may be exposed to air concentrations equal to that of ONUs (Section 2.4.1.16). EPA defines ONUs to be employees who work in the facility but do not directly handle PCE. Populations living in co-located apartments are considered to be part of the general population, and do not meet the definition of ONU. The estimate of an average of 1 ONU per facility is based on the reasonably available data and consistent with the approaches used throughout the document for estimating workers and ONUs.

	dry cleaners in residential buildings where estimated 170,000 residents are potentially exposed to fugitive PCE emissions (Schreiber et al., 2002). This problem is not restricted to New York State (see Garentano and Gochfeld, 2000; Altman et al., 1995). • These residents are neither workers, a subset of workers, consumers, nor bystanders from consumer use (pp. 458-459) of PCE. By restricting the age of ONUs to "adults of both sexes," EPA ignores the well-established PCE exposure of children and older/elderly people (*e.g.*, "the [day care director] was considerably older than the other workers and had worked considerably longer than the other staff members"). • Section 2.4.1.16 (lines 3604-3606) of the draft risk evaluation states, "ONUs at dry cleaning facilities are employees who are not expected to handle PCE, operate dry cleaning machines or perform spotting or finishing operations. They include cashiers, counter clerks and other similar employees." One Committee noted that these ONUs are in essence 'bystanders' who do not load solvent into the dry-cleaning machines or handle solvent-soaked clothing. **PUBLIC COMMENTS:** As several studies show, higher PCE levels in indoor and ambient air are correlated with elevated exposures from dry-cleaning operations. As described by ATSDR: • Families of dry-cleaning workers have elevated PCE exposures (see Aggazzotti et al., 1994). • Members of the public who patronize dry cleaning establishments or pass them on the street have significant PCE exposures. • Members of the public who use self-service, coin operated laundromats have high PCE exposures (Gulyas and	

	Hemmerling, 1990; Howie, 1981). • Apartments above dry cleaners can have high PCE concentrations (Garetano and Gochfield, 2000; Schreiber et al., 1993) • Dry-cleaned garments and other fabrics stored in homes release PCE, exposing family members and visitors (Tichenor et al., 1990) A 2005 risk assessment by EPA's Office of Air and Radiation (OAR) found even with application of admissions controls, the calculated cancer risks of PCE dry cleaner emissions to the general population and persons co-residing with dry cleaning facilities remained significant. EPA also estimated the inhalation individual cancer risks posed by dry cleaners co-located with residences, assuming lifetime exposures at 5th percentile, median, geometric mean, 95th percentile, and maximum measured indoor PCE concentrations. Despite previous findings, the draft EPA evaluation addresses the last scenario but ignores the other four even though they result in significant acute and chronic exposures.	
SACC	**SACC COMMENTS:** One Committee member recommended that the dry-cleaning scenario be expanded to include newly purchased clothing/textiles that are dry cleaned prior to sale. This triggered discussion of emissions that exposed workers bring back into their homes.	EPA did not consider background PCE exposure that workers might be exposed to in addition to exposures from TSCA conditions of use. The frequency and magnitude of take-home exposure is dependent on several factors, including personal hygiene and visibility of the chemical on skin or clothing. EPA does not have methods to reliably predict take-home exposure. This may result in an underestimation of risk, and additional discussion of this underestimation has been added to the document in the Key Assumptions and Uncertainties section. Dermal exposure to PCE resulting from direct skin contact with recently dry-cleaned articles, *i.e.*, wearing

		dry-cleaned clothing, was modeled with CEM. Inhalation exposure to PCE emitted from recently dry-cleaned articles stored in a home was modeled using EPA's Multi-Chamber Concentration and Exposure Model (MCCEM). MCCEM is a higher tier model and utilizes chemical-specific emissions data to estimate air concentrations and inhalation exposure.
SACC	**SACC COMMENTS:** In the Supplemental File: Perchloroethylene Exposure from Consumer Products and Articles, EPA used data from a 3 bedroom/2 bath (with attached garage) 'test house' to model putative indoor air concentrations associated with the resident bringing freshly dry cleaned clothing (skirt, blouse, suit) into the hypothetical single family home. Although the summary of residential indoor air PCE concentrations (Detroit, Houston, Los Angeles, Boston, Minneapolis, Chicago, Denver, Ann Arbor, Dearborn, etc.) is helpful to place model results into context, there are at least two practical problems with this approach; first, the results do not necessarily apply to a 1- or 2-bedroom urban or suburban apartment and second, results from models of dry-cleaned clothes do not necessarily apply to intentional consumer indoor use of common PCE products. There is a major difficulty (uncertainty) with extrapolation of occupational breathing zone PCE data to residential exposures.	EPA used the best available science to conduct its analysis of PCE in the indoor environment, due to off-gassing from recently dry-cleaned articles, using the Multi-Chamber Concentration and Exposure Model (MCCEM). MCCEM is a higher tier model and utilizes chemical-specific emissions data to estimate indoor air concentrations and inhalation exposure. Overall, there is medium to high or high confidence in the consumer inhalation exposure modeling approach and results. This is based on the strength of the model employed, as well as the quality and relevance of the default, user-selected and varied modeling inputs. Nonetheless occupational breathing zone data was not used to extrapolate to residential exposures to for MCCEM.
SACC, 31, 39 53	**SACC COMMENTS:** Recommendation: Perform a survey to determine if coin-operated dry-cleaning machines are still in use. P. 244, lines 5851-5852: One Committee member was surprised by the statement that EPA could not determine whether coin-operated dry-cleaning machines were still in use. A small survey could easily be done to answer this question and wondered why EPA had not attempted such.	EPA disagrees with the suggestion that OSHA data may be biased high. During the SACC meeting for PCE, committee members specifically addressed this topic and added the following to the final SACC report: "Most OSHA data are from regular inspections and are not expected to be higher than usual. One Committee member added that in their state approximately 15% of OSHA inspections are for issues, with the remaining 85% as routine visits." Therefore, EPA believes OSHA

	PUBLIC COMMENTS: EPA's efforts to assess exposure to dry cleaners based on data using only newer machines is appropriate since this is most representative of current exposures. PCE dry-cleaning machines being used today were designed and built to comply with stringent emission standards, specifically NESHAP and various state PCE air standards. However, EPA could improve upon their assessment of this COU by more thoroughly evaluating the datasets that they used in the draft risk evaluation. While there are no new PCE machines being produced and sold for the U.S. market, virtually all PCE machines being used today are either fourth or fifth generation. • For the draft risk evaluation, EPA used an OSHA dataset for "post 2006" dry-cleaning machines. The OSHA datasets were collected during compliance inspections at nine different facilities between 2012 and 2016; these inspections may have been complaint-triggered and would thus tend to be high-end of the true distribution of exposures in industrial settings (as noted in the draft risk evaluation). The OSHA data also did not specify the dry cleaner types (machine generation); EPA assumes that they were representative, but it is unknown what the impact is on the exposure estimates from any misclassification. • The datasets relied upon by EPA have relatively small sample sizes. Notably, there were only nine and six data points for 15-minute TWA "Post-2006 NESHAP" worker exposures and "Fourth and Fifth Generation" data, respectively. For ONUs, there was only one data point for post-2006 and four data points for fourth- and fifth-generation machines; no data were available for 15-minute concentrations. • Not only are there few data points, but the averages calculated by EPA (Table 2-41) indicate the possible	inspection data is reasonably representative of industry conditions. EPA agrees that the machine types for each sample from the OSHA dataset are unknown; however, given the dates the data were collected, they are expected to include only machine types that are currently in use by industry. EPA has used the most recent and reasonably available information to evaluate which dry cleaning machines are still in use. The most recently available data is a 2010 survey from King County, WA which indicated 1st through 5th generation machines were still in use. To account for the additional time that has passed since completion of the survey and the general trend to newer machine generations, EPA has only considered exposures to 3rd generation or later. Any limitations to the number of data points used are considered in the confidence assessment. EPA agrees that the high-end 15-min TWA exposure for 4th/5th generation machines is very high; however, there is no indication in the study that the exposure is a result of some non-routine activity or event. Regardless, 15-min TWA exposure values are not used to estimate any risk values, rather, they are included to provide information on task-specific exposures for workers. Risk characterization is based on the 8-hr TWA exposure values and the corresponding AC/ADC/LADC values. EPA acknowledges that inspector responsibilities may differ from those of ONUs; however, the activities they perform are still expected to fit the definition of ONUs as they do not handle PCE directly or operate machines

	influence of outlier data points. This is apparent in the spread between the CTE and 95th percentiles for the 15-minute TWA for fourth- and fifth-generation machines, which is very large (CTE of 48 ppm and 95th percentile of 899 ppm). These values are from a dataset that includes only newer machines, and yet the upper-end 15-minute TWA estimate is nearly 10-fold higher than the 15-minute TWA (94 ppm) for the post-2006 dataset, which may include third-generation machines. It is likely that this high-end represents an equipment failure or instance of misuse, which would not represent a routine exposure in a dry-cleaning facility. This conclusion is supported by equipment design specifications that only allow for 300 ppm residual vapor in the drum of the machine post drying. Unless there was an unusual event or lack of appropriate equipment operation, EPA's high-end estimate of 899 ppm is not a reasonable representation of the upper bound routine exposure scenario. EPA should consider a WOE approach to test the reasonableness of the CTE and upper bound estimates based on maximum drum concentration of PCE and considering current emission controls and work activity patterns. • Specifically, with regard to ONUs, EPA presented an equivalent central tendency and 95th percentile based off the single data point collected for an "inspector" at the worksite. It is unclear, but it is presumed that EPA is referring to an inspector who visits the facility on behalf of a regulatory body, and who performs an exhaustive review of machinery, ventilation, record keeping, and operation of the plant. In New York, for example, inspectors must be present for at least two full-load cycles, and they must collect PCE exposure badges (Tatch, 2002). Thus, while they do not operate machinery, they are in the area and	and are expected to spend all of their time in the far-field.

	likely have a higher acute exposure to PCE than an ONU in the same time period of machine operation. They would also have a higher exposure than would be expected over the course of a full shift for a representative ONU that moves between areas of the facility. Even if EPA is referring to an "inspector" in the sense of the worker in a dry-cleaning facility who is responsible for ensuring that stains have been removed, ensuring that creases in the clothing are sufficient, and bagging and assembling the order, this also may not be an appropriate surrogate. Exposure likely varies across ONUs, particularly for those that spend time "in the back," including the inspector, relative to those who spend most of their time "in the front" (*e.g.*, counter clerk).	
39, 53	**PUBLIC COMMENTS:** EPA could improve upon their assessment of dry cleaners by incorporating additional occupational datasets to enhance the empirical basis for the risk determination. • The New York Department of Environmental Conservation (NYSDEC) has been collecting data under 6 NYCCRR Part 232, which regulates dry cleaning. Under this regulation, New York requires yearly compliance inspections with trained inspectors registered with the state (*e.g.*, an engineer or Certified Industrial Hygienist) (6 NYCRR 232-2.11). The inspector must collect badge monitoring data, which they provide to NYSDEC. The NYSDEC monitoring data are available to EPA for use in the risk evaluation and that the dataset is very robust, covering a large number of facilities collected under normal operating conditions. Inspection data obtained for the years 2013-2016, which includes thousands of data points, revealed that many PCE area concentrations were less than the limit of detection (0.18 ppm), and most were <1 ppm (NYSDEC, 2016). While	EPA evaluated data collected under 6 NYCCRR Part 232 provided by the commenter in Appendix 9. However, the data did not include appropriate metadata (sample type and exposure type) and was thus rated "unacceptable" as determined through EPA's systematic review process. Therefore, this data was not incorporated into the risk evaluation. EPA has reviewed the monitoring data collected and provided in the report as Appendix 8. However, the data provided are 2-hr area samples. EPA's preference is to use PBZ monitoring data over area data. Furthermore, 2-hr data are not expected to be representative of dry-cleaning worker's full-shift exposure. EPA did not utilize the emission data in the report as air emissions of PCE from dry cleaning shops were not included in the scope of the risk evaluation.

	personal breathing zone samples are typically preferred as a source of worker exposure data, area samples from this dataset can also provide reliable estimates of TWA exposures appropriate for assessing 8-hour and longer-term daily dose estimates. This reflects that workers in the industry move around in the facility in the cleaning and pressing departments. Such data might not adequately account for worst-case peak exposures associated with the short amount of time a worker spends unloading a recently completed run cycle. However, accounting for brief peaks of exposure to a maximum of 300 ppm PCE over the course of a work day should not generate a large difference between representative personal samples and areas samples. A work time analysis could be completed to verify this conclusion based on input from industry sector experts. For ONUs, EPA should rely on a weighted average of the NYSDEC data and work activity patterns that would include combinations of time spent in the production and non-production areas. • Attached as Appendix 8 to the comments is a report titled "A Report on Drycleaning Plant Emissions based on Test Data from Plants in the New York State" prepared by Tatch Technical Services in 2002 for the Halogenated Solvents Industry Alliance, Inc. (HSIA). The report provides a review of 300+ dry-cleaning plant inspections in New York State and an independent analysis of PCE emissions. • Attached as Appendix 9 to the comments is an Excel spreadsheet file that contains critical data from New York State Part 232 Dry Cleaning Compliance Inspection Reports for the years 2013-2105.	
52	**PUBLIC COMMENTS:** When considering dry cleaners, the majority of workers are women, and EPA should therefore consider pregnant workers	EPA does not ignore risks to infants, children, or pregnant women. EPA presents PODs and risk estimates for developmental toxicity, for which

	and their developing fetuses under its worker/ONU section. Additionally, data show that owners and workers in small businesses such as dry cleaners often bring their children to work through an inability to afford childcare among other reasons. Therefore, children's exposures (under age 16) should also be considered in this section. While it makes sense that bystanders could be any age (infant to adult) and the draft risk evaluation takes into account developmental and reproductive concerns, the age cutoff for exposed child consumers being age 11 and above is given here without any justification. Unless EPA has justification for the age cutoff, it cannot assume that children under 11 and pregnant women will not be users.	pregnant women and their developing fetus are susceptible. EPA also provides distinct consumer dermal risk estimates for different age groups including children. All lifestages including infants are included in consumer bystander exposure and risk estimates, however exposures are presented as air concentrations and therefore consumer inhalation risks do not differ between these lifestages. Additionally, EPA has added an analysis of risks to children of employees present at dry cleaners that accounts for the increased exposure of younger lifestages using the assumption that HECs could be scaled based on their increased breathing rate/ body weight ratio compared to adults (Sections 3.2.5.4.1 and 4.2.2.13.2).
SACC, 37	**SACC COMMENTS:** One Committee member recommended that the brake cleaning product exposure scenario should be expanded to include an outdoor use version. This would illustrate the beneficial effect of greater ventilation. **PUBLIC COMMENTS:** The aerosol degreasing and aerosol lubricants OES relies upon a high number of data points from four monitoring studies and the EPA data quality rating is high. • The one monitoring study available is limited in sample number (20); however, the five different commercial brake shops from which samples were obtained comprise a diverse range of conditions. The 8-hour time-weighted average (TWA) concentration from these five shops ranged from 4.69 to 16.65 ppm with the mean and SD for all shops being 7.65±4.16 ppm. This mean value is substantially higher than the mean 8-hour TWA exposure concentration of 1.4 ppm used in the PCE risk evaluation.	All 4 monitoring studies are appropriate for use in assessing aerosol degreasing scenarios. The Cosgrove Study and NF/FF model both relate specifically to brake cleaning applications; however, aerosol degreasers can be used in multiple end-uses beyond brake cleaning. The data from the additional sources helps EPA capture additional possible uses of PCE-based aerosols. EPA acknowledges that including outdoor use may show the benefits of increased ventilation; however, the goal of the model is to estimate exposures in brake servicing shops. Because vehicles are typically put on lifts to perform brake jobs, they are generally performed indoors where the lifts are located. EPA did consider a distribution of ventilation rates in the model to account for variation between shops.

	• The other three monitoring studies are from military uses of PCE and an industrial hygiene study at a chemical company. These studies may not be representative for this occupational use scenario. The near field/far field model predicts a mean 5.5 ppm for this OES, which is in good agreement with the Cosgrove study. EPA should reassess the aerosol degreasing and aerosol lubricants exposure assessment by reviewing the suitability of the four monitoring studies to represent this OES. As measured and modeled results are in very good agreement for aerosol break cleaning, it may be necessary to develop an exposure assessment for aerosol lubricants.	
SACC	**SACC COMMENTS:** Recommendation: Inhalation exposures in the Other Industrial Uses COU should include workers engaged in other activities in addition to loading and unloading. The Committee commented on the activity modeled in the Other Industrial Uses COU. Section 2.4.1.23 reports inhalation exposure estimates to workers related to Other Industrial Uses COU using the Tank Truck and Railcar Loading and Unloading Release and Inhalation Exposure Model, suggesting that only loading and unloading activities are involved in this COU. But, Section 2.4.5.2.1 of the draft risk evaluation notes: "PCE is used (in the New Clothing/Textile Industry) to remove spinning oils, lubricants and naturally occurring dirt and oils from yarn and fabric used in clothing manufacturing, and as a carrier solvent for dyes in the textile industry (Morrison and Murphy, 2013). While a high percentage of PCE applied to textiles during manufacturing is expected to volatize, there is potential for consumer exposure due to off-gassing from new textiles and fabrics. Chan (2014) measured PCE in indoor air in apparel stores, with a detection frequency of 30% (120 samples) and	EPA has revised the "Other Industrial Use" OES to incorporate data from OSHA CEHD that are directly applicable to each of the subcategories under the OES. Although the OSHA data do not describe the specific activities during which they were obtained, because they are full-shift samples from facilities directly applicable to the subcategories, EPA expects them to include all of the exposure activities the worker performs throughout the day including unloading activities and the activities described by the commenter at such facilities where those activities occur.

	reported mean air concentration of 0.2 μg/m^3." • Inhalation exposures in the Other Industrial Uses COU should be discussed and EPA should assess exposures to workers engaged in these other activities in addition to loading and unloading.	
43	**PUBLIC COMMENTS:** There is concern that EPA's risk evaluations are based on specialty products with unusually high concentrations of PCE and not representative of other products affiliated with its "condition of use." EPA based its worker exposure estimates on a handful of workplace monitoring studies by the National Institute for Occupational Safety and Health (NIOSH) and others, one dating back to 1981. • As product formulations have changed significantly over the past 20 years to largely minimize and phase out PCE and other TSCA workplan chemicals, there is concern that these studies do not accurately represent quantities of PCE typically found in paints, coatings, sealants, and adhesives, which only report trace amounts (<0.1%) of PCE in raw materials with even lower amounts in final products. • Although the Orris and Daniels (1981) study does not identify the quantities of PCE handled, it is unlikely that this accounts for such low amounts of PCE as typically used in manufacture of paints, coatings, sealants, and adhesives. • Also, worker exposure from downstream use of products varies greatly depending on the product, the substrate, engineering controls, personal protective equipment (PPE) and even the weather on the day of use. EPA recognizes that exposure will vary greatly but, nonetheless and rather inexplicably, assigns a confidence rating of "medium" for its conclusions (p. 164, draft risk evaluation). • It is suggested that EPA use the Chemical Screening Tool	EPA acknowledges that the exposure data from Orris and Daniels is older and the date data were collected are considered in the data evaluation step of systematic review. However, EPA does not have specific data to indicate that the processes described in this study are outdated or no longer used by industry. EPA's preference is to use monitoring data rather than models where such data are reasonably available and there is no information to indicate the monitoring data are not representative of current industry operations. Additionally, EPA expects the most common PCE-based aerosol products to be degreasers not coatings or adhesives; degreaser products are expected to contain higher concentrations of PCE than coatings or adhesives. Formulation of non-aerosol products are assessed separately. In the *Preliminary Information on Manufacturing, Processing, Distribution, Use, and Disposal: Tetrachloroethylene (perchloroethylene)* document, EPA identified over 60 coatings and adhesive products with concentration of PCE ranging from 0.1 to 100%. EPA acknowledges that a 100% concentration is unreasonable and, therefore, referenced Emission Scenario Documents (ESD) published by OECD for typical organic solvent (the assumed function of PCE in the formulations) concentrations in coatings and adhesives. The ESDs estimate organic solvent concentration in coatings to be between 30-80% and 60-75% in adhesives. Therefore,

	for Exposures and Environmental Releases (ChemSTEER), using accurate data inputs to estimate worker exposure during packaging of aerosol paints and coatings. EPA should consider that PCE is present in *de minimis* amounts in paints, coatings, sealants, and adhesives, if present at all, and clearly limit its findings narrowly to those products represented in the cited studies with similar levels of PCE. EPA should also assign a "low" confidence rating to proposed findings for this COU, based on outdated studies, the high potential for variability in exposure, and the likelihood of lower amounts of PCE in today's products than those reflected in the cited references. In the alternative, EPA should provide additional explanation as to why it assigned a confidence level of "medium."	EPA assumed products indicating concentrations of PCE up to 100% actually had a max concentration of 80%. EPA does not have data on the market share of each product to determine whether such high concentration products are specialty products or typical products. Furthermore, the goal of EPA's assessment is to account for all intended, known, and reasonably foreseen uses of a chemical, so without data to indicate that a particular product is no longer available for use, EPA considered exposures to all potential products. EPA assigned a medium confidence rating primarily based on the quality ratings of the studies scored through systematic review. EPA acknowledges that there can be variety of PCE concentrations in products but does not have any reasonably available data to indicate that the products used in the referenced studies are not representative of products currently in the market.
46	**PUBLIC COMMENTS:** EPA knowingly underestimates PCE exposures to metalworkers. EPA estimates PCE exposures from metalworking fluids based on the expected concentrations of PCE in the mist created by the use of such fluids. • EPA acknowledges that "these estimates may underestimate exposures to PCE during use of metalworking fluids as they do not account for exposure to PCE that evaporates from the mist droplets into the air." • EPA does not attempt to quantify or correct for this underestimation; instead, it simply says that "[t]his exposure is difficult to estimate and is not considered in this assessment." • The fact that realistic exposure scenarios may be more "difficult" or less "certain" to estimate does not permit EPA	EPA acknowledges that this exposure estimate may be an underestimate; however, EPA did not identify reasonably available data to estimate what the true exposure concentration is for workers in this OES. EPA reworded the text in the Risk Evaluation to remove the word "difficult" and instead describe it as a lack of reasonably available data. EPA used the high-end exposure estimates for unreasonable risk determination of all COUs in order to account for potential uncertainties that could result in underestimation of exposure or risk.

	to rely on inaccurate exposure assumptions that understate worker risks. NIOSH has recommended a methodology for the sampling and analysis of metalworking fluid aerosols (mist). Just as the draft risk evaluation accounts for evaporation of PCE from liquid PCE when applied to surfaces, it must account for metalworkers' PCE inhalation from evaporated mists	
45	**PUBLIC COMMENTS:** EPA is strongly urged to drop the use of PCE as a catalyst regenerator in the risk evaluation because of the remote likelihood for exposures; or, at a minimum, revise the COUs to ensure that the assessed risks reflect real-world conditions. • PCE is used as a catalyst regenerator (*i.e.*, chloriding agent) at petroleum refineries. It is used in closed systems and is consumed in the process. As a heavily regulated industry with a strong safety culture, refinery workers wear personal protective gear and routinely surpass Occupational Safety and Health Administration (OSHA) regulations. The likelihood of exposure to PCE at a refinery is minimal.	EPA does not have any data to suggests that catalyst regeneration uses will be any more controlled than industrial sites using PCE for other processing aid uses. EPA expects the exposures to occur from: 1) connecting and disconnecting of hoses by workers when unloading PCE from bulk containers into process equipment for use; 2) the presence of fugitive emissions due to equipment leaks while performing various maintenance activities; and 3) from displaced vapors as vessels are filled. EPA expects these exposure activities to be consistent across all processing aid type uses. For the purposes of determining whether or not a condition of use presents unreasonable risks, EPA incorporates assumptions regarding PPE use based on information and judgement underlying the exposure scenarios. These assumptions are described in the unreasonable risk determination for each condition of use, in section 5.2. Additionally, in consideration of the uncertainties and variabilities in PPE usage (*e.g.*, the burden associated with the use of supplied-air respirators, including the expense of the equipment and the necessity of fit-testing and training for proper use), EPA uses the high-end exposure value when making its unreasonable risk determination in order to address those uncertainties. EPA has outlined its PPE assumptions in section 5.1.

44	**PUBLIC COMMENTS:** PCE as a byproduct in the production of EDC is controlled and regulated throughout its lifecycle. PCE in this process is not associated with consumer use or exposure. There are essential differences between PCE unintentionally produced as a byproduct in EDC manufacturing and the intentional production of PCE. EPA's draft risk evaluation for PCE fails to distinguish these different manufacturing scenarios as separate COUs. As a result, EPA's draft finding that manufacture of PCE presents a potential unreasonable risk to workers is not appropriately tailored and fails to properly consider the COUs. • PCE is found at a concentration ranging from 19 to 1,410 ppm in the primary EDC intermediate manufacturing stream before purification to remove light and heavy ends at a balanced EDC manufacturing facility. PCE is found in heavy ends at a concentration ranging from 0.2 to 15% but heavy ends are a single stream comprising a small part (less than 1%) of the overall production at a balanced EDC facility. • Unintended yields of PCE in manufacturing EDC are recovered in heavy ends and primarily used as feedstocks to make HCl or other chlorinated organics, or destroyed on site, and should be considered a low exposure, site-limited impurity. • EPA's exposure modeling must reflect the limited exposure to PCE during EDC manufacturing. Similarly, the potential for inhalation exposure is significantly reduced by the much lower concentration of PCE in all process streams. EPA must correct its draft risk evaluation and assess the production of PCE as a byproduct in EDC production as a separate COU, considering the low levels of PCE present in these facilities and the demonstrated lower worker exposures. Because EPA did not apply available data for readily distinguishable byproduct production operations, EPA's	EPA has clarified in the final risk evaluation that EPA did not assess PCE production as a byproduct in the manufacturing scenario. Rather, EPA assessed processing of PCE for reactant use. More details are in section 5.3 in the risk evaluation. EPA believes the use described by the commenter is consistent with other reactant uses, and, therefore, EPA evaluated these exposures as equivalent to exposures at other sites where PCE is processed for reactant use.

	calculations and unreasonable risk conclusion for the production of PCE during EDC manufacture are erroneous and unsupported.	
48	**PUBLIC COMMENTS:** EPA has over-estimated the number of workers who directly handle maskant for chemical milling. EPA's method for determining the number of workers and ONUs exposed to PCE from maskants was highly flawed for the following reasons: • EPA's determination of which North American Industry Classification System (NAICS) codes apply to sites using PCE-based maskant was based on incorrect assumptions about what industries utilize maskant. • EPA's assumption that a site reporting emissions or discharges of PCE within the identified NAICS codes using maskant was arbitrary. • EPA's assumption of Standard Occupational Classification codes for workers and ONUs exposed to PCE in maskant was arbitrary and resulted is a gross overstatement of workers and ONUs. • According to EPA, the sites reporting NAICS code 928110 are either U.S. Air Force or Navy bases. Based on that, EPA assumed that the activities at the site with this NAICS code are typical of an aircraft or aircraft parts manufacturer and it therefore used worker and ONU estimates from NAICS code 336411 (Aircraft Manufacturing) to estimate the number of workers at the site. This assumption by EPA is inappropriate because U.S. Air Force and Navy bases do not manufacture aircraft or parts, and most employees at these bases are likely not handling maskant or even exposed to it. Thus, the estimate of workers from this site is a gross overestimate. • Work is currently being done to determine a more complete and accurate representation of the number of workers and ONUs within the group of PCE-based maskant users in the	EPA did not select NAICS or SIC codes arbitrarily. EPA used NAICS/SIC codes primarily related to aircrafts parts manufacturing as the basis for identifying sites performing maskant activities. These included NAICS 332912, 336411, 336412, 336413, 336414, and 336415. Except for 332912, all of these NAICS fall under the 4-digit NAICS for "Aerospace Product and Parts Manufacturing." NAICS 332912 includes manufacture of valve and hose fittings for aircrafts, and, thus, was assumed to also be reasonably likely to perform masking activities related to aircraft manufacturing. Additional NAICS/SIC codes were selected based on information reported to NEI/TRI/DMR and review of reporters' websites for milling capabilities. EPA analysis is based on reasonably available BLS data and average number of employees for identified worker and ONU SOC codes. EPA acknowledges that this may result in inaccuracies in worker/ONU estimates as SOC codes can be general and the number of employees performing a specific task within an SOC code is uncertain. EPA appreciates the customer-specific worker and ONU estimates provided by the commenter. EPA has incorporated data from this and other commenters and has adjusted worker/ONU estimates in the risk evaluation accordingly. However, the unreasonable risk determination did not change as a result of the new data. Furthermore, the number of workers is not a factor in

	U.S. aerospace market segment. The third-largest customer by volume reported that three of its employees directly handle maskant (*i.e.*, workers) and another three are potentially exposed to residual PCE during removal of cured maskant from chemically milled parts (*i.e.*, ONUs). The fourth-largest customer has reported that only 2 of its employees directly handle maskant (*i.e.*, workers) and another 45 are potentially exposed to residual PCE during removal of cured maskant from chemically milled parts (*i.e.*, ONUs). For both of these users of PCE-based maskant, their actual numbers of workers and ONUs are substantially below the EPA-estimated number of workers (95) and ONUs (75) attributed to each and every PCE-based maskant user. • Based on volumetric sales, the usage of maskant across the industry varies greatly. Therefore, using average worker and ONU estimates from 28 sites across the entire 71 sites using maskant in 2017 is inappropriate and grossly overestimates the number of workers and ONUs. • Over a 5-year period through 2017, the only military installation that made a PCE-based maskant purchase, purchased, on average, 667 gallons of maskant per year. In 2014, this customer installed a new dip tank that was part of a brand new fully automated surface treatment facility. This new facility replaced a legacy facility that had essentially no engineering controls. The new facility is completely automated and the masking of parts is performed by a person in a control room isolated from the dip tank. For this type of operation, the number of workers is estimated to be approximately six, which includes the dip tank operator, and five other workers loading and unloading parts and filling the dip tank. • EPA also reported in the Assessment of Occupational Exposure and Environmental Releases for PCE that it	evaluating unreasonable risks. This information is used during risk management.

	estimated the number of employees at an airfield as the same as at an aircraft manufacturer. This too is likely a gross overestimate. • EPA's assumption that the 28 specific sites for which it had information on workers and ONUs were representative of all of the sites utilizing maskant was arbitrary and capricious and resulted in a gross overestimate of the number of workers and ONUs exposed to PCE in maskant. Because the number of both workers and ONUs are overestimated at the 28 facilities, it was not appropriate for EPA to use those averages across the rest of the sites in the U.S. (reported by AC Products [ACP] in 2017 to be 71, in total) to determine the total number of workers and ONUs exposed to PCE-based maskant in the U.S. Use of the average at the 28 facilities for the 43 facilities for which no data exist further compounds the over-estimate. • EPA has substantially overestimated the number of ONUs of maskant. Most maskant application and curing operations are conducted in dedicated rooms with few employees entering those rooms. The six largest purchasers of maskant in 2019 from ACP purchased more than 99% of all of the maskant sold by ACP in 2019. Each of those six customers have sophisticated PCE capture and recycling systems, and five of them return captured PCE to ACP for recycling. The amount returned from these five customers represents over 93% of total PCE contained in maskant sold to all of ACP's customers. The PCE capture and recycling systems utilized by ACP's six largest customers further assure that employees at the site who are not working with maskant have no exposure to PCE vapors. Thus, EPA's estimate of ONUs at facilities utilizing PCE-based maskant is grossly over-stated.	

	EPA's conclusion that use of maskant containing PCE in chemical milling presents an unreasonable risk of injury to human health is arbitrary, capricious, and not based on competent information because it is based on inaccurate numbers of workers and ONUs exposed to maskant, it is based on old and inapplicable data, and EPA assumes exposure without any competent basis.	
48	**PUBLIC COMMENTS:** It is not appropriate for employees who only remove maskant after chemical milling to be counted as workers directly handling maskant because substantially all of the PCE in the maskant has been volatilized from the maskant prior to its removal. • The PCE in maskant is substantially volatilized prior to the chemical milling process. The chemical milling process itself results in further volatilization of any minor amounts of PCE in the maskant that remains after the pre-milling curing period. Thus, for employees who only remove the maskant after chemical milling, it would only be appropriate to count such employees as ONUs because they are only exposed to incidental amounts of PCE. However, such employees were likely identified by EPA as workers rather than ONUs.	EPA agrees that workers removing maskants should be considered ONUs and not workers as PCE is expected to volatilize prior to this activity. EPA has updated its determination on which monitoring data are for workers and which are for ONUs based on this information and adjusted the exposure results accordingly. Workers described as either scribes or demaskers are now considered ONUs. These updates are described in Section 2.4.1.18.
48	**PUBLIC COMMENTS:** The exposure monitoring data from the 1977 NIOSH investigation at an aircraft parts manufacturing site using a dip coating application process (Hervin et al., 1977) should not have been used by EPA in the risk evaluation because the Aerospace Manufacturing and Rework Facilities NESHAP was promulgated after the investigation and significant emission control improvements have been implemented at most, if not all, of the facilities using maskant for chemical milling in the intervening 43 years. • The NIOSH investigation was conducted 43 years ago,	EPA acknowledged the uncertainty of the Hervin et al. 1977 study given data were collected prior to the most recent NESHAP for the aerospace industry; however, EPA did not have more recent data or information about how the NESHAP may have affected exposures reasonably available at the time the draft risk evaluation was published. EPA has evaluated the exposure data submitted by public commenters for maskant uses of PCE and updated the final assessment accordingly. As described in Section 2.4.1.18, a comparison of the NIOSH data to more recent data from 2015 to 2020

	which was prior to the promulgation of the Aerospace Manufacturing and Rework Facilities NESHAP (the "AMRF NESHAP") in 1995. The AMRF NESHAP required covered facilities (which includes aircrafts parts manufacturing sites using solvent based maskants) to either utilize reduced solvent content maskants or install solvent capture devices. Either of these requirements would have reduced worker and ONU exposure at the facility at which the NIOSH investigation was conducted in 1971. Moreover, general occupational hygiene and PPE advances in the last 40 years must render the data from an investigation in 1977 useless for evaluating the risk at a facility today. The draft risk evaluation acknowledges that "it is unclear if these data are representative of a 'typical' site." Furthermore, EPA concedes in the draft risk evaluation that "worker exposures may be lower than identified data" as a result of the promulgation of the AMRF NESHAP. EPA should not have utilized these data in its risk evaluation. • Contemporary industrial hygiene assessments undoubtedly exist in the industries utilizing maskant for chemical milling (examples were provided). EPA should have solicited this type of industrial hygiene information from the industry participants for use in conducting the risk evaluation rather than rely on clearly outdated information. An industrial hygiene PCE assessment was provided with the comments as an exhibit.	submitted via public comment did not indicate emissions controls implemented as a result of the NESHAP reduced exposures. For comparison, 8-hr TWAs for workers in the Hervin et al. (1977) study ranged from 0.7 to 2.1 ppm with a median of 1.2 ppm, and 8-hr TWAs from public comments ranged from 0.87 to 66 ppm with a median of 4.7 ppm. Therefore, data from both 1977 and public comments were both used in the risk evaluation.
48	**PUBLIC COMMENTS:** The exposure data from the 15-minute TWA samples taken by the Department of Defense between July 2013 and May 2017 should not have been used by EPA in the risk evaluation because all results from that sampling were below the limit of detection. • These data consisted of nine samples, all of which were below the limit of detection. In other words, all nine samples	The commenter's characterization of the DOD data is incorrect. The DOD data consisted of 20 15-min samples of which 9 were below the LOD. EPA policy is to assess values below the LOD using the 1994 *Guideline for Statistical Analysis of Occupational Exposure Data*. EPA added text to Section 2.4.1.18 to clarify this point.

	were non-detect. Despite the fact that these data could be evidence of no exposure, EPA instead said that each sample was 50% of the limit of detection, which assumes exposure where none may exist. EPA relied on its 1994 Guideline for Statistical Analysis of Occupational Exposure Data. This was inappropriate. Rather than use these data in the draft risk evaluation, EPA should not have relied on the data.	The commenter should also be aware that 15-min TWA exposure values are not used to estimate any risk values, rather, they are included to provide information on task-specific exposures for workers. Risk determination is based solely on the 8-hr TWA exposure values and the corresponding AC/ADC/LADC values.
54	**PUBLIC COMMENTS:** In order to provide clarity and appropriate data for evaluation of risk related to PCE based maskants, Spirit AeroSystems has collected additional information to provide to EPA, including employee exposure data (provided on p. 5 of the comments). Briefly, maskants are used in the aerospace industry. Although alternatives for PCE maskant have been pursued for many years, no acceptable alternatives have been identified that meet the process requirements and fulfill the characteristics for successful production of aircraft parts like PCE maskant. • Over 95% of the PCE solvent used in the maskant has been successfully recaptured and recycled through carbon adsorption technology for over 28 years. The recapture process virtually eliminates emissions to the environment, while greatly reducing employee exposure to PCE. • The system utilized to apply the maskant material is completely enclosed and the material is applied through automated means (no employees directly apply the maskant) and all vapors are captured and returned to the adsorption recovery system for recycling. The application process is controlled remotely by operators that use cameras to visualize operations within the booth. The maskant application and cure process occur entirely within the confines of the booth structure, with solvent vapors captured and returned to the adsorption system for ultimate recycle by the maskant manufacturer. More vapors are captured from	EPA has accounted for the estimates of 95% of the PCE-based maskants are recycled, per information AC Products provided during a meeting with EPA in 2017. EPA appreciates the additional exposure information, worker/ONU data, and inhalation monitoring data and has evaluated and incorporated the data into the assessment, as appropriate.

	production parts, preventing any further release. • Precautions are taken for employees to minimize exposure including restricting entry to the booth until vapors are below 100 ppm, and the use of PPE (additional details were provided). • The number of employees is well below the "Estimated Number of workers potentially exposed to PCE During Use of Chemical Maskants" as outlined in Table 2-45 in the EPA draft risk evaluation (data provided in comments).	
37	**PUBLIC COMMENTS:** Table 1-4 of the draft risk evaluation identifies the occupational and consumer COUs for PCE. In the "cleaning and furniture care products" category, there are several uses of aerosolized and non-aerosolized PCE which include spray adhesives, spray lubricants, spray paints and primers, spray degreasers (brake and engine cleaning, parts cleaning and electronics cleaning), spray protectants, and stain removers. For parts cleaning, the draft risk evaluation calculates consumer inhalation exposure to aerosolized and liquid PCE but only to aerosolized PCE for occupational inhalation exposure. • California banned the use of aerosolized brake and parts cleaners containing PCE in the automotive repair industry in 2006. Based on reporting in the California Environmental Reporting System, use of PCE is still ongoing in the automotive industry in California, especially in automotive dealerships and repair shops. Automotive dealerships and automotive repair shops reported having average daily amounts of 52.1 and 46.6 gallons of PCE, respectively, on site in 2016. These volumes suggest PCE is in liquid form and the records for these facilities suggest PCE is being used as a brake/parts cleaner, mostly at 50% of the formulation.	EPA assessed the industrial and commercial use of PCE in wipe cleaning, including liquid degreasers, in the "wipe cleaning and metal/stone polishes" occupational exposure scenario where liquid PCE solvent is applied to a rag and used to clean a substrate. EPA added additional text to clarify this in Section 2.4.1.21. The unreasonable risk determination for industrial and commercial use of PCE in wipe cleaning is in Section 5.2.1.24.

	• EPA should evaluate an occupation exposure scenario wherein PCE is used as a liquid parts cleaner.	
43	**PUBLIC COMMENTS:** For the "Miscellaneous" category of worker exposure, EPA estimates exposures during loading and unloading of PCE-containing raw materials and products by using EPA models identified as "loading and mass balance models." Relevant data are derived from market data for formulating degreasing and cleaning solvents with the number of containers loaded and unloaded per day, with some corrections for weight fraction of PCE in products and other parameters. EPA did not have market data specific to paints, coatings, sealants, and adhesives to provide more accurate estimates of volumes handled per day during formulation of these products. • There is concern that market data for degreasing and cleaning solvents is a grossly inaccurate surrogate for paints, coatings, sealants, and adhesives. EPA should use ChemSTEER with accurate data inputs. The American Coatings Association (ACA) can try to obtain data to input into EPA's models, if EPA identifies specific data inputs required to improve its estimates.	EPA did not use data specific to formulating degreasing and cleaning solvents as a surrogate for the formulation of paints, coatings, sealants, and adhesives. The market data used separates the uses into four categories: vapor degreasing solvents (7% of PV), aerosol degreasing (10% of PV), dry cleaning solvents (10% of PV), and a catch-all for "miscellaneous" products (3% of PV). Paints, coatings, sealants, and adhesives are expected to be included in the miscellaneous portion of the PV and exposures for formulation of these products were modeled using the market data for miscellaneous products and the weight fractions expected for paints, coatings, sealants, and adhesives.
38	**PUBLIC COMMENTS:** It is requested that EPA consider a research and development (R&D) exemption that would relieve R&D programs from consideration during all of the scoping processes and the subsequent risk evaluations. Similar to EPA's TSCA §5 R&D exemption, the exemption could be narrowly crafted to ensure that activities were limited to "the analysis of the chemical or physical characteristics, the performance, or the production characteristics of a chemical substance, a mixture containing the substance, or an article. This exemption would exempt manufacturers and processors of chemical substances subject to TSCA (3)(B)(4) if they manufacture or process the substances	EPA did not consider a research and development exemption in this risk evaluation.

	"only in small quantities solely for the purposes of scientific experimentation or analysis, or chemical research on, or analysis of such substance, or another substance, including such research or analysis for the development of a product." An exemption would allow our R&D programs to continue their essential work without the time and financial burden imposed by regulation. Such an exemption could focus on small quantities solely for the purposes of scientific experimentation or analysis, or chemical research for the development of a product.	
34	**PUBLIC COMMENTS:** EPA does not include important and relevant COUs. Without the appropriate inclusion of important COUs and exposure pathways that reasonably reflect actual exposures and conditions, the draft risk evaluation is inadequate and inconsistent with the directives of TSCA. It is acknowledged that there is a lack of chemical-specific toxicity and exposure data to address COUs for even long-used, high-volume, and well-studied chemicals.	EPA used reasonably available information to determine the conditions of use (COUs) for PCE. EPA is not aware, nor has the commenter identified specific COUs (defined in TSCA section 3(4) to mean "the circumstances, as determined by the Administrator, under which a chemical substance is intended, known, or reasonably foreseen to be manufactured, processed, distributed in commerce, used, or disposed of") that EPA has not included in its assessment.
Exposure pathways and aggregate exposure		
SACC, 26, 29, 33, 34, 35, 40, 41, 47, 50, 51, 52	**SACC COMMENTS:** Biomonitoring data show that the general population is exposed to PCE. EPA should note that the most significant exposures to the general population outside of the COUs are exposures from PCE in drinking water, ambient air, and indoor air via soil vapor intrusion from contaminated groundwater. This is critical for understanding background exposures to workers and consumers engaged in COUs. EPA failed to consider community drinking water and air exposures because they are assumed to be adequately assessed and effectively managed by other EPA regulatory programs – without providing a summary of activities that justify this	EPA has provided an expanded discussion of the regulatory programs and statutes with jurisdiction over PCE exposures and risks in section 1.4.2. During the course of the risk evaluation process for PCE, OPPT worked closely with the offices within EPA that administer and implement regulatory programs under the Clean Air Act (CAA), the Safe Drinking Water Act (SDWA), the Clean Water Act (CWA), the Resource Conservation and Recovery Act (RCRA), and the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). Through intra-agency coordination, EPA determined that specific exposure pathways are well-regulated by the EPA

	assumption. Additional text is needed to direct readers to those other regulatory programs where PCE exposures and risks are evaluated. The discussion should provide a clear presentation of how all aspects of PCE exposures and risks are evaluated by the combination of regulatory programs and identify any aspects that may not currently be evaluated. Include information describing how risk determination information from other units of EPA will be used by EPA to develop a comprehensive risk determination for PCE. One Committee member offered that exposures from PCE in biosolids is one example where a source of exposure to environmental receptors is not regulated under any current statutes. Recommendation: Include in Section 1.3 a list of all U.S. regulatory programs having responsibility for assessing risks from exposures to PCE in air, water, land, and waste disposal, and summarize the status of these assessments. Expand the regulatory discussion to describe the manner in which aspects of PCE contamination are assessed by other regulatory programs. Provide additional discussion on how non-TSCA regulations will manage other PCE exposures and their (added) contribution to worker, occupational non-user (ONU), and consumer total exposures and risks. **PUBLIC COMMENTS:** EPA's assumption that environmental pathways of exposure are of lesser concern ignores the significance of these pathways for chemicals like PCE and the importance of accounting for all sources of exposure so that human health risks are not understated. Few chemicals are as ubiquitous in the environment as PCE. The survey of PCE environmental releases demonstrates	statutes and regulations described in section 1.4.2 of the risk evaluation. EPA reviewed other potential sources of PCE which included data from other countries. However, EPA did not take into account atmospheric data in the Risk Evaluation because assessing global emissions of PCE is outside the scope of the risk evaluation.

	the important contribution of PCE air emissions and contaminated groundwater, drinking water, and soil to overall PCE exposure. EPA recognizes in its draft risk evaluation that PCE "is present in various environmental media, such as groundwater, surface water, and air." EPA further recognizes that exposures to human and environmental receptors by PCE "may occur from industrial and/or commercial uses, industrial releases to air, water or land; and other COUs." However, in contravention of TSCA and the EPA implementing regulations, EPA excludes numerous exposure pathways in its risk evaluation. This approach is inappropriate and undervalues the role that TSCA plays in protecting public health from unreasonable risks not only at the chemicals primary point of use, but also through disposal and environmental contamination. Nothing in TSCA justifies EPA dispensing with evaluation of risks to the general population and environment. The SACC has repeatedly urged EPA to consider under TSCA all exposure pathways, including drinking water ingestion and air inhalation. EPA wrongfully asserts that it need not evaluate general population and other exposures because such exposures might be covered under other environmental statutes administered by EPA, such as the CAA, Safe Drinking Water Act (SDWA), CWA, and Resource Conservation and Recovery Act (RCRA). Exemptions, exceptions, and exclusions of environmental statutes must be examined in detail before these statutes are assumed to be universally protective. There is no indication that existing environmental laws have adequately addressed the risks of PCE. A piece in the University of California, Los Angeles (UCLA) Law Review highlights how the CAA fails to consider air pollution "hotspots," which contain pollution levels that are	

	folds higher than the standards. Even when chemical substances are listed as HAPs and are regulated, there are multiple exemptions, including use of burn boxes in Alaska. Additionally, all very small municipal landfill incinerators qualify as Other Solid Waste Incineration (OSWI) and are subject to less reporting and less monitoring. In the draft risk evaluation, where risks to consumers (and presumably bystanders) were considered, only acute inhalational exposures were evaluated. Many New Yorkers, however, live or work in a building adjacent to, or co-located with, a PCE-using facility and may be exposed to low concentrations of this solvent on a chronic basis. While there are emission standards for PCE, local agencies are not able to prevent frequent excursions over the standards other than at the time of inspection. EPA did not evaluate human exposure to PCE from drinking water or bathing (dermal and inhalation) in the draft risk evaluation because it is subject to National Primary Drinking Water Regulations under the SDWA. This decision underestimates the exposure of the population to PCE. While there is a national primary drinking water regulation for this chemical (a MCL of 5 μg/L), it is still detected at levels above 0 in drinking water systems around the country. PCE is detected in surface water and groundwater, making it a common drinking water contaminant across the U.S. It has been estimated that 24 million people in 47 states have detectable levels of PCE in their drinking water and that the MCL of 5 ppb is exceeded for around 8,000 people. With respect to biosolids, EPA asserts that "risks would not be evaluated for land-applied biosolids because PCE is currently being addressed in the Clean Water Act (CWA) regulatory analytical process." The CWA does not regulate PCE levels in	

	biosolids. The mention of PCE in a biennial review does [not] have any regulatory significance; biennial reviews are used to identify chemicals in biosolids that may warrant further research to determine whether or not to regulate them. PCE was first included in a CWA biennial review in 2005, and EPA has not taken or proposed any measure to regulate PCE in biosolids in the 15 years since then. PCE has been detected in rain from industrial cities in the United Kingdom and U.S., and in snow in Australia, Italy, and Antarctica. PCE and related chlorinated compounds may transition between environmental compartments and these compounds are toxic both to humans and wildlife. Given that global transport of PCE in the atmosphere seems relevant to the CAA, we need to determine how to integrate such findings and whether EPA is doing what's needed to effectively regulate PCE under the CAA. With regard to RCRA and the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), scientists have identified PCE as one of the most common contaminants at hazardous waste sites. EPA says one in four Americans lives within 3 miles of a contaminated site that could pose "serious risks to human health and the environment." Additionally, there can still be exposures near 'former' or 'remediated' sites. EPA is encouraged to be more transparent with the public about the substance of its inter- and intra-agency consultation and coordination and provide more information in its scoping documents and draft risk evaluations about how it determines whether existing regulations under other statutes are adequate to address potential risks associated with a TSCA chemical under	

	certain COUs. EPA OPPT is encouraged to convene a broader discussion with EPA's other program offices about how OPPT can: (1) better understand the regulatory requirements and processes of the various environmental statutes under EPA's purview; (2) reach agreement with other program offices on the criteria to use to determine when and under what circumstances TSCA risk evaluations should address air, water, and other waste pathways under the COUs of a TSCA high priority chemical; and (3) establish better approaches for coordinating with each program office to improve environmental protection under each statutory authority more efficiently and without duplication.	
SACC, 26, 29, 30, 40, 46, 47, 50, 52	**SACC COMMENTS:** Recommendation: Consider aggregate and cumulative exposure across inhalation and dermal routes of exposure, in work and out of work exposures, and multiple chemicals that act on similar pathways. • Several Committee members reiterated the need for this evaluation to consider cumulative and aggregate exposures – integrating ambient air, soil vapor, occupational, and consumer exposures. • Consumer dermal and inhalation exposure estimates should be aggregated to obtain a more accurate estimate of the consumer's total exposure. Recommendation: Consider evaluating aggregate and chronic exposures to consumers and bystanders. • Some Committee members discussed whether chronic exposures to consumers and bystanders should be considered in this draft risk evaluation with aggregation of "background" and consumer product-use related exposures. • One Committee member disagreed on the grounds that consumers very infrequently use PCE containing products. • The Committee noted that bystanders to consumer use	TSCA section 6(b)(4)(F)(ii) directs EPA to "describe whether aggregate or sentinel exposures to a chemical substance under the conditions of use were considered, and the basis for that consideration" in risk evaluations. EPA defines aggregate exposures as the combined exposures to an individual from a single chemical substance across multiple routes (*i.e.*, dermal, inhalation, or oral) and across multiple pathways (*i.e.*, exposure from different sources). 40 CFR 702.33. EPA defines sentinel exposures as the exposure from a single chemical substance that represents the plausible upper bound of exposure relative to all other exposures within a broad category of similar or related exposures. 40 CFR 702.33. EPA considered the reasonably available information and used the best available science to determine whether to consider aggregate or sentinel exposures for PCE. EPA has determined that using the high-end risk estimate for inhalation and dermal risks separately as the basis for the unreasonable risk determination is a

	might be young children or other PESS. Aggregation of exposures by both dermal uptake and inhalation was also supported by multiple members. **PUBLIC COMMENTS:** Assessment of aggregate exposure for COUs, coupled with exposures known or anticipated to exist outside of a COU, should always be implemented as a benchmark of a credible and responsible exposure assessment. EPA states that they must describe whether or not they have considered aggregate exposures in their assessments. However, EPA has not conducted such an assessment or made findings of (no) unreasonable risk based upon combined (aggregate) exposures, either to account for multiple routes of exposure known to occur simultaneously during a specific COU or with consideration of exposures from non-TSCA-related scenarios. Exposure to PCE can come from numerous sources, including ambient and indoor air, drinking water, consumer products, waste and contamination sites, and even food. These sources of exposure are additive and, therefore, must be aggregated to evaluate overall risk. • For example, job-related PCE exposures may be magnified by consumer product use and environmental sources of exposure. Workers in the facilities where PCE is manufactured, used, and released are also more likely to live in the communities surrounding those facilities, and dry-cleaning workers may live in housing that is co-located with their businesses. EPA could make reasonable assumptions about the number of people with concurrent workplace and consumer exposure to PCE and develop a range of exposure scenarios for these overlapping populations based on its exposure assessments for different industrial and commercial uses and consumer products.	best available science approach. There is low confidence in the result of aggregating the dermal and inhalation risks for this chemical if EPA uses an additive approach, due to the uncertainty in the data. EPA does not have data that could be reliably modeled into the aggregate, which would be a more accurate approach than adding, such as through a PBPK model. Using an additive approach to aggregate risk in this case would result in an overestimate of risk. Given all the limitations that exist with the data, EPA's approach is the best available science. Additional explanation is provided in the Executive Summary and Section 4.3.2 of the Risk Evaluation. EPA did not consider background PCE exposure that workers might be exposed to in addition to exposures from TSCA conditions of use. The frequency and magnitude of take-home exposure is dependent on several factors, including personal hygiene and visibility of the chemical on skin or clothing. EPA does not have methods to reliably predict take-home exposure. This may result in an underestimation of risk, and additional discussion of this underestimation has been added to the document in the Key Assumptions and Uncertainties section. One overarching uncertainty is that the consumer risks may be underestimated, because background exposures were not incorporated to the risk estimations for each COU. While there are documented background exposures of PCE in residential or consumer environments (Section 2.4.2.1), those concentrations

	• Families of workers may also have "take home" exposures (*i.e.,* elevated air levels in residences because of the worker's contaminated clothing or skin, a known occurrence for families of dry-cleaning workers). • Subpopulations with elevated exposure to PCE from multiple routes and pathways are PESS under TSCA and evaluating known, intended or foreseen combinations of exposures is a necessary step in adequately protecting them from unreasonable risks. Exposure via multiple routes and across multiple pathways is inherent in tribal lifeways and should be considered. EPA chose "not to utilize additivity of exposure pathways at this time within a condition of use because of the uncertainties present in the current exposure estimation procedures and this may lead to an underestimate of exposure." It is scientifically inappropriate for EPA to not combine exposures from inhalation and dermal routes. The lack of consideration of aggregate exposures leads to an underestimation of exposure and risk and, potentially, the incorrect declaration of "no unreasonable risk" when one actually exists. As no other environmental law enables EPA to evaluate exposure across all environmental media, TSCA must be used to address the additive and cross-media risks of PCE.	were not attributable to a specific condition of use and, therefore, not included in our evaluation. In other words, EPA assumed a PCE background air concentration of zero for consumer exposure estimates. General background concentration of PCE in indoor air measured at residential sites in the U.S. is summarized in Section 2.4.2.1.
SACC, 36	**SACC COMMENTS:** Recommendation: Improve the justifications/documentation for excluding consideration of a terrestrial route of exposure to humans. Several Committee members questioned the justification for excluding consideration of a terrestrial route of exposure to humans (*e.g.,* vapor intrusion). They suggested that soil discharges are at least as likely as discharges to surface water. At a minimum, the draft risk evaluation should clarify in the	Clarifying language about what pathways are under the jurisdiction of other EPA-administered statutes has been added to Section 1.4.2 of the Risk Evaluation. EPA is not evaluating on-site releases to land from RCRA Subtitle C hazardous waste landfills or exposures of the general population or terrestrial species from such releases in the TSCA evaluation. EPA is not evaluating on-site releases to land from RCRA Subtitle

	regulatory discussion under which regulatory program these exposures are evaluated. **PUBLIC COMMENTS:** We note with concern that exposures to PCE continue after use and lead to groundwater and soil contamination, resulting in additional public exposure that should be captured by the risk assessment.	D municipal solid waste (MSW) landfills or exposures of the general population or terrestrial species from such releases in the TSCA evaluation. EPA is not evaluating on-site releases to land from industrial non-hazardous waste and construction/demolition waste landfills or associated exposures to the general population or terrestrial species in the PCE risk evaluation. The relevant pathways which affect terrestrial environmental exposure are out of scope of this risk evaluation because these are under the jurisdiction of other EPA-administered statutes or regulatory programs.
47	**PUBLIC COMMENTS:** In this draft risk evaluation, EPA assumes that "PCE disposal is managed and prevented from further environmental release by RCRA and SDWA regulations" (p. 460), and exposure of the general population to PCE from disposal pathways was not evaluated. Disposal pathways include exposures from municipal landfills, hazardous landfills, hazardous and municipal waste incinerators, underground injection wells, and off-site waste transfer. PCE is listed as a hazardous waste under RCRA Subtitle C. The disposal exposure pathways faced by tribes throughout the U.S. as a result of the multiple RCRA exceptions and exemptions that apply to rural, remote, and small populations should be evaluated. Assuming that RCRA is universally protective is inaccurate, especially in the case of tribes and their potential waste disposal exposure scenarios. • Because EPA is responsible for authorized exemptions, and because exposures from disposal site releases are not adequately managed under other statutes, releases from all waste disposal and waste disposal sites, including those left unregulated by RCRA, such as transfer stations and construction waste landfills need to be evaluated. The multiple exposure pathways associated with proximity to	Clarifying language about what pathways are under the jurisdiction of other EPA-administered statutes has been added to Section 1.4.2 of the Risk Evaluation. As explained in more detail in section 1.4.2 of the final risk evaluation, EPA believes it is both reasonable and prudent to tailor TSCA risk evaluations when other EPA offices have expertise and experience to address specific environmental media, rather than attempt to evaluate and regulate potential exposures and risks from those media under TSCA. EPA believes that coordinated action on exposure pathways and risks addressed by other EPA-administered statutes and regulatory programs is consistent with the statutory text and legislative history, particularly as they pertain to TSCA's function as a "gap-filling" statute, and also furthers EPA aims to efficiently use Agency resources, avoid duplicating efforts taken pursuant to other Agency programs, and meet the statutory deadlines for completing risk evaluations. EPA has therefore tailored the scope of the risk evaluations for carbon tetrachloride using authorities in TSCA sections 6(b) and 9(b)(1). See

	unlined disposal site releases to environmental media must be analyzed. • EPA is urged to evaluate environmental release to air, water, soil, and sediment from all waste disposal sites, including transfer stations, C&D sites, materials recovery facilities, disaster debris facilities, and landfills in the light of common exceptions these facilities have for the range of design, performance, and monitoring features. In this draft risk evaluation, exposures to PCE from surface water and sediment are assumed to be adequately managed by the CWA, and EPA did not evaluate these exposure pathways. Multiple CWA exemptions and exceptions, however, leave small communities unprotected by this statute. • Consumption of aquatic species was also not considered because of PCE's low bioaccumulation potential. However, tribes consume fish, shellfish, marine mammals, and aquatic plants and seaweed at far greater quantities than the general population and are exposed to the water and sediment while harvesting these foods. The water quality criteria developed under Section 304(a) of the CWA were assumed by EPA to sufficiently address exposures from the presence of PCE in ambient water. This is unacceptable because the human health assessment methodology used by EPA to develop Ambient Water Quality Criteria does not meet the congressional mandate in TSCA to protect PESS that may have higher exposures and different exposure pathways than the general population. Exposure via multiple routes and across multiple pathways is inherent in tribal lifeways and should be considered.	section 1.4.2 of the Risk Evaluation. EPA determined that PCE has low bioaccumulation potential and is therefore not a significant concern for communities with elevated fish ingestion.

26	**PUBLIC COMMENTS:** No oral exposure assessments were performed for any COU.	EPA generally does not evaluate occupational exposures through the oral route. Workers may inadvertently transfer chemicals from their hands to their mouths or consume contaminated food. The frequency and significance of this exposure route are dependent on several factors including the p-chem properties of the substance during expected worker activities, workers' awareness of the chemical hazards, the visibility of the chemicals on the hands while working, workplace practices, and personal hygiene that is difficult to predict.
Worker exposure estimation: methods, models, and data		
SACC	**SACC COMMENTS:** Recommendation: Revisit the data quality review confidence rating for all monitoring data and assign a rating of low to any monitoring data that have missing or incomplete metadata describing data collection and processing descriptions. The draft risk evaluation expresses "high confidence" in the HSIA data, primarily breathing zone measurements, and indicates those data are highly representative in geographic scope and are reflective of current operations. • The quality review of the HSIA data document provides no indication that the measurements are breathing zone (or area samples) and no mention of the method of collection (charcoal tubes, passive dosimeters, volume of air sampled, etc.). • While the draft risk evaluation data quality rating may be warranted, these data suffer from many of the same criticisms around missing information (*e.g.*, no metadata) that assigns peer-reviewed publications a lower quality score during systematic review (*e.g.*, missing study descriptions). No mention is made of the laboratory analysis method(s) used or whether sampling or laboratory methods	EPA evaluated all submitted monitoring data as described in EPA's *Application of Systematic Review in TSCA Risk Evaluations* and all quality ratings, including the rating for HSIA data, are consistent with the methodology described in that document. The rating of the HSIA data considers all the factors raised by commenters and based on the current scoring and weighting used in the data quality ratings, the data meets the criteria for a "high" score. The systematic review process has been reviewed by the NASEM TSCA Committee, and EPA is in the process of revising the process based on the comments received.

	were NIOSH- or OSHA-compliant. Manufacturing plant location information is missing, meaning that geographic representativeness cannot easily be determined. In several locations in the HSIA data document, there is an indication that there are eight U.S. manufacturing facilities, which begs the question as to which measurements come from which location. • One Committee member remarked that exposure times recorded for "full shift" workers may not reflect actual exposures. Consultations with industrial hygienists suggest that some consistently record actual exposure times, whereas others simply record exposures as occurring for the full shift. For example, the "full shift" workers for Facility A and B all list sample durations in minutes that are exactly 8 or 12 hours (480 or 720 minutes), suggesting that the actual length of monitoring was not recorded by the industrial hygienist collecting the sample, and therefore actual exposure duration, was not available to HSIA. It may also be that HSIA was sent monitoring data that only indicated "full shift" as the exposure time, so HSIA added the time of a full shift to those samples. In contrast, Facility C monitoring times are reported in actual minutes exposed such as 449 and 504, etc. For Company A, the full shift samples are for "operators" with work descriptions indicating "general 8 hr. exposure." These could be area samples or for operators from multiple manufacturing lines. • Without more information, interpreting these monitoring data depends on speculation and assumptions. The Committee recommended review of the original manufacturing worker monitoring data to better understand how they were collected and transcribed (the metadata) and indicate those data for which explanations are not available. This information should be included in the document. For	

	monitoring data where metadata are not available, the associated data quality review confidence rating should be reduced to low. This approach should be applied consistently for all monitoring data regardless of its associated COU.	
SACC	**SACC COMMENTS:** • Some Committee members noted that the data used do not include peak exposures, which may contribute more to workers' doses. This is most important in the context of central nervous system (CNS) depression associated with PCE exposure during short-term tasks whereas the 8-hour TWA would not necessarily capture these shorter-term events. • One Committee member noted that for highly volatile chemicals like PCE, handling the materials is less important an exposure indicator than the volume of material being released.	EPA included data for short-term exposures where such data were reasonably available. However, the health risks for PCE are generally based on exposure durations of 8-hrs or longer. Therefore, no attempt was made to estimate shorter peak exposures, where no data were reasonably available.
SACC, 46	**SACC COMMENTS:** Recommendation: Use OSHA enforcement monitoring data in addition to the monitoring data that were included in the evaluation to estimate exposures for workers and ONUs. The Committee recommended that EPA should use OSHA enforcement monitoring data in conjunction with other monitoring data to represent the worker exposure concentration distribution. • EPA declined to use OSHA enforcement monitoring data, except for dry cleaners, because of concerns that it was biased towards workplaces with exposure complaints. However, these inspections provide a good estimate of the upper end of the true exposure distribution and should be used to represent such. • The Committee discussed the common misperception that OSHA data are biased high. Most OSHA data are from	EPA has updated the risk evaluation to incorporate reasonably available OSHA enforcement data, where appropriate. Sampling data from other countries could still receive a high rating if the methods were determined to be equivalent to a NIOSH/OSHA method or a medium rating if the methods were determined to be acceptable but were not equivalent to the NIOSH/OSHA methods. EPA believes it had sufficient information to complete the Perchloroethylene Risk Evaluation using a weight of scientific evidence approach. EPA selected the first 10 chemicals for Risk Evaluation based in part on its assessment that these chemicals could be assessed without the need for regulatory information collection

	regular inspections and are not expected to be higher than usual. One Committee member added that in their state, approximately 15% of OSHA inspections are for issues, with the remaining 85% as routine visits. • CTEs are unlikely to be influenced by inspection bias since a relatively smaller proportion of the monitoring data are triggered by exposure complaints (reported as 18% by one SACC member). • One Committee member suggested that OSHA data may specify type of inspection to allow separating any that were triggered by complaints. • At a minimum, the Committee recommended that EPA compare the distributions of data from enforcement monitoring with the distributions used in the evaluation. • Some Committee members recommended that EPA could obtain more monitoring data from states that run OSHA consultation programs and suggested that EPA make a data call-in to ask states for these data. Recommendations: (1) Review the OSHA enforcement database report findings by COU. (2) Examine international enforcement agency databases for PCE exposure information. There is a lack of description or comparative use of data available from the OSHA inspection database or data from international programs similar to OSHA. There does not seem to have been a systematic review of exposures from international enforcement agencies such as in Germany or Japan. It is not clear if this was attempted, but many of the scientific studies reported are from these countries, so monitoring data should exist. **PUBLIC COMMENTS:** EPA's failure to identify relevant monitoring data does not mean that such data does not exist. First, there is a substantial	or development. When preparing this Risk Evaluation, EPA obtained and considered reasonably available information, defined as information that EPA possesses, or can reasonably obtain and synthesize for use in Risk Evaluations, considering the deadlines for completing the evaluation.

	amount of PCE exposure data from OSHA inspections available online. However, EPA failed to consider the vast majority of that data in its draft risk evaluation. • In addition to data reported to or collected by EPA, OSHA also requires employers to preserve and maintain employee exposure records – including "the sampling results, the collection methodology (sampling plan), a description of the analytical and mathematical methods used, and a summary of other background data relevant to interpretation of the results obtained" – for 30 years. • OSHA's respirator standard also requires that employers "evaluate the respiratory hazards at their workplaces," including a quantitative determination of potential exposures so the employer can determine whether respirators are required and, if so, what type of respirator will adequately protect workers. • Therefore, if respirators were as widely used as EPA assumes, employers would have significant amounts of workplace exposure data that would be reasonably available to EPA. If no such data exist, then EPA's assumptions of widespread and health-protective respirator use are wrong. EPA could have requested that exposure data directly from employers. If the employers do not voluntarily provide it, EPA has the authority to compel its production under TSCA section 870 or to issue subpoenas for "the production of . . . documents . . . that the administrator deems necessary" under section 11. Finally, in the unlikely event that no monitoring data exists for a COU, EPA can order the generation of such data under TSCA Section 4. EPA cannot, however, rely on incomplete and self-selected data from PCE manufacturers to the exclusion of other available monitoring data.	
SACC	**SACC COMMENTS:** Recommendation: Discuss how National Health and Nutrition	A description of NHANES' purpose in the quantification of exposure has been added.

	Examination Survey (NHANES) data can be used to validate estimated worker and consumer exposures. NHANES data may be useful to quantify some parameters of interest. For example, NHANES data with occupational codes may be useful, in conjunction with a PBPK model, to check worker exposure estimates. NHANES data may be useful to estimate background exposures for cumulative risk or to check consumer exposure estimates. NHANES data may also be useful to estimate the proportion of the working age population that has various body size, body fat, or liver function parameters, for use in considering protectiveness of the risk evaluation and size of susceptible populations. The discussion in Section 2.3.4.3 summarizes what NHANES and National Center for Health Statistics (NCHS) provide in the way of biomonitoring data but does not indicate how these data were used to inform human equivalent concentration (HEC) determinations.	
SACC	**SACC COMMENTS:** Recommendation: Consider estimating exposures from older studies and for older technology and incorporate these into exposures for older workers when computing lifetime cancer risks. • Studies are graded downward when the data are older, or for dry cleaning, if the studies do not indicate what types of machines were used. The draft risk evaluation uses studies involving current machine technology only and collected within 10 years. • This is short-sighted, because for the cancer assessment the estimated risks are for a lifetime exposure. Data from Gold et al. (2008) found that the mean personal exposure for 1,395 U.S. dry-cleaning workers during 1936-2001 was 59 ppm (400 mg/m3). Gold et al. (2008) also found that the average PCE exposure for 441 dry-cleaning machine	Thank you for the comment and for raising this topic. EPA will consider this issue as we move forward in developing future risk evaluations.

	operators who transferred wet garments to a dryer was 150 ppm (1,017 mg/m^3) with peak exposures to 1000 ppm (6,785 mg/m^3). Using only "state of the art" machine data underestimates the already accrued exposure years of the current workforce. • In the cancer evaluation, current workers with 10 or more years of exposure as individuals should be considered especially vulnerable and potentially at high risk. The older data should be used to estimate prior exposure doses, which can then be added to exposures going forward in time. • It is unrealistic to only address workers who start their exposures today (or within the last 10 years only). The draft risk evaluation did not accurately estimate the risks to 40- and 50-year-old individuals who already have accumulated 20+ years of prior exposure. Those older exposures are relevant to today's added risks.	
SACC	**SACC COMMENTS:** Recommendation: Discuss the studies by Seiji (1989), Seiji (1990), and Nakatsuka (1992) as added support for the estimated of PCE exposure for manufacturer workers. Many of the studies reviewed in the supplemental document describing the data quality review (U.S. EPA, 2020p) appear in the evaluation, but several studies that appear to include data informative of COU exposures are not included. • Section 2.1.3.3 of U.S. EPA (2020n; supplemental file: Assessment of Occupational Exposure and Environmental Releases for Perchloroethylene studies) discusses three additional studies that are not mentioned or used in the draft risk evaluation. The study by Seiji (1989, rated medium on p. 177 of U.S. EPA, 2020p) reports a geometric mean of 10.8 ppm and a maximum of 112 ppm. The next study by Seiji (1990, rated medium on p. 210 of U.S. EPA, 2020p) reports a geometric mean of 17 ppm, and a maximum of	EPA elected not to use the data from the two Seiji studies as more recent and applicable data were were better suited for use in the evaluation. In general data from the U.S. are preferred with second preference given to data from OECD-member countries. The data from Seiji is from China which is a non-OECD country, making it the lowest preference with respect to geographic representativeness. Generally, this does not mean EPA will exclude such data (accordingly, the Seiji studies were not given "unacceptable" quality scores through systematic review); however, in some instances EPA may choose not to use such data when a large, more representative dataset is available, as is the case for manufacturing. Furthermore, incorporating such data into the assessment may bias the results in a direction that is not representative of U.S.-based facilities and give an unreasonable or unrealistic picture

	567 ppm. • Section 2.1.3.3 of U.S. EPA (2020n) justifies exclusion of these studies because they "were from China and almost 30 years old and are unlikely to be representative of current conditions at U.S. manufacturing sites." • The study by Nakatsuka (1992, rated unacceptable on p. 200 of U.S. EPA, 2020p) was rated "unacceptable" because of lack of metadata completeness. Note that the data reported in HSIA (2018a) are monitoring data from 2010 (see review p. 554, U.S. EPA, 2020p) and EPA considered exposure data >10 years old as unacceptable. • One Committee member suggested the draft risk evaluation should discuss in detail these three studies and their estimates to help place the estimate of 0.03 ppm central tendency for manufacturer worker exposure calculated from the HSIA data into a proper historical context.	of risks to U.S. workers. The Nakatsuka study was rated unacceptable based on the lack of metadata, including information on sample type, measurement types, sample and durations, making the data unusable in the assessment. EPA does not consider data >10 years to be unacceptable. There is not a specific cutoff date that make data unacceptable for use. Rather, as described in Table D-10 of the *Application of Systematic Review in TSCA Risk Evaluations,* data are only considered unacceptable based on temporal representativeness if "known factors (*e.g.,* new and completely different process or equipment) are so different as to make outdated information unacceptable."
SACC	**SACC COMMENTS:** Recommendation: Consider updating the Westat (1987) survey of household solvent use. The Committee generally agreed that EPA's modeling approach was appropriate and adequately explained. Issues raised included adequacy of data describing housing characteristics (age of home, number and size of rooms, ventilation rates, presence or absence of an attached garage, etc.) and consumer behaviors (product use rates, gender specific use patterns, room in which product is used, bystander proximity, etc.). • The Committee noted that the Westat (1987) survey of household solvent use is old and might be out of date in important respects. • One Committee member commented that the dry-cleaning industry should have data on consumer use of their services.	The Draft and Final Risk Evaluation evaluated those conditions of use where PCE containing products are available for purchase and use by a consumer. This included PCE containing products intended for industrial/commercial uses and/or consumer uses. Section 2.4.2.2.2 provides a discussion about the Westat Survey and the assumptions and uncertainties associated with use of the Westat Survey, respectively. While some consumer use patterns may have changed somewhat, most of the products evaluated for this Risk Evaluation fit well within the categories identified by the Westat Survey including the expected durations of use and mass used. Additionally, while the Westat Survey is more than 30 years old, SACC members also noted that it is a very good survey and the best available data and supported its use. Further, the Westat Survey

		was rated as a high-quality study under EPA's systematic review process. Finally, to help minimize potential biases to high-end exposure scenarios for certain durations or mass used, EPA chose to evaluate consumer exposure across a spectrum of durations/mass used including the 10th, 50th, and 95th percentile data as identified within the Westat Survey. Along similar lines, while supplanting, updating, or repeating the Westat Survey is a possibility in the future, to develop such a survey is a long-term project requiring multiple reviews and approvals outside of the TSCA framework (*e.g.*, Paperwork Reduction Act, information collection authorities,).
SACC	**SACC COMMENTS:** Supplementary File #16 (Assessment of Occupational Exposure and Environmental Releases for Perchloroethylene) comprises two appendices, Appendix B [Equations for Calculating Acute and Chronic (Non-Cancer and Cancer) Inhalation Exposures) and Appendix C (Sample Calculations for Calculating Acute and Chronic (Non-Cancer and Cancer) Inhalation Exposures]. In neither of these sections do Committee Members see any incorporation of breathing rate into exposure estimates.	Breathing rates do not factor into the AC/ADC/LADC calculations as those values are based on average air concentrations a worker is exposed to over a day, working years, or lifetime. Breathing rates were used when extrapolating PODs air concentrations to internal doses. Additionally, the occupational HEC values take elevated breathing rate of workers into account compared to the default HEC based on resting breathing rate.
27, 28	**PUBLIC COMMENTS:** For most industrial manufacturing and use scenarios, empirical data were used as the basis for the inhalation exposure assessment. In some cases, monitoring data were limited. In other cases, particularly for manufacturing, the difference between the high-end estimate and the central tendency was very large. For example, in Table 2-18, which presents the inhalation monitoring data for the manufacture of PCE, the central tendency 8-hour TWA is 0.033 ppm and the high-end 8-hour TWA is 2.6 ppm; however, EPA noted that 65% of the 8-	EPA disagrees with the suggestion that the large difference between central tendency and high-end exposures indicates the high-end concentrations are associated with non-routine tasks. EPA is combining exposure data across multiple sites and in the case of manufacturing, one site accounts for all of the data at the higher end of the distribution (from 88th percentile and up). Therefore, these data points are not outliers or necessarily associated with non-routine tasks, but rather full-shift exposures at a site that happens to have higher

	hour samples were below the limit of detection. Therefore, the estimates are highly influenced by the high-end outliers in this dataset. • For some scenarios, ample personal breathing zone and area monitoring samples were available, but in several scenarios, very few samples were used to characterize exposure, such as for closed loop degreasing (p. 146); these data may not be representative of typical conditions across facilities. • Because of the task-oriented nature of chemical manufacturing, these high-end estimates are likely an inappropriate lumping of routine and non-routine tasks. The samples with high concentrations may reflect scenarios that have job hazard analyses conducted at the facility. These job hazard analyses would take into account special precautions for non-routine exposures. Such exposures should not be included as part of the long-term daily average calculation. The SACC should consider how non-routine exposures should be incorporated in the risk characterization.	exposures than other sites within the population. EPA's goal is to characterize the full distribution of exposures for workers at all sites within a condition of use; therefore, EPA cannot exclude data from the assessment simply because they are higher than data at other sites. This would bias the results low and result in EPA only evaluating risk to workers at sites with the most controlled exposures.
42, 46	**PUBLIC COMMENTS:** In the draft risk evaluation, EPA utilized data submitted by the HSIA to characterize exposure for chemical manufacturing scenarios (and surrogate data for processing as a reactant). Large proportions of TWA exposure samples (24-70%) were below the limit of detection, likely owing to closed-loop processes and low-exposure potential of routine tasks. There was, however, a substantial difference between central tendency and high-end inhalation exposures, suggesting that the maximum concentrations may be associated with non-routine tasks. In fact, a visual inspection of the HSIA dataset shows that several high-end task samples were collected during tasks noted as "infrequent" and ≤15 minutes in duration (*e.g.*, special samples taken by a tank area loader, which was associated with	EPA disagrees with the suggestion that the large difference between central tendency and high-end exposures indicates the high-end concentrations are associated with non-routine tasks. EPA is combining exposure data across multiple sites and in this case, one site accounts for all of the data at the higher end of the distribution (from 88th percentile and up). Therefore, these data points are not outliers or necessarily associated with non-routine tasks, but rather full-shift exposures at a site that happens to have higher exposures than other sites within the population. EPA's goal is to characterize the full distribution of exposures for workers at all sites within a condition of use; therefore, EPA cannot exclude data from the assessment

	a 15-minute task sample of 200 ppm PCE). • Members of the SACC expressed concern regarding a lack of clarity in the HSIA data, and expressed concern regarding the possibility that some of the data represented ONU tasks, which would skew average exposure estimates low. • The dataset also includes infrequent exposure scenarios for workers, which may skew the averages towards higher concentrations than those experienced during routine work. • Regardless of the direction of skewing, the central tendency and high-end estimates that EPA derived using the HSIA dataset are a poor representation of typical, routine exposures for workers and ONUs in manufacturing. • EPA should consider including an analysis that excludes outlier data points (including infrequent or non-routine tasks) or otherwise re-analyzing the dataset to better characterize average exposures during routine tasks for workers. It is standard practice to assess the impact of possible outliers in monitoring data by providing analyses with these data points both included and excluded. Further, it is recommended that occupational data be categorized by similar exposure groups (SEGs) and that for SEGs with large geometric standard deviations, additional subdivisions of exposure be considered. As such, EPA should reevaluate the HSIA dataset to determine whether data should be divided by SEGs. High-end, infrequent exposure data of shorter duration should then be assessed separately and compared to acute-duration health benchmarks. [Because] these exposure data contained a considerable number of values below the limit of detection, the calculated exposure estimates are highly influenced by the high-end outliers in this dataset. EPA relied on the guidance provided in the Guidelines	simply because they are higher than data at other sites. This would bias the results low and result in EPA only evaluating risk to workers at sites with the most controlled exposures. EPA does not assess worker exposure through similar exposure groups (SEGs) because EPA does not have information reasonably available to determine similar exposure groups based on the provided worker activity descriptions. Facility personnel conducting the monitoring study intimately know the facility and can interview workers to determine SEGs. Additionally, worker activities and job titles are determined differently at each facility making an equal comparison difficult; therefore, EPA has relied only on designations between workers and ONUs. With respect to conducting near-field/far-field modeling for ONUs, EPA has included all modeling opportunities with the data reasonably available. However, for most occupational exposure scenarios, ONU-specific monitoring data or data for modeling are not reasonably available. In these OESs, EPA assumes ONU exposures are equal to central tendency (50^{th} percentile) of worker inhalation exposures. However, the data submitted by HSIA was re-analyzed based on public comments and ONU-specific data was identified and ONUs were assessed based on this data. EPA evaluated all submitted monitoring data as described in EPA's *Application of Systematic Review in TSCA Risk Evaluations.* Application of Systematic Review in TSCA Risk Evaluations and all quality

	for Statistical Analysis of Occupational Exposure Data to address values reported as below the limit of detection. However, there are alternative approaches that are conducted with resources utilized by occupational health and safety professionals and reflect best practices (these are provided by the commenter in an appendix) • The American Industrial Hygiene Association (AIHA) recommends that occupational data be categorized by SEGs in order to accurately represent the exposure profiles for workers conducting similar tasks. Failure to distinguish between SEGs in exposure data by combining data for workers or tasks with different exposure profiles may lead to misrepresentation of exposures and misguided risk management decisions. • Alternative analyses of occupational exposure data for PCE manufacturing by task length and task frequency reveal important differences in exposure potential based on the nature of specific tasks. Comparing these results to the occupational exposure estimates for PCE manufacturing presented in the draft risk evaluation, which groups all HSIA data points together, indicates that EPA's exposure estimates do not represent average routine exposures in the industry. • Specifically, infrequent, non-routine tasks may present a substantially greater potential for worker exposure, a distinction that is not made in EPA's current approach to its draft risk evaluation for PCE. Grouping data for infrequent tasks with high exposure potential with data for routine tasks based solely on task length overestimates both the central tendency and 95th percentile PCE exposures. It would be prudent for EPA to adopt a more refined approach in the revised risk evaluation for PCE. • It is recommended that EPA re-analyze the HSIA data to	ratings are consistent with the methodology described in that document. EPA did not identify any issues with the data from HSIA that would preclude using it in the risk evaluation. EPA also did not identify any reasonably available data for reactant uses; however, EPA expects reactant uses and manufacturing to have similar processes where PCE is unloaded from or loaded into transport containers, and either formed or consumed in a reaction vessel. Some additional process steps may occur in either use but EPA expects these to have smaller contributions to the total exposure; therefore, EPA believes the use of manufacturing exposure data as an approximation for reactant use exposures is appropriate.

	not only consider task length, but also task frequency, in estimating exposures. • Estimates for non-routine, infrequent exposures should be compared with acute health benchmarks, and estimates of routine exposures should be compared with chronic benchmarks. • Such an approach will allow EPA to distinguish the SEGs present within the HSIA dataset and develop a more robust characterization of potential risks to PCE manufacturing workers in the final risk evaluation. Finally, EPA should consider conducting near-field/far-field modeling of ONU exposures in the absence of adequate empirical data (*e.g.*, a single empirical data point). EPA did not obtain this necessary information from HSIA or attempt to gather additional manufacturing exposure data from other sources. Compounding this error, EPA then used the industry-selected, potentially-biased manufacturing data as a surrogate for the processing of PCE as a reactant, one of several COUs for which EPA had no exposure data whatsoever.	
44, 53	**PUBLIC COMMENTS:** EPA must drop its assumption that work in chemical manufacturing represents a single OES. Rather, work in chemical manufacturing should be determined by using SEGs, based on similarity of job description, tasks, and potential for exposure. Consequently, the central tendency and high-end estimates of worker exposure based on a single OES will be erroneously higher than the actual value representative of most employees and routine duties involved in byproduct production scenarios, such as EDC production. EPA should consider gathering information from industry regarding SEGs to represent occupational exposure potential more accurately during chemical manufacturing.	EPA does not assess worker exposure through similar exposure groups (SEGs) because EPA does not have information reasonably available to determine similar exposure groups based on the provided worker activity descriptions. Facility personnel conducting the monitoring study intimately know the facility and can interview workers to determine SEGs. Additionally, worker activities and job titles are determined differently at each facility making an equal comparison difficult; therefore, EPA has relied only on designations between workers and ONUs. Furthermore, EPA has clarified in the final risk

	The degree of granular information obtained using SEGs based on tasks allows for a greater understanding of the potential exposures presented during those tasks. This is particularly true when considering non-routine operations that may be infrequent, but may have higher exposures (*e.g.*, sample collection). Failure to distinguish between SEGs in exposure data by combining data for workers or tasks with different exposure profiles may lead to misrepresentation of exposures and misguided risk management decisions.	evaluation that EPA did not assess PCE production as a byproduct in the manufacturing scenario. Rather, EPA assessed processing of PCE for reactant use. More details are in Section 5.3 in the risk evaluation. EPA believes the use described by the commenter is consistent with other reactant uses, and, therefore, assesses exposures equivalent to exposures at other reactant use sites.
42	**PUBLIC COMMENTS:** EPA should use a tiered approach towards risk evaluations under TSCA to minimize agency burden while affording an efficient way to derive exposure levels. By beginning with screening-level assessments, EPA can recognize COU with unreasonable risk quickly and identify data needs prior to analysis using a higher-tier model. Further, a tiered approach provides a *de facto* means to analyze sensitivity for a given exposure scenario by incorporating protective assumptions that are replaced with more accurate data in higher-tier models. • For this risk evaluation, EPA calculates exposure levels using the Tank Truck and Railcar Loading and Unloading Release and Inhalation Exposure Model for the "Waste Handling" and "Other Industrial Uses" COUs – a reasonable approach given that these COU involve activities such as connecting and disconnecting hoses while the chemical resides within a closed system. This scenario should be proposed as a screening level exposure assessment for all occupational COUs that use closed systems. This approach would allow EPA to identify areas where occupational use presents low concern quickly.	EPA used reasonably available model input data for modelling occupational exposures in several OESs. EPA considered both monitoring and modeling for several OES, including Cold Cleaning, aerosol degreasing, and dry cleaning, for which both were reasonably available. Data for modeling were not reasonably available for other OESs. With respect to screening-level models, the Tank Truck and Railcar Loading and Unloading Release and Inhalation Exposure Model referenced is not an appropriate screening-level tool as it only accounts for a single exposure activity and likely underestimates exposures at sites that have multiple exposure activities.
42	**PUBLIC COMMENTS:** Amended TSCA specifically includes workers in the definition	EPA consults regularly with its federal partners and will consult with state agencies if they are known to have

	of "potentially exposed subpopulations" and TSCA Section 6 authorizes EPA to consider workers as relevant subpopulations in risk evaluations and impose "restrictions" on manufacturing/processing where an unreasonable risk concerning the health of workers has been determined. However, these changes in amended TSCA do not mean that EPA stands in place of OSHA on all chemical risk issues in the workplace. • TSCA Section 9(a) contemplates consultation between EPA and OSHA and authorizes OSHA to decide whether it agrees with EPA's risk determination concerning worker health. EPA failed to include in its risk evaluation, as with all others published to date, any discussion of its coordination and consultation with OSHA on its approaches, considerations, and conclusions in the PCE risk evaluation. • EPA is urged to include such a discussion in the final PCE risk evaluation and in all future draft risk evaluations of other substances, where relevant, going forward.	relevant occupational exposure data. EPA's discussions and consultation with OSHA are described in section 1.4.4.4 of Supplemental Information on Releases and Occupational Exposure Assessment. Additionally, EPA conferred with OSHA and NIOSH during interagency review and their contributions during review are reflected in the Draft and Final Risk Evaluation. EPA regularly engages with OSHA along with its other federal partners. However, it should be noted that under section 6 of TSCA, EPA is not mandated to consult with OSHA. Under section 9(a) of TSCA, the Administrator may determine it is appropriate, after making an unreasonable risk finding, to refer an action to OSHA, but the Agency is not mandated to do so. In the 2017 Procedures for Chemical Risk Evaluation Under the Amended Toxic Substances Control Act (82 FR 33726, July 20, 2017), EPA committed to, by codifying, interagency collaboration to give the public confidence that EPA will work with other agencies to gain appropriate information on chemical substances. This is an ongoing deliberative process and EPA is not obligated to provide descriptions of predecisional and deliberative discussions or consultations with other federal agencies. In the interest of continuing to have open and candid discussions with our interagency partners, EPA is not intending to include the content of those discussions in the risk evaluation.
42	**PUBLIC COMMENTS:** EPA should more thoroughly evaluate sources of gray literature, focusing on the identification of valuable exposure monitoring data.	EPA used the best available science and reasonably available data to assess exposures for each COU. EPA evaluated data collected under 6 NYCCRR Part 232 provided by the commenter in Appendix 9. However,

	• Based on the data sources included for some COUs in the occupational exposure assessment for PCE, EPA's search of the gray literature appears to have missed key sources of information. For example, for occupational exposure to dry cleaning, there are existing sources of data collected as a part of state regulatory enforcement monitoring that are not mentioned in the PCE draft risk evaluation; notably, by the NYSDEC. The NYSDEC data should be considered for inclusion in the revised risk evaluation for PCE. Moving forward, EPA should consider refining its process for scoping and problem formulation, since it is during these early phases that EPA gathers previous evaluations, peer-reviewed studies, and gray literature on the chemical under review. The scoping and problem formulation phases of the risk evaluation are also an opportune time to request additional industry data and review any submitted data for the purposes of assessing its relevance and completeness. • EPA should consider re-visiting its protocols for data requests and more generally, industry communication, in the problem formulation phase of the risk evaluation. This includes clearly articulating to stakeholders the types of data and form of submissions most useful for risk evaluation. If there is a lack of clarity in a submitted exposure dataset or a critical data gap identified early in the risk evaluation process, EPA will have more time to resolve the issues and/or request additional data before drafting the risk evaluation. • Additional data gathering and communication in the problem formulation phase of the PCE evaluation may have been able to address issues in this draft risk evaluation before the draft was complete, such as questions relating to the assessment of potential exposures to (ONUs).	the data did not include appropriate metadata (sample type and exposure type) and was thus rated "unacceptable" as determined through EPA's systematic review process. Therefore, this data was not incorporated into the risk evaluation. EPA does not intend to conduct a separate problem formulation step in future risk evaluations.

42	**PUBLIC COMMENTS:** There are several sources of occupational monitoring data that EPA did not include in the PCE draft risk evaluation. This includes a robust PCE dataset collected by NYSDEC under 6 NYCRR Part 232, a regulation for dry-cleaning facilities that requires yearly inspections, including collection of PCE vapor badges in each facility. EPA is encouraged to engage manufacturers to assist in monitoring data guidelines that increase the accuracy of the exposure assessment.	EPA evaluated data collected under 6 NYCCRR Part 232 provided by the commenter in Appendix 9. However, the data did not include appropriate metadata (sample type and exposure type) and was thus rated "unacceptable" as determined through EPA's systematic review process. Therefore, this data was not incorporated into the risk evaluation.
46	**PUBLIC COMMENTS:** EPA has ready access to a wealth of occupational exposure data on PCE and has the ability to require the production of that data under TSCA. Yet EPA made no effort to review that data when preparing the draft risk evaluation. • For instance, EPA concludes that workers who are exposed to PCE from penetrating lubricants, cutting tool lubricants, and other similar products face no unreasonable risk. However, EPA's sole occupational exposure data was from workers who use aerosol lubricants, a distinct exposure scenario. Even then, EPA had a total of 130 data points for an estimated 280,000 exposed workers. EPA does not have sufficient data of sufficient relevance to support a finding of no unreasonable risk.	EPA used the best available science and reasonably available data to assess exposures for each COU. The aerosol degreasing data were only used to assess risks for aerosol products (some of which include lubricants) and EPA found such products do present an unreasonable risk to human health. Non-aerosol lubricants, such as the cutting tool lubricant product identified, were assessed using the OECD Emission Scenario Document on the Use of Metalworking Fluids and resulted in a no unreasonable risk finding. This finding only applies to the non-aerosol metalworking fluid and not the aerosol products mentioned by the commenter.
53	**PUBLIC COMMENTS:** It is recommended that the following statistics be calculated for all monitoring data: number of samples (n), maximum exposure, minimum exposure, range, percent of exposures greater than the applicable occupational exposure limit (OEL), mean exposure, SD, mean of log-transformed exposures, SD of log-transformed exposures, geometric mean, and geometric SD.	For each occupational exposure scenario and worker job category ("worker" or "ONU"), where available, EPA provides occupational risk estimates at both high end and central tendency in the Final Risk Evaluation. EPA believes that this range adequately captures the range of estimated exposures associated with each occupational COU. See the *Assessment of Occupational Exposure and Environmental Releases for Perchloroethylene (Ethene, 1,1,2,2,-Tetrachloro) CASRN: 127-18-4* (Supplemental Engineering Report) for a discussion of

		EPA's statistical analysis approach for assessing inhalation exposure.
46	**PUBLIC COMMENTS:** EPA's inadequate data results in the underestimation of many worker exposures. For the use of PCE in cold cleaning and break cleaning products, EPA relies on two studies supplied by Vulcan Chemicals Company. However, the cold cleaning products used in those studies contained a maximum PCE concentration of 50% and the break cleaning products contained a maximum PCE concentration of 60%. EPA acknowledges that pure PCE (concentrations greater than 99%) may be used for cold cleaning, and that the median PCE concentration in PCE-containing brake cleaning products is 78%. By relying on limited exposure data involving products with lower PCE concentrations, EPA ignores the risks to the workers that use more concentrated forms of PCE.	EPA accounts for higher worker exposures as a result of the use of products with higher PCE concentrations using the high-end exposure results. Furthermore, for both cold cleaning and aerosol degreasing, EPA has developed near-field/far-field models to corroborate monitoring data results.
53	**PUBLIC COMMENTS:** EPA assumed in the draft risk evaluation that aerosol brake cleaner usage was 14.4 ounces per brake job or 2- to 4-fold higher that empirical data suggested in Fries et al. (2018) and supported by Norton (1993). • Norton (1993) reported the results of a survey of automotive repair facilities on chemical brake cleaner usage conducted by the HSIA in 1993. This study provides information regarding the use of brake cleaners and the context of that use relevant to the inputs in the previously used model and 8-hour TWA concentration estimates. Specifically, information regarding facility size, brake cleaner use, and number of brake jobs performed per week were reported by Norton (1993), all of which are relevant either to the model inputs or 8-hour TWA concentration estimate inputs. However, a limitation of much of the information reported by Norton (1993) is that it was collected on a categorical	The Fries et al. (2018) study is based on a toluene degreaser which may not be an appropriate surrogate for PCE degreasers due to possible differences in efficacies. Furthermore, Norton (1993) estimates 0.85 cans/job and another public comment from CRC (2017), a manufacturer of PCE-based aerosol products, estimated 6 oz of degreaser is used per wheel, which is equivalent to ~0.83 cans for a two-brake job and 1.67 cans for a four brake job. The date of the Norton study is unlikely to be relevant for this parameter as the efficacy of PCE-based aerosol products is unlikely to have changed with time. Therefore, EPA believes the use of 1 can per brake job is an appropriate estimate for this parameter.

	basis, which makes it difficult to estimate averages and maximum and minimum values. Further, similar to the CARB (2000) data, the data reported by Norton (1993) are over 20 years old. • The findings of Norton (1993) that most respondents' use of less than one can of aerosol brake cleaner per brake is consistent with the estimate of 50 g of brake cleaner applied per brake. The 50 g estimate is considered a reasonable worst-case use mass, based on the empirical data in Fries et al. (2018), in which a mechanic was instructed to use the product generously. Use of 50 g of brake cleaner per brake equates to 100-200 g used per brake job (on two to four brakes, respectively), or 3.5-7 ounces. This is lower than EPA's assumption of one 14.4 oz can per brake job, indicating that EPA's scenario may represent "beyond" reasonable worst-case.	
28, 42	**PUBLIC COMMENTS:** EPA relied largely on monitoring data to assess worker inhalation exposures. In several cases, however, EPA presents both monitoring (sometimes for two separate datasets) and modeled data for inhalation exposures to workers, and subsequent risk estimates separately for each source of data (*e.g.*, cold cleaning, aerosol degreasing and aerosol lubricants, and dry cleaning, see pp. 351-354). • EPA's inclusion of several approaches in effect serves as a sensitivity analysis, but it is not easily discernible from the text what scenario(s) ultimately drive risk characterization. A reader can only find this information in the final risk characterization (Section 5.3), in parentheses, next to the endpoint-specific risk estimates. Moreover, while the draft risk evaluation discusses the differences in estimates using monitoring versus modeling and potential drivers of differences, EPA does not discuss the process for	In cases where EPA has both monitoring data and modeling, EPA generally prefers to use monitoring data in risk determination. Monitoring data are given the highest priority in EPA's hierarchy of approaches for occupational exposures as they are collected in actual workplace conditions. Model results are either used to help corroborate monitoring data, especially in cases where such data are limited, or to provide exposure estimates where monitoring data are not available. In general, EPA has incorporated all reasonably available monitoring data that received a quality rating above "unacceptable," as determined through systematic review, into the assessment of each COU. However, on a case-by-case basis, EPA may have elected to exclude data where other more representative data were sufficiently available. For example, in the

	determining which of the approaches/data sources (*e.g.*, in the case of multiple sources of monitoring data) is most appropriate for risk characterization. • Using both monitoring and modeling data presents other challenges that can complicate accurate exposure level estimation. The cold cleaning COU shows these difficulties by reporting a three-order magnitude decrease in central tendency exposure levels between modeled and monitored data. Extrapolating these data to ONUs compounds the issue, potentially ascribing unrealistic exposure levels to this subpopulation. • The SACC should consider whether EPA's justification of which OESs warranted both monitoring and modeling approaches is sufficient, and further, whether EPA has adequately detailed the circumstances and process for determining which of these approaches ultimately is used for risk characterization.	manufacturing COU, EPA elected not to use much older data from Chinese manufacturers of PCE due to the presence of a large number of data points from three of the eight U.S.-based PCE manufacturers.
53	**PUBLIC COMMENTS:** An alternative modeling approach was used by the commenter to evaluate EPA's modeled PCE worker exposures from the use of PCE-containing aerosol brake cleaner (details provided in Appendix 5 to the comments). The sensitivity of the estimates to specific modeling inputs was also examined. A well-accepted model (IH Mod 2.0) was parameterized based on empirical observations and subsequently validated against measurement data collected under "reasonable worst-case conditions." The measurement data were from Fries et al. (2018). PCE specific assumptions (*e.g.*, percent PCE of the product) were then substituted into the model to develop lower and upper bound estimates of short-term, near-field exposure concentrations for auto mechanics using brake cleaner while performing brake work under "reasonable worst-case" conditions. Lower and upper bound and mid-point (for two different PCE product	EPA appreciates the additional data provided by the commenter. EPA has not pursued updates to the model at this time, as risk determinations are based on the worker exposure data and the current model results show good agreement with the monitoring data. EPA disagrees that the current model is a "reasonable worst-case" based on its agreement with measured exposure data found in the literature.

	content and brake work scenarios) 8-hour TWA concentrations were estimated using this modeling approach with assumptions about number of brake jobs performed per day. • Overall, the estimated 8-hour TWA exposures based on 15-minute TWA concentrations modeled using a "reasonable worst-case" approach indicate that EPA's modeling approach is representative of "reasonable worst-case" conditions, but not all usage scenarios (*e.g.*, typical or low-use scenarios). However, EPA's use of survey derived brake cleaner usage data rather than measured data of brake cleaner use resulted in an approximately 2- to 4-fold overestimate of exposure concentrations from their model application. • EPA used data from a 2000 report from the CARB, which included 1998 survey data from the state of California as well as site visits presumably conducted sometime in the 1990s. In contrast, direct observation and measurement of mass used from the Fries et al. (2018) study indicate that the upper bound estimate of product use per brake estimated by EPA is excessive for "reasonable worst-case" use conditions. EPA should consider using a range of product use volumes in their analysis in order to represent "reasonable worst-case" use conditions as well as typical and low use conditions. Inclusion of the use of local ventilation and higher than minimal air changes per hour could also yield a more representative estimate of typical central tendency values.	
ONU and bystander exposure estimation: methods, models, and data		
SACC, 30, 40, 46	**SACC COMMENTS:** Recommendations: (1) Reconsider the separate evaluation for worker and ONU exposures. (2) Clarify the differences in exposure duration assumption between workers and ONUs. (3) Differentiate workers from ONUs based on clearly defined tasks and expected level of exposures.	EPA separates exposures into workers and ONUs in an attempt to appropriately evaluate risks. EPA defines workers as employees that are expected to work directly with the chemical and ONUs as employees that are only expected to be in the vicinity of the chemical's use but do not actually handle the chemical. Including all data

	Some Committee members felt comfortable with EPA's general approach to assessing ONUs using inhalation only and the CTE of worker exposures. Other Committee members did not, noting that the term ONU is not used in industrial hygiene or OSHA/NIOSH literature. • In practice, employees will move between worker and ONU classification over the course of their workday. Classifications may not accurately reflect workplace dynamics in many settings and are not terms of art in industrial hygiene. • Several Committee members recommended more clearly defining worker tasks. ONU locations with respect to chemical release sources need to be specified (modeled) rather than assuming all workers are near-field and all ONUs are far-field. • Other Committee members suggested that EPA should combine all workers into a single category and use exposure concentration distributions and some dermal assumptions to differentiate high and mid-range exposures. • One Committee member recommended that short term near field monitoring data could be used in models to estimate far field exposure concentrations. • Also, the same Committee member requested that EPA clarify whether the exposure duration assumptions (per day and number of years) are different for workers and ONUs, or the same. Recommendation: Present more information on worker and ONU tasks and movements, especially time spent in near-field and far-field areas.	in the same group and providing a single result for all employees in an OES may result in underestimating exposures, and thus risks, for those employees that work most directly with the chemical (*i.e.*, workers) due to the inclusion of exposures to employees that perform other activities. Likewise, such a result would overestimate exposures to employees who do not directly work or handle the chemical (*i.e.*, ONUs). EPA does not believe the use of short-term near-field concentrations to model far-field exposures is appropriate nor does EPA have a methodology to perform such modeling. Short-term sampling is often used to compare to a short-term exposure limit (STEL) which is likely inappropriate for use in extrapolating to full-shift exposures elsewhere in the facility. EPA acknowledges that workers and ONUs may not stay within their respective work zones for the entire workday, and that exposures for ONUs can vary substantially. Most data sources do not sufficiently describe the proximity of these employees to the exposure source. As such, exposure levels for the "ONU" category will have high variability depending on the specific work activity performed. It is possible that some employees categorized as "ONU" have exposures similar to those in the "worker" category depending on their specific work activity pattern. ONUs are likely a heterogeneous population of workers, and some could be exposed more than just occasionally to high concentrations. Any such exposures are accounted for where EPA has ONU-specific data for an OES and is considered in the uncertainties when using worker

	The Committee commented that Near-Field/Far-Field models are well known and have been used to reconstruct individual worker exposures. However, model results may not accurately estimate ONU exposures unless the ONU is constantly within one or the other of the fields. In practice, most workers spend varying lengths of time working or passing through areas identified as near and far field. • Exposures should consist of the time typically spent in each field times the expected exposure in each field. EPA's approach appears to be overly simplistic, especially for the manufacturing COU. Individuals are either workers who are assumed to experience near field exposures or ONUs who are assumed to experience far-field exposures. Estimates are modeled using TWAs, which are composites of an occupational worker's exposure. Workers do not spend all their time in the near field. In most instances EPA does not have job descriptions or information on how workers move. What they may have is individual samples for a single day or a summary statistic for all samples for workers which they consider "near field" exposures. Using a TWA approach does not allow characterization of near field or far field exposures unless the occupational worker is in a constant "near field" environment. If not, then the TWA will represent a composite exposure from time spent in near field work, far field work and general environment time as well as break and lunch time. On the other hand, shorter sampling periods measure near field exposures from specific activities. **PUBLIC COMMENTS:** Like previous draft evaluations, the PCE evaluation differentiates between directly exposed workers and the amorphous category of ONUs. EPA defines occupational users	central tendency data to approximate ONU exposures. EPA's near-field/far-field (NF/FF) models do not assume that workers spend their entire shift in the NF. Rather, they use OES-specific data to determine how long a specific task will occur in the NF and assume the remainder of the time the worker is in the FF and exposed at the FF air concentration. The duration in the NF may be defined by a single value or a distribution if the duration may vary across sites or workdays at the same site. For more details on the definitions of the NF and FF and worker activity durations, see the relevant model Appendices in the Assessment of Occupational Exposure and Environmental Releases for Perchloroethylene. The number of days per year and number of working years are assumed to be the same for both workers and ONUs. Although EPA's models consider ONUs to spend all of their time in the far-field, in the majority of OES EPA relied on monitoring data to assess ONU exposures either from ONU-specific data or worker central tendency exposure data. Where ONU-specific data are used, the data capture ONU exposures from all sources of exposures present. Worker central tendency values are expected to be protective estimates as they include exposures to workers who work directly with the chemical resulting in exposures that likely exceed that of ONUs within the same facility given the relative proximity to the source of exposure.

	as workers that directly handle PCE and ONUs as workers who do not directly handle PCE but perform work in an area where PCE is present. This is a false dichotomy, and is inconsistent with the state of the science for industrial exposure assessment. A simplistic categorization of all non-production workers as ONUs who have uniformly lower levels of exposure is unjustified and understates risks to many workers. • The broad range of workers that EPA defines as ONUs is too large to support any single classification. Supervisors have very different exposure patterns than skilled trade workers and cleaning workers, and thus face very different risks from PCE. As EPA acknowledges, "[i]t is possible that some employees categorized as 'occupational non-user' have exposures similar to those in the 'worker' category depending on their specific work activity pattern." Yet EPA does not account for that possibility in its draft risk evaluation. • Other experts make a more meaningful distinction between near-field and far-field exposure and differentiate among jobs by whether they may be near or far from the source of exposure. Consistent with this approach, EPA should replace the broad ONU category with more refined groupings of near- and far-field workers and, within each grouping, conduct a more detailed exposure analysis that reflects job responsibilities and exposure scenarios specific to different types of workers and chemicals. Implementing this approach for PCE will require EPA to undertake additional outreach to obtain "reasonably available" information – as required by TSCA – about real-world near- and far-field exposure scenarios for this substance. The SACC should recommend to EPA that: • It use the appropriate designations for near- and far-field	EPA used the best available science and reasonably available data to assess exposures for each COU. Additional data to further differentiate exposures to ONUs were not reasonably available. EPA requested information on all aspects of risk evaluations throughout the risk evaluation process, including opening public dockets for receipt of such information, conducting outreach to manufacturers, processors, users and other stakeholders, as well as conducting tailored data development efforts for some of the first 10 chemicals. Given the timeframe for conducting risk evaluations on the first 10 chemicals, use of TSCA data gathering authorities has been limited in scope. In general, EPA intends to utilize TSCA data gathering authorities more routinely for the next 20 risk evaluations.

	workers, with the appropriate assigned exposure. • All near-field workers should be presumed to have exposure to PCE as appropriate; EPA's current presumption that ONU exposures are 'far field' is unsupported and wrong. EPA should do a much broader outreach to get all the information that is "reasonably available" – as required by TSCA – about near- and far-field workers from PCE and the other solvents. This outreach should include TURI staff, union health and safety staff, industrial hygienists, and government experts at the local, regional, and state level as appropriate.	
SACC	**SACC COMMENTS:** Recommendation: Discuss why the estimated of numbers of workers by ONU is presented in the draft risk evaluation. • The reason for separating employees into "workers" and "ONUs" needs to be explained. The TSCA definition of an ONU is mostly qualitative and hypothetical and it is not well suited to quantifying exposures such employees may receive. • The evaluation does not define the percent of time an employee must spend in a "far field" environment to be considered an ONU. Employees move around and frequently change job tasks. • The estimate provided in the draft risk evaluation of how many employees fit the ONU description is highly uncertain. Assigning model-based far-field estimates to a theoretical TSCA ONU requires more data than generally available and these data are typically highly site specific. If monitoring data along with the employee work description can reliably classify a worker as an ONU, then it should be used. If not, then EPA should not try to assign an exposure for such individuals. They should simply be added to the count of workers. • The last entry in Table 2-13 (p. 124) is a public comment,	EPA separates exposures into workers and ONUs in an attempt to appropriately evaluate risks. Including all data in the same group and providing a single result for all employees in an OES may result in underestimating exposures, and thus risks, for those employees that work most directly with the chemical due to the inclusion of exposures to workers that perform other activities. Likewise, such a result would overestimate exposures to employees who do not directly work or handle the chemical. There is not a defined percentage of time an employee must spend in the near- or far-field to be considered a worker or ONU. This determination is based on EPA's understanding of the activities within a specific OES or at the site at which monitoring data were collected (where such information is reasonably available). The approach described by the commenter for assigning data as worker vs ONU is generally the one used by EPA. EPA only considered a monitoring data sample to be an ONU if it had specific information to do so;

	not germane to the topic of Estimated Worker Exposures, and hence should be removed. The public comment simply mentions the general trends of PCE use with no real data on "market penetration" and has no data related to the numbers of workers exposed. In addition, the Committee was unclear with how the estimates of employee numbers are used in the evaluation.	otherwise all data were considered to be for workers. In the case of modeling, ONU exposures are considered to be the far-field concentration, based on the definition of near-field and far-field zones in the models and the definition of ONU. The public comment states "According to one of the largest U.S. distributors of drycleaning equipment, as of 2017, the number of perc machines has now dropped to about 60% of the industry." EPA assumed a 60% market penetration based on this comment. The approach to how market penetration data are used to estimate the number of workers is described in Appendix A of the Assessment of Occupational Exposure and Environmental Releases for Perchloroethylene. The number of workers/ONU estimates are not used in risk determination but are considered during risk management.
SACC	**SACC COMMENTS:** Recommendation: Better explain how employees are assigned to worker versus ONU categories when there is little or no information in job descriptions or facility task flow diagrams to guide this assignment. EPA apparently assumes that all the employee data and limited job descriptions are consistent with their definition of "workers" engaged in direct handling of PCE or otherwise exposures. In the HSIA document, there is no definition or description of what the "exposure group" term means. In looking through the listed "exposure group" characterizations, it is not clear that all of these workers meet EPA's worker definition and some might be better classified as an ONU or classified as an unexposed group. Very few of the task	When assigning data as worker vs ONU, EPA only considered a monitoring data sample to be an ONU if it had specific information to do so; otherwise all data were considered to be for workers. In the case of modeling, ONU exposures are considered to be the far-field concentration, based on the definition of near-field and far-field zones in the models and the definition of ONU. EPA has updated the risk evaluation to assign some data submitted by HSIA to be ONU data based on comments submitted by HSIA on the carbon tetrachloride risk evaluation. EPA assumed similar jobs would be considered ONUs for PCE manufacturing given that

	descriptions mention PCE though some specifically mention carbon tetrachloride? There are tradesmen, supervisors and laboratory analyzers listed as 'worker exposed' that would seem to be better considered as ONUs in EPA's categorization. • For example, in company C, insulators and pipe fitters were the only workers reported to wear respirators. Analyzer technicians are described as performing "maintenance on instrumentation." One Committee member questioned whether these 'analyzer technicians' worked in a room or laboratory separated from areas directly involved in PCE manufacturing or processing activities? Laboratory analytical workers typically perform their duties using exhaust hoods; no such common work practice conditions are mentioned. • The Committee questioned if workers identified as "MCI or EDC outside equipment technician" handle PCE and/or have PCE exposures similar to the "PERC outside equipment technicians?" • A similar question arose with "utilities boiler technician." The draft risk evaluation should provide better explanations reflecting a closer review the job descriptions data. The Committee recommended that EPA should explain how they utilized the descriptors provided when there are no plant flow charts to guide the exposure assessment. Recommendations: (1) Review all COU monitoring data to determine if some of the observations attributed to workers should instead be attributed to ONUs. (2) Explore ways to use short-term monitoring results (for example, to inform exposure times and levels more precisely in near field or far field areas).	carbon tetrachloride and PCE are often produced as co-products. Jobs considered to be ONUs by HSIA include electricians, process supervisors, and utilities control board technicians. Other job types mentioned by the commenter were not identified as ONUs by HSIA and EPA did not attempt to make its own categorization of ONUs based on the job titles alone as some employees may cycle between worker and ONU tasks throughout the day regardless of job title. Therefore, EPA relied on HSIA's familiarity and communication with the facilities providing the data as the basis for making ONU determinations.
SACC	**SACC COMMENTS:** Recommendation: Routinely estimate dermal exposure to vapor for any population that has inhalation exposure. • One Committee member expressed skepticism that ONUs in	EPA acknowledges that ONUs may have incidental or occasional dermal contact with PCE. However, such exposures are not expected to be routine, and no reasonably available data were identified to estimate the

	the paint and adhesive COU are never exposed via dermal contact. • Another Committee member cited janitors as a population likely to be considered ONUs, but who would likely experience dermal contact with surface residues. The NIOSH Health Hazard Evaluation (HHE) for PCE (NIOSH, 1980) cited in the draft risk evaluation mentions reported episodic neurological symptoms that were not observed on site visit days, suggesting potential effects of spills, leaks, overfills, etc. Acute exposures to cleanup crews would likely not be reflected in area wide air monitoring data collected on limited days. • Aggregation of dermal vapor and inhalation exposures would apply to ONUs if the recommendation to routinely consider dermal vapor exposures for all populations subject to inhalation exposure is implemented. The physical-chemical properties of PCE are such that unprotected inhalation exposure should dominate dermal vapor exposure, but routine tabulation of dermal vapor results would be informative in the context of the Lautenberg Act.	frequency of such contacts and the amount of liquid that remains on the skin after contact. Therefore, these exposures were not assessed in the risk evaluations. See Section 2.4.1.1 for further discussion. Employees doing equipment maintenance are considered by EPA to be workers and not ONUs. Response to a spill would generally be covered by shorter-term exposures. EPA investigated the capability of its existing models to provide output files associated with vapor-to-skin dermal exposure, however, EPA has identified some limitations with providing such estimates within the current model constructs. Furthermore, while vapor to skin may have a minor contribution to overall dermal exposure, the high volatility of PCE is expected to cause the chemical to remain in the vapor phase and available for inhalation exposure rather than redepositing onto the skin causing a vapor-to-skin dermal exposure. EPA considered the reasonably available information and used the best available science to determine whether to consider aggregate or sentinel exposures for a particular chemical. EPA has determined that using the high-end risk estimate for inhalation and dermal risks separately as the basis for the unreasonable risk determination is a best available science approach. There is low confidence in the result of aggregating the dermal and inhalation risks for this chemical if EPA uses an additive approach, due to the uncertainty in the data. EPA does not have data that could be reliably modeled into the aggregate, which would be a more accurate approach than adding, such as through a PBPK model.

		Using an additive approach to aggregate risk in this case would result in an overestimate of risk.
SACC	**SACC COMMENTS:** Exposure data for the 'Occupational Non-User' are most clearly presented in Schreiber et al. (1993, 2002). The Schreiber empirical data are such that one need not rely on dispersion models to determine exposure and associated ONU health risks posed by PCE in indoor air. Those urban results can then be compared to the range of 'background' indoor and personal monitoring in suburban homes that do not have operating dry cleaners. An example was provided using the information from Schreiber et al. (1993, 2002), the Air Resources Board (1991) and the Sheldon (1992) studies leaving no uncertainty associated with the calculated values showing that the average indoor air PCE concentration was approximately 2.7 times the ambient outdoor PCE concentration. These data can be used to calculate health risks posed by PCE in residential indoor air for both single family and multi-family structures.	We believe the "Occupational Non-User" being referred to is "occupational bystander" brought up in other comments as people who live/work in a building co-located with a dry cleaner (or other business using PCE). This is different than the definition of ONUs used by EPA in the occupational setting as a category of workers in the facility who do not directly handle the chemical but have potential for exposure. Based on the comment, the Schreiber study looks at general indoor air concentration of PCE in urban areas, which is not the same as PBZ in an occupational setting and therefore can't be used to estimate ONU exposures. As explained in more detail in Section 1.4.2 of the Risk Evaluation, EPA believes it is both reasonable and prudent to tailor TSCA risk evaluations when other EPA offices have expertise and experience to address specific environmental media, rather than attempt to evaluate and regulate potential exposures and risks from those media under TSCA, and has therefore tailored the scope of the Risk Evaluation for PCE. Because stationary source releases of PCE to ambient air are covered under the CAA, EPA did not evaluate emission pathways to ambient air from commercial and industrial stationary sources or associated inhalation exposure of the general population.
SACC	**SACC COMMENTS:** The Committee generally agreed that it is appropriate to evaluate ONUs with the assumption that they benefit from no protective effect of PPE. Members expressed mixed opinions on the value	EPA has assumed no PPE use by ONUs for purposes of risk evaluations. Potential use of PPE to mitigate unreasonable risks to ONUs may be considered during risk management.

	of discussion of the potential benefit to ONUs of PPE use but generally did not oppose it. One Committee member encouraged adding discussion in the draft risk evaluation of PPE in ONU scenarios in which PPE use might move an ONU exposure from Unreasonable Risk to No Unreasonable Risk.	
30, 40	**PUBLIC COMMENTS:** The SACC could advise EPA on how to evaluate near-field worker exposures using established best practices. The term "ONU" or "occupational non-user" does not appear on a search of PubMed – the National Institutes of Health (NIH) medical library of over 10,000 scientific journals – or on a 'Google' search, other than in EPA TSCA documents. • Instead, experts make a more meaningful distinction between near-field and far-field exposure, dividing jobs by whether they may be near or far from the source of exposure. There are existing principles of exposure assessment that allows the assessor to evaluate exposures to the near and far field workers (citations are provided by the submitter for examples). • The near-field/far-field distinction is the state of the science because it has logic – workers whose job brings them near to the chemical are considered to share the same exposures as other near-field workers, whether or not they are specifically tasked with directly contacting the material. In fact, it is often the case that the workers tasked with directly working with the chemical are not the highest exposed, because they are the most protected, working in a fume hood or behind a shield, or with proper fitted and functioning PPE. It may be the other workers in the near-field that are not necessarily tasked with directly contacting the chemical that may be at increased risk – workers that EPA classifies as ONUs. • For example, janitorial staff that clean up spills, workers who repair leaks, lab workers in neighboring stations,	EPA acknowledges that workers and ONUs may not stay within their respective work zones for the entire workday, and that exposures for ONUs can vary substantially. Most data sources do not sufficiently describe the proximity of these employees to the exposure source. As such, exposure levels for the "ONU" category will have high variability depending on the specific work activity performed. It is possible that some employees categorized as "ONU" have exposures similar to those in the "worker" category depending on their specific work activity pattern. ONUs are likely a heterogeneous population of workers, and some could be exposed more than just occasionally to high concentrations. Although EPA's models consider ONUs to spend all of their time in the far-field, in the majority of OES EPA relied on monitoring data to assess ONU exposures either from ONU-specific data or worker central tendency exposure data. Where ONU-specific data are used, the data capture ONU exposures from all sources of exposures present. Worker central tendency values are expected to be protective estimates as they include exposures to workers who work directly with the chemical resulting in exposures that likely exceed that of ONUs within the same facility. EPA did not consider the use of PPE when evaluating

	administrative staff in nearby open offices, truck drivers who transport PCE if there is an accidental spill or leak, etc. EPA does not expect these workers to handle the chemical as part of the normal course of their workday, but the reality – which EPA ignores – is that they perform work in an area near where the chemical is present. That is, their exposure is that of 'near-field workers', but EPA wrongly classifies them in its ONU category, for which EPA assigns 'far-field' exposures. • ONUs may not stay within the "far-field zone" when they are responding to spills, maintaining equipment, and otherwise performing work activities that take them within the "near-field" zone occupied by direct users of PCE. • ONUs are likely a heterogeneous population of workers, and some could be exposed more than just occasionally to high concentrations. This possibility should be included explicitly as a source of uncertainty. As recommended earlier, EPA should consider the different categories of ONUs potentially at risk. The SACC recognized this on the previous report for methylene chloride.	risk for ONUs. Employees doing equipment maintenance are considered by EPA to be workers and not ONUs. Response to a spill would generally be covered by shorter-term exposures.
30, 40	**PUBLIC COMMENTS:** The Toxics Use Reduction Institute (TURI) comments provided to EPA regarding its methylene chloride assessment gave real-world examples of near-field workers – that EPA wrongly classifies as 'far-field' ONUs. The TURI comments and observations regarding near-field 'ONUs' are relevant to all solvents, including PCE.	EPA reviewed the TURI comment for relevant information for the PCE risk evaluation. The information in the comment did not result in reclassifying any data from ONUs to workers. The classification of data as worker vs ONU is consistent with the definition of workers and ONUs used by EPA.
40, 42, 46, 48	**PUBLIC COMMENTS:** The draft evaluation provides few details on the job responsibilities and activities of ONUs. Nonetheless, EPA takes the approach that "[w]hile the difference between the exposures of ONUs and the exposures of workers directly handling PCE	EPA used the best available science and reasonably available data to assess exposures for each COU. EPA provided as much detail as was reasonable available for specific work tasks for worker and ONUs. Additional descriptions of worker and ONU tasks is in the

	generally cannot be quantified, ONU inhalation exposures are expected to be lower than inhalation exposures for workers directly handling the chemical." • EPA arbitrarily assumed "the ONU exposures to be equal to the central tendency risk estimates for workers when determining ONU risk attributable to inhalation." • EPA also claimed, without justification, that "dermal exposures are not expected because ONUs do not typically directly handle PCE, nor they are in the immediate proximity of PCE." This assumption is unfounded for cleaning workers and skilled trade workers. ONU exposures may be as great as or greater than those of other workers, and ONUs are even less likely to be provided PPE As a result of this approach, "EPA determined that most applicable conditions of use do not present unreasonable risks" to ONUs. The assumption that exposure of ONUs is equivalent to the central tendency of the worker exposure is unwarranted and not based on any scientific or fact-based information. In the draft risk evaluation, EPA acknowledges that it has no exposure data for ONUs. Instead, EPA assumed that exposure of ONUs was equal to the central tendency of the worker exposure data. EPA has no data to support this assumption nor is there any basis in science. The assumption is arbitrary. EPA should consider alternative exposure estimate methods for ONUs, particularly to include modeling that incorporates assumptions that are tailored to ONUs (considering task types and durations). • In the industrial hygiene practice, workers who "do not directly handle PCE but perform work in an area where PCE is present" are called "bystanders."	Assessment of Occupational Exposure and Environmental Releases for Perchloroethylene. EPA has included all opportunities to perform modeling with the data reasonably available. However, for most occupational exposure scenarios, ONU-specific monitoring data or data for modeling are not reasonably available. In these OESs, EPA assumes ONU exposures are equal to central tendency (50^{th} percentile) of worker inhalation exposures. Where EPA had monitoring or modeled data specific to ONUs, unreasonable risk determinations were made based on high-end exposures. For conditions of use where the data did not distinguish between worker and ONU inhalation exposures, there was uncertainty regarding ONU exposure. ONU personal exposures are assumed to be lower than personal exposures for workers directly handling the chemical substance. To account for this uncertainty, EPA considered the workers' central tendency risk estimates from inhalation exposures when determining ONUs' unreasonable risk (rather than the high-end inhalation exposures), when data specific to ONUs was not reasonably available. Worker central tendency values are expected to be protective estimates as they include exposures to workers who work directly with the chemical resulting in exposures that likely exceed that if ONUs within the same facility given the relative proximity to the source of exposure. EPA acknowledges that ONUs may have incidental or

	• EPA had very little monitoring data for ONUs. For most COUs, EPA used worker central tendency exposure results as a surrogate to estimate exposures for ONUs. There is no scientific basis for this approach. • In the case of manufacturing, utilizing a CTE that included non-routine, high-end worker tasks likely substantially overestimates routine exposure to ONUs. EPA should consider alternative exposure estimate methods for ONUs, particularly near-field, far-field (bystander) modeling that incorporates assumptions that are tailored to ONUs (considering task types and durations). Different scenarios could be run on an ONU assuming different activities for a range of durations. While EPA may not currently understand "real world" ONU tasks in PCE manufacturing and other COUs, this information should be obtainable via communications with the industry. Lastly, the deficiencies in the approach to ONU exposure assessment are a global issue, as the same "CTE substitution" method has been used across many chemicals evaluated under TSCA. EPA should consider broadly altering its approach to ONU exposure assessment in all forthcoming assessments.	occasional dermal contact with PCE. However, such exposures are not expected to be routine, and no reasonably available data were identified to estimate the frequency of such contacts and the amount of liquid that remains on the skin after contact. Therefore, these exposures were not assessed in the risk evaluations. See Section 2.4.1.1 for further discussion. EPA did not consider the use of PPE when evaluating risk for ONUs.
SACC	**SACC COMMENTS:** Recommendation: Consider defining and using an "occupational bystander" exposure category to cover the "take-home" pathway and persons whose residences are co-located with dry-cleaning establishments. • Persons exposed at work to solvents will "de-gas" overnight and exhibit diurnal breath patterns. This source of exposure is not included in the current draft risk evaluation framework. 'Bystanders' are bystanders to consumer use generated emissions and ONUs are exposed at the place of employment. Persons may also be bystanders to occupationally generated exposures by cohabitation ("take	The frequency and magnitude of take-home exposure is dependent on several factors, including personal hygiene and visibility of the chemical on skin or clothing. EPA does not have methods to reliably predict take-home exposure. What the commenter refers to as "bystanders" are a subset of the general population. EPA did not assess inhalation exposures for persons in the general population who live or work near businesses using PCE, such as dry cleaners, because stationary source emissions of PCE to ambient air are under the

	home") or by residence in a building with a business that is a user of PCE (*i.e.*, a dry cleaner in a mixed-use building). • Substantial data exist describing exposure to persons residing in buildings also occupied by dry cleaners. The Committee did not consider this a consumer exposure but as an occupational bystander group (that is distinctly different from ONU). The Committee viewed the fact that the evaluation did not recognize this 'occupational bystander' subpopulation as evidence of incomplete utilization of available data.	jurisdiction of the Clean Air Act. EPA has promulgated National Perchloroethylene Air Emission Standards for Dry Cleaning Facilities under the authority of the CAA. See 40 CFR part 63, subpart M; 73 FR 39871 (July 11, 2008); 71 FR 42724 (July 27, 2006). As explained in more detail in section 1.4.2 of the final risk evaluation, EPA believes it is both reasonable and prudent to tailor TSCA risk evaluations when other EPA offices have expertise and experience to address specific environmental media, rather than attempt to evaluate and regulate potential exposures and risks from those media under TSCA. EPA believes that coordinated action on exposure pathways and risks addressed by other EPA-administered statutes and regulatory programs is consistent with the statutory text and legislative history, particularly as they pertain to TSCA's function as a "gap-filling" statute, and also furthers EPA aims to efficiently use Agency resources, avoid duplicating efforts taken pursuant to other Agency programs, and meet the statutory deadlines for completing risk evaluations. EPA has therefore tailored the scope of the risk evaluations for carbon tetrachloride using authorities in TSCA sections 6(b) and 9(b)(1). See section 1.4.2 of the Risk Evaluation. EPA did describe the highly exposed subpopulations (PESS) that are included in the scope of the risk evaluation in Section 2.4.3. In terms of this risk evaluation, "bystander" refers to non-product users that are incidentally exposed to the product during consumer use. EPA does identify this group as a highly exposed PESS group.
41	**PUBLIC COMMENTS:** The PCE draft risk evaluation acknowledges that bystanders are at risk of exposure if they live or work near occupational settings where PCE is used. But it does not identify such bystanders as a potentially exposed subpopulation. • EPA fails to state a rational basis for excluding bystanders associated with occupational use from the PCE draft risk evaluation. • EPA is urged to correct this deficiency in the final risk evaluation by identifying them as a potentially exposed subpopulation and by assessing the risks to them.	

		EPA considered the reasonably available information and used the best available science to determine whether to consider aggregate or sentinel exposures for a particular chemical. EPA has determined that using the high-end risk estimate for inhalation and dermal risks separately as the basis for the unreasonable risk determination is a best available science approach. There is low confidence in the result of aggregating the dermal and inhalation risks for this chemical if EPA uses an additive approach, due to the uncertainty in the data based on the absence of a dermal PBPK model compartment. EPA does not have data that could be reliably modeled into the aggregate, which would be a more accurate approach than adding, such as through a PBPK model. Using an additive approach to aggregate risk in this case would result in an overestimate of risk (see Section 4.3.1 for more details). Given all the limitations that exist with the data, EPA's approach is the best available approach. Additional explanation is provided in the Executive Summary and Section 4.4.2 of the Risk Evaluation.
26	**PUBLIC COMMENTS:** Dermal exposure to bystanders was only sometimes evaluated under a variety of COU. EPA should re-visit the settings for which dermal exposure to bystanders has not been assessed and reconsider that decision. • Unlike the ONUs in the work setting, bystanders in the consumer setting may play a more interactive role in the activity, and like the consumer, have contact with the chemical-containing product or the treated article during/after use. • Furthermore, there may be settings in which it would be	EPA assessed specific routes of exposure to a condition of use only when it was scientifically sound to do so. Otherwise, exposure routes considered to be unlikely for a condition of use based on the best available scientific evidence were not evaluated.

	appropriate to assess oral exposure, particularly to the bystander. Given that bystanders encompass individuals of every age, including toddlers and young children, there may be circumstances in which hand-to-mouth activity contributes to increased exposure following dermal contact. Dermal exposure to bystanders should be evaluated for all COUs for which dermal exposure is being assessed for consumers.	
Consumer exposure estimation: methods, models, and data		
SACC, 29, 40, 41, 50	**SACC COMMENTS:** Recommendation: Chronic cancer risks should be estimated for consumer use scenarios where storage could significantly contribute to exposure. The Committee noted that a subset of consumers have chronic exposure to PCE, and the draft risk evaluation should estimate chronic exposures (and expected health effects) for this subset of consumers. • One Committee member noted that some consumer use scenarios are likely to be associated with chronic exposures because of high frequency of the activity or because of elevated indoor air levels from use and storage in the home. These exposures should be evaluated for the chronic endpoints as well as acute endpoints. Several Committee members noted that occupational exposures included acute and chronic exposures while consumer scenarios examined only acute exposure. This led to a discussion of scenarios in which consumers or 'occupational bystanders' could be chronically exposed. The latter category would include individuals who cohabitate with workers who bring home PCE from their workplace or individuals who reside or work in buildings that share premises with dry cleaners. One Committee member cited the exposures described by Schreiber et al (2002) and McDermott et al. (2005) and asked	When appropriate, with supporting scientific data, EPA has estimated chronic exposures to consumers in previous risk evaluations, including the insulation (off-gassing) condition of use for the 1-BP risk evaluation. In that case, EPA applied both a short-term and long-term duration of exposure as well as evaluating acute and chronic exposure (Section 2.3.2.1 of 1BP RE). However, for most consumer uses, EPA generally assumes that exposure is not chronic in nature. EPA acknowledges that some exposure estimates may underestimate frequency of exposure to individuals who are involved with do-it-yourself projects, and that consumer practices are moving toward more do-it-yourself work. Activities for which duration, intensity, frequency, and number of exposures cannot be accurately predicted or calculated based on reasonably available information were not intended to be the focus of TSCA Risk Evaluation. While the expected sparse and intermittent use frequency for the vast majority of users (Westat, 1987) indicates that only acute risks are relevant to consumer uses, there is uncertainty whether chronic risks may be of concern for consumers at the very high end of

	whether EPA concurs with the (NYSDOH, 2013) action level of 30 µg/m^3 (based on risks for cancer and vision deficits associated with chronic PCE inhalation). **PUBLIC COMMENTS:** The draft EPA evaluation only addresses acute inhalation and dermal exposures for consumers. EPA states, "Risk estimates for chronic exposures were not calculated because it is unknown how the available toxicological data relates to the human exposures expected in consumer exposure scenarios" and "[t]here is uncertainty regarding the extrapolation from continuous studies in animals to the case of repeated, intermittent human exposures." • EPA's failure to develop risk estimates for chronically exposed consumers underestimates the risks for consumers and further undermines the risk. This is a feeble excuse for failing to address health risks to consumers that are plainly of concern. Risk assessors have previously had no trouble using repeated dose toxicity studies to estimate the long-term health risks of these scenarios. Indeed, PCE industrial and commercial use scenarios likely involve fluctuations in exposure over time based on worker practices and job responsibilities. Nonetheless, EPA estimates chronic health risks for these use scenarios in its draft evaluation. In only addressing risks to consumers from acute exposure to PCE EPA does not examine chronic health effects linked to PCE, including cancer, developmental and reproductive toxicity, neurotoxicity and liver and kidney toxicity. This creates the incorrect impression that consumers are not at risk for these serious effects. • Multiple lines of evidence demonstrate that consumers have long-term PCE exposure. Numerous measurements of indoor	the range for frequency of use, especially if a product is used several days consecutively. Without continued use on consecutive days or in short succession, chronic hazards are unlikely due to the relatively short half-life of PCE (Section 3.2.2.1.4). Since reasonably available information was not identified to inform these and other parameters, and the absence of data leaves it uncertain how to develop a credible worst-case scenario, chronic consumer product use and chronic exposures due to continued storage of consumer products were not evaluated in this Risk Evaluation. Detected PCE in human tissues may be from multiple sources, including environmental sources covered by other EPA statutes and occupational exposures that are assessed for chronic risks in this Risk Evaluation. EPA is not aware of any reasonably available data connecting detection of PCE in humans with consumer use as opposed to other potential exposure sources.

	air concentrations of PCE (some at extremely high levels) indicate that consumer exposure to PCE is not episodic but continuous. Consumers using contaminated drinking water are likewise exposed to PCE on an ongoing basis. There is also extensive evidence, presented in multiple studies described in the draft risk evaluation, of the presence of PCE in human blood, urine, and breath samples, and in human breast milk, again consistent with long-term continuous exposure (details of several studies are provided). • The consistent detection of PCE in human blood, urine, breath, and breast milk is incompatible with the assumption that consumer exposure is short-term and episodic. Instead, it provides strong evidence of continuous exposure to PCE by consumers, probably from multiple sources. Reinforcing this conclusion is the relatively short elimination half-life of PCE: according to the draft risk evaluation, "[h]alf-life of PCE from blood-rich tissues, muscle, and adipose tissue is 12-16 hours, 30-40 hours, and 55-65 hours, respectively." A glaring disconnect in EPA's draft evaluation is that it acknowledges and discusses the presence of measurable PCE levels in indoor air, human blood, urine, breast milk, and personal breathing zones but ignores this information in developing consumer exposure scenarios, which are based entirely on modeling of isolated releases from individual products and not on the best evidence of cumulative exposure by consumers. • EPA could construct chronic exposure scenarios for PCE-exposed consumers on the basis of central tendency and upper bound PCE concentrations in indoor air and personal breathing zones. It could also undertake PBPK modeling using biomonitoring studies showing PCE levels in blood and urine. These methods would allow for a calculation of steady-state PCE exposures that account for day-to-day	

	variations in exposure, much as EPA does in estimating worker exposures and risks. EPA could also modify representative steady-state exposure calculations to account for high-end PESS exposure scenarios, such as intensive and recurring consumer product use, proximity to dry cleaners or high-emitting industrial or commercial facilities, vapor intrusion from contaminated sites, or families with dry-cleaning workers who expose other family members to PCE. The PCE draft risk evaluation identifies consumers as a PESS. And it recognizes that "[US] EPA cannot rule out that consumers at very high frequencies of use may be at risk for chronic hazards, especially if those consumers also exhibit biological susceptibilities." Nevertheless, the PCE draft risk evaluation fails to consider the risks of chronic exposure to consumers. The failure to evaluate scenarios involving chronic exposures to consumers is arbitrary and capricious. EPA is urged to correct this failure by including such scenarios in the final risk evaluation.	
SACC	**SACC COMMENTS:** The greatest contributor to most consumer exposure, due to its repetitive nature, is likely to be dry-cleaned clothing. The dermal and inhalation estimates in the draft risk evaluation appear to be reasonable but estimates for new clothing should have been performed in a similar manner.	EPA used the best available science in its assessment of dermal and inhalation modeling.
SACC	**SACC COMMENTS:** Recommendation: Apply the Kasting and Miller (2006) approach to consumer dermal exposures to liquids, then check predictions against the Kezic et al. (2001) data. The Committee discussed three possible approaches to address the effect of evaporation in the consumer exposure calculations. • The first would be to apply the same method used for	The CEM Fraction Absorbed sub-model was selected for those COUs where evaporation is uninhibited during use. The sub-model is a mass limited model which considers evaporation from the skin and calculates a fraction absorbed portion of the total exposure occurring during product use. To minimize uncertainty, this model was run utilizing the assumption that the

	worker dermal exposure (which is based on Kasting and Miller, 2006) to the consumer case. EPA has not explained why different methods are appropriate or necessary. • The Committee notes that Kezic et al. (2001) have reported results of human in vivo trials in which skin was challenged with small amounts of VOCs including PCE. These results could be used either to check the predictions obtained by the Kasting and Miller approach, or alternatively, be adopted directly as estimates of short term absorbed doses. • The Committee also noted that Risk Assessment Guidance for Superfund (RAGS) Part E guidance (U.S. EPA, 2004) describes a non-steady-state solution for absorption from aqueous solutions. That approach can also be applied to non-aqueous solutions by analogy. Implementation would require some estimate of the duration of contact (*i.e.*, the time required for evaporation to occur). • Competition between absorption and evaporation is built into the Kasting and Miller approach, which is why it is the first recommendation. The Committee recommended a hybrid approach, applying the worker exposure model from Kasting and Miller (2006), but with checking of model predictions against the available empirical data from Kezic et al. (2001).	entire mass of chemical in the thin film enters the stratum corneum. Additionally, while the estimated absorption coefficient (Kp) within the model is based on an aqueous vehicle, a Kp for neat PCE was obtained from literature and incorporated into the model. The use of the neat Kp is more representative of the product COUs, with PCE weight fractions up to 100 percent and/or non-aqueous co-solvent formulations. The CEM Permeability sub-model was selected for those COUs where evaporation is inhibited/prohibited or where full immersion of body parts is expected during use. The sub-model assumes a constant supply of product against the skin during the entire duration of use. As with the fraction absorbed sub-model, the permeability sub-model permeability coefficient (Kp) is based on an aqueous vehicle. As discussed above, the permeability sub-model was run utilizing a neat Kp to minimalize uncertainty as this is more representative of the product COUs. More discussion on acknowledged assumptions and uncertainties concerning consumer dermal exposure modeling is included under the Consumer Exposure Assumptions and Key Sources of Uncertainty section.
SACC	**SACC COMMENTS:** The Committee generally agreed that consumers who use PCE products should be assumed not to use PPE. One Committee member thought that adding discussion in the draft risk evaluation of the potential benefit to consumers of PPE use in scenarios in which it might flip the COU from Unreasonable Risk to No Unreasonable Risk would be beneficial.	EPA does not evaluate consumer uses based on PPE use in order to be conservative. EPA appreciates the suggestion to present the potential effects of PPE on risk determinations; however, this is contrary to how EPA evaluates consumer uses. In addition, EPA did not identify reasonably available data that would support a certain assumed frequency of consumer PPE use. In some cases, "proper" PPE can sometimes require a fit test, for example, prior to using a respirator, for

		example. Training may also be required for certain PPE. EPA cannot assume consumers will take the precautions necessary to properly use PPE. Thus, EPA conducts its consumer exposure risk evaluations accordingly.
29, 40	**PUBLIC COMMENTS:** EPA's draft risk evaluation assumes use of a single product type during a day; many consumers are likely use different PCE-containing products on the same day or over time. To ignore this scenario is to overlook the additional consumer exposure resulting from multiple product use. • EPA itself expresses doubts about its consumer use scenarios, noting that "there is uncertainty whether chronic risks may be of concern for consumers at the very high end of the range for frequency of use, especially if a product is used several days consecutively." Thus, even apart from the extensive evidence that all consumers have chronic exposure, intensive users of PCE-containing consumer products are plainly exposed to PCE on a recurring basis. Because these users comprise a PESS under TSCA, EPA must directly address whether they are at risk of chronic health effects and how large that risk is. Focusing only on individual consumer products, EPA claims that "consumer exposure scenarios are expected to be intermittent and it is unlikely that the expected use patterns would cumulatively" result in repeated exposure. However, most PCE-containing consumer products are used regularly by hobbyists, household cleaners, home renovators, artists, and do-it-yourself vehicle mechanics. Even if EPA were correct that chronic consumer exposures only occur "at the very high end of use frequency," this would not justify ignoring chronic risks to consumers. • Heavy users of PCE-containing consumer products would	TSCA section 6(b)(4)(F)(ii) directs EPA to "describe whether aggregate or sentinel exposures to a chemical substance under the conditions of use were considered, and the basis for that consideration" in risk evaluations. EPA defines aggregate exposures as the combined exposures to an individual from a single chemical substance across multiple routes (*i.e.*, dermal, inhalation, or oral) and across multiple pathways (*i.e.*, exposure from different sources). 40 CFR 702.33. EPA defines sentinel exposures as the exposure from a single chemical substance that represents the plausible upper bound of exposure relative to all other exposures within a broad category of similar or related exposures. 40 CFR 702.33. EPA considered the reasonably available information and used the best available science to determine whether to consider aggregate or sentinel exposures for a particular chemical. EPA has determined that using the high-end risk estimate for inhalation and dermal risks separately as the basis for the unreasonable risk determination is a best available science approach. There is low confidence in the result of aggregating the dermal and inhalation risks for this chemical if EPA uses an additive approach, due to the uncertainty in the data. EPA does not have data that could be reliably modeled into the aggregate, which would be a more accurate approach than adding, such as through a PBPK model.

	qualify as a PESS and under TSCA, EPA must address risks to such high-exposure groups and determine if they are unreasonable. Treating these groups as irrelevant, as EPA has done, violates TSCA. • EPA has no evidence to justify concluding that chronic consumer exposure is rare and infrequent, it has extensive evidence that such exposure is ongoing and continuous.	Using an additive approach to aggregate risk in this case would result in an overestimate of risk. Given all the limitations that exist with the data, EPA's approach is the best available approach. Additional explanation is provided in the Executive Summary and Section 4.4.2 of the Risk Evaluation. EPA concluded that there is insufficient information to support analysis of aggregate exposure across multiple conditions of use. EPA acknowledges that the decision not to aggregate risk across conditions of use could result in an underestimate of risk.
29, 40	**PUBLIC COMMENTS:** EPA does not estimate the number of exposed consumers but this population includes a sizable number of Americans who use PCE-containing products and/or are exposed to PCE in indoor or outdoor air, through drinking water, or because of proximity to contaminated sites and facilities where PCE is manufactured, processed, or used.	EPA considered the reasonably available information and used the best available science to determine whether to consider aggregate or sentinel exposures for a particular chemical. EPA has determined that using the high-end risk estimate for inhalation and dermal risks separately as the basis for the unreasonable risk determination is a best available science approach. There is low confidence in the result of aggregating the dermal and inhalation risks for this chemical if EPA uses an additive approach, due to the uncertainty in the data. EPA does not have data that could be reliably modeled into the aggregate, which would be a more accurate approach than adding, such as through a PBPK model. Using an additive approach to aggregate risk in this case would result in an overestimate of risk. In addition, as explained in more detail Section 1.4.2 of the Risk Evaluation, EPA believes it is both reasonable and prudent to tailor TSCA risk evaluations when other EPA offices have expertise and experience to address

		specific environmental media, rather than attempt to evaluate and regulate potential exposures and risks from those media under TSCA. EPA believes that coordinated action on exposure pathways and risks addressed by other EPA-administered statutes and regulatory programs is consistent with statutory text and legislative history, particularly as they pertain to TSCA's function as a "gap-filling" statute, and also furthers EPA aims to efficiently use Agency resources, avoid duplicating efforts taken pursuant to other Agency programs, and meet the statutory deadline for completing Risk Evaluations. EPA has therefore tailored the scope of the Risk Evaluation for PCE using authorities in TSCA Sections 6(b) and 9(b)(1).
42, 43	**PUBLIC COMMENTS:** The input values used for the consumer exposure model values seem to reflect certain specialty products and not levels of PCE found in most paints, coatings, sealants, and adhesives. • It is requested that EPA limit its findings to those specialty products identified in the specific Safety Data Sheets referenced in EPA's draft risk evaluation. • In addition, an "adhesive" with 100% PCE is no longer an adhesive and is simply not possible to contain at 100% concentration. EPA should eliminate this data point. EPA should ensure that parameters used for consumer exposure modeling, such as duration of use, frequency of use, and mass of product used per event within the COUs, represent realistic values. • In modeling consumer exposures, for example, EPA estimated the duration and product amount corresponding to the 10th, 50th, and 95th percentile values based on data from the 1987 EPA publication Household Solvent Products: A National Usage Survey (See Table 2-65, Consumer Product	While some consumer use patterns may have changed somewhat, most of the products evaluated for this Risk Evaluation fit well within the categories identified by the Westat Survey including the expected durations of use and mass used. Additionally, while the Westat Survey is more than 30 years old, SACC members also noted that it is a very good survey and the best available data and supported its use. Further, the Westat Survey was rated as a high-quality study under EPA's systematic review process. Finally, to help minimize potential biases to high-end exposure scenarios for certain durations or mass used, EPA chose to evaluate consumer exposure across a spectrum of durations/mass used including the 10^{th}, 50^{th}, and 95^{th} percentile data as identified within the Westat Survey. To EPA's knowledge, the existence of referenced products remains relatively unchanged since initial product identification. Additionally, most conditions of

	Modeling Scenarios and Key Westat Product Use Parameters). EPA should develop and/or use more current and/or relevant exposure scenarios/data to estimate the duration of use and amount of use of consumer products containing PCE. EPA's recent efforts to collect this information via surveys and focus groups is encouraged.	use have multiple products associated with the condition of use and therefore, even if some products have since been removed from commerce, the range of products remains applicable within the Risk Evaluation by considering weight fractions across multiple products within a given COU.
Dermal exposure assumptions		
SACC	**SACC COMMENTS:** Recommendation: Include skin damage and dermal uptake from vapor in the discussion of dermal exposure estimates. • The Committee discussed how the estimation of dermal exposures (Section 3.2.2.1.1, p. 258, lines 6356-6374) should, but typically does not, consider skin damage and/or dermal uptake from vapor. If workers are wearing respiratory protection, then dermal exposure may be the dominant route of most exposure. Also noted is the fact that the protection factors (PFs) typically assigned to glove use may not be accurate since workers' gloves may not be constructed of PCE-impervious material, may be torn or permeated with the chemical leading to potentially increased exposures with prolonged repeated use. • Increased dermal absorption due to skin damage was not considered in the evaluation. Literature relevant to this topic was excluded or otherwise under-utilized.	EPA did not identify reasonably available data to estimate dermal absorption due to skin damage. EPA investigated the capability of its existing models to provide output files associated with vapor-to-skin dermal exposure, however, EPA has identified some limitations with providing such estimates within the current model constructs. Furthermore, while vapor to skin may have a minor contribution to overall dermal exposure, the high volatility of PCE is expected to cause the chemical to remain in the vapor phase and available for inhalation exposure rather than redepositing onto the skin causing a vapor-to-skin dermal exposure.
SACC	**SACC COMMENTS:** Recommendation: Correct the consumer dermal exposure calculations and revise the results accordingly**.** At the public meeting, EPA reported that the consumer dermal exposure calculations in the draft risk evaluation are incorrect and based on a methodological error – more specifically, analysis mismatched an aqueous permeability coefficient with a pure compound concentration.	Consumer dermal modeling has been updated.

	• A revised supplemental document was provided after the virtual meeting concluded and, as a result, was not discussed by the Committee. Consumer dermal exposure estimates in the draft evaluation must be considered invalid. This issue must be addressed before the evaluation is finalized.	
29, 40	**PUBLIC COMMENTS:** While finding significant risks from dermal exposure to several consumer products, EPA has arbitrarily failed to address dermal exposure risks from many others. EPA has not explained why it believes that there is no dermal exposure to these products and this conclusion would be inconsistent with realistic use scenarios and EPA's approach to assessing dermal exposure by workers. Moreover, where EPA has estimated dermal exposures for consumer products, the margins of exposure (MOEs) are often quite low, suggesting that incremental dermal exposure from other consumer products could well contribute meaningfully to overall risk and affect whether it is unreasonable.	Determinations of dermal exposure to consumer products is based on consideration of a number of data quality parameters as identified in its systematic review process. EPA uses the best available quality data to determine these potential exposures.
27, 46, 53	**PUBLIC COMMENTS:** In prior risk evaluations, EPA acknowledged that the assumption of one dermal contact per day "likely underestimates exposure as workers often come into repeat contact with [the same chemicals] throughout their workday." In other words, EPA foresees that workers will have multiple daily exposures to PCE, and that those repeated exposures would present greater risks, but has nonetheless chosen not to consider those risks in the draft risk evaluation. This failure to consider reasonably foreseen exposures is an admitted violation of TSCA. In the draft risk evaluation, because EPA did not identify information on how many dermal contact events occur each day, EPA erroneously assumed that for all dermal scenarios there was one exposure event (applied dose) per work-day with a steady-	EPA acknowledges that assuming one contact event per day creates an uncertainty in the exposure estimation and has noted this uncertainty in the Risk Evaluation. However, dermal exposures are a function of both number of contact events and duration between contact events. For example, if the first contact event resulted in a high, super-saturated applied dose and the subsequent contact event was soon afterwards, before appreciable evaporation or absorption took place, there may not be an appreciable increase in absorbed dose. The model used to estimate dermal exposures does not currently have the capability to evaluate such complex situations and EPA has not identified reasonably available data to determine number of contact events and time between events.

	state fractional absorption rate achieved. These dermal uptake estimates are not likely representative of routine Bin 1 (chemical manufacturing) work scenarios.	
27, 53	**PUBLIC COMMENTS:** With regard to PPE, EPA assessed dermal exposure assuming several different scenarios, including: 1) Dermal exposure to PCE with no PPE (gloves). 2) Using gloves, assuming overall glove PFs of 1, 5, 10, or 20. These scenarios assume that there are no occluded exposures (*i.e.*, chemical is not trapped inside the glove). 3) While EPA discussed occluded scenarios, which assume that a worker is wearing gloves, some PCE penetrates through or splashes over the cuff of gloves and remains trapped, enhancing dermal penetration. • For non-occluded scenarios, it is assumed that approximately 13% of the applied dose is absorbed through the skin for industrial scenarios and 19% is absorbed in commercial scenarios. Surface area of contact is assumed to be one full hand for CTEs, and two full hands for high-end estimates (*i.e.*, equivalent to dipping both hands into neat PCE). The quantity remaining on the skin was input as 1.4 and 2.1 mg/cm^2-event for the central tendency and high-end scenarios, respectively, and the scenarios assume that the hands remain unwashed for 8 hours. • For occluded scenarios, EPA assumed that 100% of the applied dose is absorbed through the skin, and that the quantity on the skin is 1.4 and 2.1 mg/cm^2-event for the central tendency and high-end scenarios, respectively (and two-full hands). As stated by EPA, "conceptually, occlusion is similar to the "infinite dose" study design used in *in vitro* and *ex vivo* dermal penetration studies, in which the dermis is exposed to a large, continuous reservoir of chemical" (U.S. EPA, 2020, pp. 29, 406).	EPA used the best available science and reasonably available data to assess exposures for each COU. EPA presents both central tendency and high-end exposure and risk estimates to account for potential uncertainty in the data, as well as risk estimates based on various assumptions of PPE use. See further discussion on occlusion in the Supplemental Information on Occupational Exposure and Environmental Release Assessment (EPA, 2020). The occluded scenarios were presented as a what-if scenario. EPA does not know the likelihood or frequency of these scenarios in the workplace and did not calculate risk associated with occluded exposure.

	Overall, the exposure assessment for the dermal route includes various default, scenario-centric parameters that are applied with little justification, leading to substantially overestimated dermal exposures. For the occluded scenarios, EPA scenarios assume that if PCE splashes into the glove, a worker will not remove the gloves and change them, and the PCE will uniformly coat the entire hand, including the palm and back of the hand. This is essentially an assumption of infinite contact time. The scenario also assumes that none of the PCE is able to evaporate back out of the cuff or glove, and thus, 100% of the PCE is absorbed by the skin over time. EPA assumes that the worker does not remove the glove, wash their hands, and don new gloves. This would be contrary to basic hazard communication and protective equipment policies. General industrial hygiene and worker training would dictate removal and replacement of gloves following spillage into the glove and/or change out schedules designed to limit breakthrough time. For the draft risk evaluation overall, both occluded and non-occluded dermal PCE exposure estimates were likely to be considerably overestimated based on numerous factors, including (but not limited to): • The absorption factor used (13-19%), which is higher than expected for PCE under realistic scenarios assuming evaporation and saturation kinetics. • The assumption that the skin surface area that comes in contact with PCE is one to two full hands, rather than the more likely interior hand surfaces. • The assumption that PCE exposure occurs continuously for 8 hours rather than intermittently.	

	• The assumption that the worker does not change gloves or wash hands at all during the time needed for the PCE to be absorbed. In the case of the occluded scenarios, additional overestimation likely occurred based on the assumption that the whole hand (or hands) were coated with PCE in-glove, and the lack of consideration for possible permeation back out of the glove and evaporative losses. EPA's high-end exposure scenarios are unlikely to occur in chemical manufacturing facilities, and more appropriate assumptions would result in substantially lower exposure estimates.	
27	**<u>PUBLIC COMMENTS:</u>** The potential for significant ongoing liquid contact with neat PCE in the chemical manufacturing environment is likely to be limited to specific short-duration tasks. In manufacturing, chemicals are primarily maintained in a closed process (*i.e.*, chemical feedstocks and process reactants are all maintained within piping and vessels with tight control of emissions). In PCE manufacturing plants, the affected portions of the workforce would generally be conducting tasks under the auspices of operations of the manufacturing unit or maintenance of the process equipment. • For operational staff, the types of tasks that might involve contact with liquid-phase PCE include connecting transfer lines for vessel or container loading and unloading, adding or charging PCE to reactors or mixing vessel charging, collecting samples from process points for laboratory analysis, and assisting maintenance personnel with specific tasks regarding isolation of equipment (*e.g.*, draining vessels). In general, these tasks involve limited direct contact with liquid, and the duration of active contact with the liquid	EPA acknowledges that certain gloves may limit permeation of PCE greater than the protection factors used in the assessment. However, as pointed out by SACC members, that assumes that workers are wearing the correct type of gloves and using them correctly. SACC members stated that dermal exposure does not require that the glove material actually be permeated by the solvent, rather, glove material can be permeated if the glove is torn during working conditions or if workers remove gloves to perform a specific activity and then put the gloves back on. SACC members emphasized that the donning and doffing of gloves is the primary concern when it comes to glove failure and not direct permeation of the glove material.

	chemical is very short. For example, taking samples and connecting transfer lines occurs over the course of a few minutes, not hours, and is typically done a few times over a shift, not continuously. • Thus, assumptions about dermal uptake in the EPA models would not be accurate since PCE would evaporate off the gloves and the gloves would be doffed in minutes after any contact occurred. This greatly limits time for any material to permeate through a purposely selected chemical-resistant glove. In addition, most facilities use specific equipment designs that limit release of liquid product (*e.g.*, quick hose disconnects and closed loop process sampling lines). Significant volumes of liquid contact would not be a routine event. • For maintenance staff, the tasks are generally more variable in nature depending on the equipment that is in need of maintenance or repair. In most cases, because of requirements for isolation of equipment, the maintenance on lines that contain chemicals (*e.g.*, PCE) would already have been purged of process chemicals before they are opened. Liquid material present is usually a mixture of diluted residuals from the process and the solutions used to clean and purge the equipment (often water from steam or other process aids). Under these conditions, upon initial opening of process equipment the liquids present are not neat chemical. Thus, model assumptions regarding percentage chemical context and absorption kinetics would not be accurate for this scenario. The duration of active liquid contact is also typically short (*e.g.*, minutes) and diminishes once the equipment has been drained. • Thus, for the majority of the operational time, PCE would only be present in closed vessels or process equipment with no dermal contact. Small magnitude exposures during short-	

	term tasks can occur in unit operations and maintenance activities. Based on typical industrial hygiene practice, the use of such gloves would achieve much greater protection than the default assumptions under the scenarios described for chemical manufacturing and in processing as a reactant. This is because contact with volatile PCE is limited to small quantities of the chemical and is transient. Thus, the PCE will vaporize from the gloves between exposure periods. Moreover, the effective use of gloves in a facility is specifically designed to address the dermal exposure pathway as part of the required job hazard analysis. Gross exposures or continuous exposures would not be consistent with required chemical handling programs in such facilities.	
27	**PUBLIC COMMENTS:** The SACC should consider: • Recommending that EPA investigate whether an empirical study of dermal exposure to PCE can be conducted. • Recommending that EPA conduct or solicit surveys characterizing current tasks at facilities manufacturing and utilizing PCE (*e.g.*, task duration, contact volumes, contact frequencies, PPE practices). • Recommending that EPA revise the dermal exposure assumptions and re-run exposure modeling in the revised risk evaluation using these new data to more accurately reflect potential occupational exposure to PCE. • Evaluating the impacts of inhalation exposure distributions (*i.e.*, the influence of outliers and non-detects) on the characterization of central tendency and high-end exposures, and the degree to which they are representative of routine scenarios. The SACC may then consider recommending an approach to EPA. • Evaluating whether grouping OES into six categories of	EPA requested information on all aspects of risk evaluations throughout the risk evaluation process, including opening public dockets for receipt of such information, conducting outreach to manufacturers, processors, users and other stakeholders, as well as conducting tailored data development efforts for some of the first 10 chemicals. Given the timeframe for conducting risk evaluations on the first 10 chemicals, use of TSCA data gathering authorities has been limited in scope. In general, EPA intends to utilize TSCA data gathering authorities more routinely for the next 20 risk evaluations. EPA has described how non-detects may affect exposure estimates wherever non-detects are present. EPA also considers whether data were collected under non-routine conditions when analyzing the data where such information is included with the data and may exclude data if it is expected to not be representative of the

	general exposure reflect SEGs, or whether EPA should consider more specific groupings. • Recommending that EPA include additional discussion of the impacts of these assumptions on the level of confidence in the overall estimates, and the degree to which the assumptions are more than adequately protective.	scenario being assessed. However, in most cases such information is not available, and EPA cannot exclude data based solely on the appearance of being higher or lower than other data for the scenario. EPA does not assess worker exposure through similar exposure groups (SEGs) because EPA does not have information reasonably available to determine similar exposure groups based on the provided worker activity descriptions. Facility personnel conducting the monitoring study intimately know the facility and can interview workers to determine SEGs. Additionally, worker activities and job titles are determined differently at each facility making an equal comparison difficult; therefore, EPA has relied only on designations between workers and ONUs. EPA attempted to characterize all uncertainties associated with a particular result and how such uncertainties impact the results of the evaluation.
45	**PUBLIC COMMENTS:** EPA assumes that there is dermal contact when connecting and disconnecting hoses and transfer lines. Dermal exposure was modeled with the assumption of one exposure event per workday with 13-19% of PCE being absorbed through skin. No references to measured data under the COUs as a catalyst regenerator were found; furthermore, the EPA engineering report could not be accessed to determine how EPA came up with these values, let alone an explanation of how dermal exposure is likely when the PCE is used in a closed system and totally consumed. The only measured data that are even remotely related to potential PCE exposures are biomonitoring data from the NHANES database. All samples at the 50th	EPA expects occasional connecting and disconnecting of hoses by workers when unloading PCE from bulk containers into process equipment for use (up to one container per day) and that such an activity may result in dermal contact with PCE. EPA expects these exposure activities to be consistent across all processing aid type uses. Furthermore, EPA does not have any data to suggests that catalyst regeneration uses will be any more controlled than industrial sites using PCE for other processing aid uses. Therefore, EPA believes these approaches are appropriate for use in assessing all processing aid uses including catalyst regeneration.

	percentile fell below the detection limits for PCE. • The only plausible scenario under which a dermal exposure could occur under the COUs for a catalyst regenerator is the result of an accidental spill from a hose or transfer line. That scenario is outside the scope of a risk evaluation under TSCA Section 6.	The draft engineering report is available at the link below and entitled: "Assessment of Occupational Exposure and Environmental Releases for Perchloroethylene." Link: https://www.epa.gov/assessing-and-managing-chemicals-under-tsca/draft-risk-evaluation-perchloroethylene
45	**PUBLIC COMMENTS:** EPA's approach to estimate dermal exposures was examined and several discrepancies with its assumptions were found. The draft evaluation presents the risk determinations for human health under two different scenarios, where the first assumes no protective gloves being worn by the worker and the other assumes that protective gloves are worn. • A glove PF of 10 was assigned for industrial processing aid scenarios, while a factor of 20 was assigned for manufacturing and processing scenarios. Petrochemical facilities and refineries are considered manufacturing sites under TSCA; therefore, the categorization of the sites as "Industrial Processing Aid" facilities is not valid. • EPA has mischaracterized how PCE is used in refining catalyst chloriding operations. PCE use does not require frequent manual hose engagement.	EPA disagrees that petrochemical facilities and refineries should be considered manufacturers. In the TSCA risk evaluation, the phrase "manufacturer" refers to a site that is manufacturing PCE, not any site that manufactures chemicals. EPA did not find any data to indicate that the petrochemical and refinery sites assessed under the processing aid OES are manufacturers of PCE. While EPA does not expect or include in our assessment "frequent" manual hose engagement, EPA does expect occasional connecting and disconnecting of hoses by workers when unloading PCE from bulk containers into process equipment for use. EPA also expects workers may be exposed to fugitive emissions from equipment leaks when performing various maintenance activities and from displaced vapors as vessels are filled. EPA expects these exposure activities to be consistent across all processing aid type uses. While the monitoring data used to assess processing aid uses may not specifically include uses for catalyst regeneration, the data include exposures from these types of activities. Furthermore, EPA does not have any data to suggests that catalyst regeneration uses will be any more controlled than industrial sites using PCE for other processing aid uses. Therefore, EPA believes these data are appropriate for use in assessing all processing aid uses including catalyst regeneration.

44	**PUBLIC COMMENTS:** The primary commercial process for manufacturing PCE is chlorination of ethylene or of mixed chlorinated light hydrocarbons followed by pyrolysis in a process different from the oxychlorination process (*e.g.,* temperatures, chlorine to hydrocarbon ratio, catalysts, etc.) used in manufacturing EDC. • Based on modeling of occupational dermal exposures, EPA found potential unreasonable risks from chronic dermal exposures for PCE manufacturing facilities and for facilities processing PCE as an intermediate in basic organic chemical manufacturing. Critically, EPA's calculations for dermal risk assumed contact with a solution that was 100% PCE, indicating that EPA only analyzed manufacture of PCE as a primary product, not as a byproduct or impurity. • Any occupational exposure modeling or data considered in the risk evaluation must accurately represent the COUs specific to the process for manufacturing that substance as a commercial product. Critically, the concentration of PCE in the process streams at EDC manufacturing facilities will be substantially less than those concentrations found in process streams at operations that produce PCE as the intended commercial product. Consequently, exposures to PCE at a balanced EDC facility would be expected to be significantly lower than the PCE exposure levels reported at a PCE manufacturing facility. • If EPA performed the dermal exposure calculations with a concentration of 7.6% instead of 100%, based on the linear average of the 0.2-15.0% concentration range identified for PCE in heavy liquid ends, no unreasonable risk would be expected. • When looking at data (provided by the commenter) of reported exposures for workers in an EDC unit and workers in a PCE unit on the same days and at the same site and	EPA used the best available science and reasonably available data to assess exposures for each COU. When assessing dermal exposures, COUs were grouped into similar "bins" based on similarities in the uses. In this case, EPA assessed reactant uses of PCE to have a maximum concentration of 100% PCE and dermal exposures were assessed accordingly. Similarly, for inhalation exposures, use of PCE as a reactant at EDC sites was assessed the same as other reactant use sites. While some of the data submitted by manufacturers of PCE indicate they are for EDC technicians it is unclear in the data if the exposure is from byproducts formed in the EDC process or from other sources of PCE at the facility. Given that the facilities are identified as manufacturing PCE as a primary product (rather than a byproduct), EPA attributed such exposures to that OES rather than a separate byproduct use.

	presumably using the same test lab and exposure sampling methods, EDC outside equipment technicians have a reported average exposure to PCE of 0.038 ppm, being 44 times lower than the average exposure to PCE of 1.67 ppm for PCE outside equipment technicians. It is critical that EPA's risk evaluation recognize that operations and data from facilities intentionally manufacturing PCE are foundationally different than operations and occupational exposures during EDC manufacturing where PCE is unintentionally produced.	
53	**PUBLIC COMMENTS:** For PCE manufacturing and other processing using closed systems, it is imperative to understand the exposure scenarios, after accounting for industrial hygiene practices. For the majority of the operational time, PCE is present only in closed vessels or process equipment with no dermal contact. Small magnitude exposures during short-term tasks can occur in unit operations and maintenance activities. Liquid material present on equipment during maintenance or repair is usually a mixture of residuals from the process and the solutions used to clean and purge the equipment (often water from steam or other process aids) and not neat PCE. The duration of active liquid contact is also typically short (*e.g.*, minutes) and diminishes once the equipment has been drained. • PCE dose estimates in the draft risk evaluation may have been substantially overestimated based on assumptions applied for the OES and used in the Dermal Exposure to Volatile Liquids (DEVL) model for closed industrial systems. The DEVL model and the assumptions used by EPA for dermal exposure do not reflect exposure scenarios that are likely under normal operational scenarios (particularly in chemical manufacturing facilities) following typical industrial hygiene practices.	EPA used the best available science and reasonably available data to assess exposures for each COU. For manufacturing, EPA believes it is reasonable the workers make come into contact with neat PCE during loading activities in which the manufactured PCE is loaded into containers for transport to downstream processing and use facilities. The DEVL model assesses exposures to liquid that remains on the skin after contact with the exposure source; therefore, the duration that workers remain in contact with the exposure source is not considered. Rather, the model assumes that any residues remaining on the skin after contact are either absorbed into the skin or evaporate.

27, 53	**PUBLIC COMMENTS:** EPA utilizes predominantly empirical data for inhalation exposure estimates, but due to a lack of data, relies entirely on modeling for dermal exposure estimates. It is of critical importance to pay careful attention to modeling inputs to ensure estimates are as accurate as possible. • The dermal exposure inputs and models utilized in the draft risk evaluation resulted in estimates of exposure, and consequently, estimates of risk, that lead to an overestimation of exposure and do not reflect actual industry working conditions. • However, revised scenarios with more appropriate exposure assumptions result in substantially lower exposure estimates by as much as 10-fold that may affect the risk characterizations. • EPA should consider applying a more refined exposure assessment for some scenarios in the revised PCE risk evaluation (and potentially other chemicals). The refined exposure assessment should incorporate the available knowledge in the industrial hygiene community on dermal exposure prevention coupled with appropriate modeling. • EPA should refine its overarching approach for dermal exposure estimation and apply it to all forthcoming TSCA chemical risk evaluations.	EPA used the best available science and reasonably available data to assess exposures for each COU. EPA appreciates any additional data from commenters that would improve its estimates of occupational exposures in future risk evaluations.
27, 29, 40	**PUBLIC COMMENTS:** Because "[d]ermal exposure data was not readily available for the conditions of use in the assessment," EPA used modeling techniques to estimate dermal exposure. As EPA itself acknowledged, several of the steps in this analysis were based on debatable assumptions and could well underestimation of dermal exposure. EPA's estimates of dermal exposure by workers rest on questionable assumptions and likely understate the magnitude of PCE exposure by this route.	EPA used the best available science and reasonably available data to assess exposures for each COU. EPA also attempted to characterize all uncertainties with approaches used in the risk evaluation, including those associated with dermal modeling. Uncertainties are accounted for when making risk determinations. EPA acknowledges that assuming one contact event per day creates an uncertainty in the exposure estimation and

	• EPA should model a broader range of dermal contact scenarios based on its own analysis of variations in dermal exposure conditions and base risk estimates on multiple dermal exposure events per day. It should also estimate increases in exposure and risk where occlusion results in higher skin absorption of PCE during glove use, and assess dermal exposures and risks for all PCE-containing consumer products. • EPA recognized that its dermal exposure "model assumes a fixed fractional absorption of the applied dose; however, fractional absorption may be dependent on skin loading conditions." Thus, EPA acknowledged that its assumption of rapid volatilization of PCE after skin contact did not hold true in all worker operations. • Higher exposure scenarios are not hypothetical but can be expected to occur regularly in workplaces. Thus, EPA should have developed additional risk and exposure estimates reflecting the higher levels of dermal absorption likely under reasonably foreseeable COUs. • For TCE, rapid absorption through the skin has been shown by both vapor and liquid TCE contact with the skin in several studies. ATSDR has discussed similar dermal absorption studies for PCE. However, they are not addressed in the draft PCE evaluation. • The PCE evaluation likewise recognizes that its dermal absorption model "assumes a single exposure event per day . . . and does not address variability in exposure duration and frequency." Despite acknowledging this limitation, EPA did not model any repeat contact scenarios for PCE involving higher levels of dermal exposure. EPA should base dermal exposure scenarios in the final PCE evaluation on an assumption of ongoing exposure by this route throughout the workday, not a single exposure event.	has noted this uncertainty in the Risk Evaluation. However, dermal exposures are a function of both number of contact events and duration between contact events. For example, if the first contact event resulted in a high, super-saturated applied dose and the subsequent contact event was soon afterwards, before appreciable evaporation or absorption took place, there may not be an appreciable increase in absorbed dose. The model used to estimate dermal exposures does not currently have the capability to evaluate such complex situation and EPA has not identified reasonably available data to determine number of contact events and time between events. See further discussion on occlusion in the Supplemental Information on Occupational Exposure and Environmental Release Assessment (EPA, 2020). The occluded scenarios were presented as a what-if scenario. EPA does not know the likelihood or frequency of these scenarios in the workplace and did not calculate risk associated with occluded exposure. The possibility of rapid absorption of PCE through the skin is not precluded from the occupational dermal model used in the risk evaluation. The model considers absorption over an extended period of time and takes into account a variety of factors including vapor pressure, K_{OW}, solubility and others used to predict PCE mass transfer into the skin while also accounting for simultaneous evaporation from the skin. The model assumes the entire applied dose is either absorbed through the skin or evaporates. It is possible that PCE is rapidly absorbed (as stated by ATSDR) but that

		evaporation also occurs rapidly resulting in two competing processes with the majority of absorption and evaporation occurring shortly after contact.
27, 53	**PUBLIC COMMENTS:** Dermal exposure was estimated using the DEVL model (non-occluded scenarios) or using a simple calculation (occluded scenarios) due to a lack of empirical data. Exposure estimates were conducted for each COU, but conditions of use were "binned" into six categories of exposure based on maximum possible dermal exposure concentrations (U.S. EPA 2020, p. 192). • Many of the scenarios grouped in bins have drastically different potentials for dermal contact with PCE and should have been documented and assessed separately. In fact, EPA's simplistic approach resulted in the same results for separate bins with completely distinct exposure profiles, such as: • Bin 1 (closed systems such as manufacturing, import, processing as a reactant… etc.) = Bin 2 (vapor degreasing, web degreasing, cold cleaning, use as a maskant for chemical milling), and Bin 3 (aerosol uses) = Bin 4 (dry cleaning, spot cleaning, wipe cleaning, polishes, etc.). • With respect to Bin 1 and Bin 2, it is noted in the EPA assessment that Bin 1 "covers industrial uses that generally occur in closed systems" for which dermal exposure is limited, whereas Bin 2 covers uses that "are not closed systems" and therefore have "greater opportunity for dermal exposure" (U.S. EPA, 2020a, p. 192). Therefore, to consider Bin 1 and 2 comparable would result in an overestimation of dermal exposures to workers performing Bin 1 tasks. • These problems of mixing dissimilar exposures into a presumed SEG is not appropriate occupational risk assessment practice. It is exactly for this reason industrial	EPA acknowledges that exposures in each bin may differ with the primary difference being the potential for occluded exposures. For bins with closed systems, EPA expects there to be very limited potential for occluded exposures to occur whereas bins for open systems have much greater opportunity for occluded dermal exposures. However, due to the concentrations of PCE in several bins being the same, and the assumed same number of contact events per day, the exposure results from routine exposures are the same. See further discussion on occlusion in the Supplemental Information on Occupational Exposure and Environmental Release Assessment (EPA, 2020). The occluded scenarios were presented as a what-if scenario. EPA does not know the likelihood or frequency of these scenarios in the workplace and did not calculate risk associated with occluded exposure.

	hygienists take a task-by-task job hazard analysis profile method in conducting task risk assessments and designing customized exposure control programs that are tailored to the hazards and exposures that are present. EPA should consider whether these six categories of exposure reflect similar exposure potential, or whether more refined groupings are warranted.	
38	**PUBLIC COMMENTS:** EPA appears to have relied extensively on Organisation for Economic Cooperation and Development (OECD) Emission Scenario Documents (ESDs), as well as Generic Scenario Documents (GSDs), to model exposures where monitoring data are limited or unavailable. We have raised concerns to EPA previously about the accuracy of these types of documents and the assumptions that are inherent in EPA's modeling programs. • For example, the "Generic Scenario for Automobile Spray Coating" document was developed in 1996. It was then updated to an OECD ESD document in 2003 and again in 2009. Even with the updates, it is highly likely that real-world practices are very different in 2020. Thus, it is important that EPA release for comment the scenario documents and models being used. • While we recognize that these documents and models are cited in the scope documents, a separate request for comment specific to all scenario documents and models being used by EPA would bring a focus to better characterizing real-world exposure potential and using the best science and modeling available. • We recommend that EPA release for public comment all of the models and exposure scenario documents currently being used to support scope document development and subsequent TSCA risk evaluations.	Below is a link to OECD Emission Scenario Documents (ESDs) and Generic Scenarios that EPA has developed. These are posted on EPA's TSCA Screening Tools web page. EPA regularly develops new scenarios and updates existing scenarios for posting on this web page and welcomes data and input on these scenarios. https://www.epa.gov/sites/production/files/2019-06/scenarios_documents_for_screening_level_exposure_and_release_assessment.zip

29, 40	**PUBLIC COMMENTS:** EPA used different methodologies to evaluate dermal exposure for workers and consumers, which resulted in differing estimates of dermal absorption rates. EPA does not explain its rationale and their underlying assumptions seem conflicting. For workers, EPA has understated the magnitude of PCE dermal exposure. For consumers, EPA's approach is more realistic, but it is of concern that EPA assumes no dermal exposure for half of the consumer uses it addresses. • Unlike its dermal exposure estimates for workers, EPA's estimates for consumers assumed that certain COUs involve limited evaporation of PCE from dermal surfaces and significant levels of absorption. • To determine the rate of absorption, EPA used a different model for consumers than it used for workers and its consumer permeability method accounted for product-specific low evaporation use scenarios. • For those consumer products assessed for dermal exposure, several MOEs were extremely small, indicating a high level of dermal risk. For example, the dermal MOE for high-intensity adult users of aerosol brake cleaners was $7.2x10^{-2}$, considerably smaller than the acute dermal MOEs for commercial aerosol degreasers and lubricants, which would likely be used in the same way. • Considering the large dermal risks for the consumer products that EPA does assess, its decision to assume an absence of dermal exposure for the remaining PCE-containing products is unwarranted. These products (such as caulks, sealants and column adhesives) plainly have the potential for dermal exposure although evaporative losses may be greater than for the products EPA assesses. Since EPA itself acknowledges that a "key uncertainty for the dermal estimates is the accuracy of the assumption of which	Even though consumer exposure was evaluated with a fraction absorbed model, there are some inherent differences between the approaches to occupational and consumer dermal exposure based on the unique conditions under which an occupational worker receives dermal exposure compared to the consumer. Differences include consideration of PPE use (gloves that are protective against PCE) for occupational workers and a better characterized time component for consumer due to more refined duration of use/exposure. EPA includes a discussion of the various dermal models used for occupational and consumer exposure estimates in Sections 2.4.1 and 2.4.2. As mentioned by the commenter for these consumer products, EPA assumes that due to the strong potential for evaporative losses, a dermal exposure assessment for these products was not warranted.

	COUs are likely to result in exposure with impeded evaporation," the best course is to estimate dermal exposures and risks for all PCE-containing consumer products.	
27	**PUBLIC COMMENTS:** The dermal exposure model does not define an exposure duration and effectively assumes immediate absorption of PCE to steady-state conditions. These scenarios do not consider the impact of the rate of absorption of PCE through the layers of the skin (flux). They also do not account for PCE saturating the skin (*i.e.*, the skin cannot hold an infinite amount of chemical, so it will eventually become "full"). The concepts of dermal loading and absorption flux need additional consideration in the scenarios, since actual exposures involving potential chemical handling are typically short-term tasks that do not involve continuous exposures.	The dermal model used by EPA considers competing processes of absorption into the skin and evaporation. The model assumes the entire applied dose will either be absorbed or evaporate. The model does not assume continuous exposure with liquid PCE, only that the applied dose (*i.e.*, the amount of chemical remaining on the skin after contact with the exposure source) remains on the skin until it is absorbed or evaporates. Based on the physiochemical properties of PCE, this duration may not be very long after initial contact.
53	**PUBLIC COMMENTS:** EPA's approach of applying a PF is appropriate, but simplistic, for accounting for solvent contact with a gloved hand. Notably, the volatile chemical will evaporate off the gloved hand just as it does when contacting the hand itself. If such factors are used, however, the PFs should be applied to the ungloved estimates from the Ih SkinPerm output, not the original estimates presented in the risk assessment (which were likely 2.5- to 10-fold too large).	EPA appropriately applied the glove PFs within the framework used in the PCE risk evaluation. EPA will consider further refinements to the dermal approaches in future risk evaluations.
53	**PUBLIC COMMENTS:** An appendix provided by the commenter was included that includes several modeling examples showing that the draft risk evaluation may have considerably overestimated dermal exposures. • For instance, in the non-occluded (ungloved hand) exposure scenarios, EPA did not account for exposure duration of industrial scenarios nor the saturation of the skin by PCE. The commenter used the IHSkinPerm model to estimate	EPA used the best available science and reasonably available data to assess exposures for each COU. EPA appreciates the additional data provided by the commenter and will consider further refinements to the dermal approaches in future risk evaluations.

	dermal exposures. IHSkinPerm is a peer-reviewed exposure assessment tool published by the AIHA's Exposure Assessment Strategies Committee. It is a common tool to produce reliable estimates of dermal exposure by practitioners of industrial hygiene and exposure assessment. Analyses using the IHSkinPerm model, in which duration and saturation factors were appropriately considered, show that exposure scenarios without PPE in the draft risk evaluation may have overestimated the absorption fraction of PCE by 40- to 80-fold for exposure to an ungloved hand, and the total dermal dose of PCE by approximately 2.5- to 10-fold for exposure to an ungloved hand assuming eight 1-hour exposure events per day.	
53	**PUBLIC COMMENTS:** Given the many uncertainties inherent in the PCE dermal assessment, EPA should investigate whether an empirical study of dermal exposure to PCE can be conducted and the findings can be incorporated into the final assessment. Another data gathering approach could include conducting or soliciting surveys that characterize the current tasks at facilities manufacturing and utilizing PCE, including information on task duration, contact volumes and frequencies, and PPE practices. Moving forward in future risk evaluations, EPA should more thoroughly consider data gaps and methods to fill them in the scoping and problem formulation phases of the risk evaluation.	EPA acknowledges the uncertainties associated with dermal assessment of the first 10 chemicals. EPA is considering approaches to improve its dermal modeling of the next 20 chemicals.
Exposure uncertainty discussion/confidence ratings		
SACC	**SACC COMMENTS:** Recommendation: Describe the potential influence limited COU monitoring data may have on the uncertainty of exposure estimates. The Committee noted that for most COUs, available data were surprisingly few. Section 2.4.1.3 (p. 125, line 2720) states that "A data set comprises the combined exposure monitoring data	Discussions of uncertainty due to limited number of monitoring data are addressed in Section 2.4.1.30 under "Analysis of Exposure Monitoring Data."

	from all studies applicable to that condition of use." However, in nearly every COU case, only a single or a couple of studies are identified (Table 2-14) with acceptable and available exposure data. • For example, for the manufacturing COU, only three HSIA (2018a) data sets were combined for a total of 152 observations (Table 2-15). Publications containing manufacturing worker exposure data not mentioned in the draft risk evaluation were finally found in the reference list and the Data Quality file.	
SACC	**SACC COMMENTS:** Recommendation: Clarify those places where area monitoring data are used to inform exposures. • Several Committee members commented on the wipe cleaning solvent and metal/stone polish exposure estimates, which may be unreasonably high. The data used are not representative, and as a result, exposure estimates are very high. This is an example of where the draft risk evaluation should assign greater uncertainty to risks computed using these exposures. • Several Committee members noted that in the draft risk evaluation, it is unclear whether and where area monitoring data are used. Information on how close the monitor is to the point source, a critical piece of information, is seldom available. Area monitoring data are typically used to represent background concentrations in the facility.	The data used for the wipe cleaning OES received a "high" quality rating through EPA's systematic review process. EPA acknowledges that these data are higher than seen for other OES; however, EPA does not believe that these data are not representative of the OES. The activities performed while the data were collected are directly applicable to the use of liquid degreasers, applied to rags, and then wiped on a substrate. Given the volatility of PCE, the high concentration of PCE expected in liquid degreasers, and the proximity of the worker to the source of exposures, EPA believes the high exposures are within reason for this scenario. EPA identified additional PBZ data after the SACC meeting; therefore, area data are no longer used in the risk evaluation.
SACC	**SACC COMMENTS:** Recommendation: Ensure that conclusions of overall confidence align with stated data limitations or provide a clearer and more detailed rationale for the confidence conclusion. There are numerous places in the draft risk evaluation, particularly in the Exposure section (Section 2) but also in the Hazard section (Section 3), where data limitations are	EPA attempted to characterize all uncertainties associated with a particular result. However, the presence of multiple uncertainties does not necessarily result in a lower confidence rating if EPA believes the strengths of the assessment outweigh the limitations of such uncertainties.

	acknowledged but then overall confidence in the assessment is stated to be high or medium, which does not seem to match with the stated limitation of under- or over-estimation. This is especially true when data from a model rather than actual measurements are used.	
SACC	**SACC COMMENTS:** In several places, it is unclear why the uncertainty does not modify the level of confidence. Examples mentioned by the Committee include • P. 143, lines 3140-3142 states: "It is not known whether these data points would also be representative of the worker exposure level at other similar facilities. Despite this uncertainty, EPA has a high level of confidence in the assessed worker exposures based on the strength of the monitoring data." • P. 164, lines 3816-3818 states: "Due to potential variations in the types of sites that may use PCE-based adhesives, sealants, paints, and coatings, there is some uncertainty in how representative the monitoring data are of other sites using these types of products." The draft risk evaluation then concludes: "Despite this uncertainty, EPA has a medium level of confidence in the assessed worker exposure for this condition of use." • P. 170, lines 4066-4070 states: "Due to the low concentration of PCE in the metalworking fluid, the partial pressure of PCE in the mist may be low enough such that this is not a significant route of exposure, thus mitigating the overall underestimate. Based on the available information above, EPA has a medium level of confidence in the assessed worker exposure for this condition of use." It is unclear why confidence is rated at "medium" and not "low." • In several places in the evaluation (*e.g.,* Section 2.4.1.1.5), it is noted that use of a model likely over-estimates actual	EPA attempted to characterize all uncertainties associated with a particular result. However, the presence of multiple uncertainties does not necessarily result in a lower confidence rating if EPA believes the strengths of the assessment outweigh the limitations of such uncertainties. There is no Section 2.4.1.1.5 in the risk evaluation document; therefore, EPA could not address this comment directly. However, in general EPA has used all reasonably available information when using models to estimate exposures. In some cases, the available data or assumptions used may have caused a bias to over- or under-estimate results. While EPA acknowledges potential biases in the risk evaluation, EPA did not have reasonably available data to improve the models to reduce or remove such a bias. EPA revised the statements referred to on p.171 of the SACC draft for clarity. EPA chose to define adults as ≥21 years old because, as described in the EPA's *Guidance on Selecting Age Groups for Monitoring and Assessing Childhood Exposures to Environmental Contaminants*, ages 18 to 21 years old "encompasses a period of continuing development and may capture important events such as a change in residence and epiphyseal closure."

	exposure. While the draft risk evaluation provides an explanation for the model over-estimating monitoring data, it was unclear to several Committee members why other models or a model modification was not available that would improve accuracy as this is an issue that is consistently raised. More discussion on this is needed. • One Committee member found the two sentences on p. 171, lines 4088-4090 confusing and somewhat contradictory. The text is unclear, and what data are being referred to as "these data" needs to be clarified. Related to this, the estimates for worker and ONU exposures in the Wipe Cleaning Solvent and Metal/Stone Polish scenario provided in Table 2-50, p. 172, seem very high, based on little data, and assumes impact to an unknown number of workers. The significance of this table is unclear. • Also, on p. 172, in lines 4118-4126 where the "Strength, Limitation, and Uncertainty of the Inhalation Exposure Assessment," for this COU scenario is discussed, the draft risk evaluation concludes a "medium" level of confidence in the assessed exposure. The basis of this conclusion is unclear. The significance is unclear as well because the number of exposed is stated to be unknown. • P. 211, line 5078: Why are adults defined as age 21+ when the Department of Health and Human Services (DHHS) definition is 18+? • The draft risk evaluation does not seem to allow acknowledged overestimation/underestimation in exposures to impact conclusion ratings. For example, p. 226, lines 5385-5387 overestimation for inhalation exposures during livestock grooming is acknowledging for some use situation but the overall rating remains "high." On p. 227, lines 5409-	

	5412, a "medium" rating is retained despite overestimation in exposures to caulks, sealants, and column adhesives for some scenarios and underestimation in others. Similar issue on p. 229, lines 5565-5567.	
45	**PUBLIC COMMENTS:** EPA uses a variety of default assumptions for the foundation of its exposure findings. Because of those assumptions, the exposure estimates are hypothetical and either overestimate potential exposures or misrepresent the actual COUs. There are far too many inconsistencies and uncertainties associated with how the estimates were derived, including many assumptions used by EPA. EPA states that it has medium confidence in its evaluation for the evaluated COUs, but the issues cited above, coupled with the quality of the underlying data, would indicate EPA's confidence is overstated.	EPA used the best available science and reasonably available data to assess exposures for each COU. However, EPA disagrees that exposure estimates in the evaluation are hypothetical or misrepresent the actual COUs. With the exception of only a few COUs, EPA used personal breathing zone monitoring data directly applicable to the condition of use being assessed. Where reasonably available, models were used to corroborate results from the monitoring data. In cases where EPA relied solely on modeling (due to lack of monitoring data), the models are based on fundamentals of engineering/science and literature data applicable to the COU being assessed.
53	**PUBLIC COMMENTS:** The PCE risk evaluation would be strengthened by refinements to the methodology of the exposure characterization. • EPA should consider whether grouping OES into six categories of general exposure is truly representative, or whether EPA should consider more specific groupings. • EPA should consider the incorporation of additional exposure modeling in the revised risk evaluation that reflects well-characterized industrial handling practices. • The risk evaluation should include discussion of the impacts of assumptions on the level of confidence in the overall estimates, and the degree to which the assumptions are more than adequately protective.	EPA acknowledges that exposures in each bin may differ with the primary difference being the potential for occluded exposures. For bins with closed systems, EPA expects there to be very limited potential for occluded exposures to occur whereas bins for open systems have much greater opportunity for occluded dermal exposures. However, due to the concentrations of PCE in several bins being the same, and the assumed same number of contact events per day, the exposure results from routine exposures are the same. See further discussion on occlusion in the Supplemental Information on Occupational Exposure and Environmental Release Assessment (EPA, 2020). The occluded scenarios were presented as a what-if scenario. EPA does not know the likelihood or frequency of these scenarios in the

		workplace and did not calculate risk associated with occluded exposure. EPA developed models and included model results wherever data were reasonably available to do so. Additional modeling requires data to appropriately represent the COU being modeled. EPA attempted to characterize all uncertainties and assumptions associated with a particular result. The resulting confidence ratings determined from strengths, limitations, and uncertainties in results are considered in final risk determinations.

5. Human Health Hazard

Human Health Hazard		
Charge Question 5.1: Have the most scientifically robust critical health effects and corresponding PODs been identified for PCE? Are there additional data regarding other health effects for PCE that EPA needs to consider? If data gaps exist in the PCE database, how could the uncertainty about sensitive health effects and critical windows of exposure be better accounted for in the hazard characterization (Section 3.2)? **Charge Question 5.2:** Please comment on EPA's approach for POD derivation, including selection of UFs and assignment benchmark MOEs for each endpoint. Please also include consideration of the methods and assumptions used for deriving Human Equivalent Concentrations (HECs) for each exposure scenario and receptor type (Section 3.2.5.3). **Charge Question 5.3:** Please comment on EPA's application of the PBPK model to the dose-response analysis for all endpoints, and the selection of dose metrics when considering the sensitivity, uncertainty, and variability of the data (Sections 3.2.2.2 and 3.2.5.3). **Charge Question 5.4:** EPA derived dermal HEDs by extrapolating from both oral and inhalation PODs, when available. Please comment on the transparency and clarity of EPA's methodology for deriving dermal PODs and the selection of particular values for risk estimation (Section 3.2.5.4.1). **Charge Question 5.5:** Please comment whether the cancer hazard assessment has adequately described and supported the mode of action (MOA) conclusions and the selection of a low-dose linear model and discuss any potential alternative approaches. **Charge Question 5.6:** Please comment on any other aspects of the human health hazard assessment that have not been discussed, including the data quality evaluation and the characterization of all assumptions and uncertainties (Section 3.2).		
#	**Summary of Comments for Specific Issues Related to Charge Question 5**	**EPA/OPPT Response**
Data used to determine critical health effects		
SACC	**SACC COMMENTS:** Recommendation: For future draft risk evaluations, EPA should consider using the high-throughput *in vitro* assays from the ToxCast/Tox21 database to derive mechanistic insights, if not PODs. EPA's evaluation of the health effects for PCE is mainly focused on animal and human studies with some *in vitro* studies related to mutagenicity. EPA should also consider the high-throughput *in vitro* assays from the ToxCast/Tox21 database. Currently, there are 235 assay results on PCE, of which 2 assays are positive and 233 assays are negative. It may not yet be possible to derive PODs from these high-throughput *in vitro* assays. However, their use in the future deserves consideration as multiple agencies have recommended the use of such	The ToxCast database can provide some useful mechanistic context. However, the results are not useful without broader context and can be easily misinterpreted. EPA does not have confidence in the usability of the *in vitro* database for dose-response analysis at this time but will consider increased use of this resource in the future.

	assays coupled with *in silico* models for next generation risk assessment, and EPA plans to phase out animal toxicity testing by 2035.	
SACC	**SACC COMMENTS:** Recommendations: (1) More precisely summarize the developmental neurotoxicity studies in the draft risk evaluation. (2) Include short summaries of significant findings for all adverse human health outcomes mentioned in the draft risk evaluation regardless of whether they are used later in establishing hazard. • Several recent studies have examined the potential for fetal or early childhood exposures to PCE to induce neurotoxicity in children or young adults. These studies have generated a complicated pattern of results, which mostly appear somewhere between negative and equivocal. The Committee recommended summarizing the findings of these studies in the draft risk evaluation rather than describing the individual studies and letting the reader distill the results. • There are instances in Section 3.2 where specifics are not provided that would have been useful. For example, Section 3.2.3.1.5, p. 268 (lines 6798-6801) of the draft risk evaluation states: "Studies of PCE exposure in humans have evaluated several reproductive outcomes including effects on menstrual disorders, semen quality, fertility, time to pregnancy, and risk of adverse pregnancy outcomes including spontaneous abortion, low birth weight or gestational age, birth anomalies, and stillbirth (U.S. EPA, 2012c)." Description of the outcomes of these evaluations should be provided. Descriptions need not be extensive but should indicate any significant findings.	Developmental neurotoxicity findings are described in the Hazard ID section for neurotoxicity (3.2.3.1.2). Both human and animal data on developmental neurotoxicity were available. References to the original studies have been added for increased transparency.
SACC	**SACC COMMENTS:** Recommendation: Discuss the biological importance of pattern reversal differences in VEPs and provide evidence that these differences are outside the range of normal variability. The Altmann et al. (1990) study finds statistically significant pattern reversal differences in VEPs. It is not clear that these differences are biologically important and relevant to PCE-induced acute adverse	The visual evoked potential (VEP) findings have been confirmed in several studies and are consistent with the broader indications that PCE causes neurotoxicity, including the studies in the database that identified visual and cognitive deficiencies associated with PCE exposure. As stated in the 2012 IRIS Assessment, visual

	health effects. The draft risk evaluation should discuss the extent to which these differences in VEPs are outside the range of normal variability for humans of that age and gender. • At least one Committee member expressed concern about the clinical relevance of the VEP readout, but other Committee members pointed out that VEP tests are used to diagnose certain diseases, including multiple sclerosis.	system dysfunction and processing of visuospatial information are sensitive endpoints in human studies. EPA has added references to additional human studies that identified prolonged VEPs.
SACC	**SACC COMMENTS:** Recommendation: Describe in greater detail the PCE-induced visuospatial defects in color discrimination used as the chronic endpoint for neurotoxicity. One Committee member stated that the description of the PCE-induced visuospatial deficits in Section 3.2.3.1.2 is misleading and may lead readers to believe that repeated exposure to PCE causes 'color-blindness' or perhaps even more serious vision problems. The draft risk evaluation should describe in more detail the extent of PCE-related deficits in color discrimination. Discussion of the color vision and visual pattern data should describe which tests (*e.g.*, Lanthony's Desaturated 15 Hue Test) were administered, define the magnitude and frequency of observed changes, and explain the severity of the deficit. In the draft risk evaluation, the discussion of the Getz et al. (2012) study on p. 263 (lines 6572-6582) needs to state clearly that Getz et al. (2012) concluded that the result of the contrast sensitivity test was not significant.	EPA has added citations to other studies demonstrating impaired visual contrast sensitivity and color discrimination. These outcomes are discussed in detail in Section 3.2.3.1.2, which includes the results and conclusions of Getz et al., (2012).
SACC	**SACC COMMENTS:** One Committee member recommended that the text should explain that while repeated PCE exposures can elicit subtle changes in color vision, this phenomenon has also been observed with other volatile solvents. Another Committee member did not think that a discussion of other chemicals that can cause subtle changes in color vision was necessary unless it could be shown these solvents share a common mechanism.	EPA agrees that the Risk Evaluation should remain specific to PCE.
SACC	**SACC COMMENTS:** The Committee agreed with the draft risk evaluation that the evidence	EPA presents all key and supporting data in the Risk Evaluation for transparency when

	for PCE-induced neurodegenerative disease is not convincing. The Committee questioned the inclusion of the Bove et al. (2014) and Goldman et al. (2012) studies in the evaluation but was divided on whether descriptions of the two studies should be included in the draft risk evaluation.	integrating the results in the WOE section. This is in agreement with an earlier SACC request to incorporate negative and ambiguous data in addition to positive data.
SACC	**SACC COMMENTS:** One Committee member noted that the draft risk evaluation barely mentions the study in rats by Oshiro et al. (2008) and wondered why it was not discussed in more detail. The Oshiro et al. (2008) investigation is considered a high-quality study that examined inhalation exposure to rats tested for visual signal detection using an operant discrimination procedure.	Oshiro ((2008)) is cited along with other studies that demonstrated neurotoxic effects in rodents. It was considered along with all other relevant studies for contribution to the weight of scientific evidence. However, high-quality human studies were selected for use in dose-response analysis.
SACC	**SACC COMMENTS:** The Committee found Section 3.2.3.1.5 Reproductive/Developmental Toxicity to be superficial and difficult to follow. The draft risk evaluation material is presented in a disorganized fashion and does not demonstrate distillation of the available information. There is inconsistency between the presentation in this section and the corresponding WOE section (3.2.4.1.5) (*e.g.*, evidence for adverse pregnancy outcomes from epidemiological studies is described as "suggestive" in Section 3.2.3.1.5 but "strong" in Section 3.2.4.1.5), and the limited discussion of the evidence does not permit an accurate assessment of this endpoint. Section 3.2.3.1.5 needs to be rewritten incorporating in the WOE discussion the substantial findings from the human epidemiological and animal studies linking PCE exposure with developmental toxicity.	EPA acknowledges this inconsistency. EPA has edited the language in the WOE section (now 3.2.5.1.6) to indicate that epidemiological evidence was consistent in demonstrating adverse pregnancy outcomes.
SACC	**SACC COMMENTS:** One committee member noted that the draft risk evaluation seemed to suggest that PCE-induced reproductive toxicity was not a major concern even though it was carried forward for dose-response analysis.	EPA disagrees with this assertion. As stated in Section 3.2.5.1.6, "based on evidence of both male and female reproductive effects in animals and associations between exposure and female reproductive effects in humans along with indications of developmental effects in both study types, both reproductive and developmental

		toxicity following PCE exposure are supported by the weight of evidence."
SACC	**SACC COMMENTS:** Recommendation: Consider separate reproductive and developmental toxicity discussions based on a clear description of what constitutes adverse reproductive endpoints as contrasted with adverse developmental endpoints. The evaluation did not always make clear what constitutes reproductive versus developmental toxicity. Sometimes the two are lumped together in the evaluation and sometimes they are considered independently.	EPA has split the domains where appropriate throughout the document. They remain combined in the Weight of Evidence section (3.2.5.1.6) because the studies often examined both domains and the conclusions apply to both.
53	**PUBLIC COMMENTS:** The summary of the PCE spontaneous abortion studies in the draft risk evaluation is incomplete and biased and represents an approach that is incompatible with TSCA § 26(h) as added by the Lautenberg Act. The draft risk evaluation states, "The epidemiological evidence for developmental effects associated with PCE exposure is suggestive based on several studies of maternal occupational exposure to PCE that suggest an increased risk of spontaneous abortion at high concentrations ((Olsen et al., 1990; Kyyronen et al., 1989))." EPA fails to mention that other studies reviewed in the 2012 IRIS assessment did not find an association of spontaneous abortion with PCE exposure (*e.g.*, (Ahlborg, 1990; Lindbohm et al., 1990)). • EPA provides no explanation why only two studies were selected for inclusion in the draft risk evaluation, whereas other studies were excluded. Most importantly, EPA has not conducted a systematic review of the literature, nor has it provided any evidence that the information represents the best available science. EPA's arbitrary and capricious approach to inclusion/exclusion of information on the human studies on spontaneous abortion is unacceptable. Absent substantial revision, the risk evaluation will not fulfill the requirements of TSCA regarding use of the best available science and decisions based on the weight of the scientific evidence. • For the animal developmental toxicity studies, a systematic review	EPA has conducted a systematic review of all key and supporting studies considered potentially suitable for dose-response analysis in the 2012 IRIS Assessment (U.S. EPA 2012c) in addition to any newer studies published since then. In order to be concise, EPA avoided citing individual studies from the IRIS assessment in the draft risk evaluation unless they were used for dose-response analysis. For the final risk evaluation EPA has added specific references to all individual studies (as opposed to simply citing the IRIS assessment) discussed in the risk evaluation. These studies were not evaluated for data quality however unless they were considered for dose-response analysis since they only served as supporting information for the referenced IRIS assessment.

	was conducted on only a few studies, and the draft risk evaluation provides no justification as to why these studies were considered more reliable and informative than other studies. These deficiencies need to be corrected in the final risk evaluation	
53	**PUBLIC COMMENTS:** Citing the 2012 IRIS Assessment, the draft risk evaluation states "drinking water studies have suggested associations between PCE exposure and pre-term birth, low birth weight, eye and ear anomalies, and oral cleft defects." Unfortunately, the following analysis of these studies from p. 4-352 of the 2012 IRIS Assessment was omitted: • "However, the number of cases with birth anomalies in specific diagnostic groups was very small, and CIs often included one. In addition, imprecise exposure estimates likely resulted in nondifferential misclassification, biasing risk estimates toward the null. Participants in the studies were exposed to multiple contaminants, and it was not possible to disentangle substance-specific risks." EPA does not acknowledge that Aschengrau et al. (2008) found no meaningful associations between PCE exposure in drinking water and birth weight or gestational duration. The authors found only modest (relative risk [RR] 0.8-1.5) and nonsignificant associations; there was no evidence of a dose-response, and those with high exposure generally had odds ratios (ORs) ≤1.0. EPA has not used the best available science. Furthermore, EPA has not conducted a systematic review of the literature that includes studies published since the 2012 IRIS Assessment to meet the requirement of "weight of the scientific evidence." These deficiencies need to be corrected in the final risk evaluation.	EPA has conducted a systematic review of all key and supporting studies considered potentially suitable for dose-response analysis in the 2012 IRIS Assessment (U.S. EPA 2012c) in addition to any newer studies published since then. In order to be concise, EPA avoided citing individual studies from the IRIS assessment in the draft risk evaluation unless they were used for dose-response analysis. EPA did not locate an Aschengrau et al. (2008) study. For the final risk evaluation, EPA has added specific references to all individual studies discussed in the risk evaluation.
SACC	**SACC COMMENTS:** Recommendation: Revise the immunotoxicity section to discuss findings from Emara et al (2010) and Wang et al (2017) and better justify the dismissal of PCE-induced immunotoxicity as a hazard. The Committee found it difficult to assess the immunological effects of	EPA has expanded the hazard identification and weight of evidence sections to more completely discuss the database related to immunotoxicity. The risk evaluation now includes discussion and

	PCE exposure as described in Section 3.2.3.1.6 (beginning p. 269). • The draft risk evaluation begins by stating that the association between PCE exposure and changes in immune markers is indicated in studies of dry-cleaning workers and in children in Germany but does not provide specifics or cite references. • The two animal immunotoxicity studies cited, Seo et al. (2012) and Boverhov et al. (2013), are said to provide conflicting results, but in fact they examined quite different aspects of the immune system, and their results are not necessarily incompatible. Boverhov et al. (2013) showed a decrease in anti-sheep red blood cell (RBC) plaque-forming cells per spleen in rats, while Seo et al. (2012) showed that mice exposed to PCE had a dose-dependent increase in the passive cutaneous anaphylaxis test for type I hypersensitivity. Conflating these two results underscores the fact that EPA needs to improve its assessment of immunotoxicity. • A Committee member found problematic the dismissal of the Emara et al. (2010) study as off-topic. Emara et al. (2010) correlated blood levels of PCE with increased levels of IgE and increased blood levels of several lymphocytes and serum interleukin 4 (IL-4) in dry-cleaning workers. This study is described in detail in the PCE IRIS Assessment, which concluded that it was the "strongest study examining immunologic and hematologic effects of tetrachloroethylene exposure" in terms of experimental design. It is not apparent why this paper was omitted from the evaluation. • The draft risk evaluation states that there is limited or negative data connecting PCE exposure to asthma or autoimmune diseases in humans. However, the draft risk evaluation does not include (not listed as on-topic or off-topic in the bibliography) the animal study by Wang et al. (2017). Wang et al. (2017) used a mouse model to demonstrate that exposure to PCE in drinking water for 18 weeks accelerated the generation of antinuclear and anti-scleroderma-70 antibodies, as well as increased other markers of inflammation.	evaluation of both Emara et al. (2010) and Wang et al. (2017). EPA has identified Seo et al. (2012) as unacceptable. Therefore, only Boverhof et al. (2013) is discussed in the final risk evaluation. EPA has updated the risk evaluation to include a POD and risk estimates for immune and hematological effects based on the human study Emara et al. (2010). EPA has also discussed autoimmunity, allergy, immunosuppression and other hematological effects separately and has added more information (including the study by Wang et al. (2017)) to Section 3.2.3.1.5, 3.2.4.1.5, and Appendix H.

	In view of the deficiencies described above, it was not clear to the Committee that the dismissal of PCE-induced immunotoxicity as a hazard is warranted.	
26	**PUBLIC COMMENTS:** There are indications in both human and animal studies that PCE has the potential to produce adverse effects on the immune system and various hematological components. As noted in the PCE risk evaluation, however, the data on these endpoints were not adequate for dose-response assessment and were not carried forward for further assessment. As a result, as EPA notes, "There is uncertainty whether the PODs for other endpoints carried forward are sufficiently protective of any potential immune or hematological effects that were not accounted for in this risk evaluation." The consequences of a potential "insufficiency" are that a conclusion of "no unreasonable risk'" could be made with regard to a COU when one actually exists.	EPA modeled and evaluated risks for an immunological endpoint from an epidemiological study (Emara et al., 2010).
53	**PUBLIC COMMENTS:** EPA overlooked a potentially serious methodological flaw in the immune study by Seo et al. (2012) that introduces considerable uncertainty in the interpretation of the study. Based on the physico-chemical properties of PCE and TCE (both were tested in Seo et al., 2012), there will be a high propensity for the chemicals to volatilize into air from water. Thus, it is absolutely necessary that a methodology be developed to minimize volatilization from the drinking water solutions and that analytical measurements be done to confirm whether the target concentrations were met at the beginning as well as at the end of the water bottle exposure period. Seo et al. (2012) state that "[t]he water was changed every other day to ensure dose maintenance;" no analytical data are provided in the publication, however, on whether the target concentrations were achieved, loss of PCE or TCE from the water bottles over the 2-day exposure period, or variability of concentrations over the entire 2-week exposure period. In fact, the study authors do not indicate whether any analytical measurements were conducted or what methods were used, if any, to minimize volatilization loss of either	Seo et al. (2012) was deemed unacceptable, and EPA is not relying on this study for the final risk evaluation.

	chemical. Thus, Seo et al. (2012) cannot be considered sufficiently reliable to be included in the risk evaluation.	
36	**PUBLIC COMMENTS:** New and emerging evidence demonstrates that PCE can act as an endocrine-disrupting chemical (EDC) by impacting gene networks and hormonal pathways. These findings support the determination that PCE poses an unreasonable risk to human health, and we urge EPA to carefully consider effects on endocrine systems during preparation of the final risk assessment for PCE and related chemicals. • A recent study (Alofe, 2019) provided strong evidence that PCE can interact directly with the estrogen receptor and impact estrogen, progesterone, and glucocorticoid signaling pathways. Consistent with principles of endocrinology and the latest science on EDCs, the effects of PCE were seen at very low levels and with the ability to produce additive effects in combination with other chemicals. This study was included as an attachment to the comment. • Furthermore, subsequent studies (Burman, 2020) reinforce the fact that EDCs acting on these pathways can have widespread effects, which can differ depending on the cellular environment and genetic sex. This study was included as an attachment to the comment. There is concern that the draft risk assessment does not properly account for the entire range of health effects that could be caused by PCE due to endocrine disruption. Given new evidence regarding PCE's ability to impact hormonal systems, EPA should pursue a more complete characterization of PCE with careful attention to endpoints that are relevant to endocrine systems and associated diseases.	Endocrine disruption, especially of the estrogen, progesterone, and glucocorticoid signaling pathways, may lead to downstream apical outcomes involving reproductive effects, developmental toxicity, or cancer. EPA thoroughly discusses the evidence for developmental and reproductive toxicity throughout the hazard section and these studies further support EPA's existing conclusions.
Weight of evidence approach and points of departure		
SACC	**SACC COMMENTS:** Recommendation: Improve the discussion of PCE-induced kidney toxicity and better justify why kidney toxicity should not be chosen instead of CNS neurotoxicity as the critical health effect for POD derivation. Although most Committee members agreed that PCE-induced	There is stronger support in both the human and animal database supporting CNS effects compared to kidney effects. Additionally, while kidney effects have a lower POD, when accounting for differences in benchmark MOE, risk estimates for CNS effects were more

	neurotoxicity represented the most robust endpoint, several Committee members thought that PCE-induced kidney toxicity does not receive the attention it deserves in the draft risk evaluation and that the draft risk evaluation should more clearly explain why CNS neurotoxicity was chosen as the critical health effect. • Referring to Table 3-10, one Committee member wondered why neurotoxicity was chosen for POD calculations and risk estimates when kidney effects (specifically nuclear enlargement in proximal tubules) from chronic exposures consistently result in lower estimated human equivalent dose (HED) values than neurotoxicity endpoints. In the risk estimations provided in the tables of Section 4, kidney histopathology consistently provides the lowest MOEs for chronic exposures, and these estimates are usually at least 2-fold lower than those for CNS visual effects. Kidney injury consistently produced lower benchmark MOE values and lower MOE values for both high-end and central tendency exposures.	conservative than for kidney effects. The trend of these parameters provides some evidence of renal damage due to occupational exposure to organic solvents and suggests that the lesions are mild and tubular rather than glomerular.
SACC	**SACC COMMENTS:** Recommendation: Include summaries of studies having negative findings in the WOE discussions. The Committee suggested organizing paragraphs to mention negative, or trending-but-not-significant data, but to include a more robust discussion of positive results and conclude with a summary of the overall WOE.	EPA includes studies with negative and ambiguous findings in addition to positive findings in both Section 3.2.3.1 and Appendices G and H.
SACC	**SACC COMMENTS:** The Committee found the selection of neurotoxicity for the acute toxicity endpoint and the selection of the study used to calculate the POD appropriate.	EPA acknowledges this comment. Despite uncertainties related to POD specificity due to the inability to BMD model the endpoint, EPA believes that the data from (Altmann et al. 1990) best characterizes acute human health hazard. EPA has added discussion to Section 3.2.7.2.
SACC	**SACC COMMENTS:** The Committee considered the approach used in the draft risk evaluation for deriving acute PODs for different exposure durations (based on neurological effects in Altmann et al., 1990) appropriate.	EPA agrees that using Altmann et al. (1990) is appropriate.

	• The draft risk evaluation approach to adjusting results from the Altman et al. (1990) study, which used 4-hour exposures to 8-, 12-, and 24-hour time-periods, is straightforward. The Committee agreed that lack of a control group and use of just two PCE levels in the Altmann et al. (1990) study adds uncertainty to the POD. • One Committee member was concerned that each unexposed group served as its own control, and with this approach, dose effect is confounded with time, and may be confounded with stress on participants that could occur by being placed in the same experimental conditions minus the active treatment. Given the limited dose-response data in the Altman et al. (1990) study, the draft risk evaluation defaulted to the traditional NOAEL/lowest-observed-adverse-effect level (LOAEL) approach to derive the POD. The Committee indicated this is problematic, due to its dependence on doses selected and its sensitivity to sample size. At least one Committee member contended that a single well-conducted animal study with controls and several doses may have been preferable for POD derivation.	
SACC, 53	**SACC COMMENTS:** The draft risk evaluation carries forward for dose-response analysis the endpoint of impaired visual function to represent the neurotoxicity hazard domain based on PODs from two studies, using the midpoint value as the POD. The Committee concluded that this is appropriate.	EPA acknowledges this comment.
	PUBLIC COMMENTS: Altmann et al. (1990) is a poor choice for derivation of the acute toxicity risk value. While the results suggest that exposure to 50 ppm, but not 10 ppm, PCE affects the visual system, there are difficulties when interpreting the data. First, it is unclear why the VEP peak latencies showed an increase (perceived as a deficit) at 50 ppm, but a decrease (perceived as an improvement) at 10 ppm, when compared to pre-exposure values. The reason for this lack of dose-dependency is unknown (a bi-phasic response is certainly possible but needs a biologically sound explanation). Second, the statistical analysis is not	The visual evoked potential (VEP) findings from Altmann et al. 1990 have been confirmed in several studies and are consistent with the broader neurotoxicity database that identified visual and cognitive deficiencies associated with PCE exposure. As stated in the 2012 IRIS Assessment, visual system dysfunction and processing of visuospatial information are sensitive endpoints in human studies. EPA has added references to additional human studies

	described in detail. It is unknown whether the statistical significance indicated by the authors is reliable (*i.e.*, false positive rate) given the large number of multiple comparisons. Finally, the size of the observed effect of PCE exposure on VEP peak latencies is in the range of 1.0-2.5 milliseconds (ms), which is a very small change. Moreover, only 3 of the 6 patterns used to elicit VEPs were affected, the amplitudes of all VEP latencies were not changed, and the brainstem auditory evoked potential (BAEP) was similar in both exposure groups and with the pre-exposure values. In conclusion, the changes in VEP latencies reported by Altmann et al. (1990) from acute to short-term PCE inhalation exposures appear to be highly selective results of questionable toxicological significance.	that identified prolonged VEPs. The NRC review of the 2012 IRIS Assessment noted: "The study by Altmann et al. 1990, who used controlled exposures in an experimental chamber, was chosen because it used random assignment to exposure groups, which reduced the potential for confounding of any associations between exposure and outcomes, and the exposure dosage was known." Therefore, despite the atypical dose-response, this study is still reliable for use in dose-response analysis.
SACC, 53	**SACC COMMENTS:** Recommendation: Discuss the implications on the estimate of the neurotoxicity POD for chronic exposure by using an average of LOAELs. Derivation of a chronic POD for neurotoxicity based on the average of LOAELs from two occupational studies may not take full advantage of the data. The Escheverria et al. (1995) study used an index that combined air monitoring and exhaled breath measurements of PCE concentrations combined with years spent at each job position, aligned with job title. Airborne PCE exposures for the low, moderate, and high groups were <1, 12, and 42 ppm, respectively, while for breathing zones these were 3.4, 6.5, and 11.4 ppm, respectively. These levels showed a clear exposure relationship associated with job tasks. The workers were given standardized psychological neurocognitive tests. Those showing effects were visual reproductions (number correct and reaction time), and pattern recognition (number correct and reaction time). These tests showed dose-dependent patterns, and follow-up comparisons showed that the high exposure groups performed significantly worse than the low exposure group. These data could be used for dose-response determination, although there was no zero-exposure group.	Both of the studies used for deriving a chronic CNS POD (Cavalleri et al., 1994;Echeverria et al., 1995) scored a medium in data quality evaluation, were considered appropriate for consideration as the key chronic studies/endpoints by NRC during peer review of the 2012 IRIS Assessment, and the two PODs represent related endpoints of neurovisual processing and cognition. These effects were also identified in several other studies of medium to high quality, further supporting the selection of a midpoint value as opposed to a POD from any particular study.

	• Whether the low-exposure group is considered a NOAEL or LOAEL, this well-conducted study provided more information than was reflected in the evaluation. **PUBLIC COMMENTS:** EPA's interpretation of Cavalleri et al. (1994) is inaccurate and misleading. While the Cavalleri et al. (1994) study provides qualitative evidence of color vision deficit from PCE exposure, the data are not sufficiently robust for quantitative risk assessment purposes, although there is evidence of a NOAEL at 4.8 ppm. Instead, EPA should rely on the Echeverria et al. (1995) study to derive a POD for the chronic, non-cancer endpoint. • Exposure was significantly associated with color confusion index (CCI) in regression models, but this was driven by exposures above 10-12 ppm (especially two values above 20 ppm), with no evidence of a linear association below 10 ppm. Such findings suggest a threshold at 10-20 ppm (rather than an exposure-response relationship), with no effect from lower exposures. Furthermore, neither duration of exposure nor cumulative exposure (ppm-year) was associated with CCI, suggesting a temporary or at least non-cumulative effect. • In the 2012 IRIS Assessment, EPA concluded that the mean exposure of the ironers cannot be considered a NOAEL. EPA's rationale is severely flawed and is based on an incomplete understanding of the data in Cavalleri et al. (1994). First, EPA's premise for combining the two groups of workers is based on the assumption that there is a positive linear correlation between CCI scores and PCE exposures. However, Cavalleri et al. (1994) pointed out that, "Only 3 environmental values of PCE exceeded 12.5 ppm; excluding these data, the significance of the correlation between exposure and effect disappeared." These "high" exposures are only associated with the workers defined as "dry-cleaners" (0.38-31.19 ppm) and not with the ironers (0.52-11.28 ppm). PCE exposure below 12 ppm (including all ironers) are not significantly correlated with a deficit in color vision	

	(increased CCI scores). This lack of linear correlation is supported by the lack of statistical significance in the comparison of the mean CCI scores between the ironers and the controls. Thus, the mean exposure of 4.8 ppm PCE for the ironers can be considered the NOAEL for the study. • EPA has ignored the task differences between the dry cleaners and ironers in the dry-cleaning facilities of those selected for the study in Cavalleri et al. (1994); these task differences have a significant impact on the estimation of PCE exposures. EPA did not factor task-specific PCE peak exposures as an important consideration of workplace exposures, but it does indeed justify the separation of the two groups of workers in determining a LOAEL/NOAEL for the study, particularly since PCE exposures could be significantly underestimated in the "dry-cleaners" when only the TWA data are considered in the analysis. EPA fails to note that elevated CCI scores are seen in the matched (non PCE-exposed) controls and the statistical analysis used by Cavalleri et al. (1994) showed no significance difference between the mean and SD of CCI values of ironers compared to the non-PCE exposed controls (1.061±0.058 for ironers versus 1.073±0.079 for controls). Thus, EPA cannot properly infer that the elevated CCI scores in the ironers are due to PCE exposure.	
SACC	**SACC COMMENTS:** To determine the chronic neurological endpoint, the draft risk evaluation uses data from two older inhalation studies with relatively high exposure levels to estimate the POD (Cavalleri et al., 1994; Echeverria et al., 1995). • One Committee member suggested discussing Getz et al. (2012), even though it is a mixture of ingestion and inhalation (PCE in drinking water supplied to homes); there was a suggestion that perhaps a pharmacokinetic model could be used to account for different routes of exposure. Past exposure was well-characterized and there is little chance of confounding owing to the nature of exposure.	EPA did not have high confidence in the exposure assessments from the Getz and Roberts studies. Exposure data were not directly tied to the individuals in the study population, and there was a high probability for co-exposure with other chemical pollutants. The exposure assessments in the (Cavalleri et al., 1994) and (Echeverria et al., 1995) studies were considered to be more robust.

	The same Committee member also suggested including the study by Roberts et al. (2013), which uses data from the Nurses' Health Study II cohort combined with ambient air toxics concentrations for exposure measures. These two studies provide an opportunity to notice effects at much lower exposures than in the older studies.	
SACC	**SACC COMMENTS:** One Committee member wondered whether it might be preferable to use animal data for benchmark dose (BMD) modeling than using the human data for derivation of a chronic POD for neurotoxicity.	Both of the studies used for deriving a chronic CNS POD (Cavalleri et al., 1994; Echeverria et al., 1995) were considered appropriate for consideration as the key chronic studies/endpoints by NRC during peer review of the 2012 IRIS Assessment. They are chronic occupational studies with strong exposure assessments and are therefore of the strongest relevance for evaluating chronic occupational risks in this risk evaluation.
SACC	**SACC COMMENTS:** One Committee member indicated that the Nelson et al. (1979) study that generated the neurotoxicity endpoint was rated of low quality. The draft risk evaluation argues that despite this rating, it is considered the most relevant for dose-response analysis based on adequate dose-response information relating to indicators of developmental neurotoxicity. This study identified a HEC of 29 ppm. However, other studies examining endpoints of F2 pup death and decreased fetal weights in rats (sponsored by the HSIA) were used in the draft risk evaluation to derive HECs of 18 and 16 ppm, respectively, for use in POD derivation.	The commenter is incorrect that this study was considered the most relevant for dose-response analysis. While EPA presented the POD from Nelson et al. (1979) in Table 3-8, that POD was not selected for use in for risk estimation of developmental toxicity based on the low data quality score (Section 3.2.5.4). Instead, the POD from Tinston (1994) was used for risk estimation of developmental toxicity.
SACC	**SACC COMMENTS:** One Committee member noted that for reproductive/developmental effects the WOE summary (Section 3.2.4.1.5) was much more detailed, concise, and generally useful as compared to the hazard identification section (3.2.3.1.5). It is not clear why this duplicative and confusing structure is used in the draft risk evaluation.	The WOE section integrates the available positive and negative information from the hazard ID section. It is distinct in its purpose but should be more succinct because it is stating conclusions based on the totality of the hazard information.
SACC	**SACC COMMENTS:**	Kyyronen et al. (1989) and Olsen et al. (1990)

	Recommendation: Better justify the choice of reduced sperm quality as an adverse effect for deriving the reproductive/developmental POD. The reproductive endpoint used for POD derivation is reduced sperm quality from a mouse study by Beliles et al. (1980). It was not clear why a minor effect in mice compared to adverse pregnancy outcomes, including spontaneous abortion, in women was chosen for deriving the POD.	reported significantly increased ORs for spontaneous abortion with high exposure to PCE during the first trimester in nested case-control studies within a cohort of Finnish dry cleaning and laundry workers. The numbers of cases and controls with high PCE exposure were very small, leading to very wide confidence intervals (low statistical precision) for the ORs. While these studies provide evidence for an association between PCE exposure and spontaneous abortion, a POD cannot be determined from these data due to the lack of quantitative exposure characterization. Neither of these studies included PCE air exposure measurements in the facilities where the subjects worked, nor did either study use a job-exposure matrix to assess the magnitude of individual exposures during the pregnancies. This has been added to Section 3.2.5.1.2.
SACC	**SACC COMMENTS:** Recommendation: Revise Section 3.2.3.1.5 to incorporate into the discussion the findings from the epidemiology and animal studies linking PCE exposures with developmental toxicity. Two committee members noted that recent papers looking at the reproductive and developmental effects associated with exposure to PCE-contaminated drinking water in the Cape Cod area (Aschengrau et al., 2018a, 2018b) are not cited in the draft risk evaluation. These studies found that maternal PCE exposure in the drinking water at concentrations >40 ug/L increased the odds of having a child with spina bifida, cleft lip, and hypospadias (Aschengrau et al., 2018a). This group also reported a PCE dose-dependent increase in stillbirths stemming from placental dysfunction (Aschengrau et al., 2018b). • With all of the evidence linking PCE exposure to reproductive	Aschengrau et al. (2018a) and Aschengrau et al. (2018b) were published after the conclusion of EPA's systematic review literature search. The comment is incorrect that the developmental PODs used in the risk evaluation are in the 100s of mg/kg. As shown in Table 3-11, HED values range from 22-50 mg/kg-day and contain an UF_A = 3 in accounting for expected increased toxicodynamic sensitivity in humans compared to rodents.

	failure in humans from these and other studies, it was unclear to the Committee why developmental neurotoxicity, decreased fetal weight, and increased skeletal toxicity in animal studies were used as endpoints in deriving the PODs for developmental toxicity. It is difficult to reconcile the effective PCE exposure levels in the animal studies with those in the Aschengrau studies. This is complicated by the fact that the oral PCE doses in the epidemiological studies should be compared to the inhalation exposure levels (absorbed doses) in the animal studies. • One Committee member noted that developmental toxicity in the animals appeared to require concentrations in the 100s of mg/kg/day level, while the toxicity in the human studies was apparently seen at 1-2 µg/kg/day level. If this relative toxicity is accurate, the draft risk evaluation needs to account for the discrepancy. • One Committee member stated that the draft risk evaluation should recognize that animal studies typically involve high PCE doses compared to human exposure to PCE in contaminated drinking water.	
SACC	**SACC COMMENTS:** The draft risk evaluation reports deriving a POD for decreased fetal and placental weight and skeletal effects based on data reported in the Carney et al. (2006) study. This is inconsistent with the data reported in the paper, which report significant effects on fetal and placental weight at 250 ppm but no significant skeletal effects up to the maximum dose.	Skeletal effects were observed at the highest dose of 600 ppm in the form of decreased ossification. While the HEC was derived from the NOAEC concentration, these skeletal effects are consistent with the observed decreased fetal weight retardation at lower doses and are therefore considered related to the other effects.
SACC	**SACC COMMENTS:** The Committee concluded that it was appropriate to carry forward both kidney and liver toxicity for dose response analysis using the PODs selected.	EPA acknowledges this comment.
SACC	**SACC COMMENTS:** Recommendation: Discuss the importance of 'toxicological significance' as a criterion in the choice of study for POD determination for chronic hepatotoxicity.	Toxicological significance means sufficiently adverse and applicable to human exposure scenarios. EPA considers many factors in selecting PODs including the sensitivity of the

	The Committee felt that the draft risk evaluation needs more discussion on key considerations or criteria used for selection of specific study results for PODs. One Committee member posed the question: Should a study that yields the lowest POD automatically be the first choice, regardless of the toxicological significance of the endpoint?	study, the data quality, relevance to human exposure, and other considerations. EPA does not simply select the lowest possible POD.
SACC	**SACC COMMENTS:** Recommendation: Address the toxicological significance of focal hepatic angiectasis (JISA, 1993) versus hepatic degeneration and necrosis (NTP, 1986b) relative to the choice of study for POD determination for chronic hepatotoxicity. The Committee noted that selection of the JISA (1993) bioassay for derivation of a liver-based POD for chronic scenarios was justified by the high quality of the study. For additional consideration, is increased focal angiectasis of comparable toxicological significance to the increased liver degeneration and necrosis seen in the National Toxicology Program (NTP, 1986b) bioassay?	Angiectasis is a cystic or cavernous widening of the liver sinusoids that can occur in a variety of pathological insults. It can be found in rats or mice after exposure to certain drugs or chemicals and has been associated with a number of diseases in humans as well as administration of anabolic steroids and oral contraceptives. There is no reason to believe that angiectasis observed in rodents would not be of human relevance.
SACC	**SACC COMMENTS:** Recommendations: (1) Expand the discussion of liver toxicity to discuss the findings of Cichocki et al. (2016). (2) Consider modifying the draft risk evaluation to state that humans may develop mild, but reversible, hepatic injury after chronic exposure to high concentrations of PCE. Two Committee members thought the coverage of liver toxicity was underdeveloped. Cichocki et al. (2016) cites 10 studies on the hepatic effects of PCE exposures in occupational settings. One Committee member suggested that it is more accurate to state that humans, like rodents, may develop mild, but reversible, hepatic injury upon chronic exposure to high concentrations of PCE. Humans appear to be less sensitive than rats, as metabolism of PCE to trichloroacetic acid and other oxidative metabolites is less pronounced in humans (*e.g.*, Lash and Parker, 2001a).	EPA includes details on relevant identified epidemiological studies concerning TCE liver toxicity in humans in Section 3.2.3.1.4, and EPA has added references to individual studies that were previously cited only indirectly as part of the IRIS assessment. The epidemiological database reports a mix of positive and null associations abased on hepatic enzyme levels, and Silver et al. (2014) reported a statistically significant decrease in chronic liver disease. Therefore, EPA acknowledges that the human database is limited and weaker than the animal evidence. EPA disagrees however that it is factual that humans only develop mild and reversible injury.
SACC	**SACC COMMENTS:** Some Committee members noted that Mutti et al. (1992) appears to	EPA attempted to BMD model the results from (Cavalleri et al., 1994) and (Echeverria et al.,

	have used a summary exposure measure. If so, the POD is based on limited and possibly imprecise exposure data. There also appeared to be several non-zero exposure levels used in animal studies that examined nephrotoxicity, offering the potential for dose-response modeling. The Committee recommended the draft risk evaluation justify use of NOAELs over performing dose-response modeling and deriving a BMDL (benchmark dose lower bound).	1995) for improved precision in the POD for CNS effects, however BMD modeling was not feasible for either study. Other non-cancer endpoints did not undergo BMD modeling because they were less robust and sensitive than the key CNS endpoints and were included for comparative purposes only across organ systems.
Uncertainty factors, PESS, and human equivalent concentrations		
SACC, 26, 29, 40, 41	**SACC COMMENTS:** Recommendations: (1) Consider a different approach to the assessment of PESS that integrates available data, health factors covered and not covered by the typical UF_H of 10 and estimates of the fraction of the population expected to experience increased susceptibility. (2) Consider quantitatively deriving UF_H values that fully account for variation expected in sensitive subpopulations differences. The major concern of at least three Committee members and a public commenter was that the 10X UF_H for human variability may not be sufficient. This is especially true when multiple susceptibility factors occur in the same PESS. The 10X UF_H may also be insufficient to encompass developmental effects of PCE exposure. There is evidence that certain chemicals such as 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD), lead, and TCE can induce developmental toxicity at levels that do not cause maternal toxicity. If that is the case for PCE, a 10X UF_H may not be sufficient to encompass increased sensitivity due to developmental exposure, as well as all other human intraspecies variabilities that might also increase susceptibility. If the analysis of PCE-induced developmental toxicity results in a lower POD, that could be included in the justification for increasing the 10X UF_H. • The Committee recommends more explicitly accounting for susceptible populations, for example by quantitatively deriving UF_H values that fully account for variation expected in sensitive subpopulations such as cytochrome P450 (CYP) polymorphisms, pregnancy, non-alcoholic fatty liver disease (NAFLD), other liver	EPA acknowledges in Section 4.3.1 that the Risk Evaluation cannot quantitatively account for all possible PESS considerations and that the 10x UF may not cover the entirety of human variability. However, the UF_H was established to account for uncertainty and variability that includes susceptible subpopulations, and research indicates that a factor of 10 (when considering both toxicokinetics and toxicodynamics) is sufficient in most cases (U.S. EPA, 2002). Therefore, EPA expects that the UF_H used in the risk evaluation should account for a significant portion of the intraspecies variability that include susceptible subpopulations applicable to PCE. Furthermore, EPA does not have any reasonably available data that would support increasing the UF beyond the standard 10x as recommended by EPA Guidance. As is now noted in Section 4.3.1, EPA's decision to use the high-end exposure estimates was in part to account for individuals on the high-end of the risk distribution.

	susceptibilities, obesity, alcohol use, and other gender and age differences. First, identify which specific factors are most likely to increase susceptibility. Second, delineate which of those factors are considered as included in the 10X UF_H. Third, attempt to model the range of increased susceptibility that might arise from the factors not covered by the 10X UF_H, and thus develop a larger and more accurate UF_H to account for the variability in the human response. Fourth, if possible, use NHANES or other epidemiological data to estimate the percentage of the population that would be expected to experience that increased susceptibility and would thus be considered PESS (*e.g.*, estimate the proportion of the working population that is obese and has some evidence of liver disease that would make them susceptible). • Susceptibility due to pregnancy should also be explicitly accounted for. While EPA avoids addressing aggregate exposures, a discussion of the impact of such exposure on the PESS UF_H needs to be included. The PESS section should include discussion of those exposure conditions (*e.g.*, magnitude, duration frequency) under which genetic differences in PCE metabolism and disposition are most likely to increases risk, and thus contribute to potentially increase the 10X intraspecies UF. **PUBLIC COMMENTS:** The standard 10X UF for intraspecies variability is not adequately protective of PESS. As in prior evaluations, EPA has attempted to account for the enhanced susceptibility of PESS by applying a default intraspecies uncertainty/variability factor of 10. However, this UF is customarily used by EPA to account for normal expected variations in sensitivity within the healthy population. Thus, EPA guidance provides that "a 10-fold factor may sometimes be too small because of factors that can influence large differences in susceptibility, such as genetic polymorphisms." • In cases where risks are >10 times greater for susceptible subgroups than healthy adults, a larger UF would be warranted. Since EPA has	

	not analyzed how much more susceptible the PESS might be to PCE, it has no basis to conclude that the 10X UF will be adequately protective. Given the requirement in TSCA to make specific determinations of unreasonable risk for PESS, EPA must separately evaluate risks to known PESS or apply an UF that accounts for the specific risks faced by those populations, as opposed to a default value that may leave many PESS under-protected. • To provide adequate protection to PESS, a UF beyond the default intraspecies 10X factor should be applied, as EPA has previously done for other susceptible groups such as infants and children. Determination of an appropriate intra-species UF will require further analysis of the particular susceptibilities of the PESS for PCE, but we recommend applying an additional UF of at least 10X, as Congress mandated for children exposed to pesticides under the Food Quality Protection Act. • Unless EPA can provide empirical evidence that the 10X will be adequate in this instance, it should increase the UF_H, adjust the benchmark MOEs and revise the risk determinations accordingly.	
SACC	**SACC COMMENTS:** Recommendation: Consider reducing the intraspecies UF (UF_H) used in deriving the POD for neurotoxicity from acute PCE exposures from 10 to 3 based on the National Academy of Sciences/Acute Exposure Guideline Level (NAS/AEGL, 2009) analysis. The Committee found the application of a composite (UF) of 10 and resulting MOE to be conservative/protective for a relatively modest, acute reversible CNS adverse effects such as increased latencies for pattern reversal VEPs (Altman et al., 1990). NAS/AEGL (2009) utilized an intraspecies UF_H of 3 for derivation of CNS-based AEGL-l, -2 and -3 values. The UF_H used by NAS was based upon clinical investigations showing limited inter-individual (including pediatric and geriatric populations) differences in sensitivity to inhaled anesthetics.	Considerations for AEGLs are different than considerations for sensitive and specific toxicological outcomes. AEGL guidances are used for emergency responses and are based on overt clinical symptoms, not sensitive and potentially irreversible responses. There is no evidence to suggest that the visual effects observed in (1990) are necessarily reversible and the findings are consistent with results from chronic studies. Therefore, reducing the UF_H for this endpoint is not justified.

52	**PUBLIC COMMENTS:** EPA must adopt a more protective UF_H, such as the one used by the State of California, and we recommend 100 at a minimum based on neurotoxicity effects. As EPA must make specific determinations of unreasonable risk for potentially exposed and susceptible subpopulations, EPA should increase the 10X UF_H when it lacks confidence that the 10X UF_H will assure the absence of risk to these subpopulations and there are data to show that the 10X is insufficient to account for human variability. California EPA (CalEPA) has developed guidance for incorporating differential susceptibilities to carcinogens and non-carcinogens that incorporates recent science on increased susceptibility during the prenatal period and age-related susceptibility for non-mutagenic carcinogenic agents. CalEPA recommends an increase in the default intraspecies UFs for non-carcinogens to 30 and 100 for specific endpoints such as asthma or neurotoxicity. This is particularly relevant to PCE as one of the most sensitive endpoints is neurotoxicity. The benefit of the CalEPA default factor is that it can then be modified upwards or downwards depending on chemical-specific information. Therefore, at a minimum, EPA should adopt CalEPA's age adjustment values and intraspecies UFs for incorporating age/early life susceptibility. CalEPA also developed child-specific risk values for chemicals (*e.g.*, atrazine, lead, nickel, manganese, heptachlor) that specifically address routes of exposure and differences in susceptibility unique to children compared to adults. EPA should review these evaluations and incorporate these values as appropriate.	As noted above, the UF_H was established to account for uncertainty and variability that includes susceptible subpopulations, and research indicates that a factor of 10 is sufficient in most cases (U.S. EPA, 2002). Therefore, EPA expects that the UF_H used in the risk evaluation should account for a significant portion of the intraspecies variability, including susceptible subpopulations applicable to PCE. Furthermore, EPA does not have any reasonably available data that would support increasing the UF beyond 10x.
SACC	**SACC COMMENTS:** Some on the Committee considered that the LOAEC-to-NOAEC UF of 10 used to derive the POD for chronic nephrotoxicity from Mutti et al. (1992) may be too large, given that this study monitored a large number (20) of sensitive indices of glomerular and proximal tubular injury in workers. These indices of renal injury are much more sensitive to PCE alteration than are standard measures of kidney	As stated in (Mutti et al., 1992), "these subtle abnormalities may represent an early stage of clinically silent but potentially progressive renal disease." Further, other epidemiological studies have observed evidence that PCE is a nephrotoxicant in humans, including a study by Calvert et al. (2011) found an increased

	function.	incidence (>2.5-fold) of end-stage renal disease in dry cleaning workers exposed to PCE. Since a NOAEC was not identified in the study by Mutti et al, the EPA retains the full 10x LOAEC-to-NOAEC extrapolation UF.
SACC	**SACC COMMENTS:** Use of an interspecies UF of 3 for potential toxicodynamic differences not accounted for in the HEC calculation is standard EPA policy, although it may not be warranted scientifically for the POD for nephrotoxicity by chronic exposure. Lash et al. (2001b) observed that cultured rat renal cells were more susceptible than human renal cells to injury by S-(1,2-dichlorovinyl)L-cysteine (DCVC). DCVC is a cytotoxic metabolite of TCE, while S-(1,2,2-trichlorovinyl)-L-cysteine (TCVC) is produced from PCE.	While the study by Lash and Parker (2001) observed that cultured rat renal cells were more susceptible than human renal cells to injury by DCVC, as noted above, epidemiological studies have found an increased incidence of renal disease in workers exposed to PCE. Interspecies variability is driven by both toxicokinetic and toxicodynamic factors. For the toxicodynamic factors, EPA has not identified data that allow for the determination of a quantitative difference in human and rodent susceptibility to DCVC or TCVC that would support the reduction of the TK component of the interspecies UF. It should be noted that a study by Birner et al. (1997) showed that TCVC is more nephrotoxic than DCVC when equimolar doses were compared. Further, as discussed in Cichocki et al. (2016), there is a lot of uncertainty for the contribution of the glutathione conjugation pathway to PCE metabolism, in part, due to the potential for the reactive metabolites of PCE to bind to cellular macromolecules. A study by Luo et al. (2018) found that, following equimolar treatment with TCE or PCE, the metabolic flux through the glutathione conjugation pathway in mice was 21-fold higher for PCE than for TCE, indicating that the glutathione conjugation pathway may be responsible for a greater proportion of

		metabolism for PCE compared to TCE. Overall, EPA has determined that it does not have sufficient information to support the reduction of the interspecies UF and has decided to retain the full 10x.
26, 29, 40	**PUBLIC COMMENTS:** **Use a UF of 3x** • Incorporate an additional UF of 3X for data deficiencies (UF_D) into each chronic benchmark MOE relevant for all of the non-cancer endpoints used in risk estimation and determination (*e.g.*, from 100 to 300 for CNS effects, from 30 to 100 for kidney effects, etc.) in order to account for inadequate data on the potential for PCE to cause adverse effects on the immune system and hematological parameters. If time permits, use enhanced testing authority to solicit additional observations in human cohorts and/or non-human studies to answer the outstanding questions, using standardized or tailored study designs. If the results of the new studies show that the PODs for other endpoints are sufficiently protective of any potential immune or hematological effects, then reduce the benchmark MOEs accordingly. **Use a UF of 10x** Consistent with IRIS, EPA must apply an additional 10X UF for database deficiencies. • EPA guidance calls for application of a UF where the absence of adequate data creates uncertainty in determining a chemical's health effects. • None of the 10 initial TSCA risk evaluations have applied a UF for database deficiencies, although it is standard practice in IRIS assessments and EPA guidance calling for this UF is agency-wide in application. The decision of the TSCA program to deviate from	There is no universal list of hazard data required when evaluating chemical risks under TSCA. Furthermore, for PCE, EPA has sufficient, reasonably available hazard information to conduct a risk evaluation and support the use of the chosen hazard endpoints. Therefore, EPA did not use a database UF in the PCE risk evaluation. EPA has expanded the hazard identification and weight of evidence sections to more completely discuss the database related to immunotoxicity. The risk evaluation now includes has both discussion and evaluation of both Emara et al. (2010) and Wang et al. (2017). EPA has also updated the risk evaluation to include a POD and risk estimates for immune and hematological effects based on the human study Emara et al. (2010). EPA also reconsidered the immunotoxicity database and selected a POD for immunotoxicity. Therefore, EPA has determined data are adequate to assess this endpoint.

	EPA guidance has never been explained or justified and is particularly troubling since at the same time, EPA has failed to use its streamlined testing authority under amended TSCA to fill data gaps for PCE and other risk evaluation chemicals. • EPA has consistently recognized that, despite data demonstrating adverse effects for several endpoints, critical gaps exist in understanding of PCE's human health effects. These data-gaps are called out in the 2012 IRIS assessment and TSCA risk evaluation, but the latter fails to recognize the implications of these uncertainties for EPA's determinations of risk and to include a UF to account for them. • The draft risk evaluation for PCE acknowledges "there is uncertainty whether the PODs for other endpoints carried forward are sufficiently protective of any potential immune or hematological effects that were not accounted for in this risk evaluation." However, to minimize this concern, "EPA assumes that these effects are likely to occur at a higher dose than more sensitive endpoints that were accounted for by risk estimates." This assumption is pure guesswork. EPA cannot assess the levels at which PCE is immunotoxic without adequate data. It is noteworthy that the recent draft evaluation on TCE, which is from the same chemical family as PCE and has common metabolites, identified immunotoxicity as one of two highly sensitive endpoints. As a result of the acknowledged data gaps for PCE, IRIS applied a database UF of 10. Because, contrary to IRIS and EPA guidance, the draft TSCA evaluation applies, no UF for these uncertainties, the IRIS RfCs are an order of magnitude lower than the corresponding PODs used in the evaluation to calculate MOEs. This difference has important implications for risk calculations (resulting in benchmark MOEs significantly higher than those in the draft evaluation).	

Application of the PBPK Model		
SACC	**SACC COMMENTS:** Recommendation: Use the PBPK model to simulate the effects of factors that may determine susceptible populations. The draft risk evaluation mentions uncertainties about susceptible populations, but no uncertainty or sensitivity assessments are found for these populations. To better understand the risk of these populations, EPA should run the PBPK model based on preexisting conditions such as pregnancy, genetic polymorphism, obesity, and kidney and liver disease. The factors that may determine susceptible populations should be varied in the PBPK model runs including, but not limited to: (1) altered breathing rate and/or pulmonary tidal volume due to exercise or pre-existing lung disease; (2) altered physiology due to age, sex, or physiological states (*e.g.*, pregnancy); pre-existing disease, such as diabetes, liver, or kidney disease; and (3) genetic polymorphisms, such as those known for CYPs and glutathione S-transferases (GSTs), which are important in PCE metabolism.	The PBPK model did not account for intraspecies human variability; only animal-to-human variability. Therefore, the PBPK model could not be used to model physiological variation, the impact of pre-existing diseases, or genetic polymorphisms. EPA has added a paragraph to Section 4.3.1 acknowledging PESS considerations that could not be directly accounted for in risk estimations.
SACC	**SACC COMMENTS:** Recommendation: Add a description of how the PBPK model is applied to the non-cancer endpoints using a diagram similar to Figure 3-1, the narrative provided for the cancer analyses, and the approach used in the PCE IRIS assessment. Recommendation: Expand the description and discussion of the PBPK model of Chiu and Ginsberg (2011a) to include the basic model structure and a table with key input parameters and their sources. The Committee agreed that the discussion of PBPK modeling of PCE needs to be expanded considerably. It would be desirable for readers to understand what a PBPK model is and how it can be used to reduce uncertainty in risk assessments, by relating external chemical exposures to internal (blood and target tissue) doses/concentrations, and in turn to the extent of adverse health effect. The basic model structure of Chiu and Ginsberg (2011a) should be described/depicted.	EPA has added Figure 3-2 to Section 3.2.2.2 which presents the PBPK model structure from Chiu and Ginsberg (2011). In addition, EPA included additional discussion of the model in Section 3.2.2.2 and provided the input parameters in Appendix I.

	A table of key physiological and biochemical input parameters should be included, and sources of these parameters should be cited, allowing reviewers to assess the accuracy and currency of values used. It would be informative to describe the utility of the model of Chiu and Ginsberg (2011a) in the route-to-route and interspecies extrapolations conducted in the draft risk assessment. A clear explanation should be given of how the PBPK model was used to make scientifically-based predictions of HECs from rodent oral or inhalation data.	
SACC, 49	**SACC COMMENTS:** Recommendations: (1) Display the PBPK model code (written in acslX, which is no longer available or supported) as R or Berkeley Madonna code to facilitate replication of results. (2) Better organize the PBPK code into a model, baseline parameter, and scenario files; provide specific instructions on running scenarios and interpreting output; and then combine all of this into a compressed file for easy distribution. With the model code in usable format and access to baseline parameter and scenario files, it would have been possible to address several issues unanswered in the evaluation relating to exactly how the model was used in developing the PODs. • Specifically, for each animal study: (1) What was the duration of exposure for the lifetime animal models in mice and rats? Two years, 2.5 years, 18 months, or others? (2) What exactly was the exposure window? For human exposure scenarios related to each COU, what is the duration of the lifetime human PBPK model? 70 years? 80 years? Other? From when to when? Are potential gender differences considered in the PBPK simulations? This information is important to understand whether the proper dose metrics were used and calculated correctly. **PUBLIC COMMENTS:** A co-author of the (PBPK) model published in Chiu and Ginsberg (2011) provided an attached "zip" file with all model files needed to	A public comment (see #49 below) provided the files for the PBPK model. EPA has added the hyperlink for this comment containing the file to the existing HERO reference for the PBPK model code.

	reproduce the results, as well as the original results files in order to provide some additional information/clarification that may be useful to the SACC and to EPA. It includes a RTF document "SimulationFilesDirectory" that details what each of the files is. This set of files has been previously made available to the Office of Environmental Health Hazard Assessment at California EPA (CalEPA/OEHHA) in 2015. Dr. Kenneth Kloc at CalEPA, also conducted additional investigations using this model code. Responses to several comments that the submitter read news reports are provided as PUBLIC COMMENT responses to the appropriate SACC comments above. The commenters research has focused on the GSH conjugation pathway, which was identified as the area of greatest uncertainty. He noted that other than the data that he and his colleagues published in mice, to the best of his knowledge, no "new" toxicokinetic data on PCE is available. Thus, although the updated PBPK models in mice may be useful for risk assessment, without additional toxicokinetic data, it is unlikely that any new analysis for rats and humans will substantially differ from the results for those species published in Chiu and Ginsberg (2011).	
SACC	**SACC COMMENTS:** Recommendation: Provide more detailed summaries of inputs to, and results from, the PBPK model used to analyze exposure scenarios that eventually derive the POD for neurotoxicity from acute exposures. The approach described in the draft risk evaluation for deriving HECs for each exposure scenario is not clear. The draft risk evaluation mentions that all chronic PODs were derived as 24-hour HEC values from results of animal studies adjusted for continuous exposure based on output from the PBPK, as presented in U.S. EPA (2012e) and Chiu and Ginsberg (2011a). • U.S. EPA (2012e) has more than 1000 pages, making it difficult to find the PBPK results that specifically supported this decision. It would be helpful to state clearly how results from animal studies	EPA has added Appendix I which describes all PBPK model input parameters.

	were adjusted for continuous exposure based on output from the PBPK model. In addition, more description, especially of input values, is needed to explain how exposure scenarios used the PBPK model to extrapolate the animal data to humans.	
SACC	**SACC COMMENTS:** Recommendations: (1) For each key animal study, list values and cite sources for the parameter values input to the PBPK model to estimate/ simulate the target internal dose. (2) List values and cite sources for the parameter values input to the PBPK model for each run used to estimate the human equivalent exposure needed to produce the target internal dose for a COU scenario.	EPA has added dose metrics selected for each non-cancer effect in Sections 3.2.5.3.1-3.2.5.3.2.
SACC	**SACC COMMENTS:** Recommendation: Identify the dose metric used to estimate internal dose for each outcome. The selection of dose metrics in the evaluation was considered appropriate and further justified in the publication by the work of Chiu and Ginsberg (2011a). However, it was not clear to reviewers why different dose metrics are discussed in different places in the draft risk evaluation. • In Section 3.2.2.2 of the evaluation, the dose metrics reported are: (1) daily AUC of PCE in blood, (2) fraction of PCE intake metabolized by oxidation, (3) fraction of PCE intake metabolized by GSH conjugation, and (4) equivalent daily production of TCA per kg body weight. • In Section 3.2.5.3.2, p. 304, Figure 3-2 of the evaluation, the dose metrics reported are: (1) AUC of PCE in blood; (2) rate of liver metabolism; (3) rate of kidney GSH conjugation; and (4) AUC of TCA in blood. • In Appendix E of the evaluation, for the benchmark dose-response analysis, the TCA AUC liver dose metric is used as described in Section 3.2.5.3.2. • In the paper by Chiu and Ginsberg (2011a), it is clearly mentioned that "TCA produced in the kidney and excreted directly to urine is	The two sets of dose metrics are in fact the same but were simply labeled slightly differently. EPA acknowledges the uncertainty of the dose-metric and has added language to Section 3.2.5.3.3 discussing why GSH conjugation was not selected as the primary metric for dose-response analysis. It remains as an alternative metric however because GSH metabolism is believed to be involved in kidney carcinogenesis.

	not included, since it does not reach any target organ (*i.e.*, the liver) or enter systemic circulation." It is not clear why in Figure 3-2 the rate of kidney GSH conjugation is used as a dose metric. The draft risk evaluation acknowledges that the fraction of PCE intake metabolized by GSH conjugation is of high uncertainty. It is not always clear from the draft risk evaluation text which dose metric is used for which situation.	
SACC, 46	**SACC COMMENTS:** The draft risk evaluation accounts for an anticipated higher breathing rate in some workers, based on data from an epidemiological study of dry cleaning and laundry workers, by making upward adjustments in HECs (UF_H = 10X). Based on all of the standard criteria for determining UF_H, this increase in breathing rate did not influence those values. Alterations in human physiology such as breathing rate should be expected to influence exposure. Such alterations could be incorporated into the PBPK model to test the influence on predicted exposure. **PUBLIC COMMENTS:** EPA calculates PCE's risks using a PBPK model. However, the full inputs to this model are not identified in the draft risk evaluation or the accompanying supplemental files, preventing anyone without access to the underlying modeling software from reviewing them. • EPA states that it "expects that variability in human physiological factors (*e.g.*, breathing rate, body weight, tidal volume) which may affect internal delivered concentration or dose is sufficiently accounted for through the use of a 10X UF_H, although some differences among lifestages or between working and at-rest individuals may not have been accounted for." EPA does not state the basis of this expectation or identify precisely which "differences . . . between working and at-rest individuals" are not accounted for. • EPA's PBPK model further neglects to consider the fetal	The PBPK model did not account for intraspecies human variation, only animal-to-human variation. Therefore, the PBPK model could not be used to model physiological variation and data from an epidemiological study was used instead. It is correct that the use of an occupational HEC did not affect UF determinations because it did not address variability or uncertainty across the population. Full input parameters are now provided in Appendix I. The occupational PODs are based on occupational epidemiological data which therefore incorporate actual long-term breathing rates from workers over a chronic duration. As mentioned above, the PBPK model is unable to quantitatively assess human variability and does not contain a fetal compartment. As stated in Section 4.3.1, a "10x UF for human population uncertainty/variability was applied to account for interindividual variability, but whether this factor sufficiently accounts for differences in susceptibility represents a source of uncertainty."

	compartment, leading to inadequate risk estimations for pregnant workers and their developing fetuses. • If EPA fails to account for differences in breathing rates between workers and the general public and neglects to adequately model exposure for pregnant workers, these are major omissions with the potential to significantly understate occupational risks. Workers who are engaged in manufacturing, cleaning, degreasing, and other physically demanding activities will typically have higher breathing rates than at-rest individuals, and thus greater exposures to inhalable contaminants such as PCE. EPA must clarify the breathing rates used in its PCE draft risk evaluation, and, if at-rest rates were used for occupational exposure analysis, must instead use work-based physiology from actual job profiles. Pregnant workers are faced with additional physiological burdens, including elevated cardiac output, heart rate, oxygen consumption, and total air moved in and out of the lungs, all of which can increase PCE exposure to the developing fetus. To adequately assess risk to the developing fetus, EPA must take these factors into account and employ PBPK models that reflect exposure burden in the fetal compartment.	
SACC	**SACC COMMENTS:** Recommendation: A PBPK model based on the human concentrations found at 8 or 12 hours after exposure to PCE should be run for risk estimation for the various OES. Because occupational users are exposed to PCE for 8 or perhaps 12 hours/day, it would be reasonable to run the PBPK model based on the human concentrations found at 8 and 12 hours after exposure to PCE for risk estimation.	EPA already presented occupational PODs for the chronic CNS endpoints based on 8 or 12hr exposure duration. These PODs are presented in Table 3-9. MOEs based on these values were included in an appendix, however for the final risk evaluation they have been incorporated into the primary occupational risk estimate tables in Section 4.
SACC	**SACC COMMENTS:** The draft risk evaluation assumes that inhalation of equivalent air concentrations of PCE by rodents and humans leads to equivalent internal doses, after accounting simply for body weight scaling. The Committee concluded that this assumption needs reassessment.	EPA has included attribution to Chiu and Ginsberg (2011) for the conclusions in Section 3.2.2.2. EPA utilized the PBPK model to derive Human Equivalent Concentrations (HECs) based on air concentrations from animal studies. It is

	• Rodents would be expected to receive significantly higher internal doses of PCE and other VOCs than humans during inhalation exposures (NAS, 2009). The PCE blood:air partition coefficient for the rat is significantly higher than for humans (Gargas et al., 1989). Resting alveolar ventilation rates for rats and mice are as much as 11 and 23 times higher, respectively, than that of humans (Brown et al., 1997). Cardiac outputs/pulmonary blood flows of mice and rats are about 8 and 10 times greater those in humans. The more rapid PCE metabolism in rodents acts as a 'sink' to enhance systemic uptake. Sensitivity analysis showed that blood:air partition coefficient, cardiac output, and alveolar ventilation rate have the greatest impact on predictions of PCE kinetics by the PBPK model of Chiu and Ginsberg (2011a). Conclusions stated in the last paragraph of Section 3.2.2.2 (p. 261, lines 6483-6489) should be attributed to these researchers.	incorrect to suggest that EPA assumed equivalent internal concentration. EPA has added a table containing the PBPK model input parameters to Appendix I, including citations for each of the parameters. EPA has included attribution to Chiu and Ginsberg (2011) in Section 3.2.2.2.
SACC, 49	**SACC COMMENTS:** One Committee member commented on the Markov Chain Monte Carlo (MCMC) analysis reported by Chiu and Ginsberg (2011a). The model code shows placeholders for the mean and variance inputs for these hyper-distributions but not the actual values. • A standard approach to ensure everything is 'working properly' with MCMC is to run multiple chains (*i.e.*, run the MCMC using different starting values). If the algorithms are converging (finding the correct part of the parameter space) and mixing well (moving efficiently through the parameter space), all of the chains should eventually be exploring the same parameter values. The Committee members could surmise that this was not what occurred with this model. Chiu and Ginsberg (2011a) attribute the chains not coming together to the latter two issues but failed to verify this. For the multiple mode case, alternative fitting algorithms using, for example, simulated annealing as mentioned in the paper, should have been implemented but were not. As a result, some of the inference seemed based on non-converged chains. In these situations, the authors	The Chiu and Ginsberg (2011) analysis was never meant to be a full Bayesian analysis, because Markov chain Monte Carlo (MCMC) was being used in this case as a stochastic optimization algorithm in a maximum likelihood estimation (MLE) context. The use of MCMC for MLE applications, while not common, is long-established to be valid. Chiu and Ginsberg (2011) used the standard practice in applying optimization algorithms of using different starting points to assess optimization to a global rather than a local maximum. The original Chiu and Ginsberg (2011) publication was hesitant to declare the single maxima with the highest likelihood to be the overall global maximum, and thus retained the multiple "chain-specific modes" as a measure of the uncertainty in the results. Moreover, Chiu and Ginsberg (2011)

	attempted to compute posterior modes by picking the parameter values with the highest likelihood in the chain. These estimates can be quite far from the true posterior modes, hence the final parameter values used to compute the dose metric area under the curve (AUC) were not necessarily good estimates of their values of the true posterior mode. • Inference based on non-converged chains is statistically unsupported and left some Committee members uncertain of and quite concerned about the quality of the final AUC estimates. Given this uncertainty, the Committee recommended that running the standard (deterministic) model with best available and documented estimates of input parameters accompanied by a summary of the results of a sensitivity analysis would have produced results better understood by reviewers and with acceptable confidence in the results. Recommendation: Consider re-running the PBPK model scenarios using the best available input values. While Committee members agreed that successfully performing a Bayesian uncertainty analysis would provide very important insights into the PCE risk assessment, it is unclear if this analysis is feasible given convergence problems with the Chiu and Ginsberg (2011a) model, a result of which is that the final parameter values used to compute the dose metric AUC were not necessarily good estimates of their true values. **PUBLIC COMMENTS:** Regarding the comment "The analysis in terms of the model is just not correct. It did not converge… My guess is the model is so complicated with all these identified issues to get it to converge properly you would have to write very specialized code to do it…" • Figure 11 in Chiu and Ginsberg shows that there is relatively little uncertainty in model predictions for PCE and oxidation/TCA; the greatest uncertainty is related to GSH conjugation. Given the very low variation across chain-specific modes for PCE and	emphasized that this was not a full Bayesian analysis, and was meant as an intermediate approach that was considered better than the use of traditional optimization routines, which have difficulty with more than a few parameters being optimized simultaneously, and which are no better at evaluating global versus local maxima. The analysis already conforms to the Committee's recommendation of "running the standard (deterministic) model with best available and documented estimates of input parameters," where the "best available" input parameters are those with the highest overall likelihood after optimization. As a check, EPA reran multiple chains of the original human model for up to 80,000 iterations (as opposed to the 5000 per chain in Chiu and Ginsberg (2011), and found that the resulting overall MLE parameters differed by 0.7%-28% and the dose metric predictions differed by 0%-3.9%, as compared to those obtained by Chiu and Ginsberg (2011). Therefore, despite a lack of a Bayesian analysis, the model predictions for resulting dose metric outputs have low uncertainty and EPA has confidence in the results.

	oxidation/TCA, I believe it is justified to conclude that these predictions of the model "converged." GSH conjugation, on the other hand, has very high uncertainty primarily due to lack of data, and additional analysis without additional data is unlikely to be of value. However, rather than lack of "convergence," I would suggest that this simply reflects high uncertainty. Indeed, the EPA 2012 IRIS assessment explicitly declined to use the PBPK model-based GSH conjugation predictions in its dose-response assessment due to this high uncertainty. • Regarding the comment "I think I would recommend in the short term, they do more of a deterministic model, discuss the fit and then do some limited sensitivity and then global model uncertainty," the Chiu and Ginsberg (2011) model itself is essentially a deterministic model; we used the overall posterior mode parameter estimates as the "primary" value and assessed uncertainty by running different chains and looking at the variation in posterior modes. This is akin to running a traditional least squares or maximum likelihood-based regression and using the best fit value and assessing the robustness of the best fit by running these algorithms with different starting points. Additionally, extensive comparisons of the model fits with data are shown in supplementary materials available with the article. Furthermore, the model fits are quite good, and the uncertainties are quite modest. With the model code provided, additional analysis could be done, but particularly for PCE and oxidation/TCA pathway, I would suggest that they would be of limited added value compared to the analyses already conducted by Chiu and Ginsberg (2011). • As discussed in Chiu and Ginsberg (2011), it was judged that without additional data, fully Bayesian analyses would be uninformative with respect to refining estimates of GSH conjugation. To that end, my research group and colleagues have recently published updated PCE PBPK models for mice that incorporate additional data on GSH conjugation. These are fully	

	Bayesian, population-based analyses. However, they are only available for mice, because that is the only species where new data on GSH conjugation are available. Moreover, in the Dalaijamts et al. (2018) paper [see Figures 6-8], we compared our full Bayesian results with those of Chiu and Ginsberg (2011) and found highly consistent results.	
SACC	**SACC COMMENTS:** Recommendation: Consider using Bayesian model averaging (BMA) to estimate the BMD for hepatocellular tumors. EPA used a multi-stage model to derive a BMD for hepatocellular tumors. This is a reasonable choice since it is the default mechanistic model for carcinogens. In recent years, EPA has considered alternatives to using the best fitting multi-stage model. For example, in the TSCA assessment of 1-BP, several dose-response models were fit and then BMA was used to obtain a BMD estimate that was averaged across models. The justification given for using this approach is that it provides the best fit to the observable data and then use the default linear extrapolation approach for the low doses. The BMA approach handles model uncertainty better than fitting separate models and comparing fit. • Some discussion of why EPA decided to restrict their attention to the multi-stage model instead of considering BMA seems in order.	The 2012 IRIS Assessment (U.S. EPA 2012c) assessed alternative models to the standard multistage model for dose-response analysis of hepatocellular tumors. As stated in Section 3.2.5.3.3, a sensitivity analysis using these alternative models did not produce any better results, so the original results from the multistage model were retained.
Dermal human equivalent dose derivation		
SACC	**SACC COMMENTS:** Recommendations: (1) Clarify how oral-to-dermal PODs are developed and illustrate with an example. (2) Harmonize how the methodology for deriving dermal PODs is presented in the PCE and TCE draft risk evaluations. The methodology described in the draft risk evaluation for deriving dermal PODs by extrapolation from inhalation PODs is transparent and clear; the equations on how to convert inhalation PODs to dermal PODs for non-cancer and cancer effects, respectively, are provided and explained and some Committee members were able to replicate those	The SACC's understanding is accurate for non-cancer endpoints. For cancer, a higher IUR or slope factor is more conservative, in contrast with a noncancer POD where a smaller value is more conservative. EPA has clarified language in Section 3.2.5.4.1 describing the process for route-to-route extrapolation. In summary, the PBPK model does not contain a dermal compartment. Therefore, dermal HED values were obtained either from the inhalation HEC by calculating

	calculations. However, the methodology for deriving dermal PODs by extrapolation from oral PODs was not clear. It is stated (p. 312, line 8102) that "the oral HEDs were used directly for dermal exposures." However, the oral PODs and oral HEDs are not presented and explained in this document and it is unclear how the extrapolation from oral PODs to dermal PODs was performed.	dose using standard physiological parameters or by using the oral HED directly and adjusting absorption in the exposure estimates. EPA has clarified this in Table 3-11 by indicating that the values shown are equivalent as oral and dermal HEDs.
SACC	**SACC COMMENTS:** Recommendations: (1) Clarify how the most robust and sensitive study was selected for use in risk estimation. (2) Justify the selection of the dermal POD values displayed and bolded in Table 3-10 that are used to estimate dermal risk. The draft risk evaluation states (p. 313, line 8127) that the "most robust and sensitive [study] was selected for use in risk estimation." According to Table 3-10, when both oral- and inhalation-derived values are available, the smallest POD is usually chosen. This choice makes sense from a precautionary principle standpoint, but at the same time is not ultra-conservative given that these estimates never differ by more than a factor of 2. The only exception to this practice is for the cancer dermal POD. The hepatocellular tumor POD derived from oral exposure is used even though it is twice the value of the inhalation-derived POD. This is perhaps where the "robust" criterion comes into play, but it is not clear what makes this value more robust.	The commenter is correct that when all considerations of data quality, relevance, and sensitivity have been taken into account, EPA selected the most conservative POD among the available options for risk estimation. For non-cancer effects, a lower POD indicates a more toxic effect and therefore using that POD is protective of a lower exposure. For cancer however, PODs are in terms of extra risk, and therefore a higher value is more protective. Thus, EPA was consistent in applying the more conservative POD across both non-cancer and cancer among robust, high reliability studies and endpoints.
SACC	**SACC COMMENTS:** Recommendations: (1) Oral and inhalation exposures are not equivalent and their use in route-to-dermal extrapolation, even performed using a properly calibrated PBPK model, involves additional uncertainties that should be recognized and discussed in the draft risk evaluation. (2) Provide additional justification for the selection of dermal POD values, explicitly discuss uncertainties of conducting route-to-route extrapolation for all pathways and give greater weight to studies where exposure pathways are identical. It is important to highlight the inherent uncertainty associated with route-to-route extrapolation even when applying the PBPK model	EPA has revised section 3.2.5.4.2 to indicate that there are additional uncertainties in these extrapolations. The discussion explicitly states that, due to these uncertainties, EPA selected the most robust and sensitive POD for use in dermal risk estimations.

	outputs and to preferentially use toxicity data from similar routes of exposure to avoid these uncertainties.	
ADME, Toxicokinetics, and Mode of Action		
SACC	**SACC COMMENTS:** Recommendation: Expand the discussion of PCE ADME and appropriately cite studies informing ADME. Description of the absorption, distribution, and metabolism of PCE should be expanded considerably and referenced to include citation of the primary studies. The Committee recommended EPA utilize referenced empirical data where possible (*e.g.*, absorption and distribution data from Dallas et al., 1994a, 1994b), rather than unreferenced assumptions, such as 100% absorption of inhaled PCE vapor.	The text in Section 3.2.2.1.1 has been edited to read accordingly: "A number of studies have evaluated blood:gas partition coefficients and PCE uptake following inhalation exposures ((Dallas et al., 1994b; Dallas et al., 1994a; Opdam and Smolders, 1986; Monster et al., 1979; Pegg et al., 1979) and others). These data were incorporated into the PBPK model to account for any differences in the relative inhalation absorption for humans and rats. However, since the PBPK model does not include a dermal component, the external inhalation exposure concentrations had to be used to derive dermal PODs, and for this purpose EPA conservatively assumed 100% absorption through the lungs (assuming continuous exposure)."
SACC	**SACC COMMENTS:** Recommendation: Include a diagram of PCE's oxidative and glutathione (GSH) conjugation pathways. A diagram with PCE's oxidative and GSH conjugation pathways should be incorporated into the paragraphs on metabolism. The recent review by Cichocki et al. (2016) on the role of metabolism in cytotoxicity and carcinogenicity of PCE should be abstracted and cited here.	EPA has now included Figure 3-2 which is a diagram of PCE's metabolic pathways.
SACC	**SACC COMMENTS:** Recommendation: Discuss the role of CYP2E1 versus other CYPs in PCE oxidation and liver toxicity. Although the metabolism of TCE and a variety of other volatile organic compounds (VOCs) is mediated primarily by CYP2E1, other CYPs play a role in PCE oxidation (see studies by Hanioka et al., 1995; White et al., 2001a, 2001b; Phillip et al., 2007; Luo et al., 2018). Data on the	The RE includes information on the role of CYPs in PCE metabolism. Of note, the RE states that while "there are too few studies on the relative roles of the CYP isoforms and the chemical-specific data are sparse, CYP2E1 is presumed to have an important role in tetrachloroethylene metabolism."

	identity and role of CYPs responsible for PCE oxidation, however, are more limited than for TCE and many other VOCs (Cichocki et al., 2016).	
SACC	**SACC COMMENTS:** Recommendation: Describe interspecies differences in bioactivation and metabolic clearance of PCE and how these lead to species differences in major adverse effects due to PCE exposure. • Interspecies differences in the formation and disposition of oxidative and GSH metabolites should be discussed, focusing on key metabolites associated with principal adverse effects. • It is related in lines 6432-39 that metabolism of PCE is faster in rats than humans, but that the half-life of PCE metabolites is significantly longer in humans. This gives the reader the impression that one species difference cancels the other, resulting in little apparent difference in susceptibility to PCE cytotoxicity. Interspecies studies demonstrate that this is not the case (*e.g.*, Völkel et al., 1998; Pahler et al., 1998).	EPA has included information on interspecies differences in metabolism of PCE in Section 3.2.2.1.3, including discussion of both oxidative and conjugative metabolism pathways. In this section EPA also acknowledges species-specific differences in renal carcinogenicity based on varied GSH-pathway enzyme activity.
SACC	**SACC COMMENTS:** Recommendations: (1) Describe the scientific basis for intraspecies differences in susceptibility to PCE's primary adverse effects. (2) Discuss the potential sensitivities of children, the elderly, obese individuals, and pregnant women to PCE. (3) Discuss how polymorphisms, lifestyle, and disease interact with PCE and how these factors influence the selection of appropriate UFs. Intraspecies, or inter-individual, differences in PCE metabolism and toxicokinetics need to be addressed. Such differences can contribute to carcinogenesis and other adverse effects in PESS. The Committee expressed concern that infants and children, the elderly, obese individuals, and women (especially during pregnancy) may be more sensitive to some of PCE's biological actions (NAS, 2009). Polymorphisms and lifestyle factors such as diet, exercise, alcohol, medication use, and tobacco use can influence the toxic potential of PCE by altering PCE's uptake, disposition, and/or metabolism (NRC,	These factors are all addressed in the human health hazard PESS section, 3.2.5.2. As discussed by the SACC in other comments and stated by EPA in the risk evaluation, the PCE PBPK model did not incorporate Bayesian analysis of human toxicokinetic variability and cannot be used for capturing human variability. EPA retains a full 10x UF_H in order to account for this variability.

	2009a, 2009b). Hepatic cirrhosis, chronic kidney disease, diabetes, and obesity are prevalent conditions that may significantly impact the deposition, metabolism, and elimination of PCE and its metabolites. Animal data and PBPK modeling can provide relevant information. • Nonalcoholic fatty liver caused by a high fat diet is reported to produce a 6-fold increase in PCE deposition in the liver of PCE-dosed mice, as well as a significant increase in trichloroacetate (TCA) levels (Cichocki et al., 2017a). These changes are attributed to an increased PCE liver:blood PC and reduced metabolic clearance of TCA (Cichocki et al., 2017b). PCE exposure caused larger increases in relative liver weight and hepatic serum enzyme levels in the mice with a fatty liver than in controls (Cichoki et al., 2017b). Liver disease complicated by cirrhosis, however, may reduce PCE-induced hepatotoxicity by reducing hepatic blood flow and delivery of chemical to hepatocytes, as well as by inhibiting metabolic activation of PCE. Paradoxically, fatty liver results in reduced formation of GSH metabolites by the liver, diminished delivery of these metabolites to the kidney, and decreased nephrotoxicity in mice (Cichocki et al., 2019). • Dalaijamts et al. (2018) utilized an updated PBPK model for PCE in mice to assess the impact of fatty liver disease on the toxicokinetics of PCE. Liver:blood partition coefficient, liver volume, and fat volume values from the fatty liver animals were inputted into the model. The model-generated data reflected increased metabolism of PCE to TCA, as well as decreased formation and delivery of GSH metabolites to the kidney in these animals (Dalaijamts et al., 2020). Sensitivity analysis of an earlier version of the model (Chiu and Ginsberg, 2011a) showed that changes in liver volume, liver blood flow, and oxidative metabolic clearance were important determinants of blood TCA levels. Liver volume and blood flow and GSH conjugate clearance impacted GSH metabolite kinetics. • These findings demonstrate the utility of the PBPK models in assessing the influence of physiological and biochemical changes	

	associated with genetics, lifestyles, and diseases on PCE toxicokinetics.	
SACC, 26	**SACC COMMENTS:** Recommendation: Ensure that metabolites that are measured in humans are adequately discussed in the sections on metabolism and PBPK. There were discrepancies between the metabolites modeled for human exposure and those discussed in the metabolism and PBPK sections. Careful consideration of specific metabolites responsible for toxicity and those estimated for humans from rodents need to be explicitly discussed. In many cases, metabolites potentially responsible for toxicity are unknown and as such is an uncertainty. In addition, the discussion of human health biomonitoring in Section 2.3.4.3 is more appropriate to the discussion and potential use in the human health section, *e.g.*, following the discussion of PBPK data. **PUBLIC COMMENTS:** The toxicokinetics section in the PCE draft risk evaluation lacks robustness, referring simply to the toxicokinetics section in the 2012 IRIS Toxicological Review document, which is quite extensive. The draft risk evaluation fails to acknowledge that PCE shares metabolites with a number of chlorinated VOCs, most of which are currently subject to the TSCA risk evaluation process. Those listed in Table 3-4 of the TCE risk evaluation (pp. 204-205) include PCE; 1,1,2,2-tetrachloroethane; TCE; 1,1,1-trichloroethane; 1,2-dichloroethylene; and 1,2-dichloroethane. [The 2012 IRIS PCE document does discuss similarities and differences between PCE and TCE metabolism, but does not discuss the other four VOCs.]	EPA has revised the metabolism section in section 3.2.2.1.3 to expand the discussion of each metabolite and to include more information on the biotransformation reactions. The section was also revised to ensure that all metabolites measured in humans were discussed, including N-acetylated metabolite of TCVC, NAcTCVC. Additional information was also added on the metabolites that are known to be responsible for toxicity. EPA did not acknowledge PCEs shared metabolites with other VOCs, unless it was relevant to understanding whether that metabolite was expected for PCE. The impact of other chemicals is outside of the scope of the risk evaluation for PCE. The purpose of the risk evaluation under TSCA is to determine whether a chemical substance presents an unreasonable risk of injury to health or the environment, under the conditions of use. EPA acknowledges in Section 3.2.5.3.1 that "co-exposure to other pollutants and drugs may also have either an activating or inhibitory effect on PCE-metabolizing enzymes."
SACC	**SACC COMMENTS:** Recommendation: Refine the mouse hepatocarcinoma POD discussion and calculations to include more thorough consideration of mouse liver cancer data, better MOA evaluation for PCE transformation product, and mechanistic evidence that rodent lung cancer mechanisms are relevant for humans. The EPA selected mouse hepatocellular carcinoma as the species and	EPA has improved the discussion of liver cancer MOA in Section 3.2.3.4.1 by including a more detailed discussion of evidence supporting each key event of the proposed MOAs. Overall, the MOA conclusions have not changed. While there is little or no data supporting the liver

	cancer endpoint for POD estimation. A linear extrapolation is used based on the EPA's default policy of applying this to situations where there is evidence of genotoxicity as part of the MOA or little is known. Some Committee members had problems with this decision and questioned whether mouse liver cancer is appropriate when there are little or no data supporting the liver as a PCE-related cancer site in humans. Although the genotoxicity of the DCVC and TCVC is well-established as a reasonable MOA for kidney cancer, what is not well-established is the relative importance of genotoxicity of these PCE metabolites in mouse liver cancer. Thus, while there is the potential for a genotoxic MOA in liver cancer, it is unclear how this can account for the induction of liver cancer compared to other MOAs such as cytotoxicity and compensatory proliferation documented for PCE. As for lung tumors, there is absolutely no evidence of this in humans. Despite occurrence in multiple species (mice and rats), extrapolation to humans without any supporting mechanistic data is problematic.	as a PCE-related cancer site in humans or for lung tumors, EPA followed the 2005 Guidelines for Carcinogen Risk Assessment, which states: "[S]ite concordance is not always assumed between animals and humans." EPA agrees that the evidence for the role of genotoxicity in the formation of liver tumors is not well established. The liver MOA section has been revised to give less weight to the role of genotoxicity in the liver cancer.
Data quality and uncertainties		
SACC	**SACC COMMENTS:** Recommendation: For the PBPK modeling (Section 2.2.2.2), discuss the extent to which the exact dose of compound delivered to the target is known and the degree of certainty in knowing which metabolite is responsible for the effect. Some of the Committee expressed concern that the PBPK model does not sufficiently account for "any variability and uncertainties in route-to-route extrapolation." Whether using a peer-reviewed PBPK model or not, the assumption that oral data are equivalent to inhalation data is fundamentally flawed unless there is confidence in the exact dose of compound delivered to the target and there is certainty of which metabolite is responsible for the effect. The use of a PBPK model is preferred, but there is still inherent uncertainty associated with its use.	EPA acknowledges this uncertainty in the risk evaluation. From Section 3.2.6.2: "EPA determined that the peer-reviewed PBPK model sufficiently accounted for any variability and uncertainties in route-to-route extrapolation, and therefore inhalation and oral data were considered equivalently relevant. Nonetheless, this PBPK model, like any model, does not incorporate all possible sources of biological uncertainty or variability."

6. Risk Characterization

Risk Characterization
Charge Question 6.1: EPA provided separate chronic inhalation risk estimates for the key chronic endpoint of neurotoxicity using occupational HECs (*ill,* assuming 1.25 m^3/hr inhalation rate). Please comment on whether EPA sufficiently characterized and evaluated considerations for the effects of differing breathing rates on risk estimates, especially in the context of occupational scenarios. Additionally, please provide any suggestions for adjusting risk estimates from other 24 hr PBPK-derived HECs for occupational scenarios (Appendix G and Supplemental Engineering Report, Appendices B-C). **Charge Question 6.2:** Please comment on the characterization of uncertainties and assumptions including whether EPA has presented a clear explanation of underlying assumptions, accurate contextualization of uncertainties and, as appropriate, the probabilities associated with both optimistic and pessimistic projections, including best-case and worst-case scenarios. Are the approaches used for animal-to-human and route-to-route extrapolation adequately supported? **Charge Question 6.3:** Please provide information on additional uncertainties and assumptions that EPA has not adequately presented. **Charge Question 6.4:** Please comment on whether the information presented supports the findings outlined in the draft risk characterization section. **Charge Question 6.5:** Please comment on the objectivity of the underlying data used to support the risk characterization and the sensitivity of the Agency's conclusions to analytic assumptions made. **Charge Question 6.6:** Has a thorough and transparent review of the available information been conducted has led to the identification and characterization of all PESS (Sections 2.4.3, 3.2.5.2, and 4.4.1)? Do you know of additional information about PESS that EPA needs to consider? Additionally, has the uncertainty around PESS been adequately characterized? **Charge Question 6.7:** Please comment on whether EPA has adequately, clearly, and appropriately presented the reasoning, approach, assumptions, and uncertainties for characterizing risk to workers using air-supplied respirators and to ONUs and consumers who would not be expected to use PPE.

#	Summary of Comments for Specific Issues Related to Charge Question 6	EPA/OPPT Response
EPA should consider performing cumulative risk assessments with other VOCs		
SACC	**SACC COMMENTS:** Recommendation: Discuss the benefits of using the MOE approach to characterize risk instead of the hazard index approach used in other EPA risk assessments. Table 4-112 and elsewhere, as the Committee has discussed previously: EPA's presentation of calculated MOEs in relation to target MOEs, which EPA refers to as benchmarks in this case, is confusing and	EPA uses an MOE approach instead of a hazard index/reference concentration approach because benchmarks for cancer and non-cancer risk estimates are not bright lines, and EPA has discretion to make unreasonable risk determinations based on other risk benchmarks or factors as appropriate. The RfC defines an

	difficult to interpret. It would be much easier to understand if the target "acceptable" air concentrations (*e.g.,* RfC) were compared directly with expected exposure concentrations, as is done in most risk assessment contexts at EPA. Why not simply use a hazard index approach?	exposure that is "likely to be without an appreciable risk of deleterious effects during a lifetime." In contrast, TSCA uses Unreasonable Risk determinations that incorporate many considerations and the risk evaluation does not set a goal of determining an all-encompassing "safe" exposure level.
SACC	**SACC COMMENTS:** Recommendation: Discuss in the risk considerations section for each scenario the extent to which worst-case scenarios are covered by the risk estimate. Readers of this draft risk evaluation might be expected to see "worst case" scenarios discussed in a risk evaluation. • One Committee member conducted a word search for the phrase "worst case" in the draft risk evaluation. This phrase occurs only once in the 667-page draft risk evaluation (on p. 238), and it is not in the risk characterization section. Consequently, several Committee members deduced that worst-case scenarios have not been provided in this draft risk evaluation. • While uncertainties are briefly discussed for modeling scenarios and exposure, the draft risk evaluation does not identify what a worst-case or upper (*e.g.,* 90th) percentile estimate of risk is for each scenario. For the environmental hazard assessment, worst-case scenarios would include sublethal effects, particularly at development.	EPA uses high-end exposure estimates which represent 95th percentile values (when a sufficient quantitative range of results is available) and high-intensity exposure levels (based on high-end parameters for consumer exposure). These do not necessarily represent the theoretical worst case possible, however they do represent sentinel exposures based on realistic high-end exposures.
SACC	**SACC COMMENTS:** Recommendation: Provide relative levels of confidence (quantitatively or qualitatively) associated with risk estimates, for example in Table 4-112. The Committee found Chapter 4 on risk characterization to be quite dense and unclear as to which risk estimates are based on stronger evidence than others. Section 4.2.2, where the occupational inhalation risk estimates are presented, was easy to follow and risk estimates were	Uncertainties and confidence statements for human health hazard and each exposure pathway are succinctly summarized in Section 4.2.5. The section includes cross references to detailed breakdowns by exposure scenario, and a new section integrating hazard and exposure considerations has been added (Section 4.2.5.4). The SACC is correct that confidence is higher

	reasonable. Section 4.2.3, where occupational dermal estimates are presented, was a bit less transparent. Estimates were more uncertain (than readers would assume from the text) because the uncertainties in the inputs are not accounted for and this was not always clear or acknowledged in the text. The PPE estimates are reasonable given the available data and associated uncertainty and presented accordingly. Some of the estimated risks come with greater certainty than others yet this fact is not clearly stated.	for many inhalation exposure values (confidence ranges from medium to high) compared to dermal (medium confidence).
SACC, 26, 29, 36, 40, 52	**SACC COMMENTS:** Recommendation: Discuss whether PCE is manufactured along with other similar chemicals (*e.g.*, carbon tetrachloride, TCE) and the likely impact that this might have on exposures and expected health impacts. The three plants identified with exposures to PCE are the same identified in the carbon tetrachloride draft risk evaluation. The Committee questioned whether it is likely that there are multiple chemicals being manufactured or processed in some or all facilities that manufacture or process PCE. If so, does this occur in the same building, in the same room, and/or on the same processing line? One Committee member questioned whether facilities where PCE is being emitted are in the same geographic and hydrologic areas with facilities emitting TCEs and methylene chlorides. If so, exposures and risks from these chemicals would also need to be considered in aggregate, since these chemicals impact the same human systems/ organs (*e.g.*, nervous system, liver tumors, CYP activation, reproduction/development). One Committee member offered that in his experience, this would be an incredibly complex and expensive task and discouraged recommending it. Recommendation: Provide data to indicate if facilities using PCE also use other CNS-depressing CYP-inducing solvents. A point of discussion by the Committee was the potential of co-exposures to other CNS-depressing solvents where health effects are	The impact of other chemicals is outside of the scope of the risk evaluation for PCE. The purpose of the risk evaluation under TSCA is to determine whether a chemical substance presents an unreasonable risk of injury to health or the environment, under the conditions of use. EPA acknowledges in Section 3.2.5.3.1 that "co-exposure to other pollutants and drugs may also have either an activating or inhibitory effect on PCE-metabolizing enzymes."

	likely to be additive. This is not discussed in the in the draft risk evaluation where CNS effects are mentioned. **PUBLIC COMMENTS:** The population is not only exposed to a single chemical through multiple pathways, but that they are exposed to mixtures of *multiple* chemicals (disclosed or undisclosed due to CBI) through *multiple* pathways. These chemicals may present human health hazards both individually and compounding health hazards synergistically. If risks were properly aggregated, they would show a marked increase for non-cancer and cancer risks relative to EPA's benchmarks. PCE is one of a group of large volume solvents – including TCE, methylene chloride, and carbon tetrachloride – on which EPA is now conducting or will conduct risk evaluations under TSCA. The four draft evaluations completed to date confirm that these solvents have similar molecular structures and metabolites, common health effects like cancer, and overlapping COUs that often result in co-exposure by many workers and consumers. EPA has been addressing each solvent in isolation, but it is likely that their cumulative effects on health and the environment are markedly greater than the individual EPA evaluations suggest. This understatement of cumulative risk should be an important consideration when weighing options for risk management. Co-exposure to other pollutants and drugs may have either an activating or inhibitory effect on PCE metabolizing enzymes, strengthening the argument for conducting cumulative assessments. • EPA should conduct cumulative assessments of similar chemicals. Several criteria should be applied when determining when a cumulative assessment would be appropriate: (1) concomitant exposure attendant to a category or subcategory of COUs; (2) close structural similarities, that is, members of the same chemical class; (3) shared metabolic pathways and byproducts of metabolism; (4)	

	similar toxicity profiles; and (5) similar modes/mechanisms of action of shared toxicity endpoints. The chemicals listed in Table 3-4 meet most, perhaps all, of the criteria (time did not allow for in-depth documentation of the criteria as they apply to the environmental assessment or of Criterion #5 for the human health assessment). Final decisions by EPA should add additional safety margins, acknowledging the potential for mixture effects where PCE and related chemicals can act synergistically on the same pathway to produce adverse effects.	
SACC, 26, 34	**SACC COMMENTS:** Recommendation: Consider whether exposures and associated risks are underestimated by not considering background exposures. As mentioned previously in this report, the exposures identified in most COUs underestimate risk if background and co-exposures are not considered cumulatively and in aggregate, including across chemicals with similar properties. This would be important to consider if EPA's intention is to keep worker, ONU, and consumer exposures below health-based benchmarks. For example, the MOE benchmarks do not appear to adequately account for uncertainties, such as genetic polymorphisms, and do not consider that these workers have other exposures from air, water, and consumer use. MOEs should be large enough to leave room in the "risk bucket" for these, and for co-exposures to similar chemicals. **PUBLIC COMMENTS:** Assessment of aggregate exposure for COUs, coupled with exposures known or anticipated to exist outside of a COU, should always be implemented as a benchmark of a credible and responsible exposure assessment. Tailored cumulative assessments of PCE and other VOCs also are warranted. To do otherwise is to deny reality and is irresponsible and unethical.	EPA described background exposures in the uncertainty sections (2.4.2.6, 4.2.5.4) and acknowledged that decision to not incorporate background exposures could lead to an underestimation of risk for each COU. Additional discussion of aggregate exposure is provided in Section 4.3.2. In short, uncertainties are due to the absence of a dermal compartment in the PBPK model which would account for toxicokinetic processes in determining the total internal dose. Additionally, clarifying language about what pathways are under the jurisdiction of other EPA-administered statutes has been added to Section 1.4.2 of the Risk Evaluation. EPA did not consider background PCE exposure that workers might be exposed to in addition to exposures from TSCA conditions of use. The frequency and magnitude of take-home exposure is dependent on several factors, including

	• EPA must find a way to address problems with its COU approach and to incorporate more realistic and aggregate exposure scenarios into its risk evaluations. Research and recommendations on ways of doing this, including by EPA, are voluminous. Perhaps the most cited is the NRC's 2009 report, Science and Decisions: Advancing Risk Assessment. This work recommends quantitative incorporation of such factors like susceptibility and the incorporation of scientifically based default values when specific data are lacking. • While these or similar approaches may require EPA to step outside typical risk evaluation protocols, modification of its current approach is necessary to improve the draft risk evaluation for PCE (as well as the other nine high priority chemicals) and reflect our knowledge of the real and preventable harm to human health and the environment from chemical exposures.	personal hygiene and visibility of the chemical on skin or clothing. EPA does not have methods to reliably predict take-home exposure. This may result in an underestimation of risk, and additional discussion of this underestimation has been added to the document in the Key Assumptions and Uncertainties section. EPA considered the reasonably available information and used the best available science to determine whether to consider aggregate or sentinel exposures for a particular chemical. EPA concluded that there is insufficient information to support analysis of aggregate exposure across multiple conditions of use. EPA acknowledges that the decision not to aggregate risk across conditions of use could result in an underestimate of risk for subpopulations that are exposed via multiple COUs. EPA acknowledges that an individual may be a member of multiple PESS groups resulting in concurrent susceptibilities in Section 4.3.1
29, 40, 51	**PUBLIC COMMENTS:** TSCA mandates that EPA determine whether "the chemical substance" presents unreasonable risk, but EPA has evaluated each COU in isolation, avoiding assessment of the total risk posed by PCE. EPA must examine the combination of all COUs to total risk and exposure and cannot determine unreasonable risk for each COU in isolation. EPA's approach likely underestimates the risks posed by a chemical by artificially segmenting the analysis.	Per 40 CFR 702.47 "…EPA will determine whether the chemical substance presents an unreasonable risk of injury to health or the environment under each condition of use within the scope of the risk evaluation…." This approach, in the implementing regulations for TSCA risk evaluations, is consistent with statutory text in TSCA section 6(b)(4)(A), which instructs EPA to conduct risk evaluations to determine whether a chemical substance

		presents an unreasonable risk "under the condition of use."
26	**PUBLIC COMMENTS:** Risk determinations should be reviewed and revised, following recalculation of all chronic inhalation and dermal non-cancer Benchmark MOEs, to account for data deficiencies and human variability.	EPA has updated the unreasonable risk determination for the final Risk Evaluation based on updates to the exposure, hazard, and risk characterization sections.
Data and assumptions in the occupational risk characterization, including treatment of PPE		
SACC	**SACC COMMENTS:** The Committee concluded that the worker exposures characterized in the draft risk evaluation are best described as a screening-level assessment. Due to the lack of readily available monitoring data and low confidence in the data sources, this assessment should not be used to decide whether health risks are reasonable or unreasonable. The results of a screening-level assessment can be used to determine if further refinement and more data are needed.	EPA believes that the PCE risk evaluation is sound and has met the requirements of TSCA section 26(h), (i) and (k) to use the best available science in a weight of scientific evidence approach using reasonably available information.
SACC	**SACC COMMENTS:** One Committee member opined that EPA makes assumptions and performs linear extrapolation of exposure levels causing tumors in high dose rodent inhalation studies and chronic occupational PCE exposures to the cancer risk for trivial dermal exposures associated with common PCE consumer products. The uncertainty attendant to those extrapolations to small volume use of PCE is so great that the results have little practical relevance.	EPA did not assess cancer risk to consumers. EPA assumed that only acute risks are relevant to PCE consumer uses, and therefore, neither chronic cancer nor non-cancer risks to consumers were evaluated.
SACC, 40, 46	**SACC** Recommendation: Given the inhalation unit risks presented in Table 3-9, EPA should present the corresponding occupational (30-year) inhalation cancer risks that are associated with the current PELs. Section 3.2.5.3.3 describes EPA's inhalation unit risk for PCE of $1.8x10^{-8}$ per ppm and in Table 3-6 presents a range of human inhalation unit risks ($2x10^{-3}$ per ppm or $3x10^{-7}$ per µg/m^3). In Table A-1 (p. 574), the document lists the current U.S. Department of Labor PEL for PCE as an 8-hour TWA of 100 ppm (678 µg/m^3) with a 300	As noted in the draft risk evaluation, EPA relied on Agency precedent and NIOSH guidance when choosing the 10^{-4} cancer risk benchmark to evaluate risks to workers from PCE exposure. EPA has consistently applied a cancer risk benchmark of $1x10^{-4}$ for assessment of occupational scenarios under TSCA. This is in contrast with cancer risk assessments for

	ppm (2,034 µg/m^3) "acceptable maximum peak above the acceptable ceiling for 5 minutes in any 3 hours for an 8 hour shift." This table also lists the California PEL of 25 ppm (170 mg/m^3) [which should be referenced as the California Occupational Safety and Health Agency (CAL/OSHA), 2020]. Given the inhalation unit risks presented in Table 3-9, what are the corresponding occupational (30-year) inhalation cancer risks that are associated with the current federal PELs? Recommendation: One member suggested tabulating the corresponding occupational and consumer PCE airborne concentrations (using the occupational and consumer exposure frequencies and durations used in the draft risk evaluation) associated with 10^{-6}, 10^{-5}, and 10^{-4} inhalation cancer risks. In Section 3.2.5.3 (p. 306, lines 7660-7662) the draft risk evaluation states: "Linear extrapolation from the [rodent] POD to low internal dose, followed by conversion to human exposures, led to a human equivalent unit risk of $1.8x10^{-3}$ per ppm." Table 3-6 presents a range of human candidate unit risks based on hepatocellular adenomas or carcinomas, including the male mouse data recommended by the NRC. In Table 3-9, the draft risk evaluation presents a summary of unit risks for human PCE chronic inhalation ($3x10^{-4}$ and $1.2x10^{-2}$ per mg/m^3) based on liver tumors in mice and leukemia in rats, respectively. **<u>PUBLIC COMMENTS:</u>** EPA used a cancer risk of $1x10^{-4}$ as the benchmark for determining whether PCE presents an unreasonable risk to workers; EPA used the more protective benchmark of $1x10^{-6}$ for consumers. Using this benchmark for workers results in a significantly smaller number of worker exposure scenarios that present unreasonable risks than under cancer risk levels of $1x10^{-5}$ and $1x10^{-6}$. • There is no valid reason for EPA to accept such high risks to workers. The SACC has stated that EPA has not provided an	consumers or the general population, for which $1x10^{-6}$ is applied as a benchmark. The standard cancer benchmarks used by EPA and other regulatory agencies range from 1 in 1,000,000 to 1 in 10,000 (*i.e.,* $1x10^{-6}$ to $1x10^{-4}$) depending on the subpopulation exposed. EPA, consistent with 2017 NIOSH guidance, used $1x10^{-4}$ as the benchmark for the purposes of unreasonable risk determinations for individuals exposed to PCE in industrial and commercial work environments, including workers and ONUs. $1x10^{-4}$ is not a bright line and EPA has discretion to make unreasonable risk determinations based on other benchmarks as appropriate. See section 5.1.1.2 of the risk evaluation for additional information. EPA considered the reasonably available information and used the best available science to determine whether to consider aggregate or sentinel exposures for a particular chemical. EPA has determined that using the high-end risk estimate for inhalation and dermal risks separately as the basis for the unreasonable risk determination is a best available science approach. There is low confidence in the result of aggregating the dermal and inhalation risks for this chemical if EPA uses an additive approach, due to the uncertainty in the data. EPA does not have data that could be reliably modeled into the aggregate, which would be a more accurate approach than adding, such as through a PBPK

	"adequate explanation and justification" for applying this less-stringent risk standard. Workers are specifically identified as a PESS in section 3(12) of the law. Thus, there is no basis for affording them less protection than other subpopulations. EPA should treat any increased cancer risk to workers exceeding $1x10^{-6}$ as unreasonable, thereby triggering risk management under TSCA. Contrary to EPA's claims, NIOSH does not recommend workers be exposed to a 1 in 10,000 risk of cancer. Instead, the NIOSH guidance states "for most carcinogens, there is no known safe level of exposure … [and] NIOSH will continue to recommend that employers reduce worker exposure to occupational carcinogens as much as possible through the hierarchy of controls, most importantly elimination or substitution of other chemicals that are known to be less hazardous." Consistent with NIOSH, EPA should reduce exposure to occupational carcinogens such as PCE "as much as possible," the extent of which should be decided during risk management and not risk evaluation. In contrast to the Occupational Safety and Health Act, TSCA provides protections to workers from exposures in the workplace, from air emissions and other environmental releases, and from exposures to consumer products. • While EPA draft risk evaluations have assessed worker exposure in isolation, this approach understates risks, EPA should combine exposures from all relevant pathways and determine an aggregate risk reflecting the contribution of each source. This is another reason why setting a higher cancer risk threshold for workers is unjustified under TSCA. EPA must apply to workers the same benchmarks for determining unreasonable cancer risks that it uses for other populations. For all populations, EPA should consider any increased cancer risk exceeding $1x10^{-6}$ to be unreasonable and to require action under TSCA.	model. Using an additive approach to aggregate risk in this case would result in an overestimate of risk. Given all the limitations that exist with the data, EPA's approach is the best available approach. Additional explanation is provided in the Executive Summary and Section 4.4.2 of the Risk Evaluation.

40	**PUBLIC COMMENTS:** EPA's risk evaluation fails to account for acute cancer risks to workers and consumers. We recommend that EPA follow the recommendations of the NRC to determine acute cancer risks. It is recognized that genotoxic carcinogens like PCE can induce cancer following acute exposure; methods to estimate such risks are available. • Guidance published by the NRC (2011) identifies cancer as a potential adverse health effect associated with short-term inhalation exposures to certain chemicals, recommends specific risk assessment methods for genotoxic carcinogens and for carcinogens whose mechanisms are not well understood, and states that the determination of short-term exposure levels requires the translation of risks estimated from long-term exposures to risks associated with short-term exposures. • The approach recommended for genotoxic carcinogens adopted the method developed by Crump and Howe (1984) for applying the linearized multistage model to assessing carcinogenic risks based on exposures of short duration. • There is a recognized methodology for extrapolating from findings of carcinogenicity in long-term studies to exposures of short duration. In its draft TCE risk evaluation, EPA acknowledged the possibility of calculating acute cancer risks but declined to calculate risk due to "uncertainties" in the NRC methodology. Rather than dismissing acute cancer risks because they are harder to estimate, EPA should quantify these risks using the framework outlined by NRC, which reflects the best available science.	The 2005 Guidelines for Carcinogen Risk Assessment states: "Use of short-term data to infer chronic, lifetime exposures should be done with caution. Use of short-term data to estimate long-term exposures has the tendency to underestimate the number of people exposed while overestimating the exposure levels experienced by those in the upper end (*i.e.*, above the 90th percentile) of the exposure distribution." Additionally, based on a linear dose-response assuming equivalent contribution of risk over time, cancer risk is evaluated based on lifetime average daily concentration/dose. Acute exposures averaged over a lifetime (or even a lifestage) would be orders of magnitude lower than acute or chronic exposure estimates and would result in risk estimates significantly less sensitive than those based on acute endpoints.
30	**PUBLIC COMMENTS:** EPA lists an overview of risk determinations by COUs, including COUs where EPA found no unreasonable risk (Table 5-1). EPA failed to use standard or familiar job descriptions; it is difficult to evaluate	EPA included all reasonably available information when describing worker and ONU tasks for each condition of use. No additional information was identified or provided to

	whether EPA's 'no significant use' findings are appropriate. Wherever EPA made a finding of 'no unreasonable risk,' it would be helpful if SACC members provided insight into what these ONU tasks are, who does them, how a job station may be laid out, and what workers may be in the near or far field.	further describe worker tasks vs ONUs tasks other than what has already been included in the risk evaluation.
SACC, 29, 30, 37, 40, 46, 50	**Factors affecting efficacy of PPE** **SACC COMMENTS:** The Committee noted that they could follow the risk characterization process and understood how risk levels are estimated. However, some Committee members questioned specific assumptions. The Committee also noted that assumptions regarding the use of PPE have been a source of much discussion in prior evaluation reviews. Many of the problematic occupational health exposure issues in this draft risk evaluation are the same or like ones identified and discussed in the previous reviews completed by the SACC, including inappropriate assumption of PPE use and application of PFs. Committee discussion focused on the actual use of PPE in commercial settings, especially as this relates to PCE dry cleaning of fabrics. • Multiple Committee members noted that many factors influence the efficacy of PPE. In Table 4-3, no COU lists "respirator use" as required, mandatory, or even likely. • One Committee member wondered whether one function of the risk evaluation is to provide guidance to employers and workers for situations where exposure can be ameliorated by voluntary (by worker) or mandated and monitored (by company) risk management actions. • As has been asserted in previous reviews by the SACC, PPE usage requires proper training, fit testing, material selection, timely replacement, etc., which cannot be assumed. PPE performance may degrade with time, through both deterioration of the equipment and repetition, inconvenience, and discomfort	For the purpose of this Risk Evaluation, EPA makes assumptions about potential PPE use based on reasonably available information and expert judgment. EPA considers each condition of use and constructs exposure scenarios with and without engineering controls and /or PPE that may be applicable to particular worker tasks on a case-specific basis for a given chemical. Again, while EPA has evaluated worker risk with and without PPE, as a matter of policy, EPA does not believe it should assume that workers are unprotected by PPE where such PPE might be necessary to meet federal regulations, unless it has evidence that workers are unprotected. For the purposes of determining whether or not a condition of use presents unreasonable risks, EPA incorporates assumptions regarding PPE use based on information and judgement underlying the exposure scenarios. These assumptions are described in the unreasonable risk determination for each condition of use, in Section 5.2. Additionally, in consideration of the uncertainties and variabilities in PPE usage, including the duration of PPE usage, EPA uses the high-end exposure value when making its unreasonable risk determination in order to address those uncertainties. EPA has also

	(*e.g.,* under conditions of high ambient temperatures) on the part of the employee. Some members believe that proper PPE use is only reinforced through experience of acute adverse effects. Mandated PPE can easily fail to provide the expected level of protection over extended use periods, may fail entirely in acute exposure episodes, and may provide a false sense of protection that actually results in greater risk of exposure and/or higher levels of exposure. **PUBLIC COMMENTS:** As in previous risk evaluations, EPA's determinations of unreasonable risk assume that workers will be protected from PCE exposure by using respirators and gloves. However, as the SAAC has repeatedly underscored, an expectation of universal PPE use is contrary to the realities of workplace practice and sound principles of worker protection and has repeatedly raised concerns about EPA's undue reliance on PPE for determinations of unreasonable risk. For example: • The evaluations do not discuss or account for the fact that downstream commercial users may be oblivious to chemical risks and lack even rudimentary industrial hygiene measures. • PPE may not be consistently and properly worn, as EPA assumes and that "[g]love use should not always be assumed to be protective" and, if worn improperly, gloves "could actually lead to higher exposures." • It is unreasonable to assume that workers would wear PPE for entire 8-hour shifts due to underlying medical conditions, facial hair, discomfort, and other issues. 8-Hour use of PPE should not be used in the risk characterization. Risk estimates should be presented without the use of PPE as reasonable worst case. EPA should place more emphasis on the limited likelihood that respiratory protection will be adopted without specific occupational exposure guidelines.	outlined its PPE assumptions in Section 5.1 and EPA's assumptions are described in the unreasonable risk determination for each condition of use, in Section 5.2. While EPA has assessed the extent to which certain exposure reduction tools that it assumes to be in place may be reducing risks to workers, application of the methodology of the hierarchy of controls is not relevant to risk evaluations. EPA will manage unreasonable risks presented by chemical substances when the Agency undertakes regulatory action for COUs determined to have unreasonable risk. Utilization of the hierarchy of controls to recommend or require risk management actions in the risk evaluation would be premature and inappropriate.

	• Workers in small-to-medium enterprises may not be likely to adopt PPE controls, so EPA's characterization of reasonable risk relying on use of PPE is not sufficiently supported by the practical realities of many workplaces. • Previously, distinguished OSHA administrators have also expressed concerns regarding EPA's reliance upon non-regulatory guidance and PPE to reduce risks to reasonable levels indicating that nominal PFs may not be achieved in actual practice. • Critically, without proper training, contaminant monitoring, medical examinations, and annual fit testing, respirators cannot be assumed to be protective even when they are used. A NIOSH study of respirator use found that, after a single year, 10% of employees' respirators no longer fit properly, and after three years more than a quarter of employees required different fitting respirators. Without data on fit testing, EPA cannot assume that even those workers who are provided respirators will be adequately protected from PCE's unreasonable risks. Overall, the SACC concluded that EPA's "[a]ssumptions about PPE use are likely unrealistic for many of the scenarios and so the determination of whether a condition of use results in an acceptable or unacceptable risk should be based on no PPE use, with the possible exception of in a manufacturing facility." EPA must consider whether PCE presents an unreasonable risk to exposed workers without discounting that risk by assuming the use and effectiveness of PPE. Through this unsupported assumption, EPA underestimates the risks for workers. EPA's assumption of PPE use also violates TSCA's requirement to "use scientific…methods, protocols, [and] methodologies . . . in a manner consistent with the best available science." The best available science for occupational risk assessment requires the measurement of worker exposures and risks without PPE. This methodology has been	

	incorporated into every OSHA standard promulgated since 1970. These non-PPE measurements permit OSHA and other regulatory agencies to determine whether risks can be eliminated through use of engineering controls and hazard elimination before the consideration of PPE, consistent with the well-established occupational hierarchy of controls. PCE is a prime example of why TSCA separates risk evaluation from risk management. PCE has the potential to break through respirators, rendering them ineffective, and many types of gloves offer little to no protection against PCE's dermal risks. • By assuming extensive use of PPE at the risk evaluation stage, EPA conflates risk evaluation with risk management. TSCA requires EPA to complete a risk evaluation and to make determinations of unreasonable risk before it considers how such risks may be managed. PPE is a risk management tool, albeit a poor one that may be used only when preferable options are not available. As such, PPE may only be considered, if at all, during the risk management stage when it can be weighed against more effective means of risk reduction. Because EPA assumes extensive respirator and glove use, EPA fails to capture the full extent of PCE's risks and thus will not determine whether such risks can be more comprehensively and effectively regulated through non-PPE risk management tools. The SACC previously indicated that, "The Agency's reliance on appropriate use of personal protective equipment (PPE), including both respirators and gloves, is not supported by current research literature or industrial hygiene practice. The mere presence of a regulation requiring respirators does not mean that they are used or used effectively noting that inadequacies in respirator programs are documented." • None of EPA's draft evaluations have provided any evidence that PPE is in widespread use and effectively controlling exposure in	

	workplaces where the subject chemicals are manufactured, processed, and used. EPA's risk evaluations must be supported by "substantial evidence" in the administrative record. EPA's unsupported assumptions of PPE use fall far short of that standard and are in many instances, directly contrary to EPA's prior findings and analyses.	
SACC, 29, 30, 37, 40, 46	**PPE as part of a hierarchy of controls and compliance with existing laws** **SACC** Multiple Committee members opined that it is inappropriate to comment on the effects of mitigation techniques outside of the context of a particular COU as such an approach ignores the place of PPE in the context of optimized "elimination, substitution, engineering controls, administrative controls" (*i.e.*, the higher levels of the hierarchy of controls). Committee members expressed concern that untethering of PPE from this larger context reinforces assumptions that PPE-based exposure reduction factors are real and quantitative than other esoteric and situational controls, and can be instituted and effective in the absence of a thorough application of the entire hierarchy of controls. **PUBLIC COMMENTS:** The hierarchy of controls that, in descending order of priority, calls for the use of elimination, substitution, engineering controls, administrative controls, and lastly PPE, is endorsed by NIOSH, the American Society of Safety Engineers, AIHA, ACGIH, American Public Health Association, AFL-CIO, and many others. The order is predicated on well-established observations that PPE is the hardest control to effectively implement and has the highest failure rate. OSHA has incorporated the hierarchy of controls into all its health standards, and EPA has endorsed this risk management approach.	EPA's approach for evaluating risk to workers and ONUs is to use the reasonably available information and professional judgment to construct exposure scenarios that reflect the workplace practices involved in the conditions of use of the chemicals and address uncertainties regarding availability and use of PPE. EPA uses exposure scenarios both with and without engineering controls and/or PPE that may be applicable to particular worker tasks on a case-specific basis for a given chemical. Thus, while EPA has evaluated worker risk with and without PPE, as a matter of policy, EPA does not believe it should assume that workers are unprotected by PPE where such PPE might be necessary to meet federal regulations, unless it has evidence that workers are unprotected. OSHA's hierarchy of controls is a method for eliminating workplace hazards. While EPA has assessed the extent to which certain exposure reduction tools that it assumes to be in place may be reducing risks to workers, application of the methodology of the hierarchy of controls is not relevant to risk evaluations. EPA will manage unreasonable risks presented by chemical substances when the Agency

	According to the draft PCE evaluation, "EPA expects there is compliance with federal and state laws, such as worker protection standards, unless case-specific facts indicate otherwise, and therefore existing OSHA regulations for worker protection and hazard communication will result in use of appropriate PPE consistent with the applicable SDSs." • Neither the OSHA standard for PCE nor other OSHA regulations call for employers to implement PPE or other measures sufficient to eliminate the unreasonable risks to workers demonstrated in EPA's draft evaluation in the absence of respirator and glove use. • Even in the highly unlikely event that industry safety data sheets (SDSs) recommended comprehensive PPE programs, OSHA hazard communication regulations do not require employers to follow SDS recommendations, and the preamble to these regulations expressly state that "there is no requirement for employers to implement the recommended controls." • OSHA regulations give employers wide latitude to interpret evidence of workplace risks and to select worker protection measures they deem appropriate. Thus, OSHA's PPE standard requires employers to assess the hazards workers face but to provide PPE only when the employer deems such measures "necessary." • As SACC has noted, the NIOSH and Bureau of Labor Statistics report on respirator use cited in the PCE evaluation found that many establishments where respirators were required by law "had indicators of potentially inadequate respirator programs," including multiple failures to implement requirements of the OSHA Respiratory Protection Standard (RPS). The small businesses where most PCE use occurs are, if anything, likely to be even less diligent in complying with respiratory protection protocols. • In the absence of a health-protective OSHA limit on workplace exposure, it is inconceivable that OSHA is enforcing – or	undertakes regulatory action for COUs determined to have unreasonable risk. Utilization of the hierarchy of controls to recommend or require risk management actions in the risk evaluation would be premature and inappropriate. EPA acknowledges that there is a PEL but did not use it as a benchmark for either risk assessment or unreasonable risk determination. EPA provided the PEL as a point of comparison only to help readers understand EPA's workplace exposure and risk estimates compared to a familiar exposure concentration, as expressed in the PEL. EPA did not use the PEL in the development of the risk estimates or as part of making an unreasonable risk determination. Information reasonably available to EPA, including data submitted by chemical manufacturers and processors, indicates that PPE is generally used. EPA does not assume that the inclusion of PPE on SDSs is sufficient to ensure PPE use. While EPA considers the information on SDSs, EPA does not make PPE use assumptions based solely on SDSs. PCE is the subject of an OSHA standard. OSHA has established a permissible exposure limit (PEL) of 100 ppm for PCE. However, as noted on OSHA's website, "OSHA recognizes that many of its permissible exposure limits (PELs)

	employers are systematically implementing – the stringent PPE requirements that would be necessary for the substantial reductions in worker exposure required to achieve safe levels of PCE in the workplace • EPA improperly assumes the use of respirators at levels far below the PCE PEL. EPA cites OSHA's RPS to support its assumption that all directly exposed workers in many COUs will use and be adequately protected by PPE. Those regulations, however, do not require employers to provide respiratory protection to workers exposed to PCE below the OSHA PEL of 100 ppm unless OSHA can show that such exposures violate the general duty clause. Where OSHA has established a PEL for a chemical, only exposures that exceed the PEL trigger worker protections, and such protections are only required to the extent necessary to attain the PEL. • OSHA regulations preclude the Agency from relying on the general duty clause to impose a stricter requirement that is established by an OSHA standard absent actual knowledge by the employer that the OSHA standard does not protect workers. • An EPA draft risk evaluation does not provide actual employer knowledge that the existing PEL for PCE is inadequate. To the best of our knowledge, OSHA has never issued a citation to an employer under the general duty clause for PCE exposures below the PEL. • EPA is simply wrong to assume that employers have a duty under the Occupational Safety and Health Act to provide PPE to workers at exposure levels below 100 ppm and EPA has no evidence to suggest that employers voluntarily do so. • EPA cites no evidence that workers have or will voluntarily provide expensive and burdensome PPE in circumstances where OSHA does not require it. For instance, according to EPA, the "high-end" exposure concentration for the use of PCE in aerosol degreasing is 32 ppm, an exposure that is far below the OSHA	are outdated and inadequate for ensuring protection of worker health. Most of OSHA's PELs were issued shortly after adoption of the Occupational Safety and Health (OSH) Act in 1970 and have not been updated since that time." Section 6(a) of the OSHA Act granted the Agency the authority to adopt existing Federal standards or national consensus standards as enforceable OSHA standards. OSHA provides an annotated list of PELs on its website, including alternate exposure levels. As described in Appendix A in the final risk evaluation, OSHA recommends that employers consider using the alternative occupational exposure limits because the Agency believes that exposures above some of these alternative occupational exposure limits may be hazardous to workers, even when the exposure levels are in compliance with the relevant PELs (https://www.osha.gov/annotated-pels). For PCE, the alternates provided are the California OSHA PEL of 25 ppm and the ACGIH TLV of 25 ppm. (https://www.osha.gov/dsg/annotated-pels/tablez-2.html). For the purpose of determining whether or not a condition of use presents unreasonable risks, EPA incorporates assumptions regarding PPE use based on information and judgment underlying the exposure scenarios. These assumptions are described in the unreasonable risk determination for each condition of use, in section 5.2 of the risk evaluation. Additionally, in consideration of the uncertainties and variabilities in PPE usage,

	PEL and would thus require no respiratory protection under OSHA regulations. Yet, when calculating PCE's risks, EPA still assumes that all directly exposed workers in this COU are provided with and consistently wear an APF 25 respirator. There is simply no evidence that employers voluntarily implement expensive respirator protection programs, which are costly to establish and maintain, to achieve exposure levels below those required by OSHA. • EPA relies on OSHA's Hazard Communication Standard to support its "expect[ation]" that workers will be provided "appropriate PPE consistent with the applicable SDSs." However, the Hazard Communication Standard merely requires the provision of SDSs, not PPE, and OSHA has made clear that employers are under no obligation to follow SDS recommendations. The information and recommendations included in SDSs are based on manufacturers' judgment. As a result, they are often vague and inconsistent. For instance, one SDS advises users of "[w]ear appropriate protective gloves and clothing to prevent skin exposure" but provides no guidance on the type of gloves to be worn. Another SDS states that "[i]f permissible levels are exceeded use NIOSH mechanical filter/organic vapor cartridge or an air-supplied respirator," but fails to identify the permissible levels that would trigger the need for respiratory protection. More broadly, a comprehensive survey of SDSs identified "a number of common themes . . . regarding inaccuracies, incompleteness, [and] incomprehensibility" and cautioned that "there are serious problems with the use of [SDSs] as hazard communication tools." • OSHA cannot cite an employer for failing to follow manufacturer recommendations in an SDS. • In the absence of a requirement, there is no basis for EPA's assumption that the Hazard Communication Standard will result in the uniform use of PPE.	EPA uses the high-end exposure value when making its unreasonable risk determination in order to address those uncertainties. EPA has also outlined its PPE assumptions in section 5.1 of the risk evaluation. Further, in the final risk evaluation for PCE, EPA has determined that most conditions of use pose an unreasonable risk to workers even when assuming PPE. The OSHA regulations at 29 CFR 1910.132 require employers to assess a workplace to determine if hazards are present or likely to be present which necessitate the use of personal protective equipment (PPE). If the employer determines hazards are present or likely to be present, the employer must select the types of PPE that will protect against the identified hazards, require employees to use that PPE, communicate the selection decisions to each affected employee, and select PPE that properly fits each affected employee.

	EPA may be correct in "expecting" compliance with OSHA regulations, but it's plainly incorrect that these regulations compel employers to use PPE to eliminate unreasonable risks that fall below the OSHA PEL.	
SACC, 26, 29, 40, 46	**Availability of data to support the use of PPE** **SACC COMMENTS:** Recommendation: EPA should clarify how information in NIOSH (2001b) was utilized in the draft risk evaluation. The Committee expressed varying degrees of confidence that workplaces considered in the COUs and described in the evaluation can be characterized as uniformly having or not having credible respiratory or dermal protection programs. This issue impacts confidence in the relevance of central tendency and high-end exposure estimates. The evaluation cites a 2001 NIOSH survey of respirator use in private sector firms. Two Committee members recommended that the draft risk evaluation clarify how information from that publication was used. One Committee member stated that uncertainty associated with PPE use by PESS was not adequately captured in the draft risk evaluation. **PUBLIC COMMENTS:** In a departure from some previous evaluations, EPA divides PCE COUs into two categories: (1) those where respirator use is "plausible" and workers "may use" respirators; and (2) those with "no respirator use." While some industrial and commercial activities are likely carried out without respirators, viewing respirator use as "plausible" for other activities is a far cry from demonstrating that respirators are consistently and reliably protecting workers. For example, EPA classifies open-top degreasing as a PCE use where workers "may use" respirators. But EPA also finds that, at the 50th percentile use level, 4,942 sites are using PCE in open-top vapor degreasing operations and that these operations employ a total of 54,000 exposed workers and	The risk evaluation does acknowledge the work completed by NIOSH and the BLS on respirator use in Section 2.4.1.4. However, for the purpose of this Risk Evaluation, EPA makes assumptions about potential PPE use based on reasonably available information and expert judgment. EPA considers each condition of use and constructs exposure scenarios with and without engineering controls and /or PPE that may be applicable to particular worker tasks on a case-specific basis for a given chemical. Again, while EPA has evaluated worker risk with and without PPE, as a matter of policy, EPA does not believe it should assume that workers are unprotected by PPE where such PPE might be necessary to meet federal regulations, unless it has evidence that workers are unprotected. For the purposes of determining whether or not a condition of use presents unreasonable risks, EPA incorporates assumptions regarding PPE use based on information and judgment underlying the exposure scenarios. These assumptions are described in the unreasonable risk determination for each condition of use, in section 5.2. Additionally, in consideration of the uncertainties and variabilities in PPE usage, including the duration of PPE usage, EPA uses the high-end exposure value when making its unreasonable risk determination in order to

	ONU. Most of the facilities where open-top degreasing is performed are small businesses which lack extensive industrial hygiene programs that focus on working training in proper respirator use and adequate fit testing. EPA identifies no data concerning the use of respirators by workers exposed to PCE. In the absence of chemical-specific data, EPA relies on a generic 2003 NIOSH survey of respirator use across private sector employers. Far from supporting EPA's PPE assumptions, this survey directly undermines them. The NIOSH survey reported that less than 5% of private sector employers required use of respirators but provided no information on the chemicals to which the employees in those workspaces were exposed. • EPA acknowledges that even this estimate may be too high as "establishments with low or no respirator use may choose to not respond to the survey." Moreover, among the employers that required respirator use, the survey found that only 59% provided training to workers on respirator use, 34% had a written respiratory protection program, 47% performed an assessment of the employees' medical fitness to wear respirators, and 24% included air sampling to determine respirator selection. Each of these elements is a necessary part of the respirator protection program required by OSHA when an employer requires its employees to use respirators. In connection with the TCE risk evaluation, an EPA risk assessor prepared a memorandum warning that the NIOSH study "highlight[s] the potential uncertainty that comes with assuming widespread usage of respiratory protective equipment for estimating occupational exposures." Yet in the PCE draft risk evaluation, EPA made that very assumption anyway. EPA has no information on how many workers who are exposed to PCE wear gloves, or how protective such gloves would be if worn. Moreover, even if gloves are provided to and worn by workers, EPA	address those uncertainties. For workers (who are one example of PESS), EPA captures uncertainties in PPE usage in the analysis. Additionally, EPA does not assume that ONUs, consumers, and bystanders use PPE. EPA has also outlined its PPE assumptions in Section 5.1 and EPA's assumptions are described in the unreasonable risk determination for each condition of use, in Section 5.2. Uncertainties in worker PPE use are captured; ONUs, consumers and bystanders aren't assumed to use PPE.

	has little to no information about the types of gloves worn, a critical omission given that not all gloves are protective against PCE. For gloves made from the name material (nitrile), PCE breakthrough times can vary by a factor of 10. EPA has no basis for assuming specific glove PFs in its draft risk evaluation. EPA's assumption that gloves will provide any level of protection from dermal absorption is speculative. In the Supplemental File: Environmental Releases and Occupational Exposure for its PCE evaluation, EPA acknowledges that "Data about the frequency of effective glove use – that is, the proper use of effective gloves – is very limited in industrial settings. Initial literature review suggests that there is unlikely to be sufficient data to justify a specific probability distribution for effective glove use for a chemical or industry. Instead, the impact of effective glove use should be explored by considering different percentages of effectiveness (*e.g.,* 25% vs. 50% effectiveness)." Yet EPA assumes that workers across all COUs will be provided gloves of varying protectiveness. EPA admits that "[g]love protection factors are presented as what-if scenarios to show the potential effect of glove use on exposure levels. EPA does not know the actual frequency, type, and effectiveness of glove use in specific workplaces with PCE conditions of use." Even when gloves are used, their effectiveness is not assured. As the Supplement recognizes, some gloves may lack impermeability for specific chemicals and even protective glove types will fail to fully prevent exposure if not properly maintained and replaced. As EPA notes, "EPA does not know the actual frequency type, and effectiveness of glove use in specific workplaces with PCE conditions of use," buttressing the argument that risk determinations should be based solely upon COU scenarios in which workers are not using any form of PPE. Risk is underestimated, perhaps significantly so, when assuming workers will use PPE appropriately for the entire duration of	

	the work activity throughout their careers, even when such equipment is not required, provided, or used.	
38	**Comment supporting assumption of PPE use** **PUBLIC COMMENTS:** When conducting risk evaluations, EPA's base assumptions should reflect use of all required PPE and current regulatory standards. EPA makes several assumptions regarding the need and use of PPE. Often, those assumptions do not include the use of all PPE as required by NIOSH and/or EPA. Where EPA does calculate data based on the use of PPE, EPA often defaults to low- or mid-range protection instead of the higher end. Since the safety and protection of our industry's workers remains one of the highest priorities at our facilities, the automotive industry maintains procedures and worker requirements that meet or exceed recommended safety protections and PPE. It is therefore important that EPA base its evaluations on manufacturing scenarios where the automotive industry is fully utilizing all required PPE. In the automotive sector, facilities endeavor to comply with all applicable OSHA standards as well as the General Duty Clause of OSHA, which requires employers to keep their workplace free of serious recognized hazards. It is recommended that EPA ensure that OSHA workplace standards and requirements of the OSHA general duty clause be taken into consideration when assessing the potential exposures associated with any industrial use of PCE including maintenance and cleaning activities. When EPA takes these workplace practices into consideration, it will find that exposures in the workplace would present only *de minimis* exposure or otherwise insignificant risks.	EPA has outlined its PPE assumptions in Section 5.1 and has supplemented some sources and information on respirator use in Section 2.4.1.4. of the Risk Evaluation. Additionally, in consideration of the uncertainties and variabilities in PPE usage, including the duration of PPE usage, EPA uses the high-end exposure value when making its unreasonable risk determination in order to address those uncertainties. EPA's approach for developing exposure assessments for workers and ONUs is to use the reasonably available information and expert judgment. When appropriate, in the risk evaluation, EPA will use exposure scenarios both with and without engineering controls and/or PPE that may be applicable to particular worker tasks on a case-specific basis for a given chemical. While EPA has evaluated worker risk with and without PPE, EPA does not believe it should assume that workers are unprotected by PPE where such PPE might be necessary to meet federal regulations, unless it has evidence that workers are unprotected. For the purposes of determining whether or not a condition of use presents unreasonable risks, EPA incorporates assumptions regarding PPE use based on information and judgment underlying the exposure scenarios. Once EPA has applied the appropriate PPE assumption for a particular

		condition of use in each unreasonable risk determination, in those instances when EPA assumes PPE is used, EPA also assumes that the PPE is used in a manner that achieves the stated APF or PF. While OSHA has established a PEL for PCE, OSHA has recognized that many of its permissible exposure limits (PELs) are outdated and inadequate for ensuring protection of worker health. Most of OSHA's PELs were issued shortly after adoption of the Occupational Safety and Health (OSH) Act in 1970, and have not been updated since that time. Section 6(a) of the OSH Act granted the Agency the authority to adopt existing Federal standards or national consensus standards as enforceable OSHA standards. OSHA provides an annotated list of PELs on its website, including alternate exposure levels. As described in Appendix A in the final risk evaluation, OSHA recommends that employers consider using the alternative occupational exposure limits because the Agency believes that exposures above some of these alternative occupational exposure limits may be hazardous to workers, even when the exposure levels are in compliance with the relevant PELs (https://www.osha.gov/annotated-pels). For PCE, OSHA recommends the use of the California OSHA PEL of 25 ppm and the ACGIH 2019 TLV of 25 ppm (as an 8-hour TWA) (https://www.osha.gov/annotated-pels).

27, 29, 40, 46, 53	**<u>Comments specific to glove use</u>** **<u>PUBLIC COMMENTS:</u>** For scenarios including the use of gloves, EPA assumes that a worker wears the same gloves for the entire work shift (8 hours) without stopping to wash their hands and change their gloves. The amount that is able to penetrate a glove depends on the assumed protection of the glove material and worker training. For the glove PF of 5, it is assumed that the glove material is "good" and there is no worker training; in this scenario, 20% of the total PCE in contact with the gloved hand will penetrate the glove and come into contact with skin. For the PF of 20, which assumes a chemically resistant glove and good worker training, EPA assumes that 5% of PCE will still permeate the glove. • There is likely very little, if any, penetration of PCE through the glove in this situation. Standard industrial hygiene practice is such that a glove is tested and selected to ensure suitability for the specific chemical being used and the use duration to ensure no chemical breakthrough for the duration of specific tasks. General industrial hygiene practice in place at facilities would likely incorporate PPE change out schedules designed to limit breakthrough time. Any detectable breakthrough or glove degradation would indicate the need for new gloves. It also is notable that situations in chemical manufacturing with full glove coverage of liquid material would be rare, and if considered probable would involve specific job hazard analyses that would include specific controls (*e.g.*, use of an inner glove) to limit dermal contact. It is well-known that glove use can increase skin absorption under some circumstances. As the PCE Supplement notes, "[g]loves can prevent the evaporation of volatile chemicals from the skin, resulting in occlusion. Chemicals trapped in the glove may be broadly distributed over the skin ... , or if not distributed within the glove, the chemical mass concentration on the skin at the site of contamination may be maintained for prolonged periods of time."	EPA acknowledges that certain gloves may limit permeation of PCE greater than the protection factors used in the assessment. However, as pointed out by SACC members, that assumes that workers are wearing the correct type of gloves and using them correctly. SACC members stated that dermal exposure does not require that the glove material actually be permeated by the solvent, rather, glove material can be permeated if the glove is torn during working conditions or if workers remove gloves to perform a specific activity and then put the gloves back on. SACC members emphasized that the donning and doffing of gloves is the primary concern when it comes to glove failure and not direct permeation of the glove material. See further discussion on occlusion in the Supplemental Information on Occupational Exposure and Environmental Release Assessment (EPA, 2020). The occluded scenarios were presented as a what-if scenario. EPA does not know the likelihood or frequency of these scenarios in the workplace and did not calculate risk associated with occluded exposure.

	• As EPA noted in the TCE evaluation, "[d]ermal exposure may be significant in cases of occluded exposure," exceeding absorption levels where no gloves are used. EPA recognizes that occlusion is an expected occurrence for several PCE COUs. EPA expects occlusion to be a reasonable occurrence at sites where workers may come in contact with bulk liquid chemical and handle the chemical in open systems. This includes COUs such as vapor degreasing, cold cleaning, and dry cleaning where workers are expected to handle bulk chemical during cleanout of spent solvent and addition of fresh solvent to equipment and at coating or adhesive application sites when workers replenish application equipment with liquid coatings or adhesives. • The Supplement discusses various methodologies for estimating the increase in dermal absorption due to occlusion but states that, rather than making these calculations, EPA "addresses the occlusion scenario in combination with other glove contamination and permeation factors through the use of a protection factor." This compounds uncertainties because EPA's PFs are purely hypothetical and in any case do not address occlusion scenarios, which result in more dermal absorption than in the absence of gloves. The PFs utilized by EPA in the dermal exposure assessment were developed for the European Centre for Ecotoxicology and Toxicology of Chemicals (ECETOC) targeted risk assessment (TRA) model. There is very little information on how these PFs were derived. • In the draft risk evaluation for PCE, EPA cited the Marquart et al. (2017) study in support of the use of the ECETOC PFs. • Based on the findings of Marquart et al. (2017) and typical hygiene practices, the PF value of 20 would be a significant underestimate of glove protection for many industrial chemicals. Given that the PFs used in the dermal evaluation go beyond "worst case" glove performance, EPA should reevaluate and consider revising the PFs for the final risk evaluation. EPA should incorporate	

	empirically derived PFs using literature on chemical permeation through gloves, considering critical factors such as the extent and length of contact with the chemical, amount of hand/glove flexion, and worker behavior (Chao et al., 2004; Cherrie et al., 2004). The TSCA SACC has previously advised EPA that improper glove use can also lead to increased worker exposures due to "contamination of the interior of the glove" (if workers are not properly training in glove use and replacement) or by "acting as a reservoir" for contaminants (if the gloves are not impermeable). • EPA notes that the effectiveness of gloves is dependent in part upon "the presence of an employee training program," but provides no data about how many of these programs are in place. In the PCE draft risk evaluation, EPA also acknowledges the potential for gloves to create occluded exposure scenarios that increase dermal exposures. In its final risk calculations, however, EPA ignores the foreseeable exposure scenarios in which employees are not provided protective gloves, or, worse, are provided inadequate gloves or are not adequately trained and thus face even greater dermal exposures due to glove contamination and the occlusion of PCE close to the skin. EPA's assumption that all workers will be provided with, and properly wear, chemical-resistant gloves is unfounded and contrary to TSCA.	
Data and assumptions in the environmental risk characterization		
SACC	**SACC COMMENTS:** Recommendations: (1) Use the term "Hazard Quotient" when discussing environmental hazards and exercise caution in stating the risk conclusion. (2) Provide bounds on exposure estimates when data adequate for this purpose are available. Throughout the evaluation, the draft risk evaluation refers to exceeding RQs or MOEs as attaining "unreasonable risks" or when below as "no risk." Risk is typically defined as the probability of an adverse event occurring. For most of the draft risk evaluation, risks are not discussed as probabilities and probability estimates are not provided.	EPA uses a deterministic approach or the quotient method to compare toxicity to environmental exposure. In the deterministic approach, a risk quotient (RQ) is calculated by dividing a point estimate of exposure by a point estimate of effects. EPA is taking steps to fill data gaps in future risk evaluations and will consider probabilistic analyses when data meets the assumptions of the tests.

	• The Committee noted that in several places in the draft risk evaluation, exposure information/data are available that would facilitate assigning a probability to the final estimate. However, there are some benefits in using the HQ approach to expressing risk as seems to be the preferred approach in TSCA evaluations. • The Committee recommended that clear and precise statements be used in the draft risk evaluation. Since HQs are used and not risk estimates, the decision rule looks for scenarios where the HQ exceeds a value of one or for MOEs, the reverse. This is not the same as deciding based on comparing risks. • The Committee recommended that when observing a HQ <1, the draft risk evaluation should not conclude that there is "no risk," rather the conclusion should be that "unacceptable risk is unlikely."	"No risk" has been replaced with "Risks were not identified" in the environmental risk narratives.
SACC	**SACC COMMENTS:** Recommendation: Provide information about the PDM output to support the assessment of the days of exceedance used in Table 4-110. Table 4-110 (p. 405) shows RQ values and calculated days of exceedance derived from modeling data. Data from Table 4-110 was used and set for 11 specific use categories ("OES" labels). COCs were provided for acute toxicity, chronic toxicity, and algal toxicity. RQs >1 were used to indicate risk. In all use categories, RQ values were >1 for algal toxicity and in many cases for chronic toxicity (although many of these did not exceed the 20-day limit imposed by the agency for exposure necessary to elicit the responses). • The low number of days of exceedance in Table 4-110 is difficult to justify given the high mean predicted aqueous concentrations of PCE. Furthermore, the data analysis cannot be evaluated with the information presented. The PDM output will drive these exceedances and PDM inputs and outputs are not available. Without an understanding of the assumptions about the stream flow and release distributions that were used for the PDM, the appropriateness of the reported days of exceedance is impossible to assess. Even if these data were available, the SACC was given	Wherever possible, EPA used site specific 7Q10 flow metrics to estimate flows at waterbodies receiving known facility releases. For still water bodies, a dilution factor approach is applied since no available 7Q10 metric is available. If neither of these metrics are available a flow associated with the industry sector of the discharging facility was chosen to approximate the instream flow. • The uncertainties and assumptions of these estimates are discussed in Section 4.3. EPA used the best available science to evaluate this exposure from facilities. There was no better estimate of possible dilution occurring within this specific waterbody that was found.

	insufficient time for review of the PDM results in this level of detail.	
SACC	**SACC COMMENTS:** Recommendation: Describe what the RQ values presented in Table 4-110 represent. It is unclear to some on the Committee exactly what the RQs in Table 4-110 represent. Do the values in the table represent the average for a facility or some other property? If so, were these RQs calculated using arithmetic or geometric means? All the data manipulations in Table 4-110 appear to be geared to minimize RQs. Questionable choices used to generate RQs include using average risks, assuming average 7Q10 release, and including no explanation of the distribution type used for dilution. Improving this discussion would increase confidence that appropriate toxicological response COCs are being compared to appropriate PCE occurrence data.	The risk estimation approach is described in Section 3.2.4. RQs were calculated using surface water concentrations and the COCs calculated in the hazard section of this document (Section 3.1.4). The RQ is defined as: RQ = Predicted Environmental Concentration / Effect Level or COC The number of days that a COC was exceeded was calculated using E-FAST (U.S. EPA, 2014), as described in Section 2.3.1.2. Please see above response discussing 7Q10 flow metrics to estimate flows at waterbodies receiving known facility releases.
SACC	**SACC COMMENTS:** RQs in Section 5.3 and associated language on p. 403 need to be revised to include COCs that are based on the more robust analysis of exposure and effect data. The comments at the end of Section 4.5.1 (p. 404) should acknowledge that there are likely to be additional acute and chronic environmental risks when more robust COCs are considered. These risks must be included in a refined evaluation.	Aquatic hazard values for acute fish, amphibian, and invertebrates have been revised, as well as the acute COC. Additionally, the algae end point and COC has been revised. COCs were developed using reasonably available information and the best available science. While any potential additional data may reduce uncertainty, it is unclear whether updated risk estimates would increase or decrease.
SACC	**SACC COMMENTS:** In Section 4.3.1 (p. 400), the draft risk evaluation statements mislead the reader to assume that ambient environmental concentrations of PCE rarely exceed COCs.	Section 4.1.5 *Environmental Risk Characterization Assumptions and Key Sources of Uncertainty*, describes the measured surface water data, and the associated uncertainties. For example, "The available data represent a variety of discrete locations and time periods; therefore, it is unclear whether the data are representative of other locations in the U.S.; however, this limitation does not diminish the overall findings reported in this assessment, as the exposure data

		show very few instances (*i.e.,* less than 0.01 percent) where measured PCE levels in the ambient environment exceeded the identified hazard benchmarks for aquatic organisms."
SACC	**SACC COMMENTS:** Recommendation: Provide an explanation for how the COU designated as releasing the most PCE does not present an unacceptable environmental risk. The chronic exceedances for invertebrates at location FRS 110000317194 (Hubbard-Hull, Inc) presented in Table 4-110 (p. 407) are predicted to occur on 70% (14 of 20) of modeled days and produce an RQ of 7.2, yet these cells are not shaded in the table. • Lack of shading appears to indicate that no risks are identified. Similar situations exist for algae near LA0000761, and several other facilities. • Dismissing chronic RQs of 4-120 because the days of exceedance are 12-19 days in duration needs justification. When COCs are exceeded for more than 4 days, caution is needed in discounting RQs above 1. Given that there are no measured PCE concentration data in environmental media near release PCE points, assumptions in this evaluation must be conservative to maximize protection of the environment until measured data become available to better estimate the likelihood of exceedances and reduce uncertainty. While estimated releases from TX0007412 (Table 4-110, p. 420) are predicted to exceed COCs on 13% of days, 38 days in a year represents on exceedance approximately every 9.6 days.	Thank you for your comment. EPA has revised environmental risk calculations based on revised aquatic hazard values for acute exposures to invertebrates, an updated acute COC, an updated algae end point and COC. These updates include updates to the days of exceedance and RQs for the sites assessed.
SACC	**SACC COMMENTS:** Recommendation: Revise conclusions for environmental scenarios that have high uncertainty to a protective statement that high uncertainty in data sets reinforces the RQ prediction of Unacceptable Risk. • The draft risk evaluation on p. 469, states: "While EPA identified environmental risk for this COU (Manufacture – Domestic manufacture), given the uncertainties in the data, EPA does not	Thank you for your comment. An RQ greater than 1, when the exposure is greater than the effect concentration, supports a determination that there is unreasonable risk of injury to the environment. Consistent with EPA's human health evaluations, other risk-based factors may be considered (*e.g.,* confidence in the hazard and

	consider these risks unreasonable." If uncertainty is high for situations where RQs exceed 1, uncertainty should be minimized before a determination of "no unreasonable risk" can be justified. This applies to all places in Section 5 where this improper rationale is used. Similarly, the draft risk evaluation on p. 482, states: "While EPA identified environmental risk for this COU, given the uncertainties in the data, EPA does not consider these risks unreasonable." • The environmental risk conclusion through p. 542 of the draft risk evaluation should be re-evaluated. • It is also difficult to resolve the lack of unacceptable risk from adhesives (p. 474, line 10624) when adhesives are predicted to have the highest releases (see Table 2.2, p. 67).	exposure characterization, duration, magnitude, uncertainty) for purposes of making an unreasonable risk determination. EPA considers the uncertainties associated with each condition of use, and how the uncertainties may result in a risk estimate that overestimates or underestimates the risk. Based on such analysis, EPA determines whether or not the identified risks are unreasonable. EPA has revised the unreasonable risk determinations for all conditions of use for risk to the environment (aquatic organisms) based on revised aquatic hazard values for acute exposures to fish, amphibian, and invertebrates, an updated acute concentration of concern, an updated algae end point and concentration of concern, and updates to the days of exceedance for the sites assessed. Based on the revisions and updates, EPA has determined that there is no unreasonable risk to the environment (aquatic organisms) from all conditions of use.
26	**PUBLIC COMMENTS:** Using RQs to compare predicted environmental concentrations against aquatic hazard values, EPA identified a total of 41 unreasonable environmental risks to aquatic organisms (invertebrates, fish, and/or aquatic plants) based on endpoints for immobilization from acute exposure, growth effects from chronic exposure, and mortality or sublethal effects to algae. In general, there is agreement with the risks that EPA identified for aquatic organisms.	Thank you for your comment.
29, 40	**PUBLIC COMMENTS:**	EPA has revised environmental risk calculations based on revised aquatic hazard values for acute

	Throughout the draft risk evaluation, EPA repeatedly underestimates PCE's ecological risks. First, as it did its evaluation of human health risks, EPA violates TSCA and fundamental risk assessment principles by making use-by-use determinations of unreasonable environmental risk. • TSCA requires EPA to evaluate the risks presented by "a chemical substance" under all of its COUs. EPA's piecemeal ecological risk determinations understate the effects of PCE on the environment, since if two facilities discharge PCE to the same water body at the same time, EPA may never evaluate the combined impacts on the fish, algae, and other species that are exposed to PCE from both sources. • For the manufacturing of PCE, repackaging/importing, and incorporation of PCE into formulations, EPA calculated unreasonable risks from PCE, with RQs up to 1,453 and up to 299 days of exceedance per year. Yet, for all of those COUs, EPA "does not consider these risks to be unreasonable." • For some COUs, EPA's sole explanation for this drastic departure from its own risk calculations is unspecified "uncertainties in the data." Any such uncertainties should result in a more conservative risk characterization, not the wholesale disregard of high ecological risks. • For others, EPA notes that some of the greatest dischargers do not have NPDES permits and argues that "lack of a NPDES permit increases the uncertainty in the surface water release estimate for a facility." Lack of a NPDES permits also increases the likelihood of excessive PCE releases, since there is no regulatory mechanism to hold the discharger accountable and readily enforce effluent limitations. • EPA's decision to discount its own risk evaluations and to determinations of no unreasonable risk despite RQs of nearly 1,500 does not reflect of the "best available science."	exposures to invertebrates, an updated acute COC, an updated algae end point and COC. These updates include updates to the days of exceedance and RQs for the sites assessed which include the manufacturing of PCE, repackaging / importing, and incorporation of PCE into formulations COUs. Per 40 CFR 702.47, "…EPA will determine whether the chemical substance presents an unreasonable risk of injury to health or the environment under each condition of use within the scope of the risk evaluation…". This approach in the implementing regulations for TSCA risk evaluations is consistent with statutory text in TSCA section 6(b)(4)(A), which instructs EPA to conduct risk evaluations to determine whether a chemical substance presents an unreasonable risk "under the condition of use." EPA concluded that there is insufficient information to support analysis of aggregate exposure across multiple conditions of use. EPA acknowledges that the decision not to aggregate risk across conditions of use could result in an underestimate of risk.

	• Although EPA has correctly determined that PCE presents an unreasonable risk to the environment, it must address these concerns so that its final evaluation accurate reflects the full magnitude of PCE's harmful ecological impacts as required under TSCA • In the draft risk evaluation, EPA references direct PCE discharges from an Occidental Chemical Plant in Geismar, LA (COU: manufacturing) and a Honeywell Plant in Geismar, LA (COU: processing as a reactant) but does not discuss whether those facilities discharge to the same water bodies and, if so, what the effects of those combined discharges would be. EPA also identifies five different facilities discharging PCE to the Cherry Creek-South Platte River in Colorado but does not calculate the total risk to the species in that river from their combined discharges. Accordingly, EPA has not evaluated the total risks posed by "the chemical substance," as required.	
45	**PUBLIC COMMENTS:** The incidence of surface water concentrations exceeding the COC for PCE is quite rare. In fact, there are only three total use scenarios out of many for which EPA proposed a finding of unreasonable environmental risk. The COUs for two of the three, processing intermediate and catalyst regenerator, are the same as the use scenario for manufacturing because the sites at which those use scenarios take place are the same manufacturing facilities for which no unreasonable environmental risk was proposed.	EPA has revised environmental risk calculations based on revised aquatic hazard values for acute exposures to invertebrates, an updated acute COC, an updated algae end point and COC. These updates include updates to the days of exceedance and RQs for the sites assessed. In this final risk evaluation, EPA has determined there is no unreasonable risk to the environment (aquatic organisms) from all conditions of use of PCE.
Characterization of uncertainty		
SACC, 36	**SACC COMMENTS:** Recommendation: Account for uncertainties more completely to reduce the chances of underestimating risks to ONUs. The draft risk evaluation in Section 4.3.2.1 provides an evaluation and a brief overview in which it states (p. 401, lines 9930-9931): "Major uncertainties include the selection of cancer endpoint for IUR selection and inconclusive human evidence for a few health domains."	EPA has added a cross reference in the human health risk characterization section on uncertainties (Section 4.2.5.1) to Section 3.2.6. Regular PPE use is not expected for consumers or bystanders and therefore was not evaluated in characterizing risk to consumers or bystanders.

	• Several Committee members agreed that this is quite an understatement and probably needs additional discussion. Reference back to Section 3.2.6 would help readers of this long document easily find this uncertainty discussion. The draft risk evaluation clearly identifies the two key areas of uncertainty related to occupational user risk, namely dermal exposure, and PPE usage. One Committee member made the following observation. • Discussion of dermal exposures and related uncertainties are considered logical and consistent with the chemical properties of PCE and the desire to be protective of human health. • Risks to workers using PPE and whether, how, and where they should be discussed in the TSCA draft risk evaluation is a continuing topic of discussion for the Committee. Primarily there are little data to validate such usage during different occupational COUs. Nonetheless, it is appropriate that the evaluation reports MOEs both with and without PPE as is done in Table 4-112. • For consumer use, MOEs are only calculated without PPE use. While the rationale for no PPE use for consumers seems reasonable, the risk evaluation could add in the use of PPE and recalculate MOEs to demonstrate the beneficial impact of proper PPE use. Alternatively, simple reference to MOE calculations for different consumer COUs with and without PPE can be discussed where there are unreasonable risks identified for consumer use scenarios, to again demonstrate the potential beneficial impact of PPE use. The Committee expressed concern about designating ONUs in many scenarios as having no unreasonable risk without accounting adequately for uncertainties. The Committee recommended that EPA make more of an effort to reduce the chance of underestimating true risk. This is important because a designation of no unreasonable risk will limit options for future efforts to reduce their exposures.	EPA considers the uncertainties associated with each condition of use, and how the uncertainties may result in a risk estimate that overestimates or underestimates the risk. Based on such analysis, EPA determines whether or not the identified risks are unreasonable. Such consideration carries extra importance when the risk estimates are close to the benchmarks for acute, chronic non-cancer risks, and cancer risks. EPA does not have sufficient reasonably available information for performing a statistical analysis on PPE usage.

	PUBLIC COMMENTS: The current risk draft evaluation for PCE acknowledges that 8-hour PPE use should not be used by footnoting each risk estimation table in Chapter 4 with the note, "EPA does not expect routine use of PPE with this exposure scenario." That acknowledgement does not capture the uncertainty associated with PPE. Use and performance are the two key elements of PPE effectiveness and the note provides no way to incorporate either uncertainty into the risk evaluation. EPA should incorporate uncertainty analysis methods for PPE into the risk evaluation. As it does with other parameters in the risk estimation, EPA should define a statistical distribution for PPE usage and performance and apply Monte Carlo modeling to account for a range of PPE effectiveness. Several studies have proposed methods for characterizing uncertainty in respirator performance and usage.	
SACC	**SACC COMMENTS:** Recommendation: Consider reducing uncertainties associated with gender/age differences in dermal absorption by incorporating body weight. The Committee identified additional uncertainties and assumptions not considered in the draft risk evaluation. The draft risk evaluation estimates dermal exposure based on age and gender. This does represent actual dermal absorption of PCE since the hand surface area of each individual is as different as are their body weights. To improve the characterization of risk from dermal exposures, EPA should consider body weight in determining toxicity of PCE through dermal exposure.	Dermal dose is on a per-kg basis and therefore does account for body weight in the derivation of exposure dose.
SACC	**SACC COMMENTS:** Recommendation: Include in the risk estimation tables (*e.g.*, Table 4-108 and others) the exposure concentrations that are being compared with the HECs/UFs to produce the MOEs. The draft risk evaluation estimates PCE air concentrations for workplaces and in homes under the specified COUs. These estimates should be compared with PCE air concentration estimated in published research and/or in other PCE assessments, such as the PCE IRIS	Please refer to the risk calculator (*Risk Evaluation for Perchloroethylene Supplemental File: Occupational Exposure Risk Calculator* (U.S. EPA, 2020)) for detailed side-by-side presentation of risks and exposures for all exposure scenarios and relevant endpoints. The risk evaluation presents exposures in Section 2.4 and human health risks in Section 4.2 in order to

	Assessment inhalation RfC values. This would add interpretability and utility to the evaluation. For example, it will facilitate the interpretation of current and future workplace and residential air measurements. Along those lines, in Table 4-108 and the rest of the risk estimation tables, it would be helpful if the exposure concentrations that are being compared with the HECs/UFs to produce the MOEs could be included in these tables.	avoid being repetitive. Risk summary tables in Section 4.4.2 include cross-references back to the appropriate exposure subsection where exposures are presented.
Risk evaluation of potentially exposure or susceptible subpopulations		
SACC	**SACC COMMENTS:** The PESS characterization in this, as in other draft risk evaluations, is essentially *pro forma*. While the rationales for including all of the potential factors that might impact susceptibility are clear, specific data estimating the relatively increased susceptibility associated with these factors is not provided. This obviously creates uncertainty, which was appropriately incorporated into UF values that were used to calculate the various POD values. One Committee member thought that co-exposure to other similarly acting toxicants such as TCE should be addressed in this section as another factor that might increase PCE toxicity in PESS. One Committee member did not think the draft risk evaluation does a good job of evaluating or distinguishing the potentially exposed population from the susceptible subpopulations. The draft risk evaluation notes that susceptible subpopulations are people who may require a more protective overall acceptable limit to keep safe from the effects of the chemicals. The same Committee member also noted that if exposure levels are primarily set from animal data, there might be little evidence of the human range of response. In such a case, there should be more discussion of what the range of normal might be, and potential contributing factors should be considered, at least additively, to create a unique UF for the agent in question.	EPA acknowledges that other exposure to other chemicals may influence the response to PCE in the PESS section. As stated in Section 3.2.5.2, "co-exposure to other pollutants and drugs may also have either an activating or inhibitory effect on PCE-metabolizing enzymes." The Potentially Exposed and Susceptible Subpopulations are each described in succinct sections. Considerations for elevated exposure (*i.e.*, Potentially Exposed Subpopulations) are discussed in Section 2.4.3 and biological susceptibility (*i.e.*, Susceptible Subpopulations) is discussed in Section 3.2.5.2. Section 4.3.1 integrates both sections and describes how those considerations were accounted for in risk estimates.

SACC	**SACC COMMENTS:** Some Committee members remarked that 'bystanders' such as children exposed to PCE via geographic proximity to facilities producing fugitive PCE emissions or PCE emitted from worker's clothes in the home setting represent an additional sensitive population as children's brains may very vulnerable due to their immature detoxifying/metabolic capacity.	As explained in more detail in Section 1.4.2 of the Final Risk Evaluation, EPA believes it is both reasonable and prudent to tailor TSCA Risk Evaluations when other EPA offices have expertise and experience to address specific environmental media, rather than attempt to evaluate and regulate potential exposures and risks from those media under TSCA. EPA believes that coordinated action on exposure pathways and risks are adequately addressed by other EPA-administered statutes and regulatory programs is consistent with statutory text and legislative history, particularly as they pertain to TSCA's function as a "gap-filling" statute, and also furthers EPA aims to efficiently use Agency resources, avoid duplicating efforts taken pursuant to other Agency programs, and meet the statutory deadline for completing Risk Evaluations. EPA has therefore tailored the scope of the Risk Evaluation for PCE using authorities in TSCA Sections 6(b) and 9(b)(1).
26, 29, 36, 40, 50	**PUBLIC COMMENTS:** The draft risk evaluation identified a substantial number of PESS including pregnant women, the developing fetus, and newborn infants. Similarly, the PCE IRIS assessment indicates that "*In utero*, lipophilic substances are known to cross the placental barrier" and "[t]here is biological plausibility of transfer of [PCE] across the human placental barrier as [PCE] has been measured in fetal blood and amniotic fluid in rodents." IRIS also indicates that the "neurological effects of PCE may constitute the most sensitive endpoints of concern for noncancer effects, and limited data show that early lifestages may be more susceptible to visual deficits than are adults."	EPA does not ignore risks to infants, children, or pregnant women. EPA presents PODs and risk estimates for developmental toxicity, for which pregnant women and their developing fetus are susceptible. EPA also provides distinct consumer dermal risk estimates for different age groups including children. All lifestages including infants are included in consumer bystander exposure and risk estimates, however exposures are presented as air concentrations and therefore consumer inhalation risks do not differ between these lifestages.

	Although EPA has recognized the susceptibility of many of these subpopulations, it ignores the well-documented risks to infants, children, and pregnant women and fails to evaluate the risk that PCE poses to these subpopulations and, therefore, cannot determine whether that risk is reasonable or unreasonable. • Absent evidence demonstrating safety, EPA should pursue actions that minimize human exposure to PCE with careful attention to vulnerable populations, such as pregnant women and children. The risk evaluation must evaluate the risk to these particularly susceptible populations. EPA's failure to do so results in an underestimation of the overall risk of exposure to PCE.	
SACC, 41	**SACC COMMENTS:** Recommendation: Include in the PESS discussion individuals with existing liver (*e.g.*, fatty liver disease) or kidney dysfunction, or neurological problems related to vision or pattern recognition. The Committee found that EPA did not consider PESS within the general public that might be affected by environmental exposure to PCE. The draft risk evaluation discusses the usual factors affecting susceptibility including age, sex, polymorphisms in metabolism genes, and lifestyle factors. The potentially greater risk for pregnant women, the developing fetus, and newborn infants were also noted. Plus, in the case of the lipophilic PCE, people with more adipose tissue such as pubescent and adult women, or obese individuals, may retain PCE and thus be exposed to a sustained higher level of the chemical. Also unique to PCE, people with existing liver (*e.g.*, fatty liver disease) or kidney dysfunction, or neurological problems related to vision or pattern recognition may be at increased risk for PCE-induced toxicity. **PUBLIC COMMENTS:** TSCA mandates that a risk evaluation considers risks to a PESS. The PCE draft risk evaluation divides potentially exposed and susceptible subpopulations into two broad categories – subpopulations "identified as relevant based on greater exposure" and "subpopulations identified as	These considerations are all discussed in Section 3.2.5.2 in terms of affected subpopulations and the potential impact of these susceptibilities on PCE toxicity. As previously noted, EPA did not evaluate general population exposures or risks and has tailored the scope of the risk evaluation when exposure pathways and risks are addressed by other EPA-administered statutes and regulatory programs. These factors are all discussed in Section 3.2.5.2. EPA has clarified that an individual exhibiting any of the factors can be considered part of a susceptible subpopulation. EPA acknowledges uncertainty around whether it is possible to directly account for all possible PESS considerations and subpopulations in the risk estimates in Section 4.3.1.

	relevant based on greater susceptibility," but it fails to adequately assess the risks of PCE for either category. The PCE draft risk evaluation does not identify exactly which subpopulations it considers to be susceptible. • The PCE draft risk evaluation identifies the following as potential relevant factors: "lifestage, biological sex, genetic polymorphisms, race/ethnicity, pre-existing health status, lifestyle factors, and nutrition status." It then discusses the potential implications of lifestage ("child-bearing age"), biological sex ("pregnant women"), pre-existing health status ("liver or kidney dysfunction," "poor vision or neurocognitive deficiencies"), and nutrition status (but only regarding body fat composition). • It fails to address the race/ethnicity, lifestyle factors, and nutrition status (other than body fat composition). • It arbitrarily identifies specific susceptible subpopulations. For example, after stating that "pubescent and adult women (including women of child-bearing age)" may be more susceptible, it identifies as a susceptible subpopulation only "women of child-bearing age." • Similarly, it recognizes that "effects in male fertility are more likely to present in older men" but does not identify men of a particular age as a susceptible subpopulation. And while it states that "kidney and liver effects are of most concern to subpopulations with pre-existing liver or kidney dysfunction," it does not clearly designate such subpopulations, or those with poor vision or neurocognitive deficiencies, as a susceptible population, or discuss differential impact given variability in CYP metabolic capacity as susceptible under TSCA.	
41, 47	**PUBLIC COMMENTS:** There is concern that EPA has once again left out tribal populations' exposures to toxic chemicals from consideration, mainly by: (1) not evaluating tribes as PESS; (2) assuming that environmental statutes are protective of tribal communities; and (3) not considering all COUs and all exposure pathways.	The commenter appears to be describing aspects of the Land Disposal Program Flexibility Act of 1996, codified at RCRA section 3010a(c)(5) and (6). The law directed EPA to provide additional flexibility to approved states for landfills that receive 20 tons or less of municipal solid waste per day. The additional flexibility applies to

	TSCA defines a PESS as a "group of individuals within the general population identified by the Administrator who, due to either greater susceptibility or greater exposure, may be at a greater risk than the general population of adverse health effects from exposure to a chemical substance or mixture, such as infants, children, pregnant women, workers, or the elderly." • Tribes clearly meet this definition but are not considered as PESS in this or previous TSCA draft risk evaluations. If tribal risks are not evaluated under TSCA, they will not be included in future risk management decisions and tribes will be left unprotected. The purpose of the new TSCA risk assessment process is to evaluate toxic chemical risks to Americans and use that information to make decisions that protect them from unreasonable risk. • Tribes have unique lifeways that place them at different risk due to multiple exposure pathways not experienced in the general population, including differences in diet (*e.g.*, higher fish consumption), higher consumption of deer, elk, and other wildlife that may be contaminated from industrial and mine releases to tribal lands, housing (*i.e.*, substandard, older furnishings, absent of garages for storage, and associated with dirt yards and unpaved roads), worker safety protocols (*i.e.*, less stringent due to small businesses, self-employment, do-it-yourself practices, and absence of OSHA oversight), and water use (with respect to drinking, hygienic use, ceremonial use, cultural activities, subsistence activities, recreational activities, and other lifeways). Native Americans may be exposed at a greater frequency and duration than those of the general population or other human receptor groups. While exposures are unique to each tribe, it is possible to distinguish broad categories of tribal exposure scenarios that tribes are likely to face that differ from the general population.	alternative frequencies of daily cover, frequencies of methane monitoring, infiltration layers for final cover, and means for demonstrating financial assurance. Section 3010a(c)(6). Further, under section 3010a(c)(5), if the Alaska governor certifies that application of the requirements for groundwater monitoring, siting, or corrective action to a solid waste landfill unit of a Native village, or a unit located in or near a small, remote Alaska village, would be infeasible, would not be cost-effective, or would be otherwise inappropriate because of the remote location of the unit, Alaska may exempt the unit from some or all of those requirements. It is not at all clear to EPA that Congress intended for TSCA to override the flexibilities specifically provided for small municipal solid waste landfills and the additional flexibilities specifically provided to Alaska in the Land Disposal Program Flexibility Act of 1996. EPA believes that the 1996 Act represents Congressional recognition that the RCRA Subtitle D program is not always feasible, or practicable, for the small landfills covered by the Act, and the additional flexibility provided by the Act is therefore necessary and appropriate. EPA remains committed to ensure environmental justice is integrated into EPA's programs to strengthen environmental and public health protections. TSCA requires EPA to consider potentially exposed or susceptible subpopulations as part of the risk evaluation

	• Many tribal communities live in proximity to a landfill or other waste disposal site, such as a transfer station. For example, 75% of the 229 tribal communities in Alaska have residents living within 1 mile of unlined landfills, which lack design performance, are open access, and employ open burning without emissions treatment as a waste management strategy, all in compliance with RCRA Subtitle D, as well as the CAA, which includes a specific provision for Alaska villages. • Because such communities are often off the road system, drinking water sources and primary diet sources are typically proximate, so that aggregate exposures are likely to be present. Analyses of the aggregate exposures associated with living in proximity to such landfills must be analyzed for individual and aggregate exposures that tribal members face from their customary and traditional lifeways. If they are not analyzed, no determination can be made on the risk these populations face. • When EPA presumes that environmental and other federal statutes protect a population from chemical release exposures, it must consider tribes practicing ceremonial and traditional activities, which are a protected basic American right under the American Indian Religious Freedom Act of 1978 (AIRFA). EPA's TSCA risk assessment process includes a risk management stage following the risk evaluation stage. EPA cannot adequately manage chemical risks to tribal populations without including tribal practices in the risk evaluations. Without addressing these risks, EPA risks violating AIRFA. Exclusion of tribes from risk assessment is not only in violation of TSCA, but also in violation of EPA's commitment to integrating environmental justice into "the development, implementation, and enforcement of environmental laws, regulations, and policies." • Environmental justice is defined as the fair treatment and meaningful involvement of all people regardless of race, color,	process, which the Agency views as carrying out the spirit of Executive Order 12898.

	national origin, or income, with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies. • According to EPA, "no group of people should bear a disproportionate share of the negative environmental consequences resulting from industrial, governmental, and commercial operations or policies." Executive Order 12898, to which risk assessment processes are subject, directs federal agencies to identify and address "the disproportionately high and adverse human health or environmental effects of their actions on minority and low-income populations." • Tribes are a minority and low-income population whose lifeways place them at higher exposure potential to chemicals. In not including exposure scenarios representative of tribal lifeways in its risk assessment process, tribal risks are left unevaluated, and tribes are left with a disproportionate share of negative consequences and effects resulting from EPA's TSCA policies and operations. • EPA's SACC, in its November 2019 report on the hexabromocyclododecane (HBCD) and 1,4-dioxane draft risk evaluations, agreed with the recommendation that EPA must give special consideration to specific populations (including tribal) that depend on fish as a major food source owing to cultural considerations and provide some quantitative sense of how much extra risk exists for these subpopulations; in considering special and susceptible population exposures, more consideration should be given to subpopulations with specific pre-existing conditions, such as metabolic disease and obesity, as well as to tribal, ethnic, and other subpopulations that depend heavily on potentially contaminated foods, such as Native American subsistence fishers.	

	• The SACC also recommended that the assessment would be improved by the inclusion of a graphic that illustrates exposure routes for potentially sensitive or highly exposed populations. To protect all Americans, not just Americans who can be represented through general population exposures, TSCA requires that EPA decisions identify and protect PESS. Without evaluating risks to PESS, it would be impossible to propose protection of PESS, except in the case of a chemical ban. This is especially important because general population exposures have not been evaluated in this draft risk evaluation. Environmental statutes do not guarantee protection from exposures, particularly in the case of tribes. Tribes are generally remote, rural, and small populations, and federal statute variances, exemptions, exclusions, and local flexibilities tend to be promulgated specifically for these very demographics. • In proposing blanket determinations as to whether releases are managed under RCRA, CWA, SDWA, or CAA, EPA does not consider populations impacted by environmental releases falling under its own exemptions. In doing so, EPA is failing in its mission to adequately protect not only the health of tribes, but of other rural, remote, and small populations that fall through the regulatory cracks. • Because exceptions for small systems, businesses, and communities are common throughout federal statute authorities, and tribes use resources in ways that are not considered in granting such exceptions, evaluating all primary tribal exposure pathways under TSCA is critical. It is not acceptable to assume blanket protections when these statutes wholly or partially exclude the protection of tribal people.	

	Despite feedback from SACC and the National Tribal Toxics Council (NTTC) work to educate EPA on tribal exposures, tribes were not considered as PESS in the PCE draft risk evaluation. The TSCA amendments of 2016 require that EPA consider all PESS for each chemical risk evaluation and EPA should evaluate tribes as PESS in the final risk evaluation for PCE.	
47	**PUBLIC COMMENTS:** There is a paucity of data on tribal risks. Tribal people are underrepresented or absent from EPA's risk evaluations and proposed actions. • It is well-documented in the scientific and medical literature that Native Americans experience significant health disparities as compared to the general population. The practice of leaving tribes out of risk evaluations, and excluding them from risk management strategies, will only contribute to further health disparities. • NTTC has provided detailed information to EPA on multiple chronic chemical exposures tribal people experience, including those presented by living in proximity to unlined landfills and other waste disposal sites, many of which are managed with unmonitored and untreated waste burning. To protect tribal communities, their unique lifeways and exposures must be considered by EPA. NTTC is willing to assist EPA in obtaining or generating relevant data on tribal risks and exposures that EPA can use to accurately determine tribal risks.	EPA does not make racial or ethnic distinctions in its risk evaluation of existing chemicals. Instead it conducts its risk evaluation to include all potentially exposed members of the general population, when the general population is evaluated, or any employee or consumer of a specifically identified product or condition of use. Furthermore, EPA assesses exposures to "potentially exposed or susceptible subpopulations" where appropriate. EPA appreciates NTTC's willingness to improve the quality of exposure data used for future risk evaluations.
47	**PUBLIC COMMENTS:** On p. 32 of the PCE draft risk evaluation, EPA states, PESS "include the developing fetus (and by extension, women of childbearing age) as well as those with pre-existing health conditions, higher body fat content, or particular genetic polymorphisms." According to the U.S. DHHS, American Indian/Alaska Native (AI/AN) adults are 50% more likely to be obese than the non-Hispanic white (NHW) population, which results in higher body fat content. AI/AN people also have higher rates of chronic diseases than other ethnic	As stated by the commenter, EPA addresses higher body fat content in the risk evaluation (both in the executive summary and more so in Section 3.2.5.2). EPA acknowledges that certain populations are more likely to exhibit particular susceptibilities than the general population.

	groups in the U.S. For example, AI/AN adults are almost 3 times more likely than NHW adults to be diagnosed with diabetes and are 2.5 times more likely than NHWs to die from diabetes. AI/ANs are also more likely to have chronic liver disease, heart disease, chronic lower respiratory diseases, and high blood pressure.	
47	**PUBLIC COMMENTS:** On pp. 272-273 of the PCE draft risk evaluation, EPA mentions a thorough review of epidemiological data EPA performed in 2012, which found that "there was a pattern of evidence associated PCE exposures with several types of cancer, specifically bladder cancer, non-Hodgkin's lymphoma (NHL), and multiple myeloma (MM), and more limited data supporting a suggestive effect were available for cancer at other sites, including esophageal, kidney, lung, liver, cervical, and breast cancer." • AI/AN women are 2.3 times more likely to have and 2 times more likely to die from liver cancer, as compared to NHW women and 20% more likely to have kidney cancer. AI/AN men are also almost 2 times as likely to have liver cancer than NHW men. Further, while AI/AN lung cancer incidence rates are lower overall, their mortality rate is 17% higher than that for NHW. Additionally, Alaska Native people have 53% higher lung cancer incidence rate than the NHW population.	As stated by the commenter, the epidemiological evidence for each of these cancer types was thoroughly reviewed. EPA acknowledges that certain populations are more likely to exhibit particular susceptibilities than the general population.
47	**PUBLIC COMMENTS:** Private drinking water wells are unregulated by SDWA. Due to the rural and remote nature of most reservations, multiple tribes have residents relying on individual groundwater wells or community water systems serving less than 25 people, which are also exempt from SDWA.	PCE is expected to hydrolyze in groundwater. EPA determined during problem formulation that no further analysis beyond what was presented in the problem formulation document would be done for the ambient water pathway in the risk evaluation. However, during the systematic review process, EPA identified and evaluated additional studies that warranted further evaluation. Therefore, exposures to aquatic organisms from ambient surface water,

		were assessed and presented in this risk evaluation and used to inform the risk determination. These analyses are described in Sections 2.1, 2.3, and 4.1
47	**PUBLIC COMMENTS:** PCE has moderate potential to accumulate in sediment. Sediment immersion during subsistence activities is common for tribes. Human exposure to PCE was not evaluated via pathways covered by the CWA in this draft risk evaluation. CWA exemptions and exceptions leave tribes (and other small communities) unprotected. • Tribal communities and reservations typically support multiple small businesses and self-employed contractors. The Small Business Exemption under CWA § 122.21(g)(8) does not consider local use of water for the wide variety of tribal uses, and the vast majority of tribes at this time have no specific delegated authority to make the exemption more stringent.	EPA does not make racial or ethnic distinctions in its risk evaluation of existing chemicals. Instead it conducts its risk evaluation to include all members of the general population, when the general population is evaluated, or any worker or consumer of a specifically identified product or condition of use. Furthermore, EPA assesses exposures to "potentially exposed or susceptible subpopulations" where appropriate. As explained in more detail in Section 1.4.2 of the Final Risk Evaluation, EPA believes it is both reasonable and prudent to tailor TSCA Risk Evaluations when other EPA offices have expertise and experience to address specific environmental media, rather than attempt to evaluate and regulate potential exposures and risks from those media under TSCA. EPA believes that coordinated action on exposure pathways and risks are adequately addressed by other EPA-administered statutes and regulatory programs is consistent with statutory text and legislative history, particularly as they pertain to TSCA's function as a "gap-filling" statute, and also furthers EPA aims to efficiently use Agency resources, avoid duplicating efforts taken pursuant to other Agency programs, and meet the

		statutory deadline for completing Risk Evaluations. EPA has therefore tailored the scope of the Risk Evaluation for PCE using authorities in TSCA Sections 6(b) and 9(b)(1).
47	**PUBLIC COMMENTS:** Water quality criteria developed under CWA 304(a) are calculated to be protective of the general population and not subpopulations like tribes. • The tribal fish consumption rate is an order of magnitude higher than the general population. EPA acknowledges that the CWA can be considered only protective for a majority of the general population. By not considering unique exposure pathways or high-end users, EPA fails in its responsibility to evaluate risks to PESS under TSCA.	EPA determined that PCE has low bioaccumulation potential and is therefore not a significant concern for communities with elevated fish ingestion.
47	**PUBLIC COMMENTS:** Multiple exemptions to the CAA leave tribes unprotected from certain exposures and the risks that they face need to be evaluated under TSCA. • A majority of Native American tribes live in rural areas where individuals employ barrels for burning of household wastes. • Small and Remote Commercial/Industrial Solid Waste Incineration (CISWI) units such as those used at mine camps, oil/gas facilities, and construction camps are likewise subject to reduced burdens of reporting and monitoring. Owing to small population sizes, and the inherent nature of natural resource development occurring in rural areas, tribes are more likely to live near incineration units with less stringent regulations.	EPA considers both exposure and hazard in evaluating potentially exposed and susceptible subpopulation (PESS)s. Factors affecting susceptibility include lifestage, gender, genetic polymorphisms, race/ethnicity, preexisting health status, lifestyle factors, and nutrition status. These additional susceptibility factors that are not explicitly quantified in the hazard assessment are expected to be accounted for through the use of a 10x UF to account for human variability. EPA believes it is both reasonable and prudent to tailor TSCA risk evaluations when other EPA offices have expertise and experience to address specific environmental media, rather than attempt to evaluate and regulate potential exposures and risks from those media under TSCA. EPA believes that coordinated action on exposure pathways and risks addressed by other EPA-administered statutes and regulatory programs is
47	**PUBLIC COMMENTS:** Beyond the sections of the CAA dealing with waste disposal, states, local governments, and tribes can be given delegated responsibilities for developing emission plans for area sources and small businesses. These sources may be under general permits, which again do not guarantee monitoring or compliance for HAPs, and may thus be subject to little or no enforcement. In addition, many tribes are impacted by state-issued permits, that are often violated and leave tribal lands with elevated	

	levels of contamination. Tribal members are left unprotected by the CAA and rely on the intent and foundation of TSCA to offer some protections.	consistent with statutory text and legislative history, particularly as they pertain to TSCA's function as a "gap-filling" statute, and also furthers EPA aims to efficiently use Agency resources, avoid duplicating efforts taken pursuant to other Agency programs, and meet the statutory deadline for completing risk evaluations.
47	**PUBLIC COMMENTS:** Assuming that the RCRA is universally protective is inaccurate, especially in the case of tribes and their potential waste disposal exposure scenarios. Most tribal populations are in rural areas and operate or use waste transfer stations, which are not regulated by RCRA. They are not subject to federal design or monitoring requirements and are likely to allow public access and be unlined. Outside of Alaska, a majority of tribes use such facilities and they are often located proximate to residences for service convenience. Because they often reside in rural areas with small populations, tribal communities may live proximate to tribal or county landfills receiving less than 20 tons/day, equivalent to a population base of about 10,000 persons. Under RCRA and the 1996 Land Disposal Program Flexibility Act (LDPFA), such landfills are exempted from the requirements of larger facilities, including daily cover, leachate treatment, gas recovery, and liners. Aggregate exposures that presume PESS and worker proximate residence, access and use of the facility, and a range of lifeways practiced near and in lands and waters impacted by facility environmental releases must be considered.	The commenter appears to be describing aspects of the Land Disposal Program Flexibility Act of 1996, codified at RCRA section 3010a(c)(5) and (6). The law directed EPA to provide additional flexibility to approved states for landfills that receive 20 tons or less of municipal solid waste per day. The additional flexibility applies to alternative frequencies of daily cover, frequencies of methane monitoring, infiltration layers for final cover, and means for demonstrating financial assurance. Section 3010a(c)(6). Further, under section 3010a(c)(5), if the Alaska governor certifies that application of the requirements for groundwater monitoring, siting, or corrective action to a solid waste landfill unit of a Native village, or a unit located in or near a small, remote Alaska village, would be infeasible, would not be cost-effective, or would be otherwise inappropriate because of the remote location of the unit, Alaska may exempt the unit from some or all of those requirements. It is not at all clear to EPA that Congress intended for TSCA to override the flexibilities specifically provided for small municipal solid waste landfills and the additional flexibilities specifically

		provided to Alaska in the Land Disposal Program Flexibility Act of 1996. EPA believes that the 1996 Act represents Congressional recognition that the RCRA Subtitle D program is not always feasible, or practicable, for the small landfills covered by the Act, and the additional flexibility provided by the Act is therefore necessary and appropriate. EPA did not consider aggregate or background exposure that workers, ONUs, consumers, or bystanders might be exposed to in addition to exposures from the conditions of use in the scope of the risk evaluation because there is insufficient information reasonably available as to the likelihood of this scenario or the relative distribution of exposures from each pathway. This may result in an underestimation of risk, and EPA acknowledges that risk is likely to be elevated for individuals who experience TCE exposure in multiple contexts. Additional discussion of this issue has been added to Sections 2.4.2.6, and 4.3.2.
47	**PUBLIC COMMENTS:** NTTC notes that unreasonable risk was found for aquatic organisms from PCE exposures based on direct releases from processing as a reactant COU, and indirect releases from incorporation into formulations COU. Risks from PCE exposures were identified for algae based on direct and indirect releases from multiple COUs, including waste handling, disposal, treatment, and recycling. • These risks were found despite the very limited scope of COUs, and the exclusion of any consideration of releases from unlined disposal facilities near tribal populations, such as very small municipal	EPA has revised unreasonable risk determinations for risk to the environment (aquatic organisms) based on revised aquatic hazard values for acute exposures to fish, amphibian, and invertebrates, an updated acute COC, an updated algae end point and COC, and updates to the days of exceedance for the sites assessed.

	landfills, transfer stations, and construction landfills. • As noted, tribes depend on locally caught fish, algae (seaweed), and shellfish for their diets in far greater amount and in greater diversity that the general population. • It is recognized that fish consumption may not be an appreciable exposure pathway for the general population; however, there is a spiritual connection between fish and many tribes, and harm to them results in harm to tribal peoples' health. This draft risk evaluation does not include a method to examine such harm. A risk management strategy for PCE should be proposed that reduces all releases to the environment, to the point where aquatic species are not negatively impacted.	EPA determined that PCE has low bioaccumulation potential and is therefore not a significant concern for communities with elevated fish ingestion. EPA will initiate TSCA section 6(a) risk management actions on the conditions of use determined to present an unreasonable risk injury to health or the environment as required under TSCA section 6.
47	**PUBLIC COMMENTS:** Not considering legacy use, and the risks it poses, disproportionately affects tribes. According to the U.S. Census, Native Americans experience the highest poverty rate in the country, much higher than the general population. Low income housing is prevalent in tribal communities. Older electronics, furniture, and thrift store purchases can lead to continued and chronic exposure to toxins inside people's homes. • As determined by the Ninth Circuit Court of Appeals, EPA can no longer exclude "legacy" chemical uses from a risk evaluation, nor can it exclude any COUs from consideration. EPA is urged to consider the impacts of legacy use of PCE on tribal populations.	EPA evaluated uses that are known, intended, or reasonable foreseen to occur. EPA did not identify any "legacy uses" (*i.e.*, circumstances associated with activities that do not reflect ongoing or prospective manufacturing, processing, or distribution) or "associated disposal" (*i.e.*, future disposal from legacy uses) of PCE, as those terms are described in EPA's Risk Evaluation Rule, 82 FR 33726, 33729 (July 20, 2017). Therefore, no such uses or disposals were added to the scope of the risk evaluation for PCE following the issuance of the opinion in *Safer Chemicals, Healthy Families v. EPA*, 943 F.3d 397 (9th Cir. 2019). EPA did not evaluate "legacy disposal" (*i.e.*, disposals that have already occurred) in the risk evaluation, because legacy disposal is not a "condition of use" under *Safer Chemicals*, 943 F.3d 397.
29, 40, 50, 52	**PUBLIC COMMENTS:** In the draft risk evaluation, when EPA lists PESS, its listings leave out a number of susceptible groups when discussing workers, ONUs, and	Both workers and consumers are considered PESS in this Risk Evaluation, as described in Section 2.4.3.

	consumers. This is especially clear when considering the example of dry cleaners. People working in dry-cleaning industries or using metal degreasing products may be exposed to elevated levels of PCE. The draft risk evaluation also ignores the well-documented risks to those who live near dry-cleaning facilities. • Of particular concern are subpopulations with elevated exposures because of proximity to dry-cleaning operations, including consumers who patronize dry cleaners or use do-it-yourself cleaners, families of dry-cleaning employees, residents of apartments near, next to, or above dry cleaners, and occupants of nearby homes and businesses. • Risks to residents of areas with elevated air concentrations from dry cleaners or vapor degreasing operations exceed EPA unreasonable risk benchmarks even without considering other sources of exposure. EPA acknowledged that residents living in the same building as a dry cleaner may receive significantly higher exposure than other non-collocated receptors due to their proximity to the source. Residential apartments and other buildings near dry cleaners have been shown to have high PCE concentrations caused by vapors that travel through elevator shafts and air vents. • Although these groups comprise PESS under TSCA, they are nowhere addressed in the draft risk evaluation. This is a serious shortcoming, which has the effect of dramatically underestimating the size of PCE-exposed population and overlooking significant contributors to risk. Failure to address these subpopulations results in an underestimation of the overall risk of exposure to PCE.	During Problem Formulation, EPA acknowledged that general population exposures may occur through inhalation, oral, and dermal routes. However, in the Risk Evaluation, EPA did not include pathways under the jurisdiction of other environmental statutes, administered by EPA. As explained in more detail in Section 1.4.2 of the Risk Evaluation, EPA believes it is both reasonable and prudent to tailor TSCA risk evaluations when other EPA offices have expertise and experience to address specific environmental media, rather than attempt to evaluate and regulate potential exposures and risks from those media under TSCA, and has therefore tailored the scope of the Risk Evaluation for PCE. Therefore, general population exposure pathways were not included in the scope of the risk evaluation. Because stationary source releases of PCE to ambient air are covered under the CAA, EPA did not evaluate emission pathways to ambient air from commercial and industrial stationary sources or associated inhalation exposure of the general population. Because the drinking water exposure pathway for PCE is covered in the SDWA regulatory analytical process for public water systems, EPA did not include this pathway in the risk evaluation for PCE under TSCA. Because general population exposures to PCE via underground injection, RCRA Subtitle C hazardous waste landfills, RCRA Subtitle D municipal solid waste (MSW) landfills, and on-
52	**PUBLIC COMMENTS:** EPA fails to consider people who live in mixed-use housing above dry cleaners. Data show that people living above dry cleaners can have higher exposures than the general population and to not consider these exposures could significantly underestimate risk. ATSDR in their report on PCE conclude "[i]ndoor air of apartments where dry cleaners lived	

	was about 0.04 ppm compared to 0.003 ppm in the apartments of the controls, indicating that dry cleaners serve as a source of exposure for their families. Breath concentrations of tetrachloroethylene in dry cleaners, family members, and controls were 0.65, 0.05, and 0.001 ppm, respectively."	site releases to land from industrial non-hazardous waste and construction/demolition waste landfills are under the jurisdiction of and addressed by other EPA-administered statutes and associated regulatory programs, EPA did not evaluate exposures to the general population from those pathways. EPA did not include Superfund on-site releases to the environment, as they are under the jurisdiction of CERCLA. Lastly, EPA did not include emissions to ambient air from municipal and industrial waste incineration and energy recovery units in the risk evaluation, as they are regulated under section 129 of the Clean Air Act.
50, 52	**PUBLIC COMMENTS:** EPA ignores risks to those who live near hazardous waste sites and may be exposed to higher levels of PCE than the general population. EPA has found at least 945 hazardous waste sites contaminated with PCE on the NPL that are targeted for federal clean-up activities. PCE is also present at numerous other non-NPL hazardous waste sites throughout the country. Significantly, hazardous waste sites are often in low-income and/or communities of color presenting potential environmental injustice. • Nearby residents may face the impacts of not just disposal of chemical contaminants, but also the impact of any potential leakage; this should be accounted for in the risk evaluation. EPA must consider the risk to subpopulations with elevated exposures because of their proximity to hazardous waste sites. These subpopulations include occupants of nearby homes, businesses, schools, and daycares. EPA's failure to address the risk to these subpopulations results in an underestimation of the overall risk of exposure to PCE.	
29, 40	**PUBLIC COMMENTS:** Urban neighborhoods in proximity to dry cleaners, high-emitting industrial facilities, and NPL sites, and whose residents consume PCE-contaminated drinking water, is example of a subpopulation that, depending on the circumstances, can greatly exceed general population exposure levels. Individuals living in these communities would inhale elevated PCE levels in indoor and outside air, ingest additional PCE in drinking water, and inhale PCE volatilized during bathing and showering. The higher exposure levels from these multiple sources would make the community a PESS, for which EPA must make a specific unreasonable risk determination under TSCA.	

	• Some community members might also work in PCE processing or manufacturing facilities and/or use PCE-containing consumer products, adding to environmentally related exposures and thus increasing likely risks. This subset of the community would also comprise a PESS that requires a specific assessment of unreasonable risk. For both PESS, the combination of exposure sources would likely result in MOEs well below benchmark MOEs for non-cancer endpoints and cancer risks far above $1x10^{-6}$. A comprehensive risk evaluation as required by TSCA would identify these PESS, estimate total exposure from all sources, and characterize the increased risk resulting from concurrent exposure pathways. The draft PCE evaluation fails to provide this analysis and therefore presents an unrepresentative and incomplete picture of PCE's risks to the public.	
29, 40, 41	**PUBLIC COMMENTS:** Subpopulations exposed to PCE by multiple pathways that likely have higher exposure levels than the general population and face elevated health risks should be considered PESS for which EPA must make specific determinations of unreasonable risk under TSCA	
52	**PUBLIC COMMENTS:** EPA's identification of PESS in the PCE draft risk evaluation does not specifically account for the groups that can have higher exposure to PCE, and groups that can have higher susceptibility due to concurrent health conditions. Workers operating as essential businesses during the COVID pandemic, may be at increased respiratory risks for COVID, due to their chronic PCE exposures.	EPA identifies "preexisting health status", race/ethnicity, and nutrition status as factors influencing biological susceptibility in Sections 3.2.5.2 and 4.3.1. Per the statute (see TSCA section 6(b)(4)(A)) and the implementing regulations for risk evaluations (40 CFR part 702, subpart B), during risk evaluation EPA must determine whether the chemical substance presents unreasonable risk under its conditions of use. For the risk evaluation, factors affecting susceptibility examined in the available studies on PCE include life stage, biological sex, genetic polymorphisms, race/ethnicity, preexisting health status, lifestyle factors, and nutrition status. EPA, however, acknowledges that it was unable to
50	**PUBLIC COMMENTS:** Residents of low-income and/or communities of color face greatest exposure to PCE, making EPA's failure to comply with TSCA and the EPA implementing regulations particularly egregious from the perspective of environmental justice. • An analysis of environmental justice programs adopted by the South Coast Air Quality Management District as part of its regulation to phase out PCE used by dry cleaners found that, even with financial	

	incentives available to dry cleaners to make the shift from PCE to greener technologies, dry cleaners in low-income, predominantly communities of color were less likely to receive a grant to switch to these technologies despite the effort to set aside half of the funding for applicants from these communities.	directly account for all possible potentially exposed or susceptible subpopulations considerations and subpopulations in the risk estimates. After making a final unreasonable risk determination, EPA will initiate TSCA section 6(a) risk management actions on these conditions of use as required under TSCA section 6. In making unreasonable risk determinations, EPA considers relevant risk-related factors, including, the population exposed (including any potentially exposed or susceptible subpopulations). TSCA requires EPA to consider PESS as part of the risk evaluation process, which the Agency views as carrying out the spirit of Executive Order 12898 relating to environmental justice in minority populations and low-income populations. During the risk management process, EPA will take into account environmental justice considerations as directed by Executive Order 12898 (59 FR 7629, February 16, 1994).
47	**PUBLIC COMMENTS:** Chemical regulation under TSCA is the most effective means that EPA has to achieving its mission to protect human and environmental health. EPA should take advantage of the authority granted by the Frank R. Lautenberg Chemical Safety Act and work to improve TSCA risk evaluations by fully applying them to subpopulations with the highest potential for exposure and those that are most susceptible. Rather than relying on environmental regulations to limit the impact of chemicals to human and environmental health, TSCA could be the primary regulatory backstop that keeps harmful chemicals from impacting the health and safety of U.S. citizens.	As explained in more detail in section 1.4.2, EPA believes that coordinated action on exposure pathways and risks addressed by other EPA-administered statutes and regulatory programs is consistent with statutory text and legislative history, particularly as they pertain to TSCA's function as a "gap-filling" statute, and also furthers EPA aims to efficiently use Agency resources, avoid duplicating efforts taken pursuant to other Agency programs, and meet the

		statutory deadline for completing risk evaluations.

7. Overall Content and Organization

Overall Content and Organization		
Charge Question 7.1: Please comment on the overall quality and relevance of the resources used in this draft risk evaluation; describe data sources or models that could improve the risk evaluation. **Charge Question 7.2:** Please comment on the overall content, organization, and presentation of the draft risk evaluation of PCE. **Charge Question 7.3:** Please provide suggestions for improving the clarity of the information presented in the documents.		
#	**Summary of Comments for Specific Issues Related to Charge Question 7**	**EPA/OPPT Response**
Risk evaluation review schedule		
26, 48, 35, 54	**PUBLIC COMMENTS:** The schedule for review is inconsistent with best management practices and the process deprives the SACC of scientific and policy input that would be valuable in informing its review of draft risk evaluations and, thus, greatly reduces the value of the public comment process. • This reinforces the view that the current agency approach values a calendar deadline over the integrity of the information going into a decision and represents yet another example of its disdain for the scientific enterprise. • Furthermore, the process appears to be a mechanism to discourage comments from the stakeholder community. There was no real lead time before the preparatory meeting and only a 2-week or so lead time granted for public comments to reach the peer review committee before it meets, each of which is clearly inadequate for submitters to prepare meaningful comments on these substantial and consequential assessments. • The Federal Register Notice (FRN) published on May 4, 2020 stated a deadline for submitting comments or requesting an oral presentation of May 1, 2020; this was 3 days before the FRN was published. This notice only provided 15 days for stakeholders to review the draft risk evaluation. • The peer review committee meeting was scheduled in the middle of the comment period leaving the SACC committee less than a week	The Lautenberg amendments to TSCA provide a three- and one-half-year timeframe for completion of existing chemical risk evaluations. However, in the first year following enactment, EPA's focus was on issuing the Risk Evaluation Rule outlining the framework for implementing TSCA Section 6(b). Consequently, the time for completing the first 10 risk evaluations has been compressed. As discussed in the Introduction, EPA believed peer reviewers were most effective in this role if they received the benefit of public comments on draft risk evaluations prior to peer review. For this reason, and consistent with standard Agency practice, the public comment period preceded peer review. The final risk evaluation changed in response to public comments received on the draft risk evaluation and/or in response to peer review, which itself may be informed by public comments. EPA will consider these comments for future risk evaluations.

	to digest public comments. This only serves to place further pressure on the committee members to maintain a constant state of preparation on important and complex issues.	
47	**PUBLIC COMMENTS:** A 60-day comment period, the entirety of which occurs during a pandemic, is far too short to expect substantial tribal comments. The current pandemic disproportionately impacts tribal communities and many isolated tribal communities have had their supply chains severely disrupted. Tribal environmental staff, who typically would be the primary parties to research and prepare comments for discussion and direction from their Councils, are the very staff who are also responsible for leading their tribal nation's response to the numerous COVID-19 environmental health concerns. As a primary grantor to most federally recognized tribes, EPA is aware that many Tribal Councils are shut down except for essential operations by explicit order. It would be impossible for tribes to send in comments or for Councils to consider whether they wish to send in comments. EPA should provide an additional 90-day comment period on the PCE draft risk evaluation.	EPA appreciates the comment and will consider whether a longer comment period is warranted for future draft risk evaluations.
Quality, relevance, and impact of findings		
SACC, 30, 40	**SACC COMMENTS:** The Committee recognized that the TSCA systematic review protocol was undergoing the NAS review, and would, as a result, be modifying its protocol for future TSCA risk evaluations. In the interim, EPA could modify and use one of the existing systematic review methods. Existing systematic review methods include the Navigation Guide and the method by NTP's Office of Health Assessment and Translation (OHAT). **PUBLIC COMMENTS:** Given the many concerns that have been raised and lack of a completed peer review, EPA should abandon the TSCA protocol and instead apply one of the established methodologies for systematic review that are consistent with the definition developed by the Institute of Medicine (IOM), such as the NTP	EPA consulted multiple systematic review frameworks when developing the systematic review process for the first 10 TSCA risk evaluations. Revisions to systematic review are under development and these revisions also consider other systematic review methods. Finally, EPA also anticipates feedback from the NASEM TSCA Committee on its systematic review process and will carefully review and implement relevant recommendations.

	OHAT method or the Navigation Guide Systematic Review Method developed by the University of California San Francisco. These methodologies embody recognized principles of systematic review and have been endorsed by NAS and other peer review bodies. • Both the IRIS and the National Institute of Environmental Health Sciences (NIEHS) methods have been extensively peer reviewed and praised by the National Academies. • EPA's rationale for developing the TSCA systematic review should include a comparison to other systematic review approaches and describe the rationale for major differences.	
SACC	**SACC COMMENTS:** One Committee member opined that EPA's work on the present document began in December 2016, and that neither the introduction to the main document nor the SACC instructions or EPA's internet announcement of the current review explains that the primary toxicological review was published six years ago (Guyton et al., 2014. Environ Health Perspect 122(4): 325-334) and that the basis for, and derivation of, the EPA's PCE cancer potency factors were reviewed by the NRC 10 years ago. • Essentially, the current document repeats those same results. While the current manuscript does include cancer potency calculation (based on mouse and rat data extrapolated to humans), ecological factors, and discussion of measured and modeled workplace and consumer exposures that were not included in the EPA's 2014 publication, the basic science discussion is the repetition of previous EPA IRIS policy. • Overall, despite the length, there are few new keys, fundamental, or applied science details and conclusions presented that lead the reader to a greater understanding PCE hazards to human health.	EPA evaluated and considered all relevant studies for this Risk Evaluation as part of the systematic review process. While many conclusions of this Risk Evaluation are consistent with the IRIS assessment, they were determined independently of what was previously published and are consistent with considerations from the statute and the Risk Evaluation Rule. These conclusions incorporate hazard data both from the IRIS assessment and data published since the IRIS publication. These newer studies are integrated into the hazard ID and WOE sections (3.2.3 and 3.2.4). Additionally, newer epidemiological cancer studies were described in detail in Appendix G.1.11.

26, 30, 35, 40, 41, 50, 52	**PUBLIC COMMENTS:** EPA continues to employ a flawed approach to identify, sort, select, and exclude studies and other information to be used in this risk evaluation and then to grade their quality and acceptability for inclusion in the assessment. EPA fails to use a protocol that outlines the pre-established methods to be used throughout the systematic review process as required by EPA regulation under TSCA. In order for EPA to adequately address issues relating to its lack of transparency in accounting for all references identified in the literature search, EPA must immediately implement protocols for all future draft risk evaluations. • This is a critical methodological step absent in the draft risk evaluation for PCE, and the use of pre-established protocols minimizes such biases in the evidence base by explicitly pre-defining how: the questions will be formulated, the searches will be conducted, the eligibility criteria will be applied, and the quality of the included studies will be assessed. • Most importantly, it allows greater transparency in the decision-making process throughout the systematic review and is a fundamental element to ensure the integrity of evidence-based evaluations. • Not using predefined protocols directly contradicts the EPA's 2017 framework rules mandating that the agency use "a pre-established protocol" to conduct risk assessments. EPA is urged to immediately implement the use of pre-established protocols to enhance transparency in the decision-making process and consistency in their draft risk evaluations. Protocols developed for applying the OHAT method and the Navigation Guide Systematic Review Method have been published and can serve as a template to further expedite EPA's systematic reviews under TSCA.	The timeframe for development of the TSCA scope documents on the first 10 chemicals undergoing risk evaluation was very compressed. Risk evaluations initiated prior to the effective date of the Risk Evaluation Rule, 82 FR 33726 (July 20, 2017)), were conducted in accordance with the requirements in the Rule, including systematic review requirements, to the maximum extent practicable. See 40 CFR 702.35. Because the evaluation must be conducted to meet statutory deadlines, EPA had limited ability to develop a protocol upfront. For these reasons, the protocol development was staged in phases while conducting the assessment work: >First, in June, 2017, EPA published the title/abstract inclusion/exclusion criteria for PCE in Appendix E of the *Strategy for Conducting Literature Searches for Tetrachloroethylene (PERC)* and provided a full bibliography of PCE studies that were included and excluded during the title/abstract screening in *Perchloroethylene (CASRN: 127-18-4) Bibliography: Supplemental File for the TSCA Scope Document*. >Next, the full text screening inclusion/exclusion criteria statements were included in Appendix F of *Problem Formulation of the Risk Evaluation for Perchloroethylene*. Although EPA did not publish an upfront protocol, EPA reviewed multiple systematic

	• Lack of time is not a credible rationale for EPA's failure to conduct an evidence-based systematic review, including using pre-established and pre-published protocols. EPA should implement a systematic review method that is compatible with empirically based existing methods and aligns with the IOM's definition of a systematic review, including but not limited to, using explicit and pre-specified scientific methods for every step of the review. If EPA uses one of the aforementioned methods (OHAT or Navigation Guide), the Agency would not have to "make an effort to adopt as many best practices as practicable." • Since EPA has not published the systematic review documentation before releasing the draft scoping documents, reliance on the Systematic Review here violates the Administrative Procedure Act and EPA's own regulations governing the scoping process. Experts agree that systematic review methods need to be established in advance of individual evaluations to eliminate the potential for bias and to assure that evidence reviews are conducted using consistent, well-defined criteria. EPA's failure to take this necessary step before conducting risk evaluations has severely compromised the scientific validity of the 10 initial TSCA risk evaluations. • The NAS review of the draft systematic review guidance document will not be completed before the First 10 draft risk evaluations have gone through a round of public comment and peer review. This presents a significant challenge to the integrity of these 10 risk evaluations and, indeed, to the entirety of the Existing Chemicals review program. • No revised risk evaluation for *any* of the First 10 chemicals should be finalized until after EPA receives the report from the NAS committee, revises the guidance in accordance with the recommendations, and applies the revised guidance in a	review methods, consulted experts in systematic review (including individuals in the IRIS program) and relied on experienced, expert risk assessors to develop a robust and valid method for the TSCA risk evaluations that could be used across multiple disciplines: human health and environmental hazard; occupational, consumer and general population exposure; environmental fate and physical-chemical properties. EPA must publish final risk evaluations for the first 10 chemicals (to meet statutory deadlines) before receiving the final NASEM TSCA Committee report on the TSCA systematic review methods. Thus, EPA will not be able to incorporate the NASEM recommendations for the first 10 chemicals. EPA has considered all reasonably available information to inform the risk evaluation and has responded to numerous comments to update the risk estimates in the final risk evaluation.

	re-visit to every step of the process, with particular emphasis on the data evaluation and data integration stages. • No draft risk evaluation for the next 22 chemicals should be issued for public comment and peer review until the same milestones are achieved. • TSCA mandates that EPA conduct risk evaluations to determine whether a chemical substance presents an unreasonable risk to health or to the environment, without consideration of costs or other non-risk factors, and including PESS under the COUs. If EPA determines through its risk evaluation that a chemical substance presents an unreasonable risk, then it must regulate the chemical substance as dictated by TSCA. Thus, the failure to conduct a proper risk evaluation could have significant adverse consequences. If EPA underestimates or fails to account for certain risks in its evaluation, it may conclude that a chemical substance poses less risk and may not adopt robust regulations. The PCE draft risk evaluation could lead to such an outcome. Flaws in the risk evaluation, if not corrected, could lead to improper conclusions in the final risk evaluation. • We request that EPA withdraw the draft risk evaluation for PCE and reevaluate the risks posed by PCE in a manner that fully complies with its obligations under TSCA to conduct the necessary, thorough evaluation of the risks presented by this chemical before issuing its final risk evaluation.	
SACC	**SACC COMMENTS:** Recommendation: Provide in the draft risk evaluation a summary of how the literature search was performed, including listing key search terms used, to help readers understand the effort expended in reviewing the literature. • Section 1.5.1 Data and Information Collection: It is not completely clear if literature searches were done with both	Appendix B of *Strategy for Conducting Literature Searches for Tetrachloroethylene (PERC)* contains the key terms used in the literature search process for PCE. All search terms identified by the SACC commenter were used in the literature search for PCE.

	the terms "PCE" and "tetrachloroethylene." It would appear this was done because the term "tetrachloroethylene" does appear in several places. Although a supplemental document was provided that described the literature search strategy (PCE_lit_search_strategy_053017_0.pdf), this information was not clearly described there and could be very briefly explained in the draft risk evaluation. • The Committee noted with concern that many scientists alternatively refer to PCE as PERC, perchloroethylene, perchloroethene, tetrachloroethylene, or tetrachloroethene. If all these search terms are not used, there is potential for missing some key studies. While all of the search information appears to be present in the supplemental document Strategy for Conducting Literature Searches for Tetrachloroethylene (PCE), (U.S. EPA, 2017j), the main Evaluation document needs to be understandable and clear on critical points on its own without reference to external documents.	EPA received other comments that the risk evaluations should be streamlined and succinct. Therefore, EPA believes that it is sufficient to refer to more detailed information in the *Strategy* document and other supplemental documents within the PCE risk evaluation (see Section 1.5.1).
SACC, 52	**SACC COMMENTS:** The literature review produced some solid studies that were removed based on the ratings given by the Systematic Review. The veracity or justification for designations of "on-topic" or "off-topic" is difficult to assess. For example, ignoring or removing some of the epidemiologic studies judged to be "off-topic" is an important weakness. • The Committee suggested that references be reorganized in the systematic review under the justification used to designate on- or off-topic as well as by the factors used to exclude references for data quality reasons. • The Committee mentioned a couple of specific flaws that should be addressed. These include using data from a single study to represent an entire database and excluding information from studies that could have confirmatory value	In June, 2017, EPA published the title/abstract inclusion/exclusion criteria for PCE in Appendix E of the *Strategy for Conducting Literature Searches for Tetrachloroethylene (PERC)* and provided a full bibliography of PCE studies that were included and excluded during the title/abstract screening in *Perchloroethylene (CASRN: 127-18-4) Bibliography: Supplemental File for the TSCA Scope Document*. Although EPA did not provide a bibliography of studies that were excluded from full-text screening, the full text screening inclusion/exclusion criteria statements were included in Appendix F of *Problem Formulation*

	(*i.e.*, adds supports to the final estimate [say the POD or COC] but may not be adequate or of high enough quality to be used in deriving the final estimate). **PUBLIC COMMENTS:** EPA fails to document how every reference identified in the literature search was used in the draft risk evaluation. • The 'PCE Bibliography: Supplemental File for the TSCA Scope Document' for Human Health Hazard Literature Search Results, there are 28 pages of 'on topic' references, with ~ 25 citations per page, totaling approximately 700 'on topic' references. However, in 'Review Supplemental File: Data Quality Evaluation of Human Health Hazard Studies – Epidemiologic Studies,' there are only 93 epidemiological studies that go through data quality evaluation, leaving >600 'on-topic' references unaccounted for by EPA. • Inconsistencies in the reporting of the 'on' and 'off topic' studies across the draft risk evaluation and supplementary materials is concerning and threatens the validity of the draft risk evaluation for PCE (inserted table shows on-topic references as >700 in bibliography, 93 in supplemental file, 79 in Figure 1-9). • Fourteen epidemiological studies have been unaccounted for in the data evaluation step without any explanation by EPA (difference between supplemental file and Figure 1-9). • Figure 1-9 indicates that 66 studies have gone through the 'Data Extraction' step, yet according to 'Systematic Review Supplemental File: Data Quality Evaluation of Human Health Hazard Studies – Epidemiologic Studies,' EPA only excludes 10 studies based on an 'unacceptable' rating (a list of the 10 studies is provided), leaving 83 epidemiological studies to be included for data extraction. Therefore, 17 epidemiological studies that have been removed from the	*of the Risk Evaluation for Perchloroethylene*. The > 600 on topic citations during title/abstract screening would have been excluded during full text screening. EPA is working on a process for future risk evaluations that will more transparently show the individual citations that are included and excluded at each step of the TSCA systematic review process.

	PCE draft risk evaluation, again, without any explanation from EPA.	
SACC, 30, 40, 52	**SACC COMMENTS:** Recommendation: The current TSCA systematic review used to rate studies and data should be better described. Clarify the criteria used in the data quality review process for rating datasets to low, medium, or high quality. One Committee member noted that although the draft risk evaluation discusses the issues of quality and relevance in selecting studies, the criteria used to determine these are not clear. • Section 1.5.2 Data Evaluation: Criteria for assessing/assigning a confidence rating to studies (and data) as unacceptable, low, medium, or high need to be explicitly explained. Reference to previous EPA documents is not sufficient. This is a critical issue since study ratings factor heavily in the draft risk evaluation. Readers should understand specifically what the criteria are that exclude certain studies that other reviews may have to consider adequate for use. • A table summarizing the criteria should be provided for ratings of studies and data. For example, the draft risk evaluation has numerous statements such as: "data were determined to have a 'medium' data quality rating through EPA's systematic review process." One Committee member noted that different criteria may exist for each type of study, making a general summary of criteria difficult to create. • Data quality evaluations and counting studies: It is always helpful to evaluate data quality of studies based on consistent criteria. The biggest challenge that is of course not addressed is that this does not include evaluation of	EPA has thoroughly described the systematic review process used to rate studies, including multiple appendices describing the criteria used for data quality evaluations, in *Application of Systematic Review in TSCA Risk Evaluations*. EPA believes that the risk evaluations should be as streamlined and succinct as possible. Therefore, referring the readers to the *Applications* document, as was done in Section 1.5.2, for detailed information on the data quality evaluation criteria is sufficient. In the data quality criteria, EPA has included several metrics related to study design for epidemiological, *in vivo* animal toxicity and *in vitro* mechanistic toxicity studies. In particular, metric 10 of the animal study criteria addresses whether the exposure frequency and duration were appropriate for the study type and outcome of interest. EPA is currently updating the data quality criteria for these types of studies and will also implement any relevant recommendations from the NASEM TSCA committee, who are currently reviewing the TSCA data evaluation criteria. As stated in Appendix A of the *Applications* document, EPA's goal in using the numerical scoring system was to provide consistency and transparency to the process of evaluating

	whether the study design was matched well to the underlying exposure-effect relationship. If it is not, you can have a high-quality study that does not see the effects. • Another important source of data for the draft risk evaluation includes all the occupational and environmental exposure information collected across the U.S. As with the available published and industry studies, the draft risk evaluation explains that the systematic review is conducted in which available datasets are graded as being either unacceptable or acceptable with low, medium, or high quality. Repeated reference is made to this throughout the document, not only for exposure information but also for risk estimates and mode-of-action (MOA) studies. While there is reference made to standard EPA policy, there is no description in the draft risk evaluation of what specific properties are included in the various ratings listed above. EPA's TSCA systematic review method utilizes a quantitative scoring method that is incompatible with the best available science in fundamental ways and excludes multiple relevant studies from consideration in the risk evaluation. • Quantitative scores to assess the quality of an individual study are arbitrary and not evidence-based; the National Academies of Sciences, Engineering, and Medicine (NASEM) recommend against such scoring methods. The implicit assumption in quantitative scoring methods is that we know empirically how much each risk of bias domain contributes to study quality, and that these domains are independent of each other; this is not a scientifically supportable underlying assumption. An examination of the application of quality scores in meta-analysis found that quality-score weighting produced biased effect estimates, with the authors explaining that quality is not a singular	chemicals risks while simultaneously meeting the science standards under TSCA Section 26(h) and (i). Justification for the weights applied to the individual metrics is provided in the appendices to the *Applications* document. EPA considered whether to include separate metrics for adequacy of reporting compared with quality of the underlying research but opted to consider adequacy of reporting within the same metric as quality of the research. EPA is currently revising some criteria (*e.g.*, for animal toxicity) to more consistently score the lack of reporting. Although a study or data source could be considered unacceptable based on a serious flaw for a single metric, the situations resulting in serious flaws were not chosen arbitrarily. Instead, they are limited to study characteristics that make a study or data source unusable (*e.g.*, lack of a negative control group). In other situations, a metric may be downgraded to low, but those low scores do not result in an overall low score for the study unless a majority of metrics are given low scores. Even if a study is given an overall score of low, EPA has the discretion to use that study. Use of studies with low scores often depends on the amount of data reasonably available for the chemical being evaluated.

	dimension that is additive, but that it is possibly non-additive and non-linear. • EPA should provide justification for using a weighted scoring system and the rationale for the specific metrics used for differential weighting in its evaluation of studies. • EPA's scoring method wrongly conflates how well a study is reported with how well the underlying research was conducted. Study reporting addresses how well research findings are written up and is not a scientifically valid measure of the quality of the underlying research. The "Strengthening of Reporting of Observational Studies in Epidemiology" or "STROBE" Initiative is an example of a checklist of items that should be included in articles reporting such research. EPA's TSCA method uses reporting measures in its scoring of the quality of human studies, including incorporating reporting guidelines into the reasons for scoring studies "low quality" (Metrics 1 and 15) or "unacceptable for use" (Metrics 3, 4, 6, 7). The authors of the STROBE guidelines specifically note that the guidelines are not a measure of the quality of the underlying research. • EPA's scoring method excludes research based on one single reporting or methodological limitation. EPA has created an arbitrary list of metrics that make studies "unacceptable for use in the hazard assessment," for each type of evidence stream, *i.e.*, epidemiologic, animal, *in vitro.* For human epidemiologic studies, 14 of the 22 metrics can be scored as a 4 (unacceptable) due to a "serious flaw. There is no empirical basis for EPA's selected list of "serious flaws." The approach is inconsistent with the Navigation Guide and OHAT method. While there will be variation in the internal validity/quality across studies, it is more appropriate to exclude studies based on pre-defined inclusion/exclusion criteria when there is a large database,	EPA is updating some of the data quality criteria, including the unacceptable bin, based on experiences with the first 10 chemicals. EPA also anticipates feedback from the NASEM TSCA Committee, who will review EPA's systematic review process under TSCA.

	rather than an arbitrary rating of the evidence, based off one domain that is not empirically supported. • EPA's list of "serious flaws" are not all related to real flaws in the underlying research, including reporting guidelines and Analysis, "Statistical Power" (metric 13). Statistical power alone is not a valid measure of study quality and should not be used to exclude studies from consideration. • Multiple authoritative review bodies, including the EPA SACC, NASEM, and IOM, have concluded that overly quantitative criteria that exclude relevant studies are inappropriate in systematic review methods; using a scoring method is inappropriate and can exclude relevant evidence.	
40, 42, 53	**PUBLIC COMMENTS:** Data integration should include comparative analyses of positive and negative results, discussions of risk of bias, meta-analyses combining results across studies if appropriate, and visual displays of all relevant evidence. U.S. EPA (2018) points to several published tools and protocols to integrate scientific evidence beyond simple data quality scores. The PCE draft risk evaluation does not fully incorporate these tools such that all evidence for each endpoint can be examined, compared, and contrasted. Recent draft risk evaluations have also been based on a "hierarchy of preferences," a new concept that was not part of the original TSCA systematic review document and has likewise not been subject to peer review or public comment. EPA does not explain why some types of studies should receive preference over others in determining the WOE for a particular endpoint and on what basis these studies should be assigned to a "higher level." Thus, there are no objective criteria for determining which evidence to rely on and which to exclude, undermining	EPA will consider recommendations from the NASEM TSCA Committee for options regarding integrating evidence within and across evidence streams (*e.g.*, human, animal, mechanistic data for the human health hazard endpoint). EPA plans to use a more structured framework for evidence integration for the next set of chemicals evaluated under TSCA. For the final risk evaluation for PCE, EPA used a structured evidence integration framework to consider the evidence on PCE's association with immunotoxicity (see Appendix H of the risk evaluation).

	transparency and consistency in the systematic review process and encouraging subjective judgments. EPA should update its systematic review methodology to include the overall approach to evidence integration and weight of scientific evidence.	
SACC, 42, 53	**SACC COMMENTS:** Recommendation: Provide quality review findings on the PCE IRIS Assessment and ASTDR Toxicological Profile reviews. Many of the subsections in the draft risk evaluation that characterized the different non-cancer hazards are concise and well-organized. However, one problem in Section 3.2 identified by the Committee related to the data referencing, and the heavy, and sometimes inappropriate use of what are essentially review articles (*e.g.*, 2019 ATSDR Toxicological Profile or 2012 EPA IRIS Assessment). • Providing a list of individual studies, or if using a review article, indicating at least the number of studies reviewed (*e.g.*, >10 studies) allows the reader to judge the weight of the published evidence. • The Committee noted numerous instances where the evaluation is discussing what is clearly an individual study but references the review (*e.g.*, the 2012 EPA IRIS Assessment) instead of providing the primary reference. This practice made it difficult for Committee members (and future readers) to identify and evaluate for themselves the findings of the specific studies if desired. • Two Committee members noted that the draft risk evaluation heavily relies on studies considered in the previous EPA IRIS Assessment (U.S. EPA, 2012c) and ATSDR Toxicological Profile (ATSDR, 2019), and reviews several newer studies published after those assessments. The draft risk evaluation indicates that more recent epidemiological	EPA updated the risk evaluation to include citations to the primary references that were cited within the IRIS assessment and the ATSDR Toxicological Profile. EPA has conducted data quality evaluations for key and supporting studies cited within the IRIS and ATSDR documents. Key studies from the IRIS assessment that EPA evaluated for data quality were those considered for dose-response analysis by IRIS as well as genotoxicity studies; EPA has added this information to the RE, section 3.2.1.

	studies are subject to a systematic review of relevance and quality in accordance with the TSCA systematic review principles and guidance. It is unclear and judged unlikely by the Committee that any of the previous IRIS and ATSDR epidemiological studies were evaluated under the TSCA systematic review principles and guidance. By assessing the quality and relevance of only some – but not all – studies considered in the risk evaluation for cancer, or any other endpoint, a significant source of bias has been introduced that hampers an objective WOE conclusion being reached. **PUBLIC COMMENTS:** Previous assessments (IRIS, ATSDR) serve as a useful baseline for an assessment; however, EPA should ensure that it conducts an independent assessment of the totality of the evidence, and not rely solely on the conclusions reached by other agencies. It is not clear how thoroughly EPA evaluated the methodologies and findings of previous PCE assessments, some of which were not conducted according to systematic review methods. • EPA should provide additional language throughout the hazard section of the PCE risk evaluation explaining the steps EPA took to evaluate the other agency assessments for quality and relevance, and how new studies were integrated with existing studies to draw conclusions on hazard. For studies reviewed in the 2012 IRIS Assessment, EPA only "evaluated the confidence of the key and supporting data sources, which included evaluation for study quality." EPA did not document why only some of the studies in the 2012 IRIS Assessment were included in the Data Quality Evaluation or what criteria were used to determine which studies would be included and excluded.	

SACC	**SACC COMMENTS:** Recommendation: Conduct a sensitivity analysis on the STP and general Level 3 fugacity models to determine if the variability associated with the physical-chemical and fate properties significantly impact conclusions in the environmental fate assessment. Several Committee members recommended that a sensitivity analysis should be conducted to determine the potential impact of key chemical input properties and the default wastewater treatment plant parameters on the predicted treatment efficiency.	Full systematic review was not completed for PCE physical-chemical properties, but followed a standard process described in Appendix B of *Application of Systematic Review in TSCA Risk Evaluations*. EPA examined the available evidence and selected values for use in the risk evaluation. Thus, EPA does not have a full extracted dataset of physical-chemical properties with which a sensitivity analysis may be conducted. Thus, log K_{OC} is the only property used in fate modeling for which the range of collected values is available. Log K_{OC} is not an input to the STP model (rather, log K_{OW} is used as a proxy for organic matter partitioning in the STP model; see Clark et al., Environ. Sci. Technol. 1995, 29, 1488-1494). Log K_{OC} values estimated or reported in EPI Suite™ range from 1.98 to 2.95. On the low end of that range, the Level III fugacity model assuming 1 kg/hr released to soil (as was used in the terrestrial risk assessment) estimates 79% of PCE to partition to air, 21% to water, and 0.02% to remain in soil. At the high end of the log K_{OC} range, the model estimates 79% of PCE to partition to air, 21% to water, and 0.14% to remain in soil. Thus, the uncertainty regarding log K_{OC} does not significantly affect the Level III fugacity results.
SACC	**SACC COMMENTS:** Recommendation: Update the systematic review criteria and process to indicate when OSHA or NIOSH mention is not applicable. • It appears that many studies were rejected or rated low or unacceptable for not having OSHA or NIOSH mentions,	EPA did not exclude sources containing monitoring data based on mentions of NIOSH or OSHA. The methodology may have been scored low if the sampling and analytical methods were not specified in the report or were specified but deemed to have serious flaws that would put the

	even for studies where the country of study origin is not the U.S. For these studies, this criterion should be "not applicable." For manufacturing, one study from Japan mentions that measured values were well below the Japan standard of 50 ppm.	sampling results in question. Sampling data from other countries could still receive a high rating if the methods were determined to be equivalent to a NIOSH/OSHA method or a medium rating if the methods were determined to be acceptable but were not equivalent to the NIOSH/OSHA methods. EPA's preference is to use quantitative data to assess inhalation exposures. Qualitative statements similar to the one provided by the commenter can be useful in characterizer results from quantitative data, or if no quantitative data are reasonably available, in helping EPA develop an estimate of exposures.
30, 38	**PUBLIC COMMENTS:** EPA's 'no unreasonable risk' findings are arguably the most important and potentially harmful part of the PCE risk evaluation. EPA's decisions will ultimately impose preemption on state authority to take stronger action than what EPA concludes is necessary. Where EPA concludes that uses pose an unreasonable risk, states will be preempted from imposing any controls beyond what EPA itself chooses to impose. Where EPA concludes that the uses it evaluates do not pose an unreasonable risk, states will be preempted from taking more protective actions. There are some important caveats: states retain authority under their own water, air, and other laws to take some action, and there is an as-yet-untested waiver provision in the revised TSCA that may provide states with additional opportunities to impose restrictions if/when the Trump EPA fails to adequately protect the public.	EPA appreciates comments on preemption from potentially affected persons and understands the interest in preemption for TSCA uses. Under TSCA section 18(a)(1)(B) and (c)(3), federal preemption over certain State actions applies to chemical substances for which a determination of 'no unreasonable risk' has been made pursuant to TSCA section 6(i)(1) or for which a final risk management rule is promulgated pursuant to TSCA section 6(a) and does not extend to those hazards, exposures, risks, and uses or conditions of use not included in that final determination or rule. Pursuant to TSCA section 18(c)(3), if uses or exposure pathways are not "included in any final action the Administrator takes pursuant to section [6(a) or 6(i)(1)]," (*e.g.*, because EPA determines the use or exposure pathway to be outside of the scope

	The stakes on what EPA does with these chemicals are very high, particularly where EPA makes an erroneous and unsupported finding of no unreasonable risk (a false negative). EPA's findings of COUs that do not pose an unreasonable risk should be rejected. We request that EPA clarify how regulation of "conditions of use" covered by other EPA statutes is considered adequate to meet the finding of "no unreasonable risk" and precludes state preemption of EPA's findings. Similarly, we request that EPA articulate the legal argument as to how other COUs that EPA has determined are adequately regulated by other agencies cannot be preempted by states, particularly if those regulated uses are deemed adequate by EPA for resulting in no unreasonable risk or the need for further evaluation. • Under the Lautenberg Chemical Safety Act, a "use" receives a federal exemption only if it is included in the scope of the risk evaluation and only if EPA makes a definitive determination as to risk. For this reason, it is critical that EPA be as clear with its 'no unreasonable risk" determinations as with its "unreasonable risk" determinations. • In the PCE draft risk evaluation, EPA indicates that hazards and exposures to the general population were not evaluated, and there is no risk determination for the general population. EPA may make a no unreasonable risk determination for COUs where the substance's hazard and exposure potential, or where risk-related factors lead EPA to determine that risks are not unreasonable. In this instance, EPA clearly states that it did not evaluate exposures to the general population, instead relying on other EPA statutes as effectively managing exposure to the general population.	of the risk evaluation (such as uses or exposure pathways regulated by EPA or other Federal agencies under other federal laws)), then TSCA permanent preemption does not apply. As the commenter notes, EPA clearly stated in the risk evaluation for PCE that it did not evaluate exposures to the general population, and as such the unreasonable risk determinations for relevant conditions of use do not account for exposures to the general population. Thus, exposures to the general population are not included in any final determinations of 'no unreasonable risk' for PCE and TSCA preemption based on those 'no unreasonable risk' determinations does not apply to those exposures.

	In the absence of a risk evaluation to support EPA's exclusions in this proposed rulemaking, has EPA considered the implications for state preemption and other TSCA activities (*i.e.,* §21 petitions)?	
51	**PUBLIC COMMENTS:** EPA has concluded that most of the COUs of PCE present an unreasonable risk. Given the many adverse health effects of PCE, there is agreement with the unreasonable risk determinations for specific COUs that EPA has made thus far. EPA needs to make a determination, under Section 6(b), as to whether PCE itself presents an unreasonable risk. The evidence which EPA has already reviewed in its draft risk evaluation compels a finding of yes.	Per 40 CFR 702.47 "…EPA will determine whether the chemical substance presents an unreasonable risk of injury to health or the environment under each condition of use within the scope of the risk evaluation…". This approach in the implementing regulations for TSCA risk evaluations is consistent with statutory text in TSCA section 6(b)(4)(A), which instructs EPA to conduct risk evaluations to determine whether a chemical substance presents an unreasonable risk "under the condition of use." In the final risk evaluation, EPA has determined the conditions of use of PCE that present an unreasonable risk of injury to health or the environment. EPA will initiate TSCA section 6(a) risk management actions on these conditions of use as required under TSCA section 6(c)(1).
38, 43	**PUBLIC COMMENTS:** When EPA issues a scope document or a risk evaluation, automakers use the International Material Data System (IMDS) as a first screen to identify potential uses of chemical substances. The IMDS has been adopted as the global standard for reporting material content throughout the automotive supply chain and for identifying chemicals of concern to human health and the environment are present in finished materials and components. The threshold for reporting is 0.1% by weight, a threshold that has been almost universally adopted by international regulatory bodies and many states.	Per the statute (see TSCA section 6(b)(4)(A)) and the implementing regulations for risk evaluations (40 CFR part 702, subpart B), during risk evaluation EPA must determine whether the chemical substance presents unreasonable risk under the conditions of use. Upon finding unreasonable risk, EPA will apply risk management actions to the extent necessary so that the chemical no longer presents such risk, in accordance with TSCA section 6(a).

	• IMDS now has over 15 years of data compiled relying on a *de minimis* levels of 0.1%. The presence of any chemical below this threshold is not required to be reported based on low underlying expected risk of exposure from de minimis quantities. EPA itself has recognized the practicality of a de minimis threshold. • Most recently, in EPA's supplemental proposal for long-chain perfluoroalkyl carboxylate and perfluoroalkyl sulfonate chemical substances, EPA put forward sound arguments for establishing a de minimis threshold, including: (1) below the selected threshold level, there is no "reasonable potential for exposure" within the meaning of § 5(a)(5) (*i.e.*, the risk of exposure is very low); and/or (2) below the threshold level, there is a "reasonable potential for exposure" (or alternatively, there may be such a potential), but the potential does not justify notification (*i.e.*, potential for risk is very low in light of the low level present). • EPA should limit its risk mitigation activities narrowly to those specific products identified in the risk evaluation, rather than developing unnecessary risk mitigation strategies that apply to all products affiliated with a COU. EPA should also set a *de minimis* threshold during risk mitigation. to so, EPA must broaden the scope of its risk evaluation to evaluate *de minimis* values in the final risk evaluation. In effect, EPA must consider more realistic PCE concentration values in paints, coatings, sealants, and adhesive products. Recommendation: EPA should identify a *de minimis* level for PCE (and other TSCA chemicals) below which EPA has no reasonable basis to conclude that there is an unreasonable risk. We recommend that EPA establish a *de minimis* threshold for chemicals in articles and mixtures based on "reasonable potential for exposure."	TSCA section 6(b) does not establish an explicit threshold or concentration that a chemical substance must meet in order to be evaluated. The Use and Market Profile contributed to the basis of EPA's identification of the conditions use for the purposes of the scope and problem formulation documents for PCE. The document presented publicly available information as of the date of the document on the manufacturing (including importing), processing, distribution in commerce, use, and disposal of PCE and was used to inform decisions regarding conditions of use. The document does not reflect information received directly from other sources such as manufacturers, processors, etc., which has further informed EPA's understanding of the conditions of use. As such, the uses and products identified in the document may differ from EPA's current understanding.

	• While EPA has deferred adoption of a *de minimis* level in the final significant use rule for long-chain perfluoroalkyl carboxylate and perfluoroalkyl sulfonate chemical substances, EPA committed (in the final rule) to continue consideration of a de minimis exemption. • We encourage EPA to give a high priority to this issue. The adoption of a *de minimis* level for existing chemicals under review would facilitate more timely and cost-effective data collection by our members and would allow for more effective use of the automotive industry's long-term investment in its internal IMDS system. A standard default *de minimis* of 0.1% would allow EPA and the regulated community to focus on major sources and exposures of concern. EPA could also use a data-driven approach to establish higher threshold levels if appropriate	
54	**PUBLIC COMMENTS:** There are concerns, as the draft risk evaluation and potential revised standards based on limited and inaccurate data would have a significant impact on the commercial and defense aircraft industry and its ability to meet customer requirements, specifically manufacture of the aluminum exterior aircraft skin s of the 737 and other commercial aircraft parts. EPA's determination in the draft risk evaluation that PCE-containing maskant presents an "unreasonable risk" to workers and ONUs is not based on accurate or sufficient data.	EPA acknowledged the uncertainty of the (Hervin et al., 1977) study given data were collected prior to the most recent NESHAP for the aerospace industry; however, EPA did not have more recent data or information about how the NESHAP may have affected exposures at the time the draft risk evaluation was published. EPA has evaluated the exposure data submitted by public commenters for maskant uses of PCE and updated the assessment accordingly. As described in Section 2.4.1.18 a comparison of the NIOSH data to more recent data from 2015 to 2020 submitted via public comment did not indicate emissions controls implemented as a result of the NESHAP reduced exposures. For comparison, 8-hr TWAs for workers in the (Hervin et al., 1977) study ranged from 0.7 to 2.1 ppm with a median of 1.2 ppm and 8-hr

		TWAs from public comments ranged from 0.87 to 66 ppm with a median of 4.7 ppm. Therefore, data from both 1977 and public comments were both used in the risk evaluation. Since the NESHAP did not appear to reduce exposures for this OES, using all available data increases EPA's confidence that the assessment is representative of all facilities that may use PCE for as a maskant for chemical milling.
28	**PUBLIC COMMENTS:** The cancer risk assessment should begin with an evaluation of the quality of relevant studies and evidence. EPA does not appear to perform the systematic review process in accordance with the TSCA systematic review principles and guidance. None of the *in vitro* genotoxicity assays have been evaluated for quality, although EPA does have data evaluation criteria for *in vitro* studies that are applicable. • EPA should evaluate the quality and relevance of key studies that EPA relies on for understanding of the relevant MOA. This understanding is critical to the subsequent determination of the appropriate approach to dose response assessment.	For the final risk evaluation, EPA evaluated genotoxicity studies using the systematic review methods described in *Application of Systematic Review in TSCA Risk Evaluations*. EPA also added details regarding the data quality evaluations in supplemental files. Descriptions of these studies and the overall data quality ratings are also included in Appendix J of the risk evaluation.
52, 53	**PUBLIC COMMENTS:** EPA has excluded 10 epidemiology studies, with 5 due to an unacceptable rating due to how well a study has been reported (metric 4) and 3 due to an unacceptable rating due to statistical power (metric 13). EPA has therefore excluded valuable evidence from the PCE draft risk evaluation based on considerations that are not related to real flaws in the underlying research (studies were listed).	Ninety percent of all epidemiology studies evaluated for PCE were considered to be of acceptable quality. EPA is confident that there were sufficient data of acceptable quality to support the conclusions made in the risk evaluation. All studies were evaluated by two reviewers to ensure consistency among scoring.

	The conclusions of the cancer epidemiology studies on PCE would be strengthened if robust, transparent systematic reviews of all relevant studies were conducted for each tumor type. • EPA's objectivity regarding the systematic review of the epidemiology studies is questionable, using the treatment of the data quality of the Vlaanderen et al. (2013) study as an example. The study was initially rated as a "High" quality study but was then re-rated as a "Medium" quality study, because the job exposure matrix (JEM) is subject to exposure misclassification. This should have been accounted for by the initial rating of Metric 4 (Measurement of Exposure) as "Low" quality for the study. It seems unjustified to use the same issue twice in the rating. Moreover, it seems unreasonable to re-rate the entire study for specific issues that should have been accounted for by simply re-rating individual aspects or metrics. Mathematically, the overall rating change from "High" to "Medium" is equivalent to a rating change specifically for Measurement of Exposure (Metric 4) from "Low" to worse than "Unacceptable," which would be unadjusted given the quality of exposure measurement in the study. It also does not appear that the strict assessment of the potential for exposure misclassification for Vlaanderen et al. (2013) was consistently conducted for all the studies under review. Similarly, Mandel et al. (1995) and Travier et al. (2002) were re-rated from "High" to "Medium" study quality because a "medium rating [was] assigned due to use of occupation in dry cleaning industry as a surrogate of PCE exposure." Again, this issue with exposure measurement should have been already accounted for in the initial rating of Metric 4 (Measurement of Exposure).	In all evaluation strategies, professional judgment was employed to determine the adequacy or appropriateness of the qualitative rating assigned by the numerical scoring system. Given that the risk of exposure misclassification with multiple chlorinated solvents was likely in the (Vlaanderen et al., 2013) study, the study was not considered to be of the highest quality compared to other studies with more robust exposure assessment. The (Mandel et al., 1995) data quality rating was determined from the scores calculated for each metric (the rating was not downgraded). For (Travier et al., 2002), the evaluator determined that the surrogate measure for exposure warranted a downgrading from high to medium; again, other systematic review frameworks allow the evaluator to use professional judgment.

40, 53	**PUBLIC COMMENTS:** While an extensive quality evaluation was performed for a number of studies, it was not done for every relevant study, and the reasons for the exclusion of studies are not apparent. Individual study quality ratings are discussed in the draft risk evaluation and on occasion study uncertainties, but EPA falls short on the data integration step. Specific uncertainties discussed are not consistent across studies (*i.e.*, specific uncertainty will be emphasized for one study but not another), and the impact of these uncertainties on the interpretation of results is not discussed. • The draft risk evaluation also does not consider that a study with an overall high rating may still have major issues with study interpretation as a result of one or a few study metrics, most notably to exposure. EPA has available several published tools and protocols to integrate scientific evidence beyond simple data quality scores. The PCE draft risk evaluation does not incorporate these tools in a way that allows all evidence for each endpoint to be examined, compared, and contrasted. • EPA's July 2017 risk evaluation framework rule defines systematic review as a comprehensive, consistent and transparent process to "identify and evaluate each stream of evidence" and "to integrate evidence as necessary and appropriate based on strengths, limitations, and relevance." Yet the TSCA document lacks any protocol for these important tasks. • While the Data Quality Evaluation included all of the new studies that estimated bladder or kidney cancer risk in the 2020 draft risk evaluation, only 12 studies for bladder cancer and 23 studies for kidney cancer in the 2012 IRIS Assessment were evaluated. It is unclear why only some of the studies included in the 2012 IRIS Assessment were	When synthesizing and integrating evidence for each human health hazard endpoint, EPA considered quality, consistency, relevancy, coherence and biological plausibility as specified in *Application of Systematic Review in TSCA Risk Evaluations*. EPA used an informal framework for most endpoints but did array the immunological evidence within a more formal framework to respond to a comment by the SACC (see Appendix H in the risk evaluation). EPA is developing and implementing more formal and structured data integration strategies for the next set of TSCA chemical risk evaluations. In addition, EPA anticipates feedback from the NASEM TSCA Committee on its systematic review process and will carefully review and implement relevant recommendations. EPA has deleted discussion of Seo et al. (2012) from the risk evaluation because it was considered unacceptable. EPA evaluated key studies from the IRIS assessment that were used for dose-response assessment as well as the genotoxicity studies cited by the IRIS assessment.

	included in the Data Quality Evaluation or what criteria were used to determine which studies would be included and excluded. This should be addressed for transparency. • The study by Seo et al. (2012) is included in the draft risk evaluation even though it was given an overall data quality rating of "Unacceptable" in the systematic review. In doing so, EPA disregards its own procedure for systematic review. The Seo et al. (2012) study received an "Unacceptable" score for the Metric "# per group," which is an important concern when evaluating the robustness of the data. If EPA overrides its systematic review procedure and includes a study that is rated "Unacceptable," the Risk Evaluation should provide the rationale for this decision.	
Content, organization, and presentation		
SACC	**SACC COMMENTS:** Committee members encountered significant difficulties in comparing contents of the risk characterization tables of Section 4 to the risk determination tables of Section 5. This may be attributed to the fact that Table 4-110 separates use categories while Table 5-1 provides results as sub-categories of use.	The risk summary tables in section 4.4.2 provides risk estimates for each exposure scenario cross walked with the COU (defined by the life cycle stage-category-subcategory). Subcategories are presented in both locations.
SACC	**SACC COMMENTS:** Recommendation: The evaluation should be reorganized for better comprehension and ease of finding specific information. Multiple Committee members commented on the complexities of the draft risk evaluation including the many and sometimes large supplemental files. The 782-page "Data Quality Evaluation of Environmental Releases and Occupational Exposure" supplemental file contains individual study information that allow the reader to see how publications were graded, and importantly to see which criteria lead to rejection. It is cumbersome to use since it is not organized in a manner that allows easy search.	EPA strives to be transparent in providing to the public all information considered for development of the risk evaluation. EPA attempted to balance consolidation of information into the Risk Evaluation document while avoiding adding too much detail by using Appendices and Supplemental Files for supporting information that may not be of interest to all readers.

	• The format includes some repetition of material, which is understandable; however, while these repetitions are needed, they make the text rather dense. • It is understandable that EPA – being mindful of potential critical comments from the public and the regulated community – endeavors to include all conceivable uses and possible exposure pathways and conditions. However, this results in a cumbersome document that, despite apparent best efforts on the part of its authors, makes it unwieldy and far less useful to the reader than it otherwise could be. • Similarly challenging to use is the 854-page bibliography has a listing of citations rated as either "on topic" or "off topic." The 316-page supplement entitled "Assessment of Occupational Exposure and Environmental Releases for PCE" includes links to the EPA HERO database, which many Committee members found difficult to access. Slightly better is the bibliography to the Scoping Document, also provided as a supplement, that has citations listed by topic, with many references listed under multiple topics. Under each topic, citations are rated as "on topic" or "off topic." Still, it is difficult from this listing to know which studies contributed information/data to the evaluation.	
SACC	**SACC COMMENTS:** Recommendation: Consider restructuring this and future TSCA risk evaluations as a multi-volume set that separately focus on ecological factors, occupational and consumer use an exposure, health outcomes, and calculation of risk to the environment and human health. To address the problem of organization, one Committee member suggested dividing the evaluation document into at least three (possibly four to five) separate volumes as described below: • Presentation of chemical properties and the like seem standard for EPA, but this can be handled by reference to	EPA is currently developing a new risk evaluation template for future Risk Evaluations. In this template, EPA is planning to group all aspects of the ecological risk assessment together and do the same for the human health risk assessment. EPA is also considering development of a standalone document containing standard operating procedures in order to reduce the size of document minimize repetition of information across Risk Evaluations.

	authoritative government reports (*e.g.,* ATSDR) rather than repeating those details here. • The first of a multi-volume set (as contrast to numerical sections used in the present format) could include production, use and occupational and consumer exposures, which apparently range from substantial among older generation dry cleaners to the trivial (*i.e.*, residential indoor air levels equivalent to or near ambient background). • A second volume could address environmental issues, including ecological impacts and ozone depletion – the latter in large part has driven PCE from commercial dry cleaning by the CARB. • A third could present a comprehensive summary of PCE epidemiology, toxicology, MOA, and EPA rationale why one or another endpoint was key (*e.g.,* genotoxicity) or include (hepatotoxicity, visual dysfunction) and severity of the adverse outcome as a function of exposure. • A fourth volume could focus on occupational and nearby ONU groups (*e.g.*, PCE dry cleaners with adjacent apartments and daycare centers). • Finally, a fifth volume can present EPA's synthesis of the literature, key studies, points-of-departure, risk characterization, and calculations. • The Supplementary Files can be divided to appear within the specific volumes 1-5 to which they relate. In this way, the reader can readily select and pull out the subject of his/her immediate interest as contrasted to digging through matters that are not relevant to their particular task at hand. • Another Committee member suggested that the discussion of exposures, hazards, and risk characterizations for Environmental Health be a separate document "part" from the Human Health part. This is similar to how EPA presented the draft risk evaluation findings at the meeting. With this	

	structure, the evaluation would first present environmental hazards, exposures, and risk characterization, then follow with occupational exposures, hazard, and risk characterization in that order.	
SACC	**SACC COMMENTS:** Recommendation: Provide indices for the draft risk evaluation and larger supplemental documents and apply more consistent and methodical cross-referencing of key discussion topics throughout the draft risk evaluation. Many on the Committee commented that the draft risk evaluation and supplemental documents would benefit from the addition of a detailed index, which is a useful editorial tool for such large reports as this. The Committee also recommended that more consistent and methodical cross-referencing of key discussion topics be done throughout the document.	EPA will consider this comment in the development of future Risk Evaluations.
SACC	**SACC COMMENTS:** Recommendations: (1) Improve the presentation of the risk calculations for consumers, clarifying sources of key information and scenarios. (2) Add an example to the introductory material of Section 4.2.4 describing in detail sources of exposure and POD values and calculation used in producing the final MOE. The consumer risk estimates, Section 4.2.4, are not presented nearly as clearly as the presentation for workers. Committee members had difficulty following the risk calculations. • PODs appear to come from Table 4.2 for estimating acute risk, but this is uncertain because the text does not clearly state this. Some Committee members remarked that the PODs for consumer exposure possibly should be different than the PODs for occupational exposure because duration of exposure may be influencing these PODs, even in the case of acute endpoints. The introductory paragraphs to Section 4.2.4 (p. 386, line 9464-9483) would benefit from taking one scenario (*e.g.*, high intensity consumer and bystander, acute,	Thank you for your comment. EPA has presented data in a consistent format with the previous REs. This comment will be considered for future REs.

	non-cancer inhalation exposures to aerosol cleaners for motors) and describing where the scenario's exposure and corresponding POD values can be found in the draft risk evaluation and/or supplemental documents, and how they are combined to calculate the acute HEC (*e.g.*, user MOE and bystander MOE).	
SACC	**SACC COMMENTS:** Recommendation: Use consistent labeling for OES headings in Tables 4-110 and COU row labels in Table 5-1. Section 5, Table 5-1 summarizes risk determination by "Condition of Use," which does not match up with the "OES" labels used in Table 4-110. This disconnect makes it difficult to link the details presented in Table 4-110 with the conclusions provided in Table 5.1.	Thank you for the comment; Table 5-1 is no longer in the RE.
SACC	**SACC COMMENTS:** Recommendation: Enhance Table 1-3 to include key recommendations/conclusions for each assessment in the assessment history of PCE. Table 1-3, Assessment History of PCE: This table is not as useful as it could be. The table simply has two columns, one listing the authorizing agency and one providing the citation. A third column should be added on the right that summarizes key recommendations or conclusions of each assessment.	Thank you for your comment. EPA has presented data in a consistent format with the previous REs. This comment will be considered for future REs.
SACC, 28	**SACC COMMENTS:** Recommendation: Consider using graphics for some tables where it improves readability and understanding. An example pie chart was provided for PCE production volume by use. **PUBLIC COMMENTS:** The SACC should encourage EPA to include flow charts and tables that provides a summary of results by OES for inhalation and dermal exposure, as was done in the TCE assessment. The SACC should also consider recommending that, to the extent	A pie chart with a breakdown of the PCE production volume by use has been added to Section 1.4.1 of the risk evaluation. EPA will continue to identify additional opportunities for graphics to improve future risk evaluation documents.

	possible, EPA standardize the summary tables and graphics across risk evaluations and update the draft PCE document to reflect this.	
SACC	**SACC COMMENTS:** Recommendation: Use more standard terminology that is more readily understandable in the scientific community. The term benchmark usually refers to an alternative to a NOEAL/ LOAEL, but in this case, EPA is using that term to mean something completely different. It would add important context if EPA would compare acceptable air concentrations calculated using this approach with other common benchmarks like PELs, risk-based screening levels, IRIS values, and discuss differences.	Thank you for your comment. EPA has presented data in a consistent format with the previous REs. This comment will be considered for future REs.
SACC	**SACC COMMENTS:** Recommendation: p. 261, line 6499 and elsewhere: Please be specific regarding irritation. As stated, it is unclear (*e.g.*, irritation of the respiratory tract).	Irritation is not a significant health effect and was only included in the risk evaluation to provide an example of qualitative acute effects. EPA believes that additional details are not required.
SACC	**SACC COMMENTS:** Recommendation: Define "pattern reversal visual evoked potentials" (p. 296, line 7666). Table 3-5 and elsewhere: For clarity, EPA should define what exactly are "pattern reversal visual evoked potentials" and describe why these potentials at the levels measured represent an adverse effect. This is not clear in the draft risk evaluation. A statistical difference is not sufficient.	EPA added a definition to Section 3.2.5 (Dose-Response Assessment): *Visual evoked potentials measure electrical signals recorded on the scalp near the occipital cortex in response to light. The pattern visual evoked potential represents an objective method of evaluating visual function and are sensitive measures of functional disorders. They can represent variation in arousal level or direct cortical depression.* Based on their potential to signal visual disorders, EPA considered the measurement to be a sensitive, but adverse, effect for this RE.
SACC	**SACC COMMENTS:** On pp. 400-401, lines 9906-9909, the draft risk evaluation states: "The systematic review of biomonitoring data yielded three viable studies that contained PCE concentration measurements in	The Biomonitoring data was from multiple sources with the National Health and Nutrition Examination Survey (NHANES) conducted by CDC's National Center for Health Statistics

	blood. These studies did indicate that PCE was detected moderately (37-60%) in samples evaluated. However, the concentration of PCE was not higher than the detection limits of the respective studies." • One Committee member indicated that this statement makes no sense. If PCE is detected, it has to exist at a concentration above the detection limit; otherwise, it is a "non-detect." If a large fraction of observations is recorded as below the detection limit and these values are recorded at half the detection limit, the average concentration will likely be below the detection limit.	(NCHS being the most comprehensive source). The studies yielded from systematic review had various detection limits. In the Fourth Report on Human Exposure to Environmental Chemicals (CDC, 2017), statistics were reported for the **50th,** 75th, 90th, and **95th** percentiles for 2-year cycles starting in 2001 through 2008. Sample sizes ranged from 978 (2001-2002) to 2,940 (2005-2006). The concentrations in all samples were less than the limit of detection (0.048 ng/mL) at the 50th percentile for all years. However, at the 95th percentile, concentrations ranged from **9.4E-02 µg/L (2007-2008) to 1.9E-01 µg/L (2001-2002).** Which is higher than the limit of detection (0.048 ng/mL). However, EPA used this data to show that PCE is in the environment (via water).
SACC	**SACC COMMENTS:** Recommendation: Properly cite ECB (2005) and WHO (2006a) in every place in the draft risk evaluation where information from these reports are used. The discussion in Section 3.1.1 (p. 249) identifies two sources of environmental hazard data for PCE, namely ECB (2005) and WHO (2006a). It was unclear whether these sources underwent quality review. Also, neither of these references are mentioned again in Section 3, so it is not clear the point of mentioning these in this section at all. Findings from these studies are cited in Section 2.	Format of citations have been verified. In Section 3.1.1 *Approach and Methodology*, has been edited to add clarity that sources went through data quality screening during the Problem Formulation.

SACC	**SACC COMMENTS:** The Committee suggested that the CBI claims noted in Figure 1-1 should be justified. If CBI limits the ability of EPA to report the complete PCE life cycle, alternative mass flow estimates should be made as, for example, the NTP (2014) appears to have done.	Figure 1-1 uses data solely from CDR and indicates certain volumes are CBI based on the information in CDR. However, to further describe the uses of PCE, EPA has added a mass balance to the RE which uses information from market reports in place of CDR. This data is less granular than reported in CDR but does remove issues related to CBI claims.
SACC	**SACC COMMENTS:** Additional information from the supplemental documents and earlier publications should be included in the draft risk evaluation; otherwise, readers must look through documents that are hundreds of pages long to find the pertinent information.	EPA received other comments that the risk evaluations should be streamlined and succinct. Therefore, EPA believes that it is sufficient to retain more detailed information in appendices, supplemental documents and other documents.
SACC	**SACC COMMENTS:** Section 1.3 (Regulatory and Assessment History) does not include enough information. The assessments are listed but there is no explanation of how or why they were or were not used in this risk evaluation or if results differed from this risk evaluation. For the regulations, the reader is directed to Appendix A where essentially no additional information or summary is provided.	Thank you for your comment. EPA has presented data in a consistent format with the previous REs. This comment will be considered for future REs.
53	**PUBLIC COMMENTS:** Table 1 of the Gradient report (Appendix 2) presents a summary of the EPA data quality evaluation of the epidemiology studies in the draft risk evaluation from the 2012 IRIS Assessment. An advantage of summary tables, such as the ones in the Gradient report showing the quality of any particular dataset, is that it makes it visually possible to evaluate the distribution of a quality metric across studies. • EPA should consider such a table in its risk evaluations, or at least discuss how these metrics are distributed across studies and how they impact the interpretation of results.	EPA appreciates the comment and will consider including this table in future REs.
SACC	**SACC COMMENTS:**	EPA has fixed this typographical error.

	Daily release is estimated as annual loading divided by days released, hence in Equation 2-3 on p. 88 (line 2023) of the draft risk evaluation the "*" symbol should actually be the "/" symbol.	
SACC	**SACC COMMENTS:** Equations 2-1 and 2-2: In Section 2.3.1.2.1 of the draft risk evaluation, Equations 2-1 and 2-2 have the same numerator, but the rearrangement of terms gives the initial impression that there is something fundamentally different about the numerators of these equations, when they are, in fact, the same.	EPA has updated equations 2-1 and 2-2 by listing the numerators in the same order of appearance for consistency.
SACC	**SACC COMMENTS:** There are quite a lot of grammatical errors, particularly in the first couple of sections of the draft risk evaluation. Some Committee members remarked that errors are more prevalent in this document than in the previously reviewed TCE draft risk evaluation.	EPA acknowledges the comment and endeavored to correct grammatical errors in the final risk evaluation.
SACC	**SACC COMMENTS:** p. 347, Table 4-20: MOE for chronic exposure with kidney histopathology as an endpoint for workers without PPE is highlighted but should not be as the MOE is > Benchmark MOE.	This error has been corrected.
SACC	**SACC COMMENTS:** Multiple locations: Suggest that EPA avoid the use of scientific notation. A Committee member found it very distracting. This may involve changing units so that numbers are readable, but overall noted that the public responds better to real numbers.	EPA acknowledges the comment. Scientific notation is preferred in some cases for comparing values that are orders of magnitude less than 1. EPA will strive to improve consistency in presentation of values throughout future Risk Evaluations.
SACC	**SACC COMMENTS:** Line 1311, p. 40: Reference links to a comment on asbestos, not CFC 113 manufacture.	This error has been corrected.
SACC	**SACC COMMENTS:** Line 1747: Extraneous "but."	EPA has deleted the extraneous "but."
SACC	**SACC COMMENTS:**	EPA has edited corrected the equation to support the text. It should be a division.

	Line 2023: Daily release is estimated as annual loading divided by days releases, hence in Equation 2-3 on p. 88 of the draft risk evaluation the "*" symbol should actually be the "/" symbol.	
SACC	**SACC COMMENTS:** Line 2052, p. 89: Format issue, underlining "Direct discharging facilities…"	EPA has corrected the formatting issue.
SACC	**SACC COMMENTS:** Line 2126+: Section 2.3.1.2.2 seems out of place. The development of the COC does not occur until a later chapter; hence, it seems appropriate to discuss measured and modeled releases above the COC (or 1.4 ppb) at this point in the draft risk evaluation.	This portion of the exposure section discusses how the calculation of days of release using the EFAST model. The exposure and hazard sections are used for risk characterization.
SACC	**SACC COMMENTS:** Line 2269, Table 2-6, p. 95: Footnote reference was not clear/missing. Add the footnote in table.	There is a caption used to describe the table as was done for the other tables in this section. Line 2584 – Line 2586 further described the table with more detail.
SACC	**SACC COMMENTS:** Line 2325, Figure 2-5, p. 98: Would read with ease if formulated as a pie chart(s).	Figure 2-5 in the April 2020 SACC draft pertained to "Modeled Release Characteristics (Percent Occurrence)." Thank you for the suggestion. EPA believes that the current table best displays the three sets of parameters. The suggested alternative would result in three individual pie charts. The current visual output allows readers to compare all three sets of parameters in one figure.
SACC	**SACC COMMENTS:** Line 2367, Figure 2-6, p. 100: Add PCE regulatory limit for comparison.	Thank you for the suggestion. This suggestion is beyond the aim of the original intent for this map.
SACC	**SACC COMMENTS:** Lines 2580-2581, p. 108: "The assumed maximum days per year of release from each facility is uncertain and may in some cases lead to underestimation of daily release rates." Why only "underestimation" of risk? Uncertainty implies that the value	EPA states that in some cases there may be an underestimation, but this assertion does not in itself negate other potential uncertainties.

	could be greater or less that that stated, hence overestimation of risk is also possible.	
SACC	**SACC COMMENTS:** Lines 2628-2631, p. 109: The Committee was unclear how this paragraph informs the confidence in aquatic exposures. It is also unclear how the availability of monitoring data truly drives the confidence ratings, since all are essentially assigned the same "moderate confidence" rating.	Confidence ratings for aquatic exposure scenarios are informed by uncertainties surrounding inputs and approaches used in modeling surface water concentrations. In Section 2.2.1.1, confidence ratings are assigned to these estimated daily releases (kg/site-day) on a per occupational exposure scenario (OES) basis and primarily reflect moderate confidence (one OES shows high confidence for this estimate). Other considerations that impact confidence in the aquatic exposure scenarios include the model used E-FAST 2014, (U.S. EPA, 2014) and its associated default and user-selected values and related uncertainties. As described in Section 4.1.2, there are uncertainties related to the ability of E-FAST 2014 (U.S. EPA, 2014) to incorporate downstream fate and transport; the likely number of release days from given discharging facilities; and, in some cases (*i.e.*, when the NPDES for the discharging facility cannot be found within the E-FAST database), the applied stream flow distribution.
SACC	**SACC COMMENTS:** Lines 4830 and 4837: For the Sax et al. (2004) exposure study noted in the draft risk evaluation on Line 4830 and Table 2-62, the Committee suggested that EPA remove "inner city" as a descriptor of that exposure because the meaning and relevance are unclear. Although the study authors described their study community in that way, it is not useful to describe the setting (teenagers and city would be sufficient).	Thank you for your comment. To ensure transparency EPA included the exact term used by the author.

SACC	**SACC COMMENTS:** Lines 4970-4971: What is "gray literature"? If this includes material that is not peer reviewed, then it probably should not be considered in this evaluation. If EPA wants to include such information, an evaluation should be completed first. A Committee member performed a Google search and found the following in Wikipedia (https://en.wikipedia.org/wiki/Grey_literature): "Grey literature are materials and research produced by organizations outside of the traditional commercial or academic publishing and distribution channels. Common grey literature publication types include reports, working papers, government documents, white papers and evaluations." Addition of a footnote defining this should be added to the evaluation.	EPA defines gray literature as: "sources of scientific information that are not formally published and distributed in peer-reviewed journal articles." Examples include: "theses and dissertations, technical reports, guideline studies, conference proceedings, publicly-available industry reports, unpublished industry data, trade association resources, and government reports." These references are valuable for many of the evaluated disciplines and are consulted in the TSCA risk evaluation process. For example, some exposure information is available only as gray literature. In addition, industry toxicity studies may not be published in peer review literature but may be conducted using GLP and appropriate test guidelines (*e.g.*, OECD) and may include a full set of data (*e.g.*, even individual animal data). EPA screens and evaluates these data sources to assure their relevancy and quality before using them in the TSCA risk evaluation.
SACC	**SACC COMMENTS:** Lines 6068-6109: Be consistent with short-hands (*e.g.*, text switches between different ways of expressing LC_{50} and EC_{50}; see pp. 250 and 251).	Edits have been made throughout the RE for consistency.
SACC	**SACC COMMENTS:** Lines 6105-6106, Section 3.1.2, p. 251: There is a typographical error in this sentence: the phrase "Observed effects in laboratory mammals that occurred at much higher concentrations thant[than?] have been measured" should be "concentrations that have been measured" or are predicted to occur in the environment." Appreciated that this statement at least tries to	The error has been corrected.

	clarify why EPA does not include terrestrial organisms in the draft risk evaluation.	
SACC	**SACC COMMENTS:** Lines 6272+, Section 3.2: It seems as if there are instances throughout this section where specifics are not provided, although it would be helpful for the reader if they were described. For example, p. 268 'Studies of PCE exposure in humans have evaluated several reproductive outcomes including effects on menstrual disorders, semen quality, fertility, time to pregnancy, and risk of adverse pregnancy outcomes including spontaneous abortion, low birth weight or gestational age, birth anomalies, and stillbirth (U.S. EPA 2012c).' It would be helpful to include some description of the outcome of these evaluations within the draft risk evaluation. This may not need to be extensive; however, the reader does not know, in this example, if there were any significant positive or negative findings.	The information in the cited paragraph was a summary with more details for each of the studies cited in the paragraphs below the summary paragraph. This has been made clearer in the final risk evaluation by adding the citations for each of the studies cited in the IRIS assessment, both in the summary paragraphs and in the detailed sections below the summary.
SACC	**SACC COMMENTS:** Lines 6281-6285: Why is the 2014 International Agency for Research on Cancer (IARC) monograph on PCE not mentioned here?	IARC (2014) is cited in sections on the MOA for hepatocellular carcinomas and genotoxicity.
SACC	**SACC COMMENTS:** Lines 6297-6302, p. 257: First paragraph appears to have a sentence duplication "EPA skipped the screening step (for relevance to PCE) of the key and supporting studies identified in previous assessments and entered them directly into the data evaluation step based on their previously identified relevance to the chemical (U.S. EPA 2018b). EPA skipped the screening step (for relevance to PCE) of the key and supporting studies identified in previous assessments and entered them directly into the data quality evaluation step based on their previously identified relevance to the chemical."	EPA deleted the duplicate sentence.
SACC	**SACC COMMENTS:**	This term has been changed to "toxicity from acute exposures."

	Line 6319: Define "overt" toxicity. This seems like a vague, non-scientific term.	
SACC	**SACC COMMENTS:** Lines 6383+: Discussion of metabolism in Section 3.2.2.1.2 is broad and vague and several key points are omitted. Reference should be made to 2 references: Lash and Parker (2001a) and Cichocki et al. (2016).	The description of metabolism has been expanded and both recommended citations have been added.
SACC	**SACC COMMENTS:** Line 6421: Not necessarily true that GSH conjugation begins in the liver; GST occurs in many tissues, although it is true that liver is generally the predominant site, although this may vary according to route of exposure. For example, when exposed by inhalation, pulmonary metabolism can be significant.	The description of the glutathione pathway has been revised and the section now more appropriately discusses liver as the predominant site.
SACC	**SACC COMMENTS:** Line 6455: Clarify that the PCE IRIS 2012 Assessment (U. S. EPA, 2012c) uses the Chiu and Ginsberg (2011a) PBPK model.	EPA clarified this in the risk evaluation.
SACC	**SACC COMMENTS:** Line 6477-6479: This sentence is not exactly correct. It should be changed to "The model predicts decreasing oxidative metabolism from mice to rats to humans, meaning that humans are predicted to receive a smaller internal dose of metabolites and a larger internal dose of parent compound for the same applied dose compared to rodents, after accounting for body weight scaling."	EPA revised the statement to the suggested sentence.
SACC	**SACC COMMENTS:** Line 6489: What is the basis for this fraction (1% of PCE undergoing GSH conjugation)? It is likely incorrect due to the generation of reactive metabolites that cannot be readily measured. The extent of GSH conjugation vs. CYP-dependent oxidation varies significantly with dose. Moreover, especially in humans, PCE seems to be a rather poor substrate for CYPs and GSH conjugation seems to play a more significant quantitative role in overall PCE metabolism as compared to what occurs in rats or mice (see Lash and Parker, 2001a; Cichocki et al., 2016).	EPA has revised this section and no longer refers to the fraction undergoing GSH conjugation.

SACC	**SACC COMMENTS:** Line 6609: What is a "nonsignificant elevation?" This is inappropriate terminology.	This phrase has been revised.
SACC	**SACC COMMENTS:** Line 6615: Not appropriate; the association is either significant or not significant! Again, terms such as “borderline significant” make no sense.	This phrase has been revised.
SACC	**SACC COMMENTS:** Line 6635: The phrase “Nonsignificant increased RRs” is not appropriate.	This phrase has been revised.
SACC	**SACC COMMENTS:** Lines 6964 and 6968: Getting the information for Question 5.4 was made more difficult by sloppy writing in parts. Numerous times in the narrative (*e.g.*, p. 271 line 6964 and line 6968), a specific interesting or useful paper was described that warranted further examination, but the only reference attached was some sort of review article (*e.g.*, EPA IRIS Assessment) that made it difficult to track down the particular study. Referencing a review article is OK for generalized conclusions, but not for specific studies. This needs to be fixed.	References to the original articles (*e.g.*,those cited in the IRIS assessment) were added to the final risk evaluation.
SACC	**SACC COMMENTS:** Line 7030: Table 3-3 uses “Perc” or “perc” for PCE; should be consistent in identifying the subject of the evaluation.	EPA has updated this table to consistently use “PCE.”
SACC	**SACC COMMENTS:** Line 7068: EPA needs to define “biologically significant increase in brain gliomas.”	The text has been revised to indicate that these tumors were considered to be biologically significant because the incidence of this rare tumor above the historical control range.
SACC	**SACC COMMENTS:** Lines 7176-7282: Section on PPAR (peroxisome proliferator-activated receptor) activation in animal studies is a nice summary. However, there needs to be a discussion of relevance to humans.	EPA has included a sentence stating that there are questions about the potential relevance of PPAR activation to humans. However, a more complete discussion was not added because EPA had concluded that PPAR activation is not the primary MOA for PCE-induced liver tumors.

SACC	**SACC COMMENTS:** Lines 7457-60: The short summary section, while good, should say more about species differences and relevance of rodent data to humans for the kidneys as an endpoint.	EPA addressed the species differences in the previous sections.
SACC	**SACC COMMENTS:** Lines 7473-7484, p. 292, Overall Conclusions: The last sentence does not follow the logic presented in the paragraph. The paragraph summarizes the animal cancer data results, suggests a complex metabolic profile, discusses differences and data gaps, and concludes that the animal data are representative for humans. This paragraph needs further revision to make this point.	EPA has made additional revisions to refine the Overall Conclusions section.
SACC	**SACC COMMENTS:** Lines 7598-9, 7600-1: These sentences seem to conflict with respect to bladder cancer and MM.	Older studies seemed to show some effects but newer studies were generally negative. Therefore, this section was revised to indicate that the results were mixed for these two cancers.
SACC	**SACC COMMENTS:** Line 7742, p. 298, Table 3-4: For clarity, please provide indications which treatments show results that are statistically different from controls. Control cancer incidence seems quite high in the studies that EPA has selected to model. This point should be explained.	Thank you for your comment. EPA has presented data in a consistent format with the previous REs. This comment will be considered for future REs.
SACC	**SACC COMMENTS:** Line 7819+, pp. 301-303, discussion of UFs: It would be helpful if all of the UFs were summarized in a table.	Thank you for your comment. EPA has presented data in a consistent format with the previous REs. This comment will be considered for future REs.
SACC	**SACC COMMENTS:** Lines 7842-7850: Clarify that residential exposures are not being estimated and added to worker exposures.	EPA only estimated risks for individual exposure scenarios and did not aggregate occupational exposures with potential residual background exposures from household products/articles. EPA acknowledges that risks may be underestimated by not accounting for chronic background exposures, however these background exposures are likely significantly lower than the assessed exposure estimates for each exposure scenario

		and would, therefore, not be risk drivers. Consideration of background exposures from consumer products is discussed in Section 2.4.2.6 and additional discussion of aggregate exposure is provided in Section 4.3.2.
SACC	**SACC COMMENTS:** Line 7979: Here it mentions that the "dimethylcyano-foramide (DMCF) ppm is derived from the PBPK model," but it does not specifically clarify what this factor means (*i.e.,* inhalation dose-metric conversion factor from what to what?). (Note: DMCF ppm cannot be found in the model code.)	The footnote in Line 7979 states that DMCF stands for "dose-metric conversion factor," not "dimethylcyano-foramide." It also states that the DMCF was derived using the PBPK model, which indicates that it is derived using a complex set of mathematical and biological relationships that were incorporated into the model, which is fully described in Chiu and Ginsberg (2011), which was cited several times in the RE.
SACC	**SACC COMMENTS:** Lines 8374-8375: p. 322: Incomplete description of Figure 4-1 "Concentrations of PCE from PCE-Releasing Facilities (Maximum Days of Release Scenario) and WQX 8374 Monitoring Stations: Year 2016, East US. All indirect releases are mapped at the receiving facility unless the receiving."	This has been corrected.
SACC	**SACC COMMENTS:** Line 9966: Correction needed. Change "TCE" to "PCE."	This has been corrected.
SACC, 45	**SACC COMMENTS:** Line 2348-2349, p. 98: Add the link to the supplemental file; it is missing. **PUBLIC COMMENTS:** There are numerous incomplete links in the draft risk evaluation for PCE that have created significant hurdles and confusion in understanding the basis and context for some of EPA's draft conclusions. • Some of the document links in the reference's column of Table 1-4 link to an incorrect document or documents that are	EPA has updated links throughout the RE where applicable.

	no longer accessible. For example, the document in the link for Dow Chem (2008) (Product Safety Assessment: PCE) is not at that location. Similarly, the link to the American Fuel & Petrochemical Manufacturers (AFPM) document goes to comments submitted in 2017 for 1-BP that regard the scoping methods for the first 10 high-priority chemicals. Links to those same AFPM comments appear in the reference column for Intermediate in Industrial Gas Manufacturing and Intermediate in Petroleum Refineries. Additionally, the reference to HSIA (2018b) in Table 1-4 links to comments for carbon tetrachloride.	