FORT DEARBORN COMPANY

1530 Morse Avenue
Elk Grove, IL 60007
847-357-9500
www.fortdearborn.com

May 1, 2019

Dave Cornell
The Association of Plastic Recyclers (APR)
1776 K Street, NW
Washington, DC 20006

Re: Summation Report for Critical Guidance Recognition

Company Information

Fort Dearborn is a leading supplier of high impact decorative labels, specializing in a variety of solutions to fit product packaging needs. We are committed to customer intimacy and providing customers with value, service and the highest quality attainable. We deliver solutions designed to meet customer's needs and exceed their expectations every single day. Our ability to effectively manage the diverse needs of our customer base has been through aggressive capital investment and selective acquisitions. Fort Dearborn has the financial strength, established infrastructure, capacity and technical expertise to support our customers today and in the future.

Sustainable and recyclable solutions are an important part of our culture at Fort Dearborn. We are developing sustainable and recyclable products in various labeling formats, one is a Recyclable Shrink Sleeve. The recyclable shrink sleeve was sent to Plastics Forming Enterprises, LLC for APR Sleeve Critical Guidance testing.

Summary of Testing

The objective of testing was to evaluate PET bottles with printed sleeve labels through the recycle process. The testing was done with 50% inked bottles with 6% coverage of the bottle with label or its equal (3% label weight of the bottle plus label) and that it meets the instruction of the Critical Guidance protocol.

The PET control bottles were processed with no label applied. Test variable was processed with pre-shrunk sleeve labels to meet the APR critical guidance requirement. Control PET bottles without label applied. The control bottle was produced using a non APR control resin. The APR Quick Color Test was completed to verify acceptability.

Control PET bottles with test labels applied:

- 870 – Control
- 870 – Test

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Process Overview:

- Control bottles were ground
- Pre-shrunk test sleeve labels were ground with PET control bottles
- Process through high agitation wash system and sink float
- Air Dry
- Elutriate to remove light fractions and loose label materials
- Extrude materials into pellets
- Injection mold pellets into 3mm plaques
- Data reporting and analysis

Equipment:

Recycle System

- Pilot Plant Wash System
- Convection Ovens (Surface Drying)
- Kice Elutriator
- Grinder with 3/8" Screen
- Desiccant Dryer
- 1.5" TEC Single Screw Extruder
- Arburg Injection Machine with a 3MM plaque mold
- Konica Minolta CM-3600d spectrophotometer

Material Information:

The label was produced with SKC recyclable material (recognized by APR) and Fort Dearborn's WISS washable inking system. It was 305% printed with the following colors; white, yellow, cyan, and black. A picture of the label is shown below, it is a brand design therefore the image has been blurred.

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Variable	Type	Weight (Grams)
870 – Control	Control Bottle	36.89
870 – Test	Shrink Sleeve Labeled Bottle (6%)	2.337

870 – Test

Labels were not applied to bottles because the labels were delivered in sheet form. PFE preshrunk labels in water bath at 85 C.

APR guidelines for a full sleeve application requires a 50% unlabeled bottles to 50% labeled bottles.

Pilot Scale Wash System

Caustic Wash: The flakes are exposed to a caustic wash solution of 0.3% by weight Triton X-l00 (6.0 gms or 5.7 m1 per 2,000 ml water) and 1.0% by weight caustic (20 gms NaOH per 2,000 ml water) at 190^0F +/- 5^0F (88^0C +/- 2^0C). Wash was highly agitated for 15 minutes.

Rinse: Flakes are drained of caustic wash solution and rinsed with room temperature water with agitation in order to remove the caustic solution.

Sink/Float: Floatables were removed at three different times. Floatables were skimmed off during the wash, after material had settled, and as well as after the rinse and agitated sink float process.

Drying: Flakes were ambient air dried with no heat or vacuum.

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Wash and Rinse Water Photographs

	Settled	Shaken
870 – Control		
870 – Test		

Air Separation

The Sleeve Label Critical Guidance Document Protocol process is set-up for one pass elutriation to remove light fractions.

The air flow was set up based on the control materials to be less than 1.2% of PET flakes removed as “lights” prior to washing.

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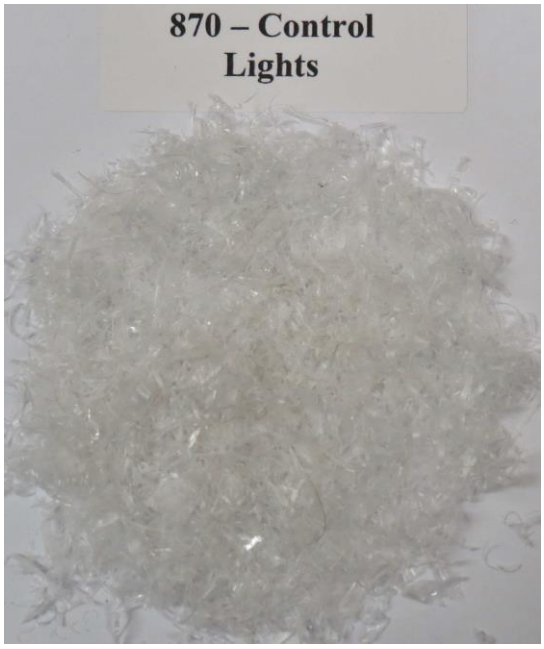
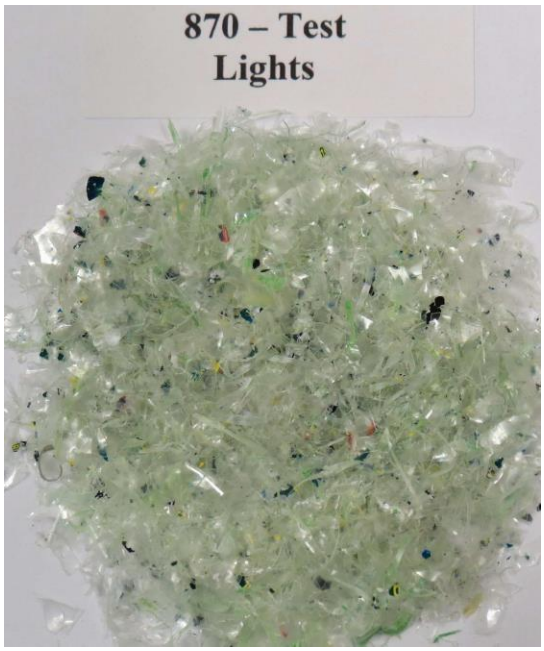
The total lights for control and test samples were recorded and % listed in chart below.

Variable:	870 – CTRL	870 – Test
PRE WASH (Calibration) Air Separation % of lights removed	1.2%	
POST WASH Air Separation % of lights removed	0.32%	2.64%





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FLAKE COLOR DATA							
Plastics Forming Enterprises, LLC							
Client:	Fort Dearborn Company						
Project:	Bleeding/Clumping SS Screening						
Experiment:	Flake Colors						
Type of Material:	Flake	X	Pellets				
Project #:	855		Operator:		BMT		
		Equipment:		Konica Minolta CM-3600d			
		Conditions:		CIE Lab, 10 degrees, D65			
Run #	Description	L * Values	a* Values	b* Values	L* Average	a* Average	b* Average
870 – Control	Processed Control Flake	69.91	-0.26	-0.38	70.51	-0.29	-0.30
		71.14	-0.36	-0.22			
		70.89	-0.27	-0.25			
		71.92	-0.26	-0.38			
		68.68	-0.31	-0.26			
870 – Test	Processed Test Flake	69.39	-2.17	1.19	67.74	-2.02	1.63
		68.84	-1.97	1.95			
		67.81	-1.95	1.71			
		64.71	-2.15	1.42			
		67.94	-1.87	1.86			

The APR specifies that flake sample meet the following parameters in comparison to the control in order to be acceptable: (L* shift less than 5 units), (a* and b* shift less than 2 units), (Absolute b* value less than 3.0).

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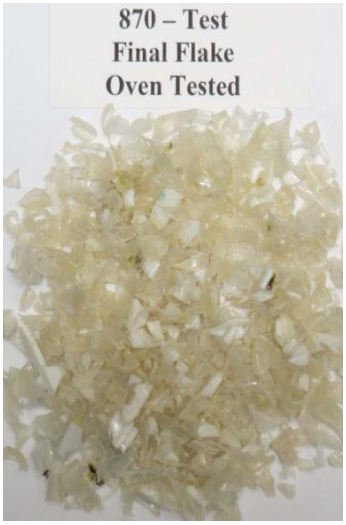
Fort Dearborn does not use any fluoresce colorants in the WISS inking system. Additionally, there was no fluoresce observed in the test plaques when compared to the control using a black light.

Oven Bake Test Photos

These photos show the oven baked materials at the start of processing, after the caustic wash and sink float and then finally at the elutriation step. These are provided to show a visual of what approximate amounts of label are contained in processed flakes. Residual label contamination is identified as particles that are brown and/or discolored.

870 – Control

870 – Test



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Measured Intrinsic Viscosity

The Control bottles were measured for intrinsic viscosity to get a starting value. After processing was completed, the crystallized pellets for each variable were measured for intrinsic viscosity in order to evaluate any significant drops in the Δ IV when compared to the control.

The Δ IV for pellet and plaques guidance:
≤0.025, (no problem)
0.025-0.04, (needs study)
>0.04, (problematic)

Pellet IVs:

870 – Control	870 – Test
0.768	0.763 (0.005)

Plaque IVs:

870 – Control	870 – Test
0.722	0.715 (0.007)

Black Specks

Plaque samples were examined for the presence of black specs over 0.015 in. Total area in the plaques is 3879 sq. mm per plaque with a total of 50 plaques examined for each test variable. The test variables all pass the specification.

870 – Control	870 – Test
1	1

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Plaque Color Data

Plastics Forming Enterprises, LLC

Client: Fort Dearborn Company

Project: SS CDG

Experiment: Plaque Colors

Type of Material:	Flake		Amorph Pellets		Bottle		Plaque	X

Project #: 855 Operator: BT

Equipment: Konica Minolta CM-3600d

Conditions: CIE Lab, 10 degrees, D65

Run #	L * Values	a* Values	b* Values	L* Average	a* Average	b* Average	Haze	Haze Average
870 – Control	90.25	-0.72	6.60	90.26	-0.75	6.65	4.07	4.07
	90.29	-0.76	6.58				4.04	
	90.26	-0.74	6.61				4.03	
	90.24	-0.77	6.76				4.12	
	90.24	-0.78	6.72				4.10	
870 – Test	84.91	-2.25	7.61	84.88	-2.25	7.67	18.45	18.46
	84.86	-2.27	7.69				18.54	
	84.93	-2.31	7.71				18.45	
	84.92	-2.24	7.53				18.38	
	84.77	-2.20	7.80				18.47	

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*The color data for each label material represents randomly selected plaque samples from the same population of material.

The APR specifies that plaque sample meet the following parameters in comparison to the control in order to be acceptable:

A. L* >82 for all Blends
B. ∆a* and b* <1.5, (no problem)
C. Control Haze <9.5%, Test Haze not to exceed 20% (no problem)

Clumping Test Results:
This test is performed in order to understand the tendency of labels to become sticky when heated which can cause agglomeration and clumping of flakes. A 2 lb. sample was subjected to an oven temperature of 208°C (408°F) for a period of 90 minutes with no load or compression. After the flakes cooled from the oven, each sample was sifted through a 0.625" sieve to remove flake clumps and then weighed and calculated as a percentage of the total weight of the sample.

Percentage of clumps in a 2 lb. sample:

Variable #	Greater than 0.625		Stuck to Pan		Less Than 0.625		Total Clump %
	Grams	Percent	Grams	Percent	Grams	Percent	Percent
320 F Control	0.00	0.00%	0.00	0.00%	908.00	100%	0.00%
409 F Control	0.00	0.00%	0.00	0.00%	908.00	100%	0.00%
425 F Control	0.00	0.00%	0.00	0.00%	908.00	100%	0.00%

Variable #	Greater than 0.625		Stuck to Pan		Less Than 0.625		Total Clump %
	Grams	Percent	Grams	Percent	Grams	Percent	Percent
320 F Control	0.00	0.00%	0.00	0.00%	908.00	100%	0.00%
409 F Control	0.65	0.07%	0.84	0.09%	906.51	99.84%	0.16%
425 F Control	9.12	1.00%	4.40	0.48%	898.40	98.51%	1.48%

Delta: Control was 533 average PSI, Test was 507 average PSI, with a drop of 26PSI and a % delta of -4.88%. All variables pass the specification for clumping.

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Conclusions

This study analyzed a printed sleeve label. Using the APR's guidelines for Sleeve Label Evaluation the following conclusions were determined from testing:

Substrate Evaluation

- Labels substrate did not float during wash/rinse and sink/float.
- During elutriation, an increase percent was seen due to thin label substrate residual.

Ink Evaluation

- The dominantly white black and green printed colors were present in the wash waters as a sediment vs in solution.
- Ink system on test label had high bleeding and minimal staining.
- The ink that did stay with the substrate shows a slight color of greens and black.

Label substrate 870 - TEST does meet the APR Sleeve Label Critical Guidance guidelines.

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APR
PET Critical Issues Guidance for Innovations: Data Reporting Sheet
Protocol for Sleeve Labels

Project Sponser: Fort Dearborn

Test Laboratory: PFE

Innovation Studied: Washable Ink on SKC polyester label substrate, SKC substrate recognized by APR

Report Date: 11/25/17

Report I.D. 870

Materials Identification

Control Resin: Not APR Control

Test Label: SKC

		CRITERIA	REPORT
6%	**Label % of bottle weight**		tested at 50%, meets protocol
2.337	Label weight, grams. Pre-shrunk at 85C labels cut and added to chopped bottle		
36.89	bottle weight, grams		PFE Reported Passed

Quick Color Test

	Control Resin	Resin used	
For flake from bottle			
L*	91.93	90.26	L* > 82
b*	4.13	6.65	
Δb*	2.52		Δb* < 3

	Control	Test	
% elutriated	0.012		Find setting so < 1.2% lost

Label and PET Flake Testing

Hot Wash

Hot Caustic Wash	30 lbs	Done per protocol
Weight of flake to be washed	30 lbs	
Weight of floating flake	0	
Floating material as % of total	0%	

Sink/Float

Sink/Float in Rinse Water	30 lbs	Done per protocol
Weight of washed settled flake	30 lbs	
Weight of floating material, #2	0	
Floating material as % of total	0%	
Weight of washed settled flake	30 lbs	
Weight of floating material, #3	0	
Floating material as % of total	0%	
Total removed by sink/float, grams	0	
Total calculated label, grams	0	
Total of label removed, %	0%	

Air Dry

Air dry without losing label flake		Done per protocol
% if Label Residue in PET flake	3%	

Elutriation

Using previous elutriation setting			Done per protocol
Weight of lights removed		N/A	} Can't Sink Float to verify
Weight of label flake removed		N/A	
Weight of PET removed		N/A	
% if Label Residue in PET flake	0.32%	2.64%	

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			Control	Test		
Clumping		Sample weight tested, grams	2 lbs	2 lbs		
		Weight % of PET clumps	0.0%	0.2%	<1% at 407F	Pass
Color of flake		L*, transmission, 3 mm plaques	70.510	67.740	Δ L from control < 5	Pass
		a*, transmission, 3 mm plaques	-0.290	-2.020	Δ a* from control < 2	Pass
		b*, transmission, 3 mm plaques	-0.300	1.630	Δ b* from control < 2, all < 3	Pass
Extrusion/Pelletization		Drying Temperature (°F)	320	320		
2nd Melt Heat History for Polymer		Initial IV (dL/g)	0.816	0.790		
First with Label and Decoration		Extruded IV (dL/g)	0.768	0.763		
Making pellets		IV Drop (dL/g)	0.042	0.027	≤+0.025, No Problem	
		ΔIV Drop from Control (dL/g)		- 0.015	>+0.025 to +0.040, Needs Study >+0.040 Problematic	Pass
		Extrusion Back Pressure (bar)	533	507		
		% Increase in Back Pressure	N/A	-4.9%	<10%	Pass
		Run time	45 mins	45 mins		
		Extrusion Rate (gms/cm2/hrs.)	>375	>375	>375 gms/cm2	
3rd Melt Heat	**IV**	Pre-mold IV (dL/g)	0.768	0.763		
History for Polymer		Post-molding IV (dL/g)	0.722	0.715		
2nd Melt History of Label,		IV Drop (dL/g)	0.046	0.048	≤+0.025, No Problem	
Making 3 mm Plaques		**ΔIV Drop from Control (dL/g)**		0.002	>+0.025 to +0.040, Needs Study >+0.040 Problematic	Pass
	Color	L*, transmission, 3 mm plaques	90.26	84.88	L* >82	
		a*, transmission, 3 mm plaques	-0.75	-2.25		
		b*, transmission, 3 mm plaques	6.65	7.67		
		Δa* from Control		-1.50	Δa* ≤1.5	Pass
		Δb* from Control		1.02	Δb* ≤1.5	Pass
		Haze (%)	4.07	18.46	<9.%, control <20% Test Sample	Pass
	Black Specs	**Number/plaque (50 plaque min.**	1	1	Failures, Control vs Test 0 vs 2 max 1 vs 4 max 2 vs 6 max	Pass
	Fluorescence		None	None	No more than Control	Pass, none observed
Observations		**Fuming during extrusion**		None	No more than Control	Pass
		Smoking during extrusion		None	No more than Control	Pass
		Unusual odor during extrusion		None	No more than Control	Pass
		Pellet sticking on drying		None	No more than Control	Pass
		Equipment fouling		None	No more than Control	Pass
		Unsafe condition		None	No more than Control	Pass

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Storyboard

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PFE

Plastics Forming Enterprises, LLC

Plastics Consulting, Research and Engineering

March 26, 2019

APR - Association of Postconsumer Plastic Recyclers
Attn: Steve Alexander and/or David Cornell
1001 G Street, NW
Suite 500 West
Washington, DC 20001

Re: Recognition Program Innovator Testing Confirmation

Plastics Forming Enterprise LLC has provided services to evaluate the recyclability for Fort Dearborn printed SKC crystallizable PET film substrate shrink sleeve labels that were preshrunk and blended with a PET commercial control bottles. Work was completed in 2017.

Plastics Forming Enterprise evaluated the material through testing that conforms to the Critical Guidance Document testing protocols as described, omitting no steps. The evaluation was processed according to the APR Shrink Sleeve Label Substrate for PET Bottles Critical Guidance Document at the time of testing.

The processed materials were evaluated for both color and haze. Material properties were also evaluated according to the recommended guidelines of the APR protocol.

Plastics Forming Enterprise confirmed that the Fort Dearborn printed SKC crystallizable PET film substrate shrink sleeve labels that were preshrunk and blended with a PET commercial control bottles were successful when processed through the PET recycle stream simulation. PFE did not observe any fuming, odd odor generation, sticking or residue build up during extrusion/pelletizing and injection molding. PFE determined the intrinsic viscosity; color and percent haze are within the recommended guidelines of the test protocol at the time of testing.

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Please understand that these results should not be represented as certification or compliance with the APR protocol. We strongly encourage you to submit these results to APR for formal recognition. We would be happy to work with you to guide you thru this process.

Sincerely,

Kristina Hansen
Technical Director

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