Plastics Forming Enterprises, LLC

Plastics Consulting, Research and Engineering

PFE Plastics Recyclability Case Study
PET Transparent Green and Blue Bottle Wall

Objectives:

- Create guidelines/recommendations on the Green and Blue PET clear bottle streams to help package designers easily make more recyclable decisions.

Materials:

- 10 Green PET samples of varying L*, a*, b* values and Haze
- 14 Blue PET samples of varying L*, a*, b* values and Haze

Case Study Purpose:

There is no current guidelines or recommendations for L*, a*, b*, or haze percentages on colored PET bottle walls in the plastic recycling industry for green and blue specifically. PFE is looking to explore providing these guidelines and recommendations for both the Blue and Green PET streams. PFE obtained a wide variety of bottles commonly seen on the shelves and performed this study in attempt to establish values for L*, a*, b*, and Haze percentages that can help lead packaging development in the ideal direction when designing/making their package.

The green PET bottle walls 1-10 were sent to MSS with the intention to see which bottles would be sorted correctly (resin and color) and which bottles would not. In addition, these bottle walls had transmittance color testing performed on them. Based on the results of testing, PFE is confident in guidelines that can be used to create a package design that will sort accordingly.

The blue PET bottle is commonly used as a bluing agent in the clear bottle stream. The goal of the blue stream is to help reduce the yellowing of the clear stream. With this in mind, PFE wanted to establish these guidelines so that the blue bottles would not be a hinderance on the clear stream (ideally a low blue color and low haze). PFE tested all the bottles for transmittance colors and with the extensive knowledge of the recycling industry, wrote guidelines sought fit to help in the making of blue bottles so they will sort accordingly and be beneficial to the clear stream.

The following pages are data collected by PFE represented by data tables along with graphs. This data is believed to be an accurate description of what is currently in the market. Guidelines proposed are based on the data collected and opinions of professionals with years of experience in PET recycling.

Green and Blue PFE Guidelines/Recommendations

Green PET Bottle Wall Recommendations

Expected to Sort Properly:
PFE
L* > 71
a* > -70
Haze < 10%

Further Testing Needed:
62 < L* < 71
a* < -70

Not Likely to Sort Accordingly:
L* < 62
Haze > 10%

Blue PET Bottle Wall Recommendations

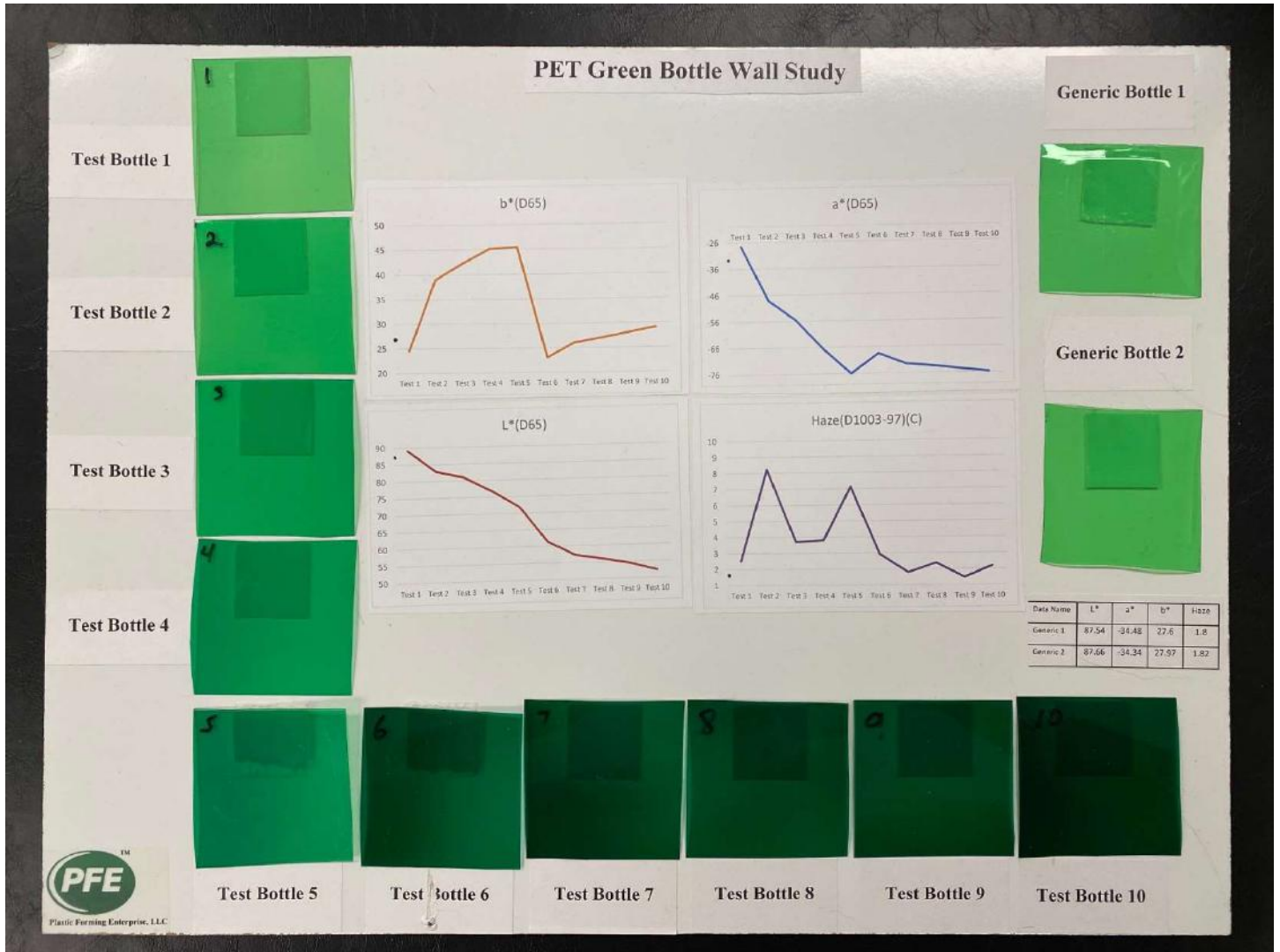**Expected to Sort Properly:**
PFE
L* > 80
b* > -10
Haze < 10%

Further Testing Needed:
b* < -10

Not Likely to Sort Accordingly:
L* < 80
Haze > 10%

Green PET Overview

PET Green Bottle Wall Study

| Data Name	L*	a*	b*	Haze
Generic 1	87.54	-34.48	27.6	1.8
Generic 2	87.66	-34.34	27.97	1.82

Green PET Conclusions and Takeaways

L* Value
- All green bottles with a L* of greater than 71 were able to correctly sort by color.
  - Bottles B1 through B5 correctly sorted.
- With a L* gap in testing of Bottle 5 (71.86) and Bottle 6 (61.31), PFE proposes a further testing needed area.
  - Bottles with a L* between 62 and 71 should be tested further to confirm sortability.

Green Bottles L* Values
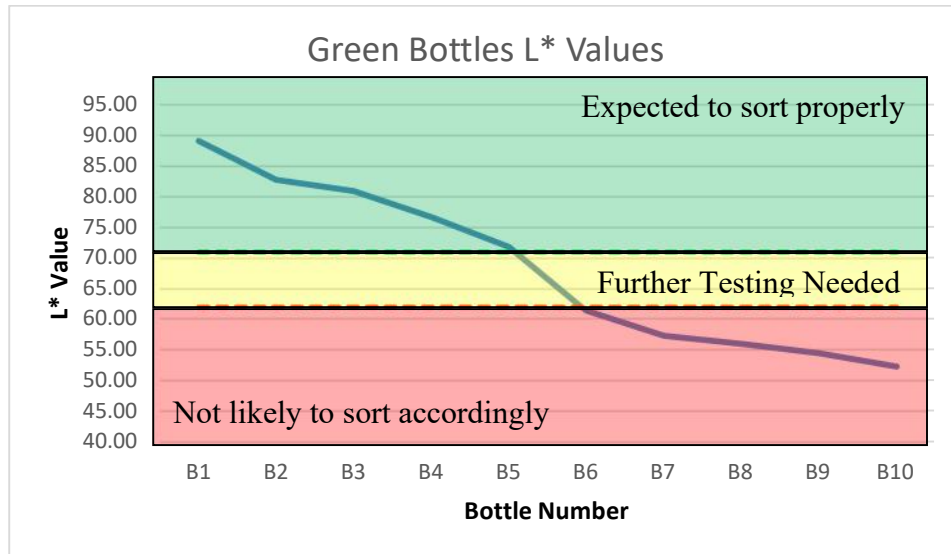
a* Value
- With the exception of Bottle 6, bottles with an a* above -70 are expected to sort correctly
  - PFE is proposing this be another requirement in addition to the L* value.
- Bottle 5 was able to sort properly leaving it as an outlier to this requirement, which is why PFE is leaving the bottles below -70 as further testing needed.

Green Bottles a* Values
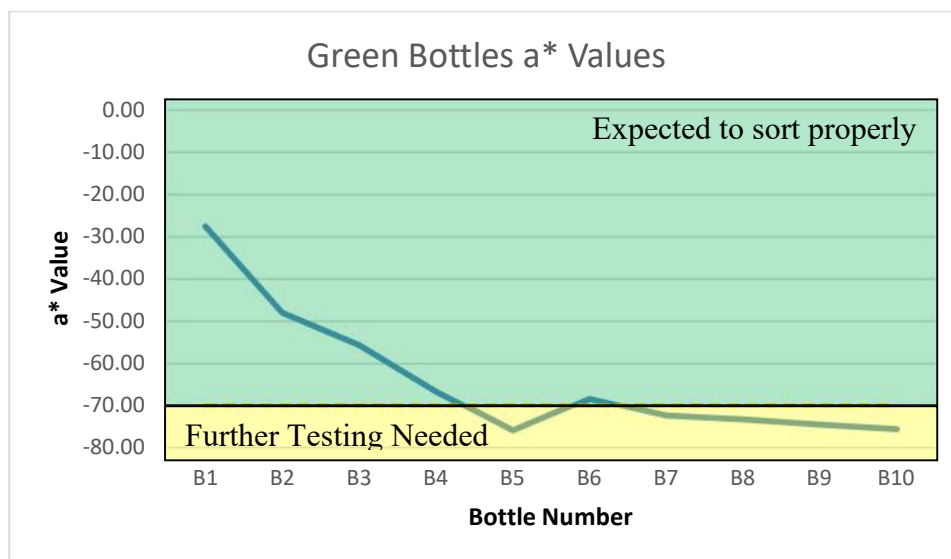
Green PET Conclusions and Takeaways (Cont.)

b* Value

- No guidelines for b* value for Green PET

Green Bottles b* Values
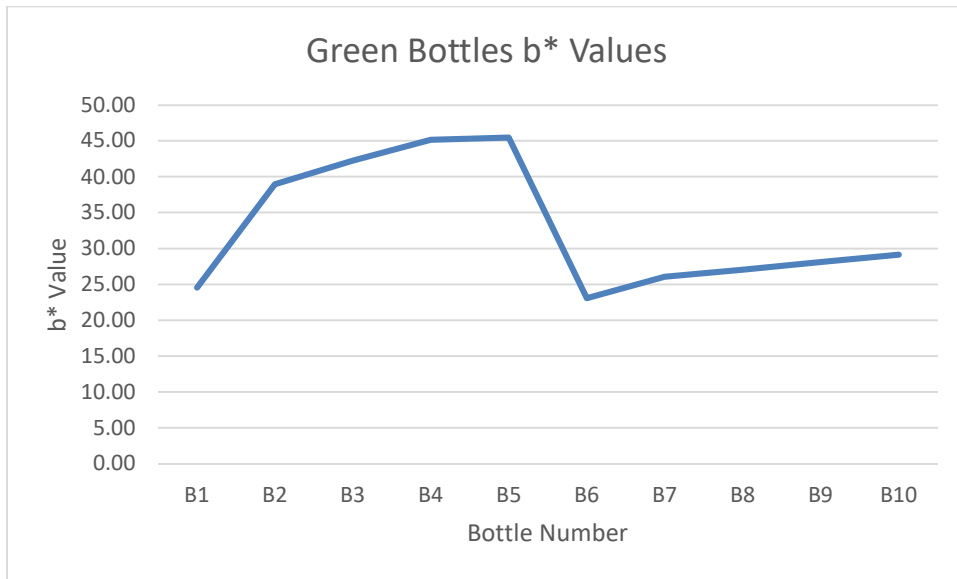
Haze Percentage

- All green bottles tested had a haze below 10%.
  - PFE proposes that the bottles have a haze below 10%, this is to help exclude any light blocking materials that meet the requirements for L* and a*.

Final PFE Requirements

- PFE is breaking the bottles into three categories.
  - Expected to Sort Properly, Further Testing Needed, and Not Likely to Sort Accordingly.
  - Definitions for Green PET can be found below:

Green PET Bottle Wall Recommendations

Expected to Sort Properly:
L* > 71
a* > -70
Haze < 10%
Further Testing Needed:
62 < L* < 71
a* < -70
Not Likely to Sort Accordingly:
L* < 62
Haze > 10%

Green Transmission Plaque Colors

Test Summary:
Measure the color values L*, a*, b*, and haze of a bottle wall.

Procedure:
The color analyzing equipment is set up on transmittance and calibrated using pure white and black standards. The bottle wall is then inserted into the testing location and the equipment runs the color test. The test indicates L*, a*, b* values and haze percentage.
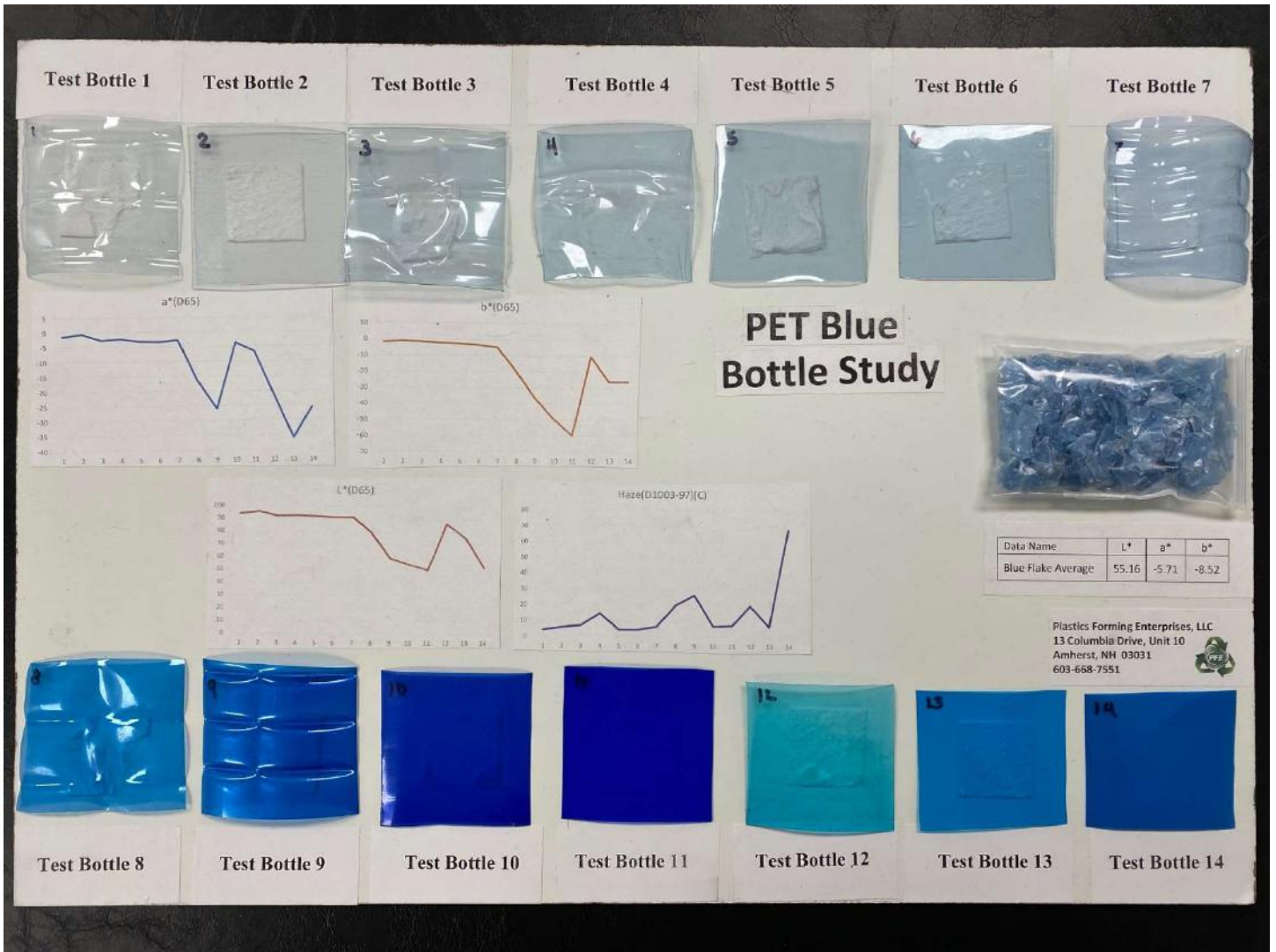
Data Table:

Run #	L* Average	a* Average	b* Average	Haze Average
Bottle 1	89.11	-27.53	24.53	2.51
Bottle 2	82.80	-47.98	38.95	8.25
Bottle 3	80.94	-55.62	42.23	3.70
Bottle 4	76.73	-66.62	45.15	3.80
Bottle 5	71.86	-75.97	45.50	7.14
Bottle 6	61.31	-68.41	23.08	2.93

Green PET Transmission Plaque Colors (Cont.)

Data Table:

Run #	L* Average	a* Average	b* Average	Haze Average
Bottle 7	57.23	-72.53	26.07	1.80
Bottle 8	55.94	-73.44	27.03	2.37
Bottle 9	54.45	-74.66	28.09	1.48
Bottle 10	52.26	-75.71	29.13	2.18
Generic Bottle 1	87.54	-34.48	27.60	1.80
Generic Bottle 2	87.66	-34.34	27.97	1.82

PET Blue Bottle Study

Data Name	L*	a*	b*
Blue Flake Average	55.16	-5.71	-8.52

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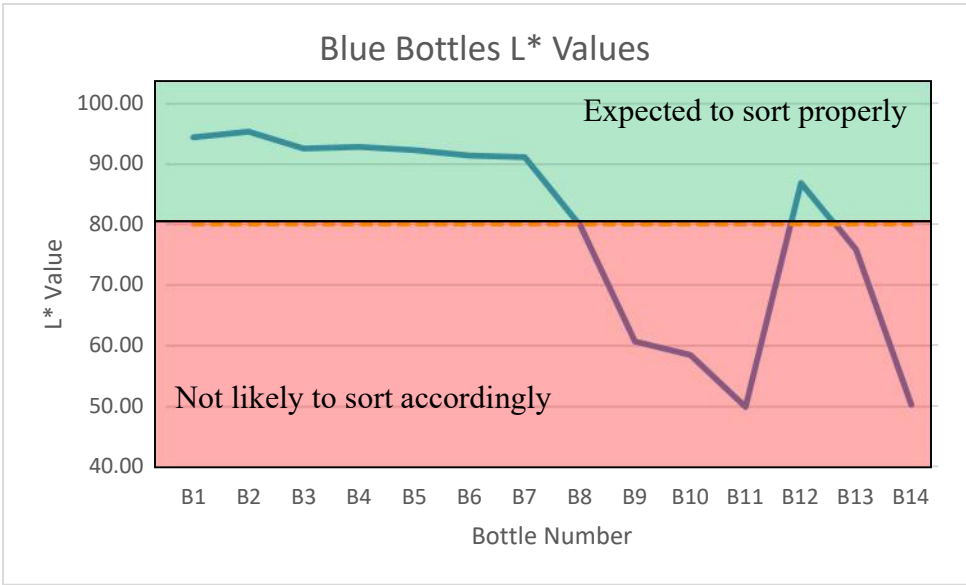13 Columbia Drive, Unit 10
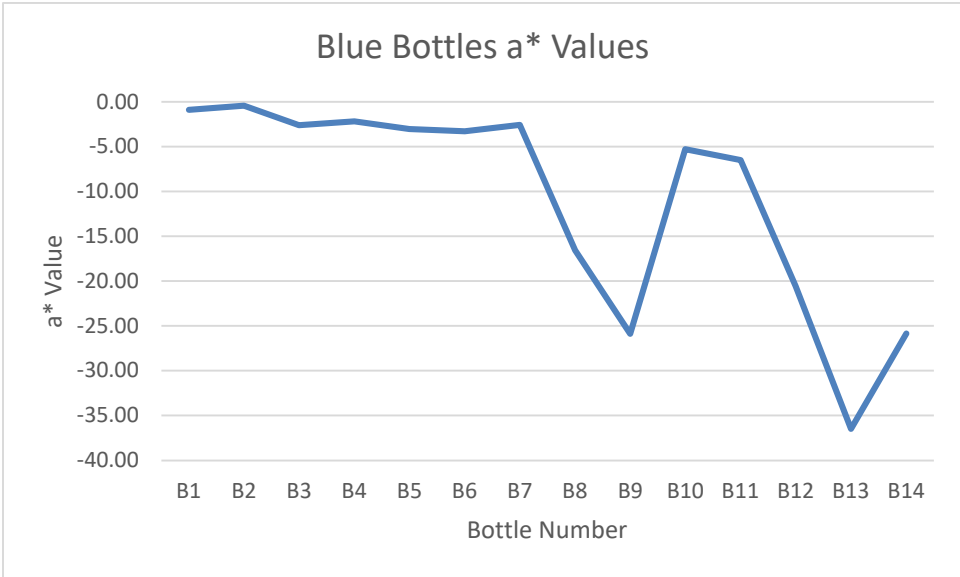Amherst, NH 03031
603-668-7551

Blue PET Conclusions and Takeaways

L* Value

- All blue bottles with a L* of greater than 80 are expected to correctly sort by color.

Blue Bottles L* Values

Expected to sort properly

Not likely to sort accordingly

X-axis: Bottle Number (B1–B14)
Y-axis: L* Value (40.00–100.00)

a* Value

- No guidelines for a* value for Blue PET.

Blue Bottles a* Values

X-axis: Bottle Number (B1–B14)
Y-axis: a* Value (-40.00–0.00)

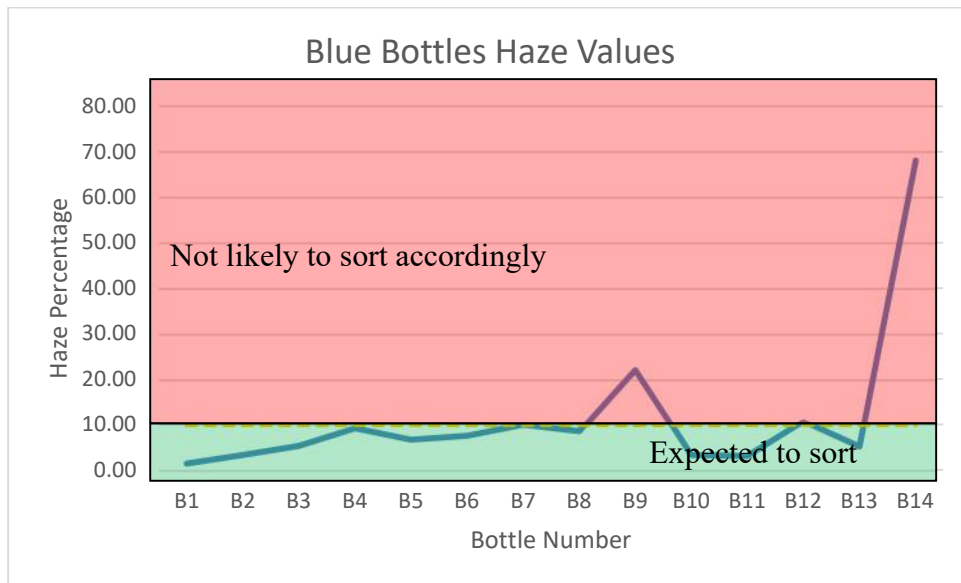# Blue PET Conclusions and Takeaways (Cont.)

b* Value
- Bottles with a b* above -10 are expected to sort correctly
    - PFE is proposing this be another requirement in addition to the L* value.
- Bottles with a b* below -10, should be further tested for sortability.
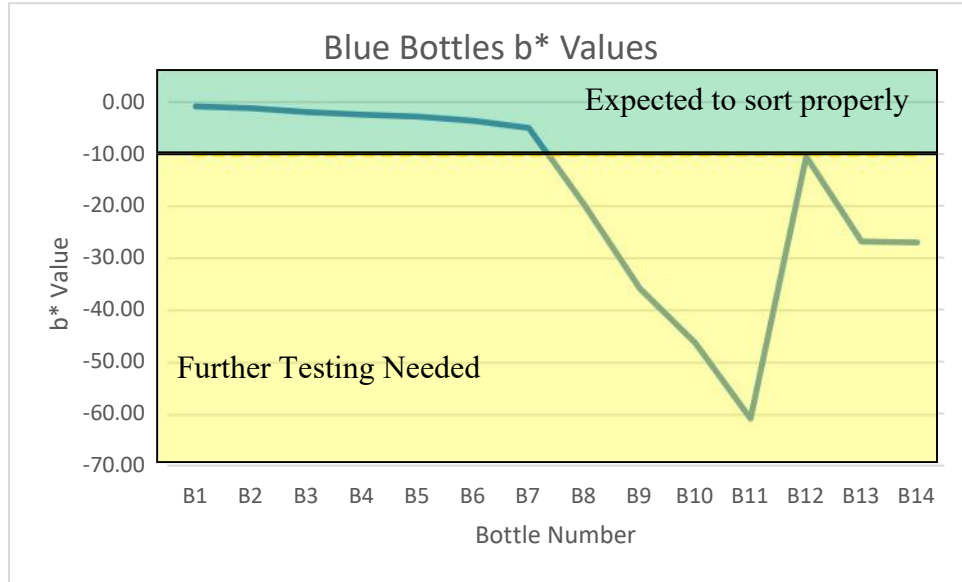
Haze Percentage
- Since blue bottles are used in the clear stream to help reduce yellowing a haze below 10% is beneficial.
    - PFE proposes that the bottles have a haze below 10%, this is to help exclude any light blocking materials that meet the requirements for L* and b*.

Blue PET Conclusions and Takeaways (Cont.)

Final PFE Requirements

- PFE is breaking the bottles into three categories.
    - Expected to Sort Properly, Further Testing Needed, and Not Likely to Sort Accordingly.
    - Definitions for Blue PET can be found below:

Blue Green PET Bottle Wall Recommendations

Expected to Sort Properly:
L* > 80
b* > -10
Haze < 10%
Further Testing Needed:
b* < -10
Not Likely to Sort Accordingly:
L* < 80
Haze > 10%

Blue Transmission Plaque Colors

Test Summary:
Measure the color values L*, a*, b*, and haze of a bottle wall.

Procedure:
The color analyzing equipment is set up on transmittance and calibrated using pure white and black standards. The bottle wall is then inserted into the testing location and the equipment runs the color test. The test indicates L*, a*, b* values and haze percentage.

Data Table:

Run #	L* Average	a* Average	b* Average	Haze Average
Bottle 1	94.45	-0.91	-0.81	1.59
Bottle 2	95.39	-0.44	-1.13	3.41
Bottle 3	92.59	-2.61	-1.88	5.42
Bottle 4	92.86	-2.19	-2.40	9.24
Bottle 5	92.36	-3.03	-2.74	6.73
Bottle 6	91.45	-3.28	-3.58	7.59
Bottle 7	91.20	-2.59	-4.93	10.02

Blue PET Transmission Plaque Colors (Cont.)

Data Table:

Run #	L* Average	a* Average	b* Average	Haze Average
Bottle 8	79.91	-16.56	-19.69	8.57
Bottle 9	60.72	-25.88	-35.80	22.27
Bottle 10	58.48	-5.30	-46.20	3.47
Bottle 11	49.95	-6.50	-60.73	3.24
Bottle 12	86.90	-20.55	-10.52	10.76
Bottle 13	75.81	-36.45	-26.80	5.28
Bottle 14	50.30	-25.84	-26.96	68.13

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