An Assessment of Heavy Metals in Packaging: A Focus on Flexible PVC from Discount Retail Chain Stores

The Toxics in Packaging Clearinghouse

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Executive Summary

This report documents the continued investigation by the Toxics in Packaging Clearinghouse of heavy metals in packaging, using x-ray fluorescence (XRF) analysis. The goals of this project were to assess compliance with state toxics in packaging laws in the target sector, specifically, "dollar" and discount retail chain stores; and to identify non-compliant packaging for coordinated action by member states. This project targeted imported flexible polyvinylchloride (PVC) packaging from discount retail chain stores, since two previous TPCH studies showed a propensity for these inexpensive, imported materials to contain restricted metals.

TPCH screened samples obtained in May - July 2010 from six dollar/discount retail chain s, and from "dollar" bins at two other retailers located in seven member states (CA, IA, NH, NJ, NY, RI and WA). The selected retailers operate over 100 stores each, while six of the eight retailers have at least 500 locations across 35 or more U.S states.

A total of 61 flexible PVC packaging samples were screened using XRF technology. Twenty-four (39%) of the packaging samples failed the screening test for cadmium and in one instance, also for lead. All the failed packaging samples were imported, mostly from China, with one exception, where the country of origin was unknown.

All eight of the retail chains where packaging was obtained, sold products found to be non-compliant with toxics in packaging laws. Non-compliant packaging was not confined to specific product sectors. Packaging that failed the XRF screening was used to package children's products, pet supplies, personal care, household items, home furnishings, hardware, and apparel.

Member states used the results of the XRF screening to undertake coordinated state action, where multiple states notified the brand owners, distributors, and/or retailers of failed packaging samples to bring them into compliance with state laws. Six member states sent a total of 26 letters to manufacturers, distributors, and retailers for 23 unique packages that failed XRF screening.[1] Seven companies received letters from multiple states. A total of 17 unique manufacturers, distributors, and retailers were notified of non-compliant packages.

Retail chain stores took corrective actions to address the failed packaging samples and future compliance, including:

- Pulled product off the retail shelf in TPCH member states, the most common action;
- Returned product and/or packaging to supplier;
- Implemented new quality assurance procedures for suppliers and incoming packaging; and
- Purchased an XRF instrument to conduct internal screening of packaging.

[1] The brand owner, manufacturer, or distributor of one package was not notified due to insufficient information on the product packaging to locate a company responsible for its sale or distribution.

For a few packages, the manufacturer or retailer provided test results claiming compliance with toxics in packaging requirements. One such case is in referral to a state attorneys general office.

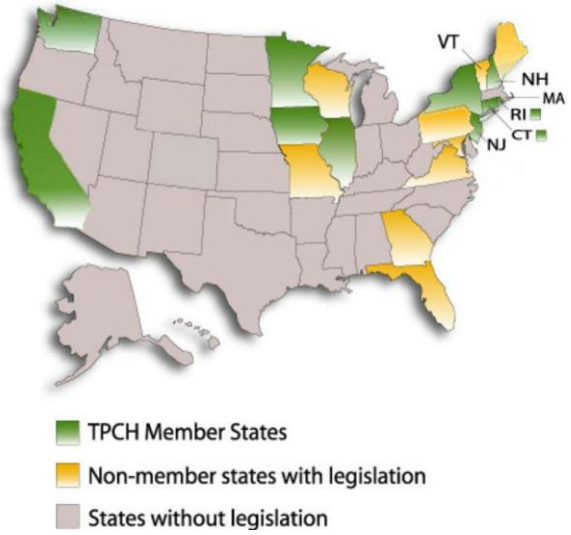
The execution of coordinated state enforcement action highlighted the variation in state laws, and specifically, who is legally responsible for compliance under individual state laws and the statutory authority of the state agency in enforcing its law. For example, in Washington State the retailer is responsible for compliance of products offered for sale in the State, and the State has statutory authority to ban retailers from selling non-compliant products in the State. In contrast, toxics in packaging laws in the states of California and New Hampshire place responsibility for compliance with state laws on companies that manufacturer or distribute products in the states. Iowa's law places responsibility for packaging compliance on the manufacturer of products sold in the state, regardless of the location of manufacture or distribution.

I. Introduction

Nineteen U.S. states have laws that prohibit the sale or distribution of packaging containing intentionally added cadmium, lead, mercury, and hexavalent chromium, and set limits on the incidental concentration of these materials in packaging. The purpose of these laws is to prevent the use of toxic heavy metals in packaging materials that enter landfills, waste incinerators, recycling streams, and ultimately, the environment.

In 2007, the TPCH released its first comprehensive report ("2007 Report") on the presence of heavy metals in packaging, using XRF analysis. The report revealed that heavy metals restricted by state toxics in packaging laws, particularly lead and cadmium, were frequently found in some types of packaging components. TPCH released its second report in 2009 ("2009 Report") that documented the continued presence of restricted metals in packaging. In both studies, imported flexible PVC packaging and inks/colorants dominated the non-compliant packaging. TPCH used the screening results to notify brand owners[2] of potentially non-compliant packages about toxics in packaging requirements, and to bring non-compliant packages into compliance.

This current report ("2012 Report") documents the continued investigation by TPCH of heavy metals in packaging, using XRF analysis. The goals of this project were to assess compliance with state toxics in packaging laws in a target sector, specifically, "dollar" and discount retail chain stores; and to identify non-compliant packaging for coordinated action by member states. The project targeted imported flexible PVC packaging from discount retail chains, since the two previous TPCH studies showed a propensity for these imported materials to contain the restricted metals.



II. Background

A. Toxics in Packaging Legislation

Nineteen states have toxics in packaging laws based on the Model Toxics in Packaging Legislation.[3] State toxics in packaging laws prohibit the *intentional* use of *any amount* of lead, cadmium, mercury, and hexavalent chromium in packaging or individual packaging components, such as inks, adhesives, or labels. If the regulated metals are unintentionally

[2] For the purpose of this report, a "brand owner" is the company whose name is identified on the package as the product manufacturer, importer, or distributor. In some cases, the package or packaged product was made for, or distributed by a retailer, making them the brand owner or responsible company that received TPCH notifications.

[3] The Coalition of Northeastern Governors (CONEG) Source Reduction Task Force adopted the Model Toxics in Packaging Legislation ("Model Legislation") and created the Toxics in Packaging Clearinghouse (TPCH) to ease the administrative burden for states and regulated industry. TPCH continues in this capacity, but is no longer affiliated with CONEG. The Northeast Recycling Council, Inc. (NERC) now administers TPCH.

present, for example, as a contaminant in raw material feedstocks, the total concentration is limited to less than 100 ppm for the sum of all four metals in any package or individual packaging component sold within these states. Limited exemptions are available for recycled-content, reusable containers, and packages regulated by other federal and state laws.

These requirements apply to all packaging and packaging components offered for sale or for promotional purposes by the manufacturer and distributor (including importers) in states with toxics in packaging legislation. The state laws further require self-certification by companies, and require companies to produce a Certificate of Compliance upon request. Most TPCH member states have included in their laws the ability to levy substantial monetary penalties for non-compliance.

The Toxics in Packaging Clearinghouse coordinates implementation of the legislation on behalf of its member states, and serves as a single point of contact for companies seeking further information, clarification of specific details, or an exemption to toxics in packaging requirements. Manufacturers, distributors, and retailers must deal directly with states that have adopted toxics in packaging legislation but are not members of the TPCH. For more information on toxics in packaging legislation and the Clearinghouse, visit www.toxicsinpackaging.org.

B. Packaging Screening Results: 2007 Report

In its first comprehensive test program of packaging in the U.S., TPCH screened 355 packaging samples between October 2005 and February 2006 for the presence of the four restricted metals using a portable XRF analyzer. The packaging samples were selected to represent different packaging materials (aluminum, glass, paper, plastic, and steel) and product types, mostly in the retail sector.

Of the packages tested, 16% exceeded the screening threshold of 100 parts per million (ppm) for the presence of one or more of the restricted heavy metals. Cadmium and lead were the most frequently detected of the four regulated metals. There were two types of packaging that dominated the samples failing the screening test: flexible PVC and inks/colorants used on plastic shopping/mailing bags.

Sixty-one percent (61 %) of the PVC packages tested were not in compliance with state laws due to the use of cadmium and/or lead. This included PVC packaging for home furnishings, cosmetics, toys, and pet supplies products, for example. Almost all of the flexible PVC packaging samples tested were from products imported from Asia, according to the product label. Interestingly, all PVC "blister packs," which are semi-rigid and were mostly imported from Asia as well, passed the screening tests.

Lead was most often found in the shopping and mailing bags that failed the screening test. The elevated levels of the restricted metals again appear to be largely from packages of products imported from Asia, .

C. Packaging Screening Results: 2009 Report

In 2008, TPCH screened 409 packages to detect trends in compliance with state toxics in packaging laws and identify areas where TPCH should focus, or continue to focus, its outreach efforts. TPCH used the XRF screening results to notify brand owners of potentially non-compliant packages about toxics in packaging requirements, and to bring companies into compliance, an outreach strategy that proved successful in the first screening project. The report documented the actions taken by companies to address non-compliant packages, thereby reducing the use of toxic heavy metals in packaging.

Fifty-eight packaging samples, or 14 percent of all samples, exceeded the 100 ppm screening threshold for one or more of the restricted heavy metals.[4] Packaging components that failed the screening test (>100 ppm of one or more of the 4 restricted metals) generally fell into one of three groups: imported flexible PVC, inks and colorants, and solder used in electronic circuitry. It should be noted that virtually all printed circuit boards that may be added to or incorporated into packaging would not comply with the states laws due to the use of lead solder, as even "lead free" solder contains over 100ppm of lead. XRF screening did not detect any of the restricted heavy metals in concentrations greater than 100 ppm in the paper-based packaging components tested. Similarly, all semi-rigid PVC packaging components (e.g., blister packs, clamshells, boxes) screened passed the screening tests, in contrast to flexible PVC.

Cadmium was the most frequently detected of the four regulated metals, followed by lead. All packaging samples failing for cadmium content were flexible PVC, and over 90 percent of these were imported. Metals, including cadmium and lead compounds, can be used as heat stabilizers in PVC resin to control degradation during processing and use, according to the Vinyl Institute.[5] Domestic manufacturers switched to alternatives many years ago.

Lead was detected in one-third of the failed packaging samples. The types of packaging materials that contained lead in this study were more diverse than those containing cadmium. Lead was found in inks and colorants used in shopping bags, flexible PVC, and solder.

Comparing packaging screening results from the 2006 project to the 2008 project showed a decrease in the percentage of packaging samples failing the screening tests in two packaging categories: flexible PVC and inks and colorants. The exact reason for the decline is not known, but anecdotal evidence suggests that the outreach efforts of the Clearinghouse undertaken as part of the 2006 project, and subsequent state actions, contributed to the improvement in compliance rate.

[4] These results include packages that failed the screening test due to total chromium. XRF measures total chromium, not hexavalent chromium. Laboratory testing is needed to determine if the chromium is hexavalent chromium.
[5] The Vinyl Institute, "Use of Metal Process Additives in the U.S. Vinyl Processing Industry," October 2007.

III. Methodology

TPCH compliance assessment projects are designed to screen packaging for compliance with the Model Legislation and state laws based on the Model. The XRF instrument allows TPCH to make a rapid determination of whether a package is likely in compliance with state laws or not.

In this project, the XRF screening results were used in two ways: to assess compliance with state toxics in packaging laws in a target sector, specifically, discount retail chains and "dollar" stores; and to identify non-compliant packaging for coordinated action by member states. The project targeted imported flexible PVC packaging from discount stores, since the two previous TPCH studies showed a propensity for inexpensive imported packaging to contain restricted metals.

A. Sample Collection

TPCH obtained packaging samples between May and July 2010 from six dollar/discount retail chains and from "dollar" bins at two other major retailers. Packaged products were purchased in seven TPCH member states, including California, Iowa, New Hampshire, New Jersey, New York, Rhode Island, and Washington.

Sample collection and analysis was a two-step process. Each step was designed to meet one of the two project goals.

Step 1: Assess compliance with state toxics in packaging laws

Member states identified discount/"dollar" retail chains located in their states. A total of six major chains that sell products for either one dollar or deeply discounted were identified. In addition, visits to two general retailers with "dollar" bins resulted in additional packaging samples.

The selected retailers operated stores in multiple states. The smallest retail chain had over 100 locations in seven states, while the largest retailers had stores across the United States. Six of the eight retail chains had at least 1,000 locations in 35 or more U.S. states.

Step 1: Packages Screened

Total unique packages:	61
Country of Origin:	
China	54
Pakistan	2
Thailand	1
Brazil	1
Korea	1
Unknown	2
Product Sectors:	
Children's toys & games	18
Pet supplies	13
Personal care/cosmetics	12
Home furnishings	7
Hardware	5
Household items	4
Apparel	2

One TPCH member state volunteered to randomly purchase products packaged in flexible PVC from the selected retail chain stores. The packaging samples were screened with an

Innov-X Systems Alpha™ Series XRF instrument to determine if the regulated metals exceeded the 100 ppm threshold for the incidental presence of the 4 restricted metals.

The box on the right provides a summary of the 61 packaging samples screened in Step 1, including country of origin and product category. Packaging samples (24) that failed the screening test (i.e., >100 ppm of one of the four heavy metals) entered Step 2 in the sample collection process.

Step 2: Coordinated state action

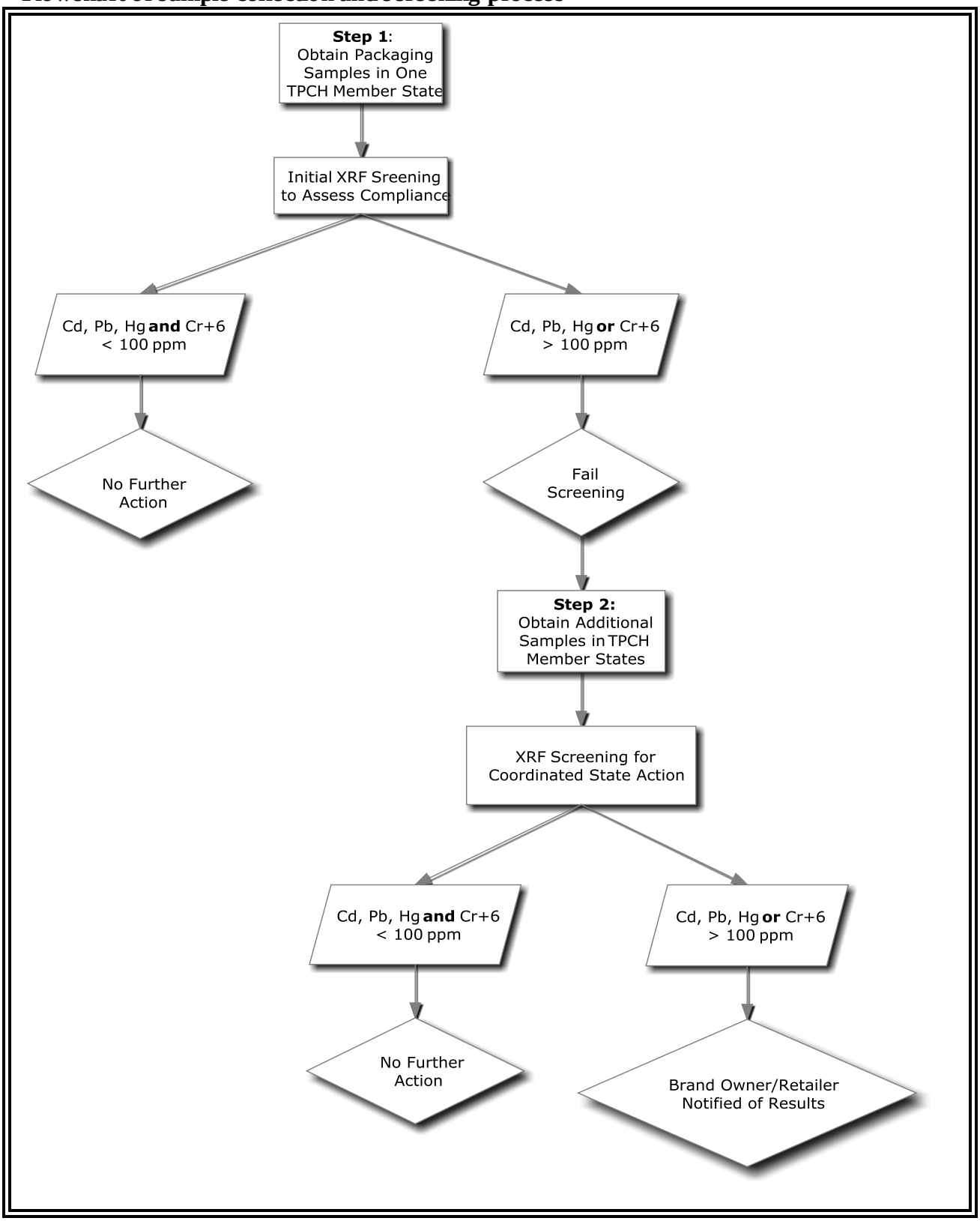
A list of twenty-four packaging samples that failed the Step 1 XRF screening was distributed to member states. Member states purchased the same or similar products in the designated retail chain stores, if located in their state and the product was available. These packaging samples, along with the initial failed packages, were subject to XRF screening to identify non-compliant packages. Again, TPCH used an Innov-X Systems Alpha Series™ instrument and the XRF screening protocol summarized in the 2009 report.[6]

Member states used the results of the XRF screening to undertake coordinated state action, where multiple states notified the brand owners, manufacturers, distributors, and/or retailers of failed packaging samples to bring them into compliance with state laws. States contacted different entities in the supply chain based on their statutory authority; for example, Iowa is prohibited from contacting retailers but has enforcement authority against manufacturers or distributors doing business in the state regardless of where they are located. Washington and New Hampshire only have enforcement authority against retailers or manufacturers located in their states.

The next page summarizes the sample collection and screening process in a flowchart.

[6] Available at http://www.toxicsinpackaging.org/projects_publications.html

Flowchart of sample collection and screening process



Note: XRF screening only detects total chromium, not hexavalent chromium.

IV. Results

A total of 61 packaging samples were screened using XRF technology. Twenty-four (39%) of the packaging samples failed the screening test for either cadmium or lead.[7] All the failed packaging contained cadmium, while one of the 24 packages also contained lead. Table 1 summarizes the failed packaging samples. Table 2 summarizes the screening results by heavy metal.

Table 1: Summary of Failed Flexible PVC Packages (>100 ppm of restricted metals)

Pkg #	Retail Chain	Product Category	Product Description	Product Origin	Average Cd in samples (ppm)	Average Pb in samples (ppm)[1]
1	Retail chain 1	Personal Care/Cosmetics	Callous remover	China	238	
2	Retail chain 1	Personal Care/Cosmetics	Pedicure kit	China	383	
3	Retail chain 1	Personal Care/Cosmetics	Manicure kit	China	276	
4	Retail chain 1	Toys & Games	Children's bath time book	China	410	
5	Retail chain 1	Hardware	Bungee cords	China	387	
6	Retail chain 2 & Retail chain 5	Household	Umbrella	China	242	
7	Retail chain 2	Personal Care/Cosmetics	Hair elastics	China	218	
8	Retail chain 2	Personal Care/Cosmetics	Hand sanitizer multi-pack	China	288	
9	Retail chain 2	Hardware	Paint brushes	China	335	
10	Retail chain 3	Home Furnishings	Pillow cases	China	274	
11	Retail chain 3	Toys & Games	Water balloons	China	260	
12	Retail chain 3	Art supplies/crafts	Crayons	China	504	
13	Retail chain 4	Hardware	Bungee cords	China	426	

[7] If multiple packages of the same product failed the screening test, only one was counted in the tally of failed packages.

Table 1: (cont) Summary of Failed Flexible PVC Packages (>100 ppm of restricted metals)

Pkg #	Retail Chain	Product Category	Product Description	Product Origin	Average Cd in samples (ppm)	Average Pb in samples (ppm)[1]
14	Retail chain 4	Pet Supplies	Cat toy	China	354	361
15	Retail chain 5	Pet Supplies	Pet chain	China	347	
16	Retail chain 5	Apparel	Children's sleepwear	China	317	
17	Retail chain 5	Household	Beach umbrella	China	206	
18	Retail chain 6	Art supplies/crafts	Children's craft item	China	311	
19	Retail chain 6	Household	Mesh storage bag	China	177	
20	Retail chain 7	Hardware	Bungee cords	China	350	
21	Retail chain 8	Toys & Games	Children's outdoor toy	China	438	
22	Retail chain 8	Home Furnishings	Pillow cases	Pakistan	669	
23	Retail chain 8	Toys & Games	Children's play set	Unknown	383	
24	Retail chain 8	Toys & Games	Children's kite	China	217	

[1] Blank cells indicates <100 ppm of the metal was detected in the sample.

Table 2: Summary of Results >100 ppm by Restricted Metal

Restricted Metal	Samples with >100 ppm Detected	Mean (ppm)	Median (ppm)	Range (ppm)
Cadmium	24	334	326	177 - 669
Lead	1	361		NA
Mercury	0	NA	NA	NA
Chromium[1]	0	NA	NA	NA

[1] XRF measures total chromium, not hexavalent chromium (Cr+6), which is the regulated metal.

Non-compliant packaging was not confined to specific product sectors. As illustrated in Table 3, packaging that failed the XRF screening was used to package children's products, pet supplies, personal care and household items, home furnishings, hardware, and apparel. Interestingly, the two product categories with the lowest percentage of failed packaging, home furnishings and pet supplies, were two sectors that TPCH targeted for outreach and education based on its initial screening project in 2007.

Table 3: Failed Packaging Samples by Product Category

Product Category	Number of Packages Screened	Number of Failed Packages	Percent of Packaging Samples Failing
Children's toys & games	18	7	39%
Pet supplies	13	2	15%
Personal care/cosmetics	12	5	42%
Home furnishings	7	2	29%
Hardware	5	4	80%
Household items	4	3	75%
Apparel	2	1	50%

Failed packaging samples were identified from all eight of the discount retail store chains, where packaging was obtained. Table 4 summarizes the number of packages screened from each retail chain and the number of failed samples

Table 4: Failed Packages by Discount Retail Chain Store

Dollar/Retail Chains	Number of Packages Screened	Number of Failed Packages	Percent of Packaging Samples Failing
Retail chain 1	13	5[1]	39%
Retail chain 2	12	4	33%
Retail chain 3	8	3	38%
Retail chain 4	4	2	50%
Retail chain 5	11	4	36%
Retail chain 6	2	2	100%
Retail chain 7	4	1	25%
Retail chain 8	9	4	44%

[1]Different models of one product were tested; one package failed and the others did not; this package was counted as two different products in the analysis.

With one exception, there was consistency among packaging samples from the same product, brand and/or manufacturer. If one sample failed the screening for the presence of restricted metals, they all failed. For example, for one brand name a total of 11 packages were tested, including three different products obtained in 7 states, and all failed. The one exception was three different models of the same product that were printed with copyright dates. The model with the earliest copyright date failed the screening, while the 2 later models passed the screening tests. This lends credence to our assumption that outreach over the past few years is improving compliance rates, since the discount retail chain where these products were sold received notification for failed packages in earlier TPCH compliance projects.

A. Notification of Brand Owners, Distributors and Retail Chain Stores

Member states used the results of the XRF screening to undertake coordinated state action, where multiple states notified the brand owners, manufacturers, distributors, and/or retail chain stores of failed packaging samples to bring them into compliance with state laws. Six member states sent a total of 26 letters to manufacturers, distributors, and retail chains stores for 23 unique packages that failed XRF screening.[8] Seven companies received letters from multiple states. A total of 17 unique manufacturers, distributors, and retail chains were notified of non-compliant packages. Retail chain stores took corrective actions for the failed packaging samples and future compliance, including:

- Pulled product off the retail shelf in TPCH member states (this was the most common action);
- Returned product and/or packaging to supplier;
- Implemented new quality assurance procedures for suppliers and incoming packaging; and
- Purchased an XRF instrument to conduct internal screening of packaging.

For a few packages, the manufacturer or retailer provided test results claiming compliance with toxics in packaging requirements. One such case is in referral to a state attorneys general office.

The execution of coordinated state action highlighted the variation in state laws, and specifically, who is legally responsible for compliance under individual state laws and the statutory authority of the state agency in enforcing its law. For example, in Washington State the retailer is responsible for compliance of products offered for sale in the State, and the State has statuatory authority to ban retailers from selling non-compliant products in the State. In contrast, toxics in packaging laws in the states of California and New Hampshire place responsibility for compliance with state laws on companies that manufacturer or distribute products in the states. Iowa's law places responsibility for compliance on the manufacturer of products sold in the state, regardless of the location of manufacture or distribution.

V. Conclusions

In conclusion, this project demonstrated that compliance with state toxics in packaging laws continues to be problematic for packaging made from imported, flexible PVC. Furthermore, in this global economy, non-compliant packaging is not confined to specific product sector, discount retail chain store, or geographic region. .

This study was a departure from previous TPCH screening projects in that it targeted a specific retail sector, namely discount or "dollar" retail chains. Nonetheless, the packaging samples represented diverse product categories, similar to past studies, which allowed comparison, albeit cautiously, of compliance with state toxics in packaging laws over time.

[8] The brand owner, manufacturer, distributor, and/or retailer was notified for all but one of the 24 packages that failed the XRF screening. The brand owner, manufacturer, or distributor of that one package was not notified due to insufficient information on the product packaging to locate a company responsible for its sale or distribution.

Table 5 compares the percentage of failed packaging samples for flexible PVC packaging in the TPCH reports from 2007, 2009, and this 2012 report. A downward trend can be seen in the percentage of packaging samples reported to contain heavy metals restricted by state laws over time. Although there is no direct evidence, TPCH is hopeful that this trend is due to the extensive outreach and education that TPCH has conducted since completion of its first screening project in 2007.

Table 5: Comparison of Flexible PVC Screening Results 2007, 2009 and 2012 Reports

	% Samples Failing Screening (>100 ppm) for 1 or more restricted metals		
	2007	**2009**	**2012**
All Flexible PVC Samples	61%	52%	39%
Home Furnishings	81%	48%	29%
Pet Supplies	80%	63%	15%
Toys, Games, & Crafts		64%	39%