DEPARTMENT OF ECOLOGY
State of Washington

Quality Assurance Project Plan

Flame Retardants in Fabrics of Children's Play Tents and Other Products

January 2023

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Quality Assurance Project Plan

Flame Retardants in Fabrics of Children's Play Tents and Other Products

by Amy Salamone

January 2023

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P2RA: Pollution Prevention & Regulatory Assistance Section
EAP: Environmental Assessment Program
SCS: Statewide Coordination Section

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2.0 Abstract

In 2016, the Washington State Children's Safe Products Act (CSPA) was amended to establish restrictions on the sale of children's products that contain certain flame retardant chemicals. The CSPA also requires manufacturers to file an annual report of their children's products that contain chemicals of high concern to children (CHCC) and are offered for sale in Washington State. As part of a 2017 CSPA Reporting Rule adoption, 11 additional flame retardant chemicals were included in the CHCC reportable list.

During 2022-2023, the Washington State Department of Ecology (Ecology) will conduct a study to assess six flame retardants in fabrics of children's products. This study is designed as a follow-up to a 2016 Ecology investigation of flame retardants in children's play tents. In addition to play tents, this study includes children's products that have voluntary or required flammability standards, such as sleeping bags, camping chairs, and car seats and strollers. Children's products collected for this study will reflect those available for sale to Washington's diverse residents. Products will be those that are marketed and sold for use by children 12 years of age and younger.

Study results will be used for the assessment of reporting compliance of manufacturers of children's products for the presence of six flame retardants:

- tris(1,3-dichloro-2-propyl) phosphate (TDCPP)
- tris(2-chloroethyl) phosphate (TCEP)
- tris(1-chloro-2-propyl) phosphate (TCPP)
- triphenyl phosphate (TPP)
- 2-ethylhexyl-tetrabromobenzoate (TBB)
- bis(2-ethylhexyl) tetrabromophthalate (TBPH)

To assess the presence of these flame retardants, Ecology will analyze samples from 40 children's productss.

3.0 Background

3.1 Introduction

The Product Testing Unit at the Washington State Department of Ecology (Ecology) regularly conducts studies to support Washington's Children's Safe Products Act (CSPA), chapter 70A.430 RCW and CSPA reporting rule chapter 173-334 WAC. Product testing studies are designed to select, purchase, and analyze products for the presence of restricted toxic chemicals and to provide data to Ecology's CSPA Compliance Lead for evaluation of children's product manufacturers' compliance with regulation.

3.1.1 Problem statement

Product safety standards require that certain consumer products pass a flammability test. Although safety standards do not mandate the use of flame retardant chemicals, flame retardants are often added to products to slow risk of ignition.

Flame retardants are under increasing scrutiny since studies show that exposure can cause endocrine and immune system disruption, cancer, and harmful effects on children's growth, development, and neurological function. Additive flame retardants used in the manufacture of children's and general consumer products can easily migrate out and accumulate in homes, schools, and workplaces. Flame retardants from consumer products can also be released into the environment where they build up in wildlife and contaminate the food chain. Due to these concerns, some flame retardants are considered persistent, bioaccumulative, and toxic (PBT) chemicals , as well as chemicals of high concern to children (CHCC) (chapter 173-334-130 WAC).

The release of additive flame retardants in children's products is concerning because children are more vulnerable to exposure compared to adults because their brain and organs are still developing. Children are also more likely to be exposed because of common developmental behaviors such as crawling on the floor and mouthing, chewing, or sucking on their fingers or other items. Many researchers have assessed flame retardants in household dust, which has indicated that TDCPP, TCEP, and TPP, among others, can be very prevalent in household dust samples (Dodson et al., 2012; Meeker & Stapleton, 2010; Stapleton et al., 2014; Stapleton et al., 2009).

This quality assurance project plan (QAPP) for this 2022-2023 study describes the procedures for conducting a product testing study for flame retardants in fabrics from selected children's products. This study is designed to be a follow-up to Ecology's 2016 assessment of flame retardants in children's play tents, tunnels, and upholstered furniture (van Bergen, 2018). Applicable recommendations from the 2018 publication were as follows:

- Due to the number of play tents found to contain flame retardants, additional analysis of children's products with flammability standard labels, including the CPAI-84[1] label, should be assessed to ensure that these products comply with the CSPA reporting requirements

[1] CPAI-84 is a specification for flame resistant materials used in manufacturing camping tents published by the Canvas Products Association International (CPAI), which is currently known as the Advanced Textiles Association. The specification established test methods to evaluate flame resistance and performance criteria and certification guidelines for manufacturers.

and regulatory limits. Other products that could be assessed are children's sleeping bags, and children's camping chairs.

- Additional alternative brominated flame retardants and organophosphate flame retardants should be assessed in fabric. A number of fabric samples were found from screening analyses to contain bromine or phosphorous but the limited number of brominated and organophosphate flame retardants tested for were not found.
- Since play tents and tunnels are not intended for outdoor camping, manufacturers should assess if the flammability standard CPAI-84 – A Specification for Flame Resistant Materials Used in Camping Tentage is a requirement for their products.

3.2 Study area and surroundings

Products available to Washington state residents, including those purchased in-store and online, will be assessed for inclusion in this study. The practice of purchasing products from larger chain stores and online is used to generally reflect merchandise available and sold to residents across Washington state (Sekerak, 2016). In-store purchases will be from large chain stores in the Puget Sound area.

3.2.1 History of study area

Product testing studies conducted by Ecology are limited to products available to consumers in Washington at the time of the study.

3.2.2 Summary of previous studies and existing data

In 2016, Ecology conducted a study for select flame retardants in children's upholstered furniture, play tents, and tunnels (van Bergen, 2018). Ecology's published findings show that 10 out of 46 children's play tents and tunnels tested had flame retardants TDCPP or TCEP above the CSPA required limits (van Bergen, 2018). Following this 2018 product testing study, compliance action was initiated for eight manufacturers of children's play tents for sale in Washington. Additional research assessing flame retardants in children's products has been performed by many universities, environmental and public health organizations, and state institutions. A brief synopsis is presented here since more work has been done but is outside the scope of this QAPP publication.

Chemicals used as flame retardants in children's products have shifted with increased concerns and regulations. Harmful flame retardants have been assessed in children's toys, carriers, car seats, strollers, mats, and other child care items (Hoffman et al., 2015; Stapleton et al., 2011). While replacement flame retardant chemicals are not always safer, a successful phase out of some harmful flame retardants did happen in children's car seats (Cooper et al., 2016). Later, Wu et al. (2019) found newly characterized, harmful flame retardants at high concentrations in some newer children's products, highlighting a need for safer alternatives. A 2022 report published by The Ecology Center, a nonprofit organization based in Michigan, indicated that low-cost car seats were more likely to contain flame retardant chemicals (Bloom et al., 2022).

3.2.3 Parameters of interest and potential sources

Table 1 lists the six flame retardants to be analyzed for this study. These flame retardants are described by Consumer Product Safety Commission Guidance as hazardous additive, non-

polymeric organohalogen flame retardants. Non-polymeric indicates that the chemicals are additive and can migrate from consumer products, leading to increased risk of exposure (82 Fed. Reg. 45268).

This study is designed to collect play tents that are the same as, or very similar to, previously-tested children's play tents (van Bergen, 2018). A small number of children's sleeping bags, camping chairs, car seats, and strollers will also be collected.

Table 1: Flame retardant analytes to be assessed.

Flame Retardant Chemical	Abbreviation	CAS RN	Regulation
tris(1,3-dichloro-2-propyl) phosphate	TDCPP	13674-87-8	Restricted to ≤ 1000 ppm[1] and Reportable CHCC[2]
tris(2-chloroethyl) phosphate	TCEP	115-96-8	Restricted to ≤ 1000 ppm[1] and Reportable CHCC[2]
tris(1-chloro-2-propyl) phosphate	TCPP	13674-84-5	Reportable CHCC[2]
triphenyl phosphate	TPP	115-86-6	Reportable CHCC[2]
2-ethylhexyl-2,3,4,5-tetrabromobenzoate	TBB	183658-27-7	Reportable CHCC[2]
bis(2-ethylhexyl) tetrabromophthalate	TBPH	26040-51-7	Reportable CHCC[2]

[1]As required by Children's Safe Product Act 70A.430.030 RCW.
[2] Report intentionally-added chemicals and contaminant chemicals > 100 ppm as required by Children's Safe Product Reporting Rule Chapter 173-334 WAC.
CAS RN = Chemical Abstracts Service Registry Number
ppm = parts per million
CHCC = Chemical of High Concern to Children

3.2.4 Regulatory criteria or standards

Washington state's CSPA established limits on the presence of six flame retardant chemicals, including TDCPP and TCEP, in children's products available to people residing in Washington (chapter 70A.430 RCW). CSPA limits the presence of five flame retardants at 1000 ppm in children's products as defined in Chapter 70A.430.010. CSPA also requires manufacturers to report if their children's products contain CHCCs (chapter 173-334 WAC). The four flame retardants TCPP, TPP, TBB, and TBPH are CHCCs. Manufacturers are required to submit annual reports into the High Priority Chemicals Data System (HPCDS; previously the CSPA Manufacturer Reporting Database) which is maintained by the Interstate Chemicals Clearinghouse.

Most tents and other camping gear meet voluntary industrial flammability standards CPAI-84 and CPAI-75, which were established by the trade group Canvas Products Association International (CPAI) in 1976 and 1975, respectively. As of June 2022, CPAI is known as the Advanced Textiles Association. From 1980 to 2022, CPAI was known as the Industrial Fabrics Association International. Seven states – California, Louisiana, Massachusetts, Michigan, Minnesota, New Jersey, New York – have mandated the flammability standard CPAI-84 for camping tents. Manufacturers are encouraged to follow flammability standard CPAI-75 for

sleeping bags as well. To comply with these standards, camping gear manufacturers may use flame retardants in their products.

While indoor/outdoor children's play tents are not considered actual camping gear, many children's play tents are manufactured to meet the same flammability specifications. The scope of CPAI-84 includes "play tents and indoor tent products" due to "potential inadvertent contact with indoor flame sources." Due to increasing concern about exposure to children to flame retardants, the industry was encouraged to reform flammability specifications while maintaining safety standards.

Unlike play tents, sleeping bags, and camping chairs, use of car seats is mandatory and car seats must comply with a fire standard designed for vehicle interiors. This Federal Motor Vehicle Safety Standard, FMVSS 302, was established in 1971 by the National Highway Traffic Safety Administration and has not significantly changed since the rule was written. Historically, car seats and strollers were required to meet the California technical bulletin (TB) flammability standard TB 117, but car seats and strollers were exempt from requirements in 2014 under TB 117-2013. In car seat and stroller combination products, the car seat is more likely to contain flame retardants that need to meet vehicle flammability standards (Bloom et al., 2022).

4.0 Project Description

This 2022-2023 study will assess levels of six flame retardants in fabrics of children's play tents, sleeping bags, camping chairs, and a few car seat and stroller combination packs that are marketed and sold for use by children 12 years of age or younger. As a follow-up study, the majority of products collected will be children's play tents that are as similar as possible to those products previously tested by Ecology (van Bergen, 2018). Products are limited to those available to Washington state residents in retail stores or online.

Fabric samples selected for testing will be prioritized by (1) their similarity to previously tested play tent fabrics, and (2) screening information and product flammability specification labeling. Samples will be submitted to Ecology's Manchester Environmental Laboratory (MEL) for flame retardant analysis. Analytical data will be reviewed for quality assurance (QA) and provided to the CSPA Compliance Lead, along with a report of study findings published by Ecology.

4.1 Project goals

This study is designed to meet the following goals:

- Assess the levels of six flame retardants (see Table 1) in 40 fabric samples of children's play tents, sleeping bags, camping chairs, car seats and/or strollers available for sale in Washington.
    - Assess currently available follow-up play tent items that are similar to products previously tested by Ecology (van Bergen, 2018).
    - Assess additional currently available play tents, sleeping bags, camping chairs, car seats and stroller combination items that may have a requirement to meet a flammability standard.
- Provide data to Ecology's CSPA Compliance Lead for the review of product labeling practices.
- Provide data to Ecology's CSPA Compliance Lead to assess CSPA limit violations and manufacturer reporting compliance.

4.2 Project objectives

Study goals will be met through the following objectives:

- Purchase up to 60 items of children's play tents, sleeping bags, and camping chairs for children 12 years old and younger available for sale in Washington.
- Purchase follow-up children's play tent products that are similar to play tent products that contained flame retardants above the method reporting limit (MRL) in the 2016 Ecology study.
- Purchase two low-cost car seat and stroller combination products available for sale in Washington.
- Document flammability compliance labels present on products and packaging collected.
- Analyze six flame retardants in 40 component samples of fabrics.

4.3 Information needed and sources

Children's products purchased for this study will be selected based on review of the 2016 Ecology study of children's play tents (van Bergen, 2018) and a selection of products that likely have a requirement to meet a flammability standard. Previous Ecology study data of play tent products that contained flame retardants above the MRL will be assessed for selection of follow-up items. Those products' brands, manufacturers, distributers, and fabric patterns will be reviewed to identify similar products that are currently available. Manufacturers' reporting information in the HPCDS will be reviewed to identify manufacturers who have reported the presence of a CHCC in their product(s).

4.4 Tasks required

Ecology will perform the following tasks for this study:

- Review the previous Ecology flame retardant study (van Bergen, 2018) and analytical data to prioritize the purchase of currently available play tents similar to previously-tested products with detected flame retardants above the MRL.
- Review manufacturer reporting information in the HPCDS to prioritize the purchase of children's products reported to contain a CHCC.
- Conduct in-store and online reconnaissance for availability of children's products that will be prioritized for purchase based on the following criteria, in order of importance.
    - Identify available play tent products with the same manufacturer and Universal Product Code (UPC) as those with detected flame retardants.
    - Identify available play tent products of the same product line and/or with the same brand as those with detected flame retardants, when original product UPC is not available.
    - Identify available play tent products that are made with similar fabric patterns as those with detected flame retardants.
    - Identify available play tent products that have a flammability compliance label claim, regardless of their similarity to products with detected flame retardants.
- Purchase up to 50 play tent products, with priority for products with the same manufacturer, UPC, brand name, distribution company, and/or with the same fabric pattern as previous products with detected flame retardants. Once all currently-available follow-up items are selected, additional play tents from other manufacturers may be purchased to reach the product sampling goal.
- Purchase up to 10 products that are children's sleeping bags or children's camping chairs, with priority going to products that have a flammability compliance label claim.
- Purchase two low-cost car seat and stroller combination products identified by the CSPA Compliance Lead.
- Document purchasing information, product details, and product photos in the PTDB.
- Document product component descriptions and product flammability compliance labels (i.e., CPAI-84, CPAI-75, FMVSS 302, TB-117, TB-117-2013, CA Prop 65) with photos in the PTDB.

- Process products into component samples and screen selected fabrics using an XRF analyzer.
- Review XRF data to prioritize product fabric component samples for lab analysis.
    - For play tent products that have the same UPC, brand, manufacturer, or fabric pattern as those with detected flame retardants in the 2018 report, the same component will be submitted for laboratory testing regardless of XRF screening information.
    - Additional product component samples may be submitted for lab analysis based on XRF screening information. Of those products, the highest priority will be assigned to components with screening information indicating presence of bromine, chlorine, and/or antimony.
- Submit the pre-sampling notification form to MEL prior to submission of samples.
- Submit up to 40 fabric component samples for flame retardant analysis at MEL.
- Perform data verification, review data validation report, and document data in the PTDB.
- Perform a QA review of product and lab analysis data in the PTDB.
- Analyze study data and write a report for the client and publication by Ecology.
- Make laboratory data and product information from this study available on Ecology's PTDB website.

4.5 Systematic planning process

This QAPP addresses comprehensive systematic planning for this study.

5.0 Organization and Schedule

5.1 Key individuals and their responsibilities

Table 2 shows the responsibilities of those who will be involved in this project.

Table 2. Organization of project staff and responsibilities.

Staff[1]	Title	Responsibilities
Susie Bautista Reducing Toxic Threats Unit HWTR Program Phone: 360-584-3456	Client/ CSPA Compliance Lead	Clarifies scope and informational needs of the project. Reviews draft QAPP and approves final QAPP. Performs CSPA compliance assessment and enforcement actions.
Amy Salamone Product Testing Unit SCS, EAP Phone: 564-669-1760	Project Manager/ Principal Investigator	Clarifies scope and design of project. Writes the QAPP. Leads product sampling, processing, screening, and submission of samples to the laboratory. Leads QA review of product data. Leads QA review of lab data, analyzes and interprets data, and enters data into PTDB. Writes the draft and final report.
Jenna Rushing Product Testing Unit SCS, EAP Phone: 360-407-6492	Project Assistant	Helps process and screen samples. Enters product, component, and screening data into PTDB. Assists in QA review of product and lab data in the PTDB.
Sara Sekerak Product Testing Unit SCS, EAP Phone: 360-480-9501	Unit Supervisor for the Project Manager	Reviews project scope and budget. Reviews draft QAPP and approves final QAPP. Oversees project progress and reviews draft and approves final report.
Jessica Archer SCS, EAP Phone: 360-407-6698	Section Manager for the Project Manager	Reviews project scope and budget. Approves final QAPP.
Lola Flores Reducing Toxic Threats Unit HWTR Program Phone: 360-584-3456	Unit Supervisor for the Client	Reviews the project scope. Approves final QAPP.
Richelle Perez P2RA, HWTR Program Phone: 360-407-6724	Section Manager for the Client	Reviews and approves the final QAPP.
Alan Rue Manchester Environmental Laboratory, EAP Phone: 360-871-8801	Director	Reviews and approves the final QAPP. Oversees laboratory testing and data validation.
Arati Kaza Phone: 360-407-6964	Ecology Quality Assurance Officer	Reviews and approves the draft QAPP and final QAPP.

[1]All staff are from the Washington State Department of Ecology
EAP: Environmental Assessment Program
HWTR: Hazardous Waste and Toxics Reduction
P2RA: Pollution Prevention & Regulatory Assistance
PTDB: Product Testing Database
QA: Quality assurance
QAPP: Quality Assurance Project Plan
SCS: Statewide Coordination Section

5.2 Special training and certifications

Ecology staff who perform product purchasing and processing must follow standard operating procedure (SOP) PTP001 *Procedure for Product Collection and Sample Processing* (Wiseman, 2021). Staff who make purchases with an Ecology credit card must attend the online training program, *Ecology Curriculum – Credit Card Custodians and Purchase Coordinators – Ethics and Small Purchases*. Staff who enter data or perform data QA must follow SOP PTP002 *Data Entry and Data Entry Quality Assurance* (Wiseman, 2022a). Staff who perform sample screening must follow SOP PTP004 *Thermo Fisher Scientific Niton XL3T GOLDD+ X-ray Fluorescence Analyzer* (Wiseman, 2022b).

5.3 Organization chart

See Table 2.

5.4 Proposed project schedule

Tables 3 – 5 list key activities, due dates, and lead staff for this project.

Table 3. Schedule for completing product collection, screening, and lab testing.

Task	Due date	Lead staff
Product purchases complete	January 2023	Amy Salamone
Sample screening complete	March 2023	Jenna Rushing
Samples submitted to lab	April 2023	Amy Salamone
Laboratory analyses complete	June 2023	Alan Rue

Table 4. Schedule for data entry, data validation, and data quality assurance (QA) processes.

Task	Due date	Lead staff
Product purchase data entry in PTDB	January 2023	Amy Salamone
Sample screening data entry in PTDB	March 2023	Jenna Rushing
Lab testing data validation	July 2023	Alan Rue
Lab testing data entry in PTDB	August 2023	Amy Salamone
Data QA complete	August 2023	Amy Salamone

PTDB: Product Testing Database

Table 5. Schedule for final report.

Task	Due date	Lead staff
Draft to supervisor	September 2023	Amy Salamone
Draft to client & peer reviewer	October 2023	Amy Salamone
Final draft to publications team	November 2023	Amy Salamone
Final report due on web	January 2024	Amy Salamone

5.5 Budget and funding

Total estimated costs for this study are presented in Tables 6 and 7. Estimations include costs for product purchasing, laboratory testing, and data validation. The number of quality control (QC) samples are those that are not included in the cost of analysis (duplicates, matrix spikes, and matrix spike duplicates). This project is funded through Ecology's Environmental Assessment Program (EAP) Product Testing Program.

Table 6. Project budget and funding

Item	Cost ($)
Product Purchasing (up to 62 products)	2,425
Laboratory (See Table 7 for details)	22,356
Budget Total	**24,781**

Table 7. Laboratory budget details

Parameter	Number of Samples	Number of QC Samples	Total Number of Samples	Cost Per Sample ($)	Lab Subtotal ($)
Flame Retardant Analysis[1]	40	6	46	405	18,630
Data Validation	-	-	-	-	3,726
Lab Analysis Total					**22,356**

[1]Analytical testing for six flame retardants by EPA8270E at Ecology's Manchester Environmental Laboratory (MEL).
QC = Quality Control

6.0 Quality Objectives

6.1 Data quality objectives

The overall data quality objective (DQO) is to provide analytical data that meets all documented precision and bias standards to support CSPA compliance actions. Ecology's product testing studies follow established Guidelines for Data Verification and Validation of Chemical Data from Ecology's QA Coordinator. Lab data used to evaluate compliance will undergo verification and validation following this QAPP, EPA National Functional Guidelines for Organic Superfund Methods Data Review (EPA, 2020), and EPA Guidance for Labeling Externally Validated Laboratory Analytical Data for Superfund Use (EPA, 2009). One duplicate field sample will be collected to assess variability of sampling, processing, and screening methods. Analytical laboratory testing for the flame retardants listed in Table 1 will follow standard methods that meet measurement quality objectives (MQO) outlined below.

6.2 Measurement quality objectives

6.2.1 Targets for precision, bias, and sensitivity

Lab analysis will follow MEL's accredited SOP, MEL730123 Version 2.2: Flame Retardants and Polybrominated Diphenyl Ethers (PBDEs) in Consumer Products by EPA SW-864 Method 8270E. Specific MQOs expressed as precision, bias, and sensitivity of flame retardant data are presented in Table 8.

Table 8. Measurement quality objectives for laboratory analyses.

Parameter	Sample, MS, Surrogate Duplicates (RPD)	MS (% Recovery[2])	Surrogate[1] (% Recovery[2])	Method Blank	Target MRL (ppm)
tris(1,3-dichloro-2-propyl) phosphate (TDCPP)	≤ 40%	50 – 150%	50 – 150%	<MRL	100
tris(2-chloroethyl) phosphate (TCEP)	≤ 40%	50 – 150%	50 – 150%	<MRL	100
tris(1-chloro-2-propyl) phosphate (TCPP)	≤ 40%	50 – 150%	50 – 150%	<MRL	100
triphenyl phosphate (TPP)	≤ 40%	50 – 150%	50 – 150%	<MRL	100
2-ethylhexyl-2,3,4,5-tetrabromobenzoate (TBB)	≤ 40%	50 – 150%	50 – 150%	<MRL	100
bis(2-ethylhexyl) tetrabromophthalate (TBPH)	≤ 40%	50 – 150%	50 – 150%	<MRL	100

[1]Surrogate compounds are Triphenyl Phosphate-d15 and Decachlorobiphenyl.
[2]Acceptance limits provided are preferred maximum limits since they are not well established for product matrices.
MS = Matrix Spike
RPD = Relative Percent Difference
MRL = Method Reporting Limit
ppm = parts per million

6.2.1.1 Precision

Precision is a measure of variability among replicate measurements due to random error. Laboratory precision will be assessed through duplicate analysis of one sample per analytical batch and the MQOs are presented in Table 8.

6.2.1.2 Bias

Bias is the difference between the sample mean and the true value. Laboratory bias will be assessed through analysis of laboratory control samples (LCS) and matrix spike samples (MS). See Table 8 for MQO.

6.2.1.3 Sensitivity

Sensitivity is the capability of a method or instrument to discriminate between measurement responses representing different levels of the analyte of interest. Laboratory sensitivity is conveyed through the method reporting limit (MRL). See Table 8 for reporting limits.

6.2.2 Targets for comparability, representativeness, and completeness

6.2.2.1 Comparability

Comparability will be achieved by implementing standardized procedures for sampling, product componentization, screening, and data assurance processes. Established SOPs are listed in section 5.2.

6.2.2.2 Representativeness

Representativeness will be met by purchasing products from chain stores or online stores that are available to consumers in Washington. In-store purchases will be from large chain stores in the south Puget Sound area that have multiple locations in both small towns and large cities of Washington.

6.2.2.3 Completeness

The project manager will consider purchasing for this study to be complete if 90% of the target products are collected within the study timeframe. Some product purchases may need to be cancelled if the products will not be received within the proposed schedule. This study will be considered complete if 95% of the analytical results of the samples meet MQOs in Table 8.

6.3 Acceptance criteria for quality of existing data

Not applicable to this study.

6.4 Model quality objectives

Not applicable to this study.

7.0 Study Design

7.1 Study boundaries

Children's products selected for this study will be available for sale to Washington residents either in-store or online. This study is designed to prioritize collection of follow-up play tent products as a priority, regardless of the store the original product was purchased from. In-store purchases will be from large chain stores in the south Puget Sound area, and online stores will meet Ecology's online credit card vendor standards.

Products will be limited to children's play tents, sleeping bags, camping chairs, and a few low-cost car seats and strollers that are marketed and sold for use by children. Products with the following characteristics will be considered children's items: (1) smaller size appropriate for a child, (2) brightly colored items, and (3) contains childish themes or embellished with features that might appeal to a child of age 12 years or younger. Products will be prioritized for purchase based on (1) similarity to original play tent products in Ecology's report (van Bergen, 2018) as outlined in section 8.2.1, (2) presence of product flammability specification labels as described in section 8.8, and (3) selection by the CSPA Compliance Lead.

7.2 Field data collection

7.2.1 Sampling locations and frequency

For Ecology's product testing studies, the field may be a brick-and-mortar store or a virtual online store. Products will be purchased online or from south Puget Sound area large chain stores. In-store and online purchase events will be planned in coordination with Ecology purchasing staff.

7.2.2 Field parameters and laboratory analytes to be measured

Table 1 lists the laboratory analytes to be measured; methodology details are in Section 9. There are no field parameters to be measured for this study.

7.3 Modeling and analysis design

Not applicable to this study.

7.4 Assumptions underlying design

Children's products purchased for this study are assumed to reflect those currently available and on the market for sale to residents of Washington. Specific assumptions for items purchased for follow-up are that products of the same brand, manufacturer, and/or fabric pattern are comparable to previously available play tent products. It is assumed that online purchasing is available to most people in Washington and that large retail chain stores sell similar products at locations throughout Washington (Sekerak, 2016).

7.5 Possible challenges and contingencies

The possible logistical challenges, constraints, and schedule limitations for this study are described below.

7.5.1 Logistical problems

Product availability and selection is not consistent, so additional purchasing events may need to be planned. Limitations in receiving products through online purchases may occur due to unforeseen product unavailability or shipping delays after purchase. Some product purchases may need to be cancelled if the products will not be received within the proposed schedule. Products may be reordered through a different online retailer when possible.

7.5.2 Practical constraints

The limited availability of the Ecology credit card and the restrictions of its usage may place additional constraints, since there will be multiple purchasing events for this study. A draft purchasing schedule will be submitted to the appropriate purchasing officer to minimize availability issues.

7.5.3 Schedule limitations

This project schedule is planned to last from December 2022 to November 2023. Complex matrices may require an extended period of time for laboratory analysis, especially if the laboratory needs to perform additional cleaning or purging tasks which can be common when analyzing consumer product samples. MEL's schedule for analytical sample processing by microwave extraction has limited availability due to high requests from other projects. Complex data sets may require an extended period of time for data QA procedures or data validation.

8.0 Field Procedures

8.1 Invasive species evaluation

Not applicable to this study.

8.2 Measurement and sampling procedures

Product purchasing and processing will follow SOP PTP001 *Procedure for Product Collection and Sample Processing* (Wiseman, 2021). Data entry and data QA will follow SOP PTP002 *Data Entry and Data Entry Quality Assurance* (Wiseman, 2022a). At least one field sample duplicate will be collected and analyzed. Products purchased for this study will be brought to Ecology's product testing preparation room where they will be processed and stored under secure holding conditions.

8.2.1 Product Selection

Children's products selected for this follow-up study will be prioritized for purchase based on their similarity to those reported in Ecology's previous study (van Bergen, 2018). Prioritization of follow-up play tent products will be based on similarity to the following original product information, in order of importance: (1) manufacturer, (2) UPC, (3) brand name, (4) distribution company, and (5) the fabric pattern. Children's sleeping bags and camping chair products will be prioritized for purchase if they have the same brand name, manufacturer, and/or distributer as previously-studied play tent products (van Bergen, 2018), or if they have a flammability compliance label. Low-cost car seat and stroller combination items will be selected by the CSPA Compliance Lead based on the findings flame retardant free products that meet flammability standards are still cost prohibitive and may be unnecessarily exposing lower income children to toxic chemicals (Bloom, 2022).

Products may be purchased from both online stores and retail stores, and it is not necessary that follow-up products be purchased from the original point of purchase. It is unlikely that play tent products with the exact same UPC exist in the current marketplace, since purchasing for the previous study took place in 2016 (van Bergen, 2018). Where the exact product cannot be found for purchase, a similar product, of the same brand, made by the same manufacturer, and/or of the same fabric pattern, will be selected for purchase. In this case, alternate play tent products from the same manufacturer will be purchased, as available. The alternate products may be from a separate product line if they have the same manufacturer.

8.2.2 Product Screening

Qualitative screening of product component samples and assessment of QC standards will be performed following SOP PTP004 *Thermo Fisher Scientific Niton XL3T GOLDD+ X-ray Fluorescence Analyzer* (Wiseman, 2022b). Products that contain high amounts of halogen elements, bromine and chlorine, and/or the element antimony, may also contain flame retardants of interest (Stapleton, 2011; Petreas et al., 2016). Bromine and chlorine are present in many flame retardant chemicals and antimony trioxide is used alongside these flame retardants as a flame-suppressive synergist agent. Product component samples will be screened with an X-ray fluorescence (XRF) analyzer for bromine, chlorine, and antimony.

Detection of these compounds in product samples of fabrics and materials may indicate the presence of flame retardants (Stapleton et al., 2011; Petreas et al., 2016;).

Regardless of screening information, follow-up play tent products that have the same manufacturer, UPC, and/or brand as those with detected flame retardants in the 2018 report will be submitted for laboratory testing. Additional product component samples may be submitted for further quantitative analysis by laboratory testing based on XRF screening information. Of those products, the highest priority will be assigned to components with screening information indicating presence of bromine, chlorine, and/or antimony.

8.3 Containers, preservation methods, holding times

Table 9 presents sample matrices, minimum weight required, appropriate containers, preservation techniques, and holding times that apply to this study.

Table 9. Sample matrices, containers, preservation, and holding times.

Parameter	Matrix	Minimum Weight Required[1]	Container	Preservative[2]	Holding Time[3]
tris(1,3-dichloro-2-propyl) phosphate (TDCPP)	fabric	1 g	4 oz wide mouth clear glass jar with Teflon lined lid	none	1 year
tris(2-chloroethyl) phosphate (TCEP)	fabric	1 g	4 oz wide mouth clear glass jar with Teflon lined lid	none	1 year
tris(1-chloro-2-propyl) phosphate (TCPP)	fabric	1 g	4 oz wide mouth clear glass jar with Teflon lined lid	none	1 year
triphenyl phosphate (TPP)	fabric	1 g	4 oz wide mouth clear glass jar with Teflon lined lid	none	1 year
2-ethylhexyl-2,3,4,5-tetrabromobenzoate (TBB)	fabric	1 g	4 oz wide mouth clear glass jar with Teflon lined lid	none	1 year
bis(2-ethylhexyl) tetrabromophthalate (TBPH)	fabric	1 g	4 oz wide mouth clear glass jar with Teflon lined lid	none	1 year

[1]Additional sample will be required for analysis of sample duplicates, matrix spikes, and matrix spike duplicates.
[2]Preservation methods have not been well established for consumer products (Sekerak, 2016).
[3]Holding time is approximate for product samples received at MEL; storage may not be standard at all labs.

8.4 Equipment decontamination

Decontamination procedures will follow protocols in SOP PTP001 *Procedure for Product Collection and Sample Processing* (Wiseman, 2021). Product testing staff will not use or wear personal care products that contain flame retardants and will not use or handle cigarettes or cigars prior to sample processing. Product testing staff will clean stainless steel surfaces with 1% Liquinox solution followed by a 24% ethanol spray prior to use and between processing each product. The Product Testing Unit's vacuum with a HEPA filter will be used to pick up any debris from surfaces and minimize cross contamination between processing each product. Product testing staff will change into new gloves between processing products. All tools used in deconstruction and componentization will be cleaned between samples using 24% ethanol or isopropyl alcohol spray.

8.5 Sample ID

Upon entry into the PTDB, individual product component identification codes are automatically assigned as outlined in SOP PTP002 *Data Entry and Data Entry Quality Assurance* (Wiseman, 2022a). Product IDs convey information about the store of purchase, the purchase event, product number, and component number (e.g., "WM-1-3-1" means Walmart store, purchase event 1, product number 3, and component number 1 of the product tested).

A Pre-Sampling Notification form will be submitted to MEL prior to the planned submission of samples. MEL will generate a seven-digit work order number (WO#; e.g., 1601027) for each sample set(s) for an individual study. During sample processing at Ecology Headquarters (Lacey, WA), the addition of a two-digit suffix to the WO# will result in a laboratory sample ID number (e.g., 1601027-01, 1601027-02) for each sample (Sekerak, 2016).

8.6 Chain of custody

Appropriate chain of custody procedures will be followed according to SOP PTP001 *Procedure for Product Collection and Sample Processing* (Wiseman, 2021). Products purchased for this study will be kept in locked cabinets in Ecology's product testing preparation room for the duration of the study. Product component samples will be stored in appropriate containers in locked cabinets prior to shipment to MEL for laboratory analysis (Sekerak, 2016). A detailed chain of custody form will accompany all samples during shipment to the lab.

8.7 Field log requirements

Product advertisements, photos of in-store marketing, and receipts for purchases will be collected during purchasing events and scanned and saved in the PTDB. Online purchase order confirmations, receipts, and packing slips will be saved as digital images and saved in the PTDB. Purchasing event information will be entered into the PTDB as outlined in SOP PTP002 *Data Entry and Data Entry Quality Assurance* (Wiseman, 2022a).

At a minimum, the store name, street address, website address, purchase date, purchase price, brand name, manufacturer name, manufacture date, and distributer name, as well as other descriptive metadata, will be recorded in the PTDB for all products in this study. Photographs of in-store marketing, such as store displays and product location in the store, may be used to show that the products were marketed for children.

8.8 Other activities

Product flammability specification label claims will be documented in the PTDB by photographs of the label(s) and any associated symbols, as available. The flammability specification code (i.e., CPAI-84, CPAI-75, FMVSS 302, TB-117, TB-117-2013, CA Prop 65) will also be recorded in the product notes section within the PTDB.

9.0 Laboratory Procedures

9.1 Lab procedures table

MEL will perform the assessment of flame retardants, following the methods listed in Table 10.

Table 10. Measurement methods (laboratory).

Analyte	Sample Matrix	Number of Samples	Expected Range of Results (ppm)	Target Method Reporting Limit (ppm)	Analytical Method
tris(1,3-dichloro-2-propyl) phosphate (TDCPP)	fabric	40	< 100 - 50,000	100	EPA 8270E, GC/MS
tris(2-chloroethyl) phosphate (TCEP)	fabric	40	< 100 - 50,000	100	EPA 8270E, GC/MS
tris(1-chloro-2-propyl) phosphate (TCPP)	fabric	40	< 100 - 50,000	100	EPA 8270E, GC/MS
triphenyl phosphate (TPP)	fabric	40	< 100 - 50,000	100	EPA 8270E, GC/MS
2-ethylhexyl-2,3,4,5-tetrabromobenzoate (TBB)	fabric	40	< 100 - 50,000	100	EPA 8270E, GC/MS
bis(2-ethylhexyl) tetrabromophthalate (TBPH)	fabric	40	< 100 - 50,000	100	EPA 8270E, GC/MS

GC/MS = gas chromatography mass spectrometry
ppm = parts per million

9.2 Sample preparation method(s)

Product component sample preparation will follow SOP PTP001 *Procedure for Product Collection and Sample Processing* (Wiseman, 2021). Laboratory sample preparation by extraction for EPA method 8270E will follow EPA method 3546.

9.3 Special method requirements

The laboratory performing testing for this study must meet the acceptance criteria and MQOs listed in Table 8. The analysis method for TDCPP, TCEP, TCPP, TPP, TBB, and TBPH will follow EPA Method 8270E: *Semivolatile Organic Compounds by Gas Chromatography/Mass Spectrometry*.

9.4 Laboratories accredited for methods

MEL is currently accredited for lab analysis of TDCPP, TCEP, TCPP, TPP, TBB, and TBPH by EPA 8270E. Laboratory analysis will follow MEL's accredited SOP, MEL730123 Version 2.2: Flame Retardants and Polybrominated Diphenyl Ethers (PBDEs) in Consumer Products by EPA SW-864 Method 8270E.

10.0 Quality Control Procedures

10.1 Table of field and laboratory quality control

Table 11 presents the sample testing QC procedures for this study. Lab QC tests will consist of lab control samples, lab control sample duplicates, sample duplicates, method blanks, matrix spikes, matrix spike duplicates, and method surrogates. Laboratory method QC tests, including the initial calibration curve standards and blanks and continuing calibration verification standards and blanks, will follow analytical SOP MEL730123.

Table 11. Quality control samples, types, and frequency.

Laboratory Method	Field Sample Duplicates	Lab Sample Duplicates	Lab Control Sample & Duplicate	Method Blanks	Matrix Spike & Duplicate	Method Surrogates
EPA 8270E	1 per study	1 per batch[1]	1 set per batch	1 per batch	1 set per batch	each sample

[1]batch = 20 samples or fewer

10.2 Corrective action processes

Ecology staff will adhere to the appropriate SOPs and study-specific processing and preparation protocols described in this QAPP. MEL staff will document whether lab data meet method QC criteria. As soon as it is recognized, the lab will notify the project manager if substantial departures of method techniques will be necessary. Any departures from stated analytical methods will be documented by the laboratory and described in the case narrative. When MQO or QC criteria are not met, or if the integrity of the processing and preparation processes are in question, the project manager will determine if samples should be re-collected, re-analyzed, rejected, or used with appropriate qualification.

11.0 Data Management Procedures

11.1 Data recording and reporting requirements

The data for this project will be stored in Ecology's PTDB according to SOP PTP002 *Data Entry and Data Entry Quality Assurance* (Wiseman, 2022a). Study data recorded will include purchase receipts, product descriptions, product component descriptions, product photos, and laboratory testing data. Purchase and product metadata of store name, street address, website address, purchase date, purchase price, brand name, manufacturer name, and distributer name will be recorded in the PTDB. Photographs of in-store marketing will be included in any case narratives, as needed, and saved in the PTDB.

XRF data are used for internal preliminary screening processes only and are not searchable on the external PTDB. Verified XRF screening results are uploaded to the internal PTDB (Sekerak, 2016). XRF spectrum and data files are saved as .NDT files to the Product Testing F: Drive, in the study-specific folder. Narratives attached to XRF batches provide a discussion of issues encountered during XRF screening.

Laboratory data will be received electronically from MEL's Laboratory Information Management System (LIMS) or arrive as an electronic data deliverable (EDD), or comparable, package. The lab data packages will also be sent to the MEL QA Coordinator for data validation. The project manager will perform a final QA review of all data before they are uploaded into the PTDB.

11.2 Laboratory data package requirements

Labs performing analyses for this study will deliver a level 4 data package in electronic format to the project manager and the MEL QA Coordinator. The lab data will contain all required specific content, along with sample and QC data. Case narratives will be included to discuss any problems encountered with the analyses, corrective action taken, changes to the requested analytical method, and a glossary for data flags and qualifiers. The data package must include all raw data, QA/QC documentation, and chain of custody forms needed to perform an independent validation of the results and sample handling procedures. The data package will include lab bench sheets, calibration reports, chromatograms, and spectra for all calibration standards and samples.

11.3 Electronic transfer requirements

Laboratory case narratives and data packages will be in PDF format and EDDs, respectively. EDDs will be in a .csv or .xlsx spreadsheet format that meets Ecology's product testing formatting requirements. An alternative format may be approved by the project manager.

11.4 PTDB data upload procedures

The data for this project will be stored in Ecology's PTDB according to SOP PTP002 *Data Entry and Data Entry Quality Assurance* (Wiseman, 2022a).

11.5 Model information management

Not applicable to this study.

12.0 Audits and Reports

12.1 Field, laboratory, and other audits

Analytical labs must participate in performance and system audits of their routine procedures as prescribed by their accrediting authority. The product testing process conducted at Ecology will be audited at a minimum of one audit per year.

12.2 Responsible personnel

Ecology's QA Officer or their designee will conduct the product testing process audit. The processes can include product acquisition, product documentation and data entry in the PTDB, sample screening, sample processing, chain-of-custody, and adherence to product testing QAPPs and SOPs.

12.3 Frequency and distribution of reports

A final published report summarizing the data and findings will be written when the study is completed. The final report will include at a minimum:

- An overview of the study.
- Goals and objectives of the study.
- Summary statistics of the laboratory results from products purchased.
- Discussion of methods, any corrective actions, and the significance of any problems encountered.
- Summary tables and graphs of laboratory data.
- Discussion of laboratory results and data quality.

The final report will be available online at:
https://apps.ecology.wa.gov/publications/UIPages/PublicationList.aspx?IndexTypeName=Topic&NameValue=Product+Testing&DocumentTypeName=Publication

12.4 Responsibility for reports

The project manager is responsible for writing the final report, as stated in Table 2.

13.0 Data Verification

13.1 Field data verification, requirements, and responsibilities

The project manager, or assigned designee, will conduct a final review of product purchases, product components, component screening, and additional product metadata entered into the PTDB. All data will be reviewed by the project manager at several stages during the study according to SOP PTP002 *Data Entry and Data Entry Quality Assurance* (Wiseman, 2022a).

13.2 Laboratory data verification

Lab data verification is the process of evaluating the completeness, correctness, and conformance/compliance of a specific data set against the method, procedural, or contractual requirements. Data verification requirements for Ecology's product testing studies follows established Ecology Guidelines for Data Verification and Validation of Chemical Data. The project manager will review data packages and data validation reports and conduct a QA review of the data to assess suitability. The project manager, with guidance from Ecology's QA Officer, will be responsible for the final acceptance of lab data. Based on these verification assessments, the data will be either accepted, accepted with qualifications, rejected with re-analysis considered, or rejected without re-analysis considered.

13.3 Validation requirements, if necessary

Lab data validation is an analyte- and sample-specific process that extends the evaluation of data beyond data verification to determine the analytical quality of a specific data set. Data validation requirements for Ecology's product testing studies follows established Ecology Guidelines for Data Verification and Validation of Chemical Data. A stage 3 data validation of data for analyses by EPA 8270E will be performed by the MEL QA Coordinator following this QAPP, EPA National Functional Guidelines for Organic Data Review (EPA, 2020), and EPA Guidance for Labeling Externally Validated Laboratory Analytical Data for Superfund Use (EPA, 2009).

The stage 3 data validation report is to address the following assessments:

- Sample receipt and holding conditions.
- Project reporting limits stated in Table 10.
- Project MQOs stated in Table 8, including objectives for method blanks, laboratory control sample recoveries, duplicate analyses, matrix spike and matrix spike duplicate recoveries.
- Checks and recalculations for initial calibration standards and blanks and continuing calibration verification standards and blanks.
- Evaluation of the fit and appropriateness of the initial calibration curve.

The project manager will review the data validation reports and, with guidance from Ecology's QA Officer, will determine the final acceptance of lab data. Based on these validation and verification assessments, the data will be accepted, accepted with qualifications, rejected with re-analysis considered, or rejected without re-analysis considered.

13.4 Model quality assessment

Not applicable to this study.

14.0 Data Quality (Usability) Assessment

14.1 Process for determining if project objectives were met

The project manager will assess the quality and suitability of the data based on case narratives, data packages, the data verification report, and the data validation report. Laboratory QC information will be evaluated to determine if MQOs were met for method blanks, laboratory control samples, duplicates, matrix spike samples, and surrogates. Reporting limits will be examined to ensure that the defined reporting limit was met (Sekerak, 2016).

If all MQOs and QC criteria are met, the quality of the data will be considered suitable for meeting study objectives. The study will be considered complete, and objectives met, if 95% of the samples meet MQOs and QC criteria. If a sample does not meet MQOs or any QC criteria, the data will have an associated "REJ" in the PTDB. The final report for this study will discuss the data quality findings. Analytical data qualifiers that will be used in the PTDB are described in Table 12.

Table 12. Analytical data qualifiers.

Qualifier Symbol in PTDB	Qualifier Description
U	Analyte was not detected above the method reporting limit.
UJ	Analyte was not detected above the reporting limit. However, the reporting limit is an estimated value.
J	Analyte was positively identified. The reported result is an estimate.
NJ	The analyte was tentatively identified in the sample but the result value reported is an estimate.
REJ	The sample result was rejected due to serious deficiencies in the ability to analyze the sample, meet quality control criteria or other technical reason. The presence or absence of the analyte cannot be verified.

PTDB = Product testing data base

14.2 Treatment of non-detects

Laboratory data will be reported down to the reporting limit, with an associated "U" or "UJ" qualifier for samples with analytes not detected at or above the reporting limit.

14.3 Data analysis and presentation methods

The final report will include a summary of the results of this study. Simple summary statistics and data will be presented in tables and graphs. Example summary statistics may include minimum, maximum, median, and frequencies of detection.

The report will include a link to the study data available on the external database: https://apps.ecology.wa.gov/ptdbreporting/

14.4 Sampling design evaluation

The number and type of samples collected and tested were designed to meet the objectives of this study. The results of this study may be used to plan future study events with a larger sample size and/or a wider variety of consumer products.

14.5 Documentation of assessment

A documentation of assessment will be in the final report.

15.0 References

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16.0 Appendix: Acronyms, Abbreviations, and Quality Assurance Glossary

Acronyms and Abbreviations

CHCC	Chemicals of high concern to children
CSPA	Washington's Children's Safe Products Act
e.g.	For example
EAP	Environmental Assessment Program
Ecology	Washington State Department of Ecology
EIM	Environmental Information Management database
EPA	U.S. Environmental Protection Agency
et al.	And others
GC/MS	Gas chromatography mass spectrometry
HPCDS	High Priority Chemicals Data System
HWTR	Hazardous Waste and Toxics Reduction
i.e.	In other words
LCS	Laboratory control sample
MEL	Manchester Environmental Laboratory
MQO	Measurement quality objective
MRL	Method Reporting Limit
PBT	Persistent, bioaccumulative, and toxic substance
PTDB	Product testing database
QA	Quality assurance
QAPP	Quality assurance project plan
QC	Quality control
RCW	Revised Code of Washington
RPD	Relative percent difference
RSD	Relative standard deviation
SC	Statewide Coordination
SOP	Standard operating procedure
SRM	Standard reference material
TCEP	Tris(2-chloroethyl) phosphate
TCPP	Tris(1-chloro-2-propyl) phosphate
TDCPP	Tris(1,3-dichloro-2-propyl) phosphate
TPP	Triphenyl phosphate
WAC	Washington Administrative Code
XRF	X-ray Fluorescence

Units of Measurement

mg/kg	milligrams per kilogram (parts per million)

Quality Assurance Glossary

Accreditation: A certification process for laboratories, designed to evaluate and document a lab's ability to perform analytical methods and produce acceptable data. For Ecology, it is "Formal recognition by (Ecology)…that an environmental laboratory is capable of producing accurate analytical data." [WAC 173-50-040] (Kammin, 2010)

Accuracy: The degree to which a measured value agrees with the true value of the measured property. USEPA recommends that this term not be used, and that the terms *precision* and *bias* be used to convey the information associated with the term *accuracy* (USGS, 1998).

Analyte: An element, ion, compound, or chemical moiety (pH, alkalinity) which is to be determined. The definition can be expanded to include organisms, e.g., fecal coliform, Klebsiella (Kammin, 2010).

Bias: The difference between the sample mean and the true value. Bias usually describes a systematic difference reproducible over time and is characteristic of both the measurement system and the analyte(s) being measured. Bias is a commonly used data quality indicator (DQI) (Kammin, 2010; Ecology, 2004).

Blank: A synthetic sample, free of the analyte(s) of interest. For example, in water analysis, pure water is used for the blank. In chemical analysis, a blank is used to estimate the analytical response to all factors other than the analyte in the sample. In general, blanks are used to assess possible contamination or inadvertent introduction of analyte during various stages of the sampling and analytical process (USGS, 1998).

Calibration: The process of establishing the relationship between the response of a measurement system and the concentration of the parameter being measured (Ecology, 2004).

Check standard: A substance or reference material obtained from a source independent from the source of the calibration standard; used to assess bias for an analytical method. This is an obsolete term, and its use is highly discouraged. See Calibration Verification Standards, Lab Control Samples (LCS), Certified Reference Materials (CRM), and/or spiked blanks. These are all check standards but should be referred to by their actual designator, e.g., CRM, LCS (Kammin, 2010; Ecology, 2004).

Comparability: The degree to which different methods, data sets and/or decisions agree or can be represented as similar; a data quality indicator (USEPA, 1997).

Completeness: The amount of valid data obtained from a project compared to the planned amount. Usually expressed as a percentage. A data quality indicator (USEPA, 1997).

Continuing Calibration Verification Standard (CCV): A quality control (QC) sample analyzed with samples to check for acceptable bias in the measurement system. The CCV is usually a midpoint calibration standard that is re-run at an established frequency during the course of an analytical run (Kammin, 2010).

Control chart: A graphical representation of quality control results demonstrating the performance of an aspect of a measurement system (Kammin, 2010; Ecology 2004).

Control limits: Statistical warning and action limits calculated based on control charts. Warning limits are generally set at +/- 2 standard deviations from the mean, action limits at +/- 3 standard deviations from the mean (Kammin, 2010).

Data integrity: A qualitative DQI that evaluates the extent to which a data set contains data that is misrepresented, falsified, or deliberately misleading (Kammin, 2010).

Data quality indicators (DQI): Commonly used measures of acceptability for environmental data. The principal DQIs are precision, bias, representativeness, comparability, completeness, sensitivity, and integrity (USEPA, 2006).

Data quality objectives (DQO): Qualitative and quantitative statements derived from systematic planning processes that clarify study objectives, define the appropriate type of data, and specify tolerable levels of potential decision errors that will be used as the basis for establishing the quality and quantity of data needed to support decisions (USEPA, 2006).

Data set: A grouping of samples organized by date, time, analyte, etc. (Kammin, 2010).

Data validation: An analyte-specific and sample-specific process that extends the evaluation of data beyond data verification to determine the usability of a specific data set. It involves a detailed examination of the data package, using both professional judgment and objective criteria, to determine whether the MQOs for precision, bias, and sensitivity have been met. It may also include an assessment of completeness, representativeness, comparability, and integrity, as these criteria relate to the usability of the data set. Ecology considers four key criteria to determine if data validation has actually occurred. These are:

- Use of raw or instrument data for evaluation.
- Use of third-party assessors.
- Data set is complex.
- Use of EPA Functional Guidelines or equivalent for review.

Examples of data types commonly validated would be:

- Gas Chromatography (GC).
- Gas Chromatography-Mass Spectrometry (GC-MS).
- Inductively Coupled Plasma (ICP).

The end result of a formal validation process is a determination of usability that assigns qualifiers to indicate usability status for every measurement result. These qualifiers include:

- No qualifier – data are usable for intended purposes.
- J (or a J variant) – data are estimated, may be usable, may be biased high or low.
- REJ – data are rejected, cannot be used for intended purposes.
  (Kammin, 2010; Ecology, 2004).

Data verification: Examination of a data set for errors or omissions, and assessment of the Data Quality Indicators related to that data set for compliance with acceptance criteria (MQOs). Verification is a detailed quality review of a data set (Ecology, 2004).

Detection limit (limit of detection)**:** The concentration or amount of an analyte which can be determined to a specified level of certainty to be greater than zero (Ecology, 2004).

Duplicate samples: Two samples taken from and representative of the same population, and carried through and steps of the sampling and analytical procedures in an identical manner. Duplicate samples are used to assess variability of all method activities including sampling and analysis (USEPA, 1997).

Field blank: A blank used to obtain information on contamination introduced during sample collection, storage, and transport (Ecology, 2004).

Initial Calibration Verification Standard (ICV): A QC sample prepared independently of calibration standards and analyzed along with the samples to check for acceptable bias in the measurement system. The ICV is analyzed prior to the analysis of any samples (Kammin, 2010).

Laboratory Control Sample (LCS): A sample of known composition prepared using contaminant-free water or an inert solid that is spiked with analytes of interest at the midpoint of the calibration curve or at the level of concern. It is prepared and analyzed in the same batch of regular samples using the same sample preparation method, reagents, and analytical methods employed for regular samples (USEPA, 1997).

Matrix spike: A QC sample prepared by adding a known amount of the target analyte(s) to an aliquot of a sample to check for bias due to interference or matrix effects (Ecology, 2004).

Measurement Quality Objectives (MQOs)**:** Performance or acceptance criteria for individual data quality indicators, usually including precision, bias, sensitivity, completeness, comparability, and representativeness (USEPA, 2006).

Measurement result: A value obtained by performing the procedure described in a method (Ecology, 2004).

Method: A formalized group of procedures and techniques for performing an activity (e.g., sampling, chemical analysis, data analysis), systematically presented in the order in which they are to be executed (EPA, 1997).

Method blank: A blank prepared to represent the sample matrix, prepared and analyzed with a batch of samples. A method blank will contain all reagents used in the preparation of a sample, and the same preparation process is used for the method blank and samples (Ecology, 2004; Kammin, 2010).

Method Detection Limit (MDL): This definition for detection was first formally advanced in 40CFR 136, October 26, 1984 edition. MDL is defined there as the minimum concentration of an analyte that, in a given matrix and with a specific method, has a 99% probability of being identified, and reported to be greater than zero (Federal Register, October 26, 1984).

Percent Relative Standard Deviation (%RSD): A statistic used to evaluate precision in environmental analysis. It is determined in the following manner:

$$\%RSD = (100 * s)/x$$

where s is the sample standard deviation and x is the mean of results from more than two replicate samples (Kammin, 2010).

Parameter: A specified characteristic of a population or sample. Also, an analyte or grouping of analytes. Benzene and nitrate + nitrite are all parameters (Kammin, 2010; Ecology, 2004).

Population: The hypothetical set of all possible observations of the type being investigated (Ecology, 2004).

Precision: The extent of random variability among replicate measurements of the same property; a data quality indicator (USGS, 1998).

Quality assurance (QA): A set of activities designed to establish and document the reliability and usability of measurement data (Kammin, 2010).

Quality Assurance Project Plan (QAPP): A document that describes the objectives of a project, and the processes and activities necessary to develop data that will support those objectives (Kammin, 2010; Ecology, 2004).

Quality control (QC): The routine application of measurement and statistical procedures to assess the accuracy of measurement data (Ecology, 2004).

Relative Percent Difference (RPD): RPD is commonly used to evaluate precision. The following formula is used:

[Abs(a-b)/((a + b)/2)] * 100

where "Abs()" is absolute value and a and b are results for the two replicate samples. RPD can be used only with 2 values. Percent Relative Standard Deviation is (%RSD) is used if there are results for more than 2 replicate samples (Ecology, 2004).

Replicate samples: Two or more samples taken from the environment at the same time and place, using the same protocols. Replicates are used to estimate the random variability of the material sampled (USGS, 1998).

Representativeness: The degree to which a sample reflects the population from which it is taken; a data quality indicator (USGS, 1998).

Sample (field): A portion of a population (environmental entity) that is measured and assumed to represent the entire population (USGS, 1998).

Sample (statistical): A finite part or subset of a statistical population (USEPA, 1997).

Sensitivity: In general, denotes the rate at which the analytical response (e.g., absorbance, volume, meter reading) varies with the concentration of the parameter being determined. In a specialized sense, it has the same meaning as the detection limit (Ecology, 2004).

Spiked blank: A specified amount of reagent blank fortified with a known mass of the target analyte(s); usually used to assess the recovery efficiency of the method (USEPA, 1997).

Spiked sample: A sample prepared by adding a known mass of target analyte(s) to a specified amount of matrix sample for which an independent estimate of target analyte(s) concentration is available. Spiked samples can be used to determine the effect of the matrix on a method's recovery efficiency (USEPA, 1997).

Split sample: A discrete sample subdivided into portions, usually duplicates (Kammin, 2010).

Standard Operating Procedure (SOP): A document which describes in detail a reproducible and repeatable organized activity (Kammin, 2010).

Surrogate: For environmental chemistry, a surrogate is a substance with properties similar to those of the target analyte(s). Surrogates are unlikely to be native to environmental samples. They are added to environmental samples for quality control purposes, to track extraction efficiency and/or measure analyte recovery. Deuterated organic compounds are examples of surrogates commonly used in organic compound analysis (Kammin, 2010).

Systematic planning: A step-wise process which develops a clear description of the goals and objectives of a project, and produces decisions on the type, quantity, and quality of data that will be needed to meet those goals and objectives. The DQO process is a specialized type of systematic planning (USEPA, 2006).

References for QA Glossary

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