



Paint Analysis Test No. 16-546 Summary Report

This test was sent to 94 participants. Each sample set consisted of two items containing a "known" paint sample and one item containing "questioned" paint chips. Participants were requested to compare the items and report their findings. Data were returned from 78 participants (83% response rate) and are compiled into the following tables:

	<u>Page</u>
<u>Manufacturer's Information</u>	<u>2</u>
<u>Summary Comments</u>	<u>3</u>
<u>Table 1: Examination Results</u>	<u>4</u>
<u>Table 2: Examination Methods</u>	<u>6</u>
<u>Table 3: Conclusions</u>	<u>10</u>
<u>Table 4: Additional Comments</u>	<u>24</u>
<u>Appendix: Data Sheet</u>	<u>26</u>

This report contains the data received from the participants in this test. Since these participants are located in many countries around the world, and it is their option how the samples are to be used (e.g., training exercise, known or blind proficiency testing, research and development of new techniques, etc.), the results compiled in the Summary Report are not intended to be an overview of the quality of work performed in the profession and cannot be interpreted as such. The Summary Comments are included for the benefit of participants to assist with maintaining or enhancing the quality of their results. These comments are not intended to reflect the general state of the art within the profession.

Participant results are reported using a randomly assigned "WebCode". This code maintains participant's anonymity, provides linking of the various report sections, and will change with every report.

Manufacturer's Information

Each sample set contained three items consisting of automotive paint samples. Items 1 and 2 were known paint samples representative of the damaged area of the suspect # 1 and suspect # 2 vehicles, respectively. Item 3 was a set of questioned paint chips recovered from the guard rail. Participants were requested to examine the questioned paint chips and determine if they could have originated from the damaged area of either of the suspect's vehicles.

The paint samples in Items 2 and 3 were prepared from the same automotive paint panel obtained from ACT Test Panels. The test panels were described as gray coil coated aluminum substrate panels with varying coating layering systems applied to them. The panel which made up Item 1 was made with the same primer and basecoat, but contained a different clear coat.

SAMPLE PREPARATION-

The panels used for this test were inspected for defects, and the areas where defects were located were not used.

ITEM 1 (ELIMINATION): For Item 1, the appropriate paint panel was cut into approximately 1/2" x 1/2" wide pieces using tin snips and one piece was packaged into a glassine bag and a pre-labeled Item 1 coin envelope. Item 1 was packaged into the sample pack as described below.

ITEMS 2 and 3 (IDENTIFICATION): For the known Item 2, the appropriate paint panel was cut into approximately 1/2" x 1/2" wide pieces using tin snips and one piece was packaged into a glassine bag and a pre-labeled Item 2 coin envelope. For the matching Item 3 samples, paint chips were cut into approximately 1/4" x 1/4" wide pieces using tin snips. Two of these pieces were packaged into a glassine bag and then a pre-labeled coin envelope for Item 3. This process was repeated until all of the Items were created. Items 2 and 3 were taken in close spatial proximity to one another, within four inches, and were kept together as an identification group and packaged into the sample pack as described below.

SAMPLE SET ASSEMBLY: For each sample set, Items 1, 2, and 3 were placed in a pre-labeled envelope. The sample pack was sealed with invisible tape. This process was repeated until all of the sample sets were prepared. Once verification was completed, all sample packs were further sealed with a piece of evidence tape and initialed "CTS".

VERIFICATION-

The expected association and elimination results were confirmed by predistribution laboratories who used the following combined list of techniques: Stereomicroscopy, comparison light microscopy, polarized light microscopy, fluorescence microscopy, FTIR, SEM/EDX, cross sectioning, alternate light source (ALS), and solubility/chemical.

Summary Comments

This test was designed to allow participants to assess their proficiency in the examination, comparison and interpretation of multi-layered automotive paint samples. Each test sample set consisted of two items containing a known sample (Items 1 and 2) and one item containing questioned chips (Item 3). The paint samples in Items 2 and 3 were cut from the same automotive panel. Item 1 was cut from a different automotive panel (Refer to Manufacturer's Information for preparation details.)

All 78 responding participants reported that the questioned paint chips in Item 3 could have originated from the same source as the known paint sample in Item 2 and could not have originated from the known paint sample in Item 1. The most common examination methods utilized include stereomicroscopy and FTIR.

Examination Results

Could the questioned paint chips (Item 3) have originated from the damaged area of either suspect vehicle #1 or #2 as represented by Items 1 and 2, respectively?

TABLE 1

WebCode	Item 1	Item 2	WebCode	Item 1	Item 2
2Z8UWV	No	Yes	CMMY6M	No	Yes
3ENGUF	No	Yes	CQMAZM	No	Yes
3W3GUN	No	Yes	CRYAD4	No	Yes
46C78M	No	Yes	CULGLK	No	Yes
46T2HF	No	Yes	D934J4	No	Yes
46WHFE	No	Yes	DU7KTK	No	Yes
479N9N	No	Yes	DZRD6K	No	Yes
4RCEJW	No	Yes	EKETXY	No	Yes
67HMNC	No	Yes	EZ8N86	No	Yes
67LJ4U	No	Yes	FN9AMY	No	Yes
67M4MB	No	Yes	FYQQF6	No	Yes
6CPL9V	No	Yes	GV7P3B	No	Yes
6R7GNR	No	Yes	HCNAUE	No	Yes
7HVE3Q	No	Yes	JQ4MR7	No	Yes
7Q797E	No	Yes	JQ6WRY	No	Yes
7WC22A	No	Yes	JRY7T9	No	Yes
7YJUZZ	No	Yes	K6JGPW	No	Yes
8222RB	No	Yes	KBMWLD	No	Yes
8LPVVP	No	Yes	KF22AT	No	Yes
8Z7HQA	No	Yes	KG9GFY	No	Yes
9E6A3H	No	Yes	LW6VFT	No	Yes
9YTHER	No	Yes	MG849X	No	Yes
AL396R	No	Yes	NMTHCU	No	Yes
ARA3EA	No	Yes	PC2JYU	No	Yes
B7ZL93	No	Yes	PGFUWB	No	Yes
BEEYGF	No	Yes	PNECD9	No	Yes
BEYEWB	No	Yes	Q3VYBR	No	Yes
BNLHXP	No	Yes	QPPHAA	No	Yes
CDHMEK	No	Yes	RTYJYT	No	Yes
CHDLMN	No	Yes	TD7BGL	No	Yes

TABLE 1

WebCode	Item 1	Item 2	WebCode	Item 1	Item 2
TT3QWZ	No	Yes			
TWEDFQ	No	Yes			
U4AU6M	No	Yes			
VKCEBU	No	Yes			
W7B3FV	No	Yes			
WRBDD4	No	Yes			
X6ERD2	No	Yes			
X9E3A2	No	Yes			
XJGVRM	No	Yes			
XV4U33	No	Yes			
YAZXZL	No	Yes			
YEEWMT	No	Yes			
YMTRG2	No	Yes			
Z7YHDW	No	Yes			
Z8VTFQ	No	Yes			
ZDYAVL	No	Yes			
ZKF6CF	No	Yes			
ZQM972	No	Yes			

Response Summary			
		Item 1	Item 2
Responses	Yes	0 (0 %)	78 (100.0%)
	No	78 (100.0%)	0 (0 %)
	Inc	0 (0 %)	0 (0 %)
Participants: 78			

Examination Methods

TABLE 2

WebCode	Stereomicroscope	Polarized Light	Fluorescence	Pyrolysis GC	FTR	Solubility/ Chemical	XRF/XRF	SEM/EDX	Microspectrophotometry	Other
2Z8UVV	✓				✓	✓	✓			
3ENGUF	✓				✓					
3W3GUN	✓				✓	✓	✓	✓		Raman Spectroscopy
46C78M	✓		✓	✓			✓			
46T2HF	✓				✓					
46WHFE	✓		✓	✓						
479N9N	✓	✓			✓	✓				
4RCEJW	✓	✓			✓				✓	Comparison Microscope
67HMNC	✓				✓					
67LJ4U	✓				✓					
67M4MB	✓		✓		✓		✓			
6CPL9V	✓	✓	✓		✓	✓				
6R7GNR	✓		✓		✓					ALS, comparison microscope
7HVE3Q	✓		✓	✓						
7Q797E	✓					✓				
7WC22A	✓				✓		✓			
7YJUZZ	✓	✓	✓	✓	✓		✓			
8222RB	✓		✓		✓					
8LPVRP	✓		✓		✓		✓			
8Z7HQA	✓				✓	✓			✓	
9E6A3H	✓	✓			✓	✓	✓			
9YTHER	✓	✓			✓		✓			Thin section
AL396R	✓	✓	✓	✓						
ARA3EA	✓	✓			✓		✓			

TABLE 2

WebCode	Stereomicroscope	Polarized Light	Fluorescence	Pyrolysis GC	FTR	Solubility/ Chemical	XRS/XRF	SEM/EDX	Microspectrophotometry	Other
B7ZL93					✓					
BEEYGF	✓		✓	✓	✓		✓		✓	
BEYEWB	✓	✓		✓	✓			✓		
BNLHXP	✓	✓		✓	✓	✓				High power microscopy
CDHMEK	✓				✓	✓				
CHDLMN	✓	✓			✓				✓	
CMMY6M	✓				✓		✓			
CQMAZM	✓				✓		✓			UV Lightsource
CRYAD4	✓				✓		✓			Raman
CULGLK	✓	✓			✓				✓	
D934J4	✓				✓	✓				
DU7KTK	✓				✓			✓		
DZRD6K	✓				✓		✓	✓		
EKETXY	✓				✓					
EZ8N86	✓				✓	✓				
FN9AMY	✓				✓					RAMAN SPECTROSCOPY
FYQQF6	✓				✓					
GV7P3B	✓				✓	✓	✓	✓	✓	Pyrolysis GC/MS
HCNAUE	✓	✓	✓		✓		✓			Raman spectroscopy
JQ4MR7	✓				✓		✓			
JQ6WRY	✓			✓	✓		✓			
JRY7T9	✓	✓	✓		✓		✓			cross-sections Items 2 and 3
K6JGPW	✓				✓		✓			
KBMWLD	✓	✓		✓	✓		✓	✓		
KF22AT		✓			✓					

TABLE 2

WebCode	Stereomicroscope	Polarized Light	Fluorescence	Pyrolysis GC	FTR	Solubility/ Chemical	XRS/XRF	SEM/EDX	Microspectrophotometry	Other
KG9GFY	✓		✓		✓					
LW6VFT	✓				✓					✓
MG849X	✓	✓	✓		✓					✓
NMTHCU	✓	✓	✓	✓	✓		✓			
PC2JYU	✓				✓	✓				
PGFUWB	✓				✓					
PNECD9	✓				✓					
Q3VYBR	✓		✓		✓			✓		
QPPHAA	✓	✓			✓					✓
RTYJYT	✓				✓					
TD7BGL	✓				✓					
TT3QWZ	✓	✓			✓	✓		✓	✓	
TWEDFQ	✓	✓		✓	✓					Raman
U4AU6M	✓		✓		✓	✓				High magnification microscopy under a variety of lighting conditions
VKCEBU	✓			✓	✓			✓		
W7B3FV	✓	✓	✓	✓	✓			✓		
WRBDD4	✓				✓	✓		✓	✓	
X6ERD2	✓			✓	✓			✓		
X9E3A2	✓				✓	✓				
XJGVRM	✓		✓		✓			✓		
XV4U33	✓	✓	✓		✓			✓		Pyrolysis GC/MS
YAZXZL	✓				✓					
YEEWMT	✓	✓		✓	✓	✓		✓		
YMTRG2	✓				✓			✓	✓	
Z7YHDW	✓				✓		✓			

TABLE 2

WebCode	Stereomicroscope	Polarized Light	Fluorescence	Pyrolysis GC	FTIR	Solubility/ Chemical	XRS/XRF	SEM/EDX	Microspectrophotometry	Other
Z8VTFQ	✓				✓			✓		
ZDYAVL	✓				✓					
ZKF6CF	✓	✓			✓	✓	✓	✓		
ZQM972	✓	✓			✓	✓			✓	

Response Summary										
Participants	Stereomicroscope	Polarized Light	Fluorescence	Pyrolysis GC	FTIR	Solubility/ Chemical	XRS/XRF	SEM/EDX	Microspectrophotometry	Other
78	76	26	17	16	77	14	10	35	16	
Percent	97%	33%	22%	21%	99%	18%	13%	45%	21%	

Conclusions

TABLE 3

WebCode	Conclusions
2Z8UW	These analyses disclosed that questioned paint samples Q1a and Q1b (item 3) and known paint sample K1 (item 1), are different with respect to their chemical type. It is the opinion of the undersigned that questioned paint samples Q1a and Q1b (item 3) could not have originated from the source represented by known paint sample K1 (item 1). Questioned paint Q1a (item 3) and known paint K2 (item 2) are consistent and no discriminating differences were observed with respect to their color, texture, layer structure, chemical type, and elemental composition. It is the opinion of the undersigned that Q1a (item 3), could have originated from the same source as represented by the known submitted exemplar, K2 (item 2), or from another source exhibiting all of the same analyzed characteristics. Q1b and K2 are consistent and no discriminating differences were observed with respect to their color, texture and layer structure. No further comparison was conducted between Q1b and K2.
3ENGUF	When Item 1 was compared to Item 3, slight differences in the FTIR spectra were noted, particularly in the 900-1300 cm ⁻¹ region. Item 1 does not share a common origin with Item 3. When Item 2 was compared to Item 3, no differences were observed in the FTIR spectra. Item 2 shares a common origin with Item 3.
3W3GUN	Based on the examinations conducted (MSP, IR, Raman, SEM/EDX and XRF) Item 3 can be differentiated from Item 1. Therefore, Item 3 could not have come from the vehicle represented by Item 1. Based on the examinations conducted (MSP, IR, Raman, SEM/EDX and XRF) Item 3 cannot be differentiated from Item 2. Therefore, the paint chips recovered from the guard rail (Item 3) could have come from the vehicle represented by Item 2.
46C78M	Item 1 and Item 2, the known paint samples from the damaged area of suspect vehicle #1 and vehicle #2, and the two pieces of paint fragmentation in Item 3, the questioned paint sample from the guard rail, each comprised a piece of 4-layered paint fragment having a first colourless layer, a second metallic green layer, a third light grey layer and a fourth dark grey layer on a metallic substrate. Item 2 was found to agree in colour, layer sequence and chemical composition of the individual paint layers with Item 3, indicating that the respective paint samples had likely originated from the same source. Item 1 was found to agree generally in colour and layer sequence, but there was a discrepancy in the chemical compositions of the individual paint layers with Item 3. These findings indicated that Item 3 did not originate from the damaged area from which the paint sample was collected from Item 1.
46T2HF	Microscopic examination at 200X magnification revealed that all three items consisted of 4 coating layers: a top clear coat over a green intermediate coat with a white intermediate coat and a gray bottom coat underneath. Each of the top 3 layers was about 1 mil thick and the bottom layer was about 0.4 mil thick. FTIR spectra of the topcoats of Items 1 and 3 were not the same. The spectrum of Item 1 lacked bands at about 1089 and 1024 1/cm that appeared in the spectrum of Item 3. The spectra of the coatings layers of Items 2 and 3 were consistent with each other.
46WHFE	[No Conclusions Reported.]
479N9N	The known paint in Item 2 and the questioned paint in Item 3 were found to be alike in all measured characteristics, and may have originated from the same source. The known paint in Item 1 was found to be dissimilar to the questioned paint in Item 3.
4RCEJW	Item 3 could not have originated from the source represented by Item 1. Item 3 could have originated from Item 2, as represented by the known submitted exemplar, or from another source exhibiting all of the same analyzed/measured characteristics.

TABLE 3

WebCode	Conclusions
67HMNC	The paint recovered from suspect car #2 and the questioned paint recovered from the guard rail could be related and can come from the same source, or the source of both paints can be cars manufactured and painted at the same factory plant.
67LJ4U	The paint in Item 3 demonstrates similar physical characteristics upon comparison to the paint in Item 1 however, further analysis revealed differences in chemical composition. Accordingly, Item 1 is excluded as the source of the paint in Item 3. The paint in Item 3 demonstrates similar physical characteristics and chemical composition upon comparison to the paint sample comprising Item 2. Accordingly, Item 3 could have originated from the same source as Item 2 or another source with the same physical characteristics and chemical composition.
67M4MB	In my opinion the paint sample item 3 can be excluded from having originated from the same source as item 1. In my opinion the findings provide strong support for the view that the paint sample item 3 originated from the same source as item 2.
6CPL9V	item #1 - Contains known paint with the following layer structure: 1. clear coat top coat, 2. dark green metallic color coat, 3. white primer, 4. gray primer. item #2 - Contains known paint with the following layer structure: 1. clear coat top coat, 2. dark green metallic color coat, 3. white primer, 4. gray primer. item #3: contains questioned paint with the following layer structure: 1. clear coat top coat, 2. dark green metallic color coat, 3. white primer, 4. gray primer. Microscopic, microchemical, and instrumental (micro-FTIR) analysis of the paint from items #1, 2, and 3 yielded the following results and conclusions: item #1 (known) and #3 (questioned) are dissimilar with respect to type. Therefore, the questioned paint (#3) could not have originated from the painted surface represented by item #1. item #2 (known) and #3 (questioned) are consistent with respect to color, texture, type, and layer structure. Therefore, the questioned paint (#3) could have originated from the source represented by item #2 or from another vehicular painted surface exhibiting the same characteristics (color, texture, type, and layer structure)
6R7GNR	Questioned item #3 could have originated from the known item #2 or from another source exhibiting all of the same analyzed characteristics. Item #3 could not have originated from the source represented by item #1.
7HVE3Q	The questioned paint chips (Item 3), the know paint sample (Item 1) and the know paint sample (Item 2) are each composed of four paint layers. Each of the four layers in the questioned paint chips (Item 3) cannot be distinguished from the corresponding layers in the known paint sample (Item 2). The questioned paint chips recovered from the guard rail (Item 3) could have come from the damaged area of suspect vehicle #2 (Item 2). However, the chemical composition in the questioned paint chips (Item 3) is distinguishable from the chemical composition in the know paint sample (Item 1). Therefore the questioned paint chip recovered from the guard rail (Item 3) could not have come from the damaged area of suspect vehicle #1 (Item 1).
7Q797E	The questioned paint chips recovered from the guard rail (Item 3) did not originate from the damaged area of suspect vehicle #1 (Item 1). The questioned paint chips recovered from the guard rail (Item 3) could have a common origin with the damaged area of suspect vehicle #2 (Item 2).
7WC22A	Item 1 and Item 3 were physically comparable. Paint layers sequence of item 1 and item 3 were comparable with each. The binders of the clearcoat of item 1 and item 3 were chemically different. Therefore item 3 could not have originated from item 1. Item 2 and Item 3 were physically and chemically comparable. Item 2 and item 3 consisted of the same paint layers sequence. All the layers of item 2 and 3 consisted of the same binder systems and elemental compositions. Therefore item 3 could have originated from item 2.

TABLE 3

WebCode	Conclusions
7YJUZY	The paint chip from the suspect vehicle, item 2, and the paint chips from the guard rail, item 3, are microscopically, macroscopically, and chemically similar and could have originated from the same source. The paint chip from the suspect vehicle, item 1, is chemically different from the guard rail paint chip, item 3, and could not have originated from the same source.
8222RB	Conclusions: 1. The paint chips, Exhibit 3, originated either from the same source as Exhibit 2, or from another source bearing paint physically and chemically indistinguishable from the paint of Exhibit 2. In a laboratory database of 967 vehicular paint samples encountered in casework, none of the samples had the paint layer sequence clear / green metallic / white / grey. This database does not distinguish among different shades of colour or chemical composition. 2. The paint chips, Exhibit 3, did not originate from the same source as Exhibit 1.
8LPVRP	The known paint samples (Item 1 and Item 2) as well as the questioned paint sample (Item 3) show the same paint layers: clearcoat, green effect basecoat, white layer and grey layer. All layers of all samples were analyzed by microscopy, light microscopy, infrared spectroscopy and SEM/EDX. Item 2 can not be differentiated from Item 3 by the used methods. Item 1 shows differences to Item 3 in the IR-spectra of the clearcoat and the green effect basecoat layer. The questioned paint sample Item 3 could have originated from the suspect vehicle #2.
8Z7HQA	1) The known paint sample representative of the damaged area of suspect vehicle #1 (item 1), consist of a four layers paint system with the following layer structure: 1. Colorless acrylic-urethane (new generation) with melamine enamel whith styrene modified clear coat and bentone paint extender, 2. Dark green decorative flakes acrylic-urethane (new generation) with melamine enamel with styrene modified clear coat and barium sulfate paint extender, 3. lighth gray iso-polyester-melamine enamel primer with barium sulfate clay paint extender and 4. dark gray tere-polyester-melamine enamel primer with barium sulfate clay paint. All this sequences exhibits typical characteristics of an original automotive finish. 2) The known paint sample representative of the damaged area of suspect vehicle #2 (item 2) and questioned paint chips recovered from the guard rail (item #3), consist of a four layers paint system with the following layer structure: 1. Colorless acrylic-urethane (new generation) with melamine enamel whith styrene modified clear coat and calcium silicate paint extender, 2. Dark green with decorative flakes acrylic-urethane (new generation) with melamine enamel with styrene modified clear coat and barium sulfate paint extender, 3. lighth gray iso-polyester-melamine enamel primer with barium sulfate clay paint extender and 4. dark gray tere-polyester-melamine enamel primer with barium sulfate clay paint. All this sequences exhibits typical characteristics of an original automotive finish. 3) The four layers paint chips in items #2 and #3 matches in all properties investigated, particularly in: colors, textures, types, layer sequence, chemical composition and infrared spectrum shape. It was concluded that the paint in these items could have a common origin. 4) The four layers paint of items #1 and #3 matches with the physical and microscopic characteristics studied, particularly in color and sequence of layers, but does not match the chemical composition of the layers 1 and 2. It was concluded that the paint in these items don't have a common origin.
9E6A3H	1. Examinations of Exhibit 1 (known paint from damaged area of suspect vehicle #1), Exhibit 2 (known paint from damaged area of suspect vehicle #2) and Exhibit 3 (questioned paint chips from the guard rail) disclosed the presence of a four-layer paint system with the following color and layer sequence: clear coat/metallic green/light gray/dark gray. 2. Comparative examinations of Exhibit 2 with Exhibit 3 disclosed them to be consistent in their physical characteristics, organic compositions, and elemental compositions by microscopy, Fourier transform infrared spectroscopy, x-ray micro fluorescence, and scanning electron microscopy electron dispersive spectroscopy. Therefore, Exhibit 3 could have had a common source of origin with Exhibit 2. Pyrolysis gas chromatography-mass spectrometry was not

TABLE 3

WebCode	Conclusions
	performed, which may add additional information concerning the paint's organic composition. 3. Comparative examinations of Exhibit 1 with Exhibit 3 disclosed them to be dissimilar in their elemental compositions. Therefore, Exhibit 3 could not have had a common source of origin with Exhibit 1.
9YTHER	The questioned paint chips from the guard rail (Item 3) were found to consist of the following four layers: clear/green/light gray/dark gray. These paint chips were examined and compared to the known paints from suspect vehicles #1 and 2 (Items 1 and 2 respectively). The four layers of paint comprising Item 3 are comparable in color, layering, chemical composition and elemental composition to the corresponding layers of paint in Item 2. Accordingly, the questioned paint chips from the guard rail (Item 3) could have originated from vehicle #2 (Item 2) or from different vehicles painted in the same manner. The questioned paint from the guard rail (Item 3) and the known paint from vehicle #1 (Item 1) display dissimilarities in chemical composition of the clear coat layers indicating they did not originate from the same source.
AL396R	The questioned paint chip recovered from the guard rail (01-03-AA) is similar in visual color, layer sequence, paint type, and paint composition to the submitted known paint recovered from the damaged area of suspect vehicle #2 (01-02-AA). It is my opinion the questioned paint chips could have originated from the suspect vehicle #2 or any other vehicle with similar paint characteristics (category 2B). The questioned paint chip recovered from the guard rail (01-03-AA) is similar in visual color and layer sequence but different in paint type and paint composition to the submitted known paint from the damaged area of suspect vehicle #1 (01-01-AA). It is my opinion the questioned paint did not originate from suspect vehicle #1 (category 5).
ARA3EA	All three samples are similar in overall color and the number of layers. The clear top coat layer of item #1 is molecularly and elementally different than the top coat layers of items #2, and #3, which are similar. Therefore, it is possible that item #3 originated from suspect vehicle #2.
B7ZL93	[No Conclusions Reported.]
BEEYGF	The paint chips recovered from the guard rail (Item 3) and the known paint sample taken from the damaged area of suspect vehicle #2 (Item 2) were found to be indistinguishable from each other in all aspects tested. The paint chips from the guard rail could therefore have originated from the suspect vehicle #2. The paint chips recovered from the guard rail (Item 3) were found to be different from the known paint sample from suspect vehicle #1 (Item 1), and could not have originated from the suspect vehicle #1.
BEYEWB	CONCLUSIONS: The questioned paint recovered from the guard rail (CTS Item 3) did not originate from the area/panel of the vehicle represented by CTS Item 1 (vehicle #1). The questioned paint recovered from the guard rail (CTS Item 3) is the same distinct type of paint as the known paint from vehicle #2 (CTS Item 2) and originated either from that source or another source of automotive paint having the same distinct characteristics. RESULTS: The questioned paint from the guard rail (CTS Item 3) was examined for the purpose of determining whether or not there is any paint present like that on suspect vehicle #1 (CTS Item 1) or suspect vehicle #2 (CTS Item 2). The paint standard from vehicle #1 (CTS Item 1) has the following layer structure: 1. Colorless acrylic-melamine-urethane enamel clearcoat, 2. Dark green basecoat (with effect pigment), 3. Light gray primer, 4. Dark gray primer. This paint exhibits characteristics typical of an original automotive finish and was used for comparison with questioned paint recovered from the guard rail (CTS Item 3). The questioned paint recovered from the guard rail (CTS Item 3) has the following layer structure: 1. Colorless

TABLE 3

WebCode	Conclusions
	<p>acrylic-melamine-urethane enamel clearcoat, 2. Dark green acrylic-melamine-urethane enamel basecoat (with effect pigment), 3. Light gray polyester-melamine enamel primer, 4. Dark gray polyester-melamine enamel primer. Examination and comparison of the questioned paint (CTS Item 3) with CTS Item 1 revealed they are dissimilar with respect to the binder characteristics of the layer 1 clearcoats. It is therefore concluded that the questioned paint recovered from the guard rail (CTS Item 3) did not originate from the area/panel of vehicle #1 represented by CTS Item 1. The paint standard from vehicle #2 (CTS Item 2) has the following layer structure: 1. Colorless acrylic-melamine-urethane enamel clearcoat, 2. Dark green acrylic-melamine-urethane enamel basecoat (with effect pigment), 3. Light gray polyester-melamine enamel primer, 4. Dark gray polyester-melamine enamel primer. This paint exhibits characteristics typical of an original automotive finish and was used for comparison with questioned paint recovered from the guard rail (CTS Item 3). Examination and comparison of the questioned paint (CTS Item 3) with CTS Item 2 revealed they are alike with respect to layer structure, layer colors, layer textures, binder characteristics, and pigment characteristics. It is therefore concluded that the questioned paint from the guard rail (CTS Item 3) is the same distinct type of paint as that on vehicle #2 (CTS Item 2) and either originated from that vehicle, or from another source of automotive paint having the same distinct characteristics. METHODS OF ANALYSIS: Examinations were performed visually, by stereo microscopy, brightfield/polarized light comparison microscopy, Fourier transform infrared microspectroscopy, pyrolysis gas chromatography, and scanning electron microscopy/energy dispersive x-ray analysis.</p>
BNLHXP	<p>Paint chips from Items 1 and 2 were examined and compared to Item 3. All three of the paint chips, 1-3, consist of the following colored layer structure: clear coat/ green metallic color coat/ white primer/ gray primer. Items 3 and 2 are consistent with each other in layer structures, layer colors, layer textures, and instrumental chemical characteristics. Therefore, the paint chips from the guard rail Item 3 could have originated from suspect vehicle #2 Item 2, or from another vehicle exhibiting all of the same analyzed characteristics. Item 3 is dissimilar to Item 1 in the chemical binder characteristics of the clear coat layer, and, therefore the paint chips from the guard rail Item 3 could not have come from suspect vehicle #1 Item 1, as represented by the known submitted exemplar.</p>
CDHMEK	<p>It was determined utilizing stereomicroscopic, Fourier Transform Infrared Spectroscopy, and X-Ray Fluorescence Spectroscopy that the item 1 and item 3 paint samples exhibit dissimilar characteristics. Therefore, the known paint sample from item 1 can be eliminated as being the source of the questioned paint sample. It was determined utilizing stereomicroscopic, Fourier Transform Infrared Spectroscopy, X-Ray Fluorescence Spectroscopy, and comparison microscopic examination that the item 2 and item 3 paint samples exhibit consistent characteristics. Therefore, the known paint sample from item 2 cannot be eliminated as being the source of the questioned paint sample.</p>
CHDLMN	<p>The examined portions of the dark green metallic paint from the questioned paint chips recovered from the guard rail (Item 1-3) were found to be different in instrumental properties from the examined portions of the dark green metallic paint from the known paint sample representative of the damaged area of suspect vehicle # 1 (Item 1-1). Accordingly, the dark green metallic paint from the questioned paint chips recovered from the guard rail could not have originated from the dark green metallic paint from the known paint sample representative of the damaged area of suspect vehicle # 1. The examined portions of the dark green metallic paint from the questioned paint chips recovered from the guard rail (Item 1-3) were found to be consistent in microscopic appearance and in instrumental properties with the examined portions of the dark green metallic paint from the known paint sample representative of the damaged area of suspect vehicle # 2 (Item 1-2). Accordingly, the dark</p>

TABLE 3

WebCode	Conclusions
	green metallic paint from the questioned paint chips recovered from the guard rail could have originated from the dark green metallic paint from the known paint sample representative of the damaged area of suspect vehicle # 2 or from another damaged source with similar characteristics.
CMMY6M	Physical and microscopic examination of the paint samples from Items 1, 2, and 3 revealed the presence of green automotive paint samples with the following layer structure: Clearcoat Layer, Green Flake Layer, Light Grey Primer Layer, Dark grey Primer Layer. Physical, microscopic, and instrumental comparison of the paint from Item 3 with the paint from Item 2 revealed them to be consistent with respect to color, texture, type, layering sequence, binder composition, and pigment composition. Therefore, the green paint from the guard rail could have originated from suspect vehicle #2 or another vehicle with this same paint history. Physical, microscopic, and instrumental comparison of the paint from Item 3 with the paint from Item 1 revealed them to be inconsistent with respect to binder composition. Therefore, the paint from the guard rail did not originate from suspect vehicle #1.
CQMAZM	Items 1-3 were examined using a stereomicroscope, an ultra-violet (UV) light source and instrumentally with Fourier Transform Infrared Spectrometry and Scanning Electron Microscopy/Energy Dispersive Spectroscopy. Item 3 (questioned paint chips) was consistent with item 2 (known paint sample vehicle #2) with respect to the presence of four-layer paint systems, behavior under UV light and instrumental results indicating similar chemical properties of the individual layers. Therefore, item 3 may have originated from the same source as item 2. Item 3 (questioned paint chips) was not consistent with item 1 (known paint sample vehicle #1).
CRYAD4	Item 1 and Item 3 were physically comparable. Paint layers of item 1 and item 3 were consistent with each other however the clear coat of item 3 and item 1 were not chemically comparable. Therefore item 3 could not have originated from the source represented by item 1. Item 2 and Item 3 were chemically and physically comparable. Item 2 and item 3 consisted of the same number of paint layers and the colours were comparable. All the layers of item 2 and 3 consisted of the same binder systems, pigments and elemental compositions. Therefore item 3 could have originated from a source represented by item 2.
CULGLK	One of the 2 questioned paint chips (Item 3) was examined and compared to the known paint chips received in Items 1 and 2 using visible microscopy, polarized light microscopy, fourier transform infrared spectroscopy (FTIR), and microspectrophotometry (Items 2 and 3 only). The examined paint chips each consist of 4 layers. The FTIR results revealed discriminating differences between the clear layers of Items 1 and 3. Thus, Item 3 could not have originated from Item 1 as represented by the examined samples. The 4 layers of Items 2 and 3 are consistent in appearance, microscopic and chemical properties. Thus Item 3 could have originated from Item 2 as represented by the examined samples, or another paint source exhibiting the same analyzed characteristics and layer structure. No analysis was performed on the remaining paint chip in Item 3. Therefore, no conclusion can be reached on this sample.
D934J4	1) The known paint sample representative of the damaged area of suspect vehicle #1 (item 1), the known paint sample representative of the damaged area of suspect vehicle #2 (item 2), and the questioned paint chips recovered from the guard rail (item 3) consist of a four layers paint system with the following layer structure: Item 1: 1. Colorless acrylic-urethane-melamine enamel clear coat, 2. Dark green acrylic-melamine enamel base coat with decorative flakes, 3. Light gray isophthalic-polyester-melamine enamel primer, and 4. Gray isophthalic-polyester-melamine enamel primer. Item 2: 1. Colorless styrene modified acrylic-melamine enamel clear coat, 2. Dark green acrylic-melamine enamel base coat with decorative flakes, 3. Light gray isophthalic-polyester-melamine enamel primer, and 4. Gray

TABLE 3

WebCode	Conclusions
	<p>isophthalic-polyester-melamine enamel primer. Item 3: 1. Colorless styrene modified acrylic-melamine enamel clear coat, 2. Dark green acrylic-melamine enamel base coat with decorative flakes, 3. Light gray isophthalic-polyester-melamine enamel primer, and 4. Gray isophthalic-polyester-melamine enamel primer. 2) The four layered paint chips in item 1 and 3 match in the physical properties studied, particularly in color and layer sequence, but don't match regarding the chemical composition of colorless clear coat layer. It was concluded that the paint in these items don't have a common origin. 3) The four layered paint chips in item 2 and 3 match in all properties investigated, particularly in colors, textures, types, layer sequence and chemical composition. It was concluded that the paint in this items could have a common origin. The possibility that they don't share a common origin depend on the presence, in the crime scene, of another vehicle with the same finish (along with the damage in an external place) and that it comes from the same factory lot as the currently questioned vehicle.</p>
DU7KTK	<p>The questioned dark green paint chips marked "Item 3", recovered from the guard rail, could have originated from the same source as the dark green paint sample marked "Item 2", collected from the damaged area of suspect vehicle #2, or another source of paint with similar characteristics. The questioned dark green paint chips marked "Item 3", recovered from the guard rail, did not originate from the same source as the dark green paint sample marked "Item 1", collected from the damaged area of suspect vehicle #1.</p>
DZRD6K	<p>Questioned paint Q1 and Q2 and the known paint K1 and K2 were examined and instrumentally analyzed as follows: Fourier Transform Infrared Spectroscopy (FT-IR) was performed on all four layers of Q1, Q2, K1 and K2; X-Ray Fluorescence Spectrometry (XRF) and Scanning Electron Microscopy/Energy Dispersive X-Ray Spectrometry (SEM/EDX) was performed on all four layers of Q1 and K2. These analyses disclosed that the questioned paint, Q1 and Q2 and the known paint, K1, are different with respect to the chemical type of their respective layer 1. It is the opinion of the undersigned that the questioned paint Q1 and Q2 submitted as Laboratory item 3 could not have originated from the source represented by the known paint K1 submitted as Laboratory item 1. These analyses also disclosed that questioned paint Q1 and Q2 and known paint K2 are consistent and no discriminating differences were observed with respect to their color, texture, layer structure and chemical type. In addition questioned paint Q1 and known paint K2 are consistent and no discriminating differences were observed with respect to their elemental composition. It is the opinion of the undersigned that the questioned paint Q1 submitted as Laboratory item 3, could have originated from vehicle 2 as represented by the known paint exemplar K2 submitted as Laboratory item 2, or from another source exhibiting all of the same analyzed characteristics. Questioned paint Q2 was not further compared to known paint K2 and therefore no conclusion can be reached about Q2.</p>
EKETXY	<p>firstly painted materials were analyzed with stereomicroscope on a clear area. the view of the paints was identically. (identical paint, same paint tone etc.) after that paints were analyzed with FTIR. item1 was different, item2 and item3 were identically. on conclusion item2 and item3(crime scene) were idetically, item1 and item3 were different</p>
EZ8N86	<p>The paint in item 3 is similar in color, layer structure, solubility and infra-red absorbance spectra to the paint in item 2. Therefore the paint in items 3 and 2 could have originated from the same source. The paint in item 3 is similar in color and layer structure to the paint in item 1. However it is dissimilar in infra-red absorbance spectra. Therefore the paint in items 3 and 1 could not have originated from the same source.</p>
FN9AMY	<p>1. VISUAL AND MICROSCOPIC EXAMINTIONS - ITEM 1, ITEM 2 AND ITEM 3 ARE THE METALLIC PAINT DISTINGUISHABLE IN THEIR APPEARANCE; MICROSCOPE</p>

TABLE 3

WebCode	Conclusions
	EXAMINATIONS ITEM 1 HAVE DIFFERENT COLOR TONE FROM ITEM 2 AND ITEM 3. 2. CHEMICAL ANALYSIS AND COMPARISONS - ITEM 1 ARE DISSIMILAR FROM ITEM 2 AND ITEM 3 IN FTIR SPECTRA AND ALL THREE ITEMS HAVE NOT DIFFERENT CHEMICAL COMPONENT IN RAMAN TECHNIQUE. 3. CONCLUSIONS- ITEM3 COULD HAVE ORIGINATED FROM KNOWN PAINT SAMPLE ITEM2.
FYQQF6	Item 1, item 2 and item 3 are 3-layer paint chip. Item 3 and item 2 showed same composition from each layer. But item 1 top layer is different from item 3.
GV7P3B	The dark metallic green paint in Item 3 was identical to the dark metallic green paint in Item 2 in color, polymer type, texture, layer structure, and elemental composition. This means that the questioned paint chips recovered from the guard rail could have come from the damaged area of suspect vehicle #2. The dark metallic green paint in Item 3 was different from the dark metallic green paint in Item 1. This means that the questioned paint recovered from the guard rail did not come from the damaged area of suspect vehicle #1.
HCNAUE	The layers of the sample 2. have the same chemical, elemental and morphological properties as the layers of sample 3.
JQ4MR7	The paint samples from both vehicles (items 1 and 2) and the paint from the guard rail (item 3) all contained four layers of paint which were a colourless layer, on a metallic green layer, on a pale grey layer, on a grey layer. The corresponding layers from the paint samples were compared by their visual appearance and their chemical and elemental compositions. The colourless layer in the sample from the guard rail was different to the colourless layer in the sample from vehicle 1. Therefore, in my opinion, the paint on the guard rail has not come from vehicle 1. The layers of paint in the sample from the guard rail (item 3) could not be distinguished from the corresponding paint layers in the sample from vehicle 2 (item 2). Therefore, in my opinion, the paint from the guard rail could have come from vehicle 2. In my opinion, the correspondence of four layers of paint very strongly supports the suggestion that the paint from the guard rail has come from vehicle 2.
JQ6WRY	Microscopic Exam: All of them(Item1,2,3)are contained four layers, which is clear coat, green,white and gray(from top to bottom). Chemical Analysis:According to FTIR,Pyrolysis GC/MS and SEM/EDS result, the chemical composition of Item 3 is similar to those of Item 2.However, Item 3 is dissimilar to Item 1 because of different chemical composition.
JRY7T9	1. Examinations of Item 1 (known paint sample from suspect vehicle 1), Item 2 (known paint sample from suspect vehicle 2) and Item 3 (questioned paint samples recovered from guard rail) disclosed them to be composed of the following four layers: clear coat / green base coat / white primer / gray primer (next to metal substrate). 2. Comparative examinations of the questioned paint samples in Item 3 with the known paint sample in Item 1 disclosed them to be dissimilar in the chemical composition of their clear and base coat layers. Therefore, the questioned paint samples in Item 3 did not originate from the source for the known paint sample as provided in Item 1. 3. Comparative examinations of the questioned paint samples in Item 3 with the known paint sample in Item 2, through the use of visual and microscopic observation, Fourier transform infrared spectroscopy and scanning electron microscopy-energy dispersive spectroscopy, disclosed them to be consistent in the physical characteristics, organic composition and elemental composition of their clear coat, base coat, white primer and gray primer layers, respectively. Due to instrument inoperability, not all analytical testing of the organic compositions of the clear and base coats of Items 2 and 3 could be conducted. Therefore, the possibility that these samples could differ in the organic composition of those layers could not be fully investigated. However, the possible common origin of the question paints samples in Item 3 with the known paint sample in Item 2 could not be eliminated.

TABLE 3

WebCode	Conclusions
K6JGPW	All three items had five layers, as determined by SEM analysis. The upper layer (furthest away from the base metal) of Item 1 (Suspect Vehicle 1) differed in chemical composition from that of Items 2 and 3 (Suspect Vehicle 2 and Questioned Paint Sample respectively) by both FTIR and SEM/EDS analysis, exhibiting a different IR spectrum and varying in silicon content. Item 1 (Suspect Vehicle 1) could therefore be excluded as a possible source of Item 3 (Questioned Paint Sample). Although some small differences were detected between Items 2 and 3, by FTIR analysis, the results were not considered sufficiently conclusive to allow Item 2 to be excluded as a possible source of Item 3. In addition, SEM/EDS analysis could not exclude Item 2 as a source of Item 3. Therefore it is concluded that Item 3 (Questioned Paint Sample) could have originated from Item 2 (Suspect Vehicle 2), but not from Item 1 (Suspect Vehicle 1).
KBMWLD	The paints in Items 1, 2, and 3 were compared in layer structure and chemical composition. The three paints are original equipment manufacturer's (OEM) automotive finishes. Analysis of the paint samples was performed using visual and stereomicroscopic examination, polarized light microscopy, infrared spectroscopy, pyrolysis gas chromatography/mass spectrometry, scanning electron microscopy with energy dispersive X-ray spectrometry, and microspectrophotometry. Based on the examinations conducted, the paint of Item 3 is consistent in layer structure sequence, color, and chemical composition to the paint of Item 2. This result indicates that Items 2 and 3 could have originated from the same vehicle or from vehicles painted in the same manner. Based on the examinations conducted, the paint of Item 3 is eliminated from sharing a common source with the paint of Item 1 based on differences in chemical composition and microscopic appearance.
KF22AT	[No Conclusions Reported.]
KG9GFY	In my opinion, my findings provide very strong support for the proposition that the paint chips recovered from the guard rail have originated from the damaged area of suspect vehicle 2, represented by item 2. In addition, my findings provide very strong support for the proposition that the paint chips recovered from the guard rail have not originated from the damaged area of the suspect vehicle 1, represented by item 1.
LW6VFT	The known paint samples representative of the damaged area of suspect vehicles #1 and #2 (Items 1 and 2) consist of four layers: Clear topcoat / metallic dark green basecoat / light grey primer / dark grey primer. The questioned paint chips recovered from the guard rail (Item 3) consists of four layers, too: Clear topcoat / metallic dark green basecoat / light grey primer / dark grey primer. Item 3 was found to be consistent with respect to layer structure (stereomicroscope), color (microspectrophotometry) and chemical composition (FT-IR) with Item 2. Meanwhile, the clear topcoat layer of Item 3 was found to have a different chemical composition to the clear topcoat layer of Item 1. Therefore, it was concluded that the questioned paint chips recovered from the guard rail (Item 3) could have originated from the damaged area of suspect vehicle #2 (Item 2).
MG849X	The paint layers from a representative paint chip (A) in Item 3 and the paint layers in Item 1 were examined and compared visually, microscopically and instrumentally and the clear layers were found to be inconsistent in all measured chemical compositions. They could not have come from the same source. The paint layers from a representative paint chip (A) in Item 3 and the paint layers in Item 2 were examined and compared visually, microscopically and instrumentally and were found to be consistent in all measured microscopic and chemical compositions, and color characteristics. They could have come from the same source or any other source with the same compositions and color characteristics.
NMTHCU	the questioned paint chips (item 3) could have originated from the damaged area of suspect vehicle #2 as represented by item 2.

TABLE 3

WebCode	Conclusions
PC2JYU	The paint in item 3 is similar in color, layer structure, solubility, and infra-red absorbance spectra to the paint in item 2. Therefore the paint in items 2 and 3 could have originated from the same source. The paint in item 3 is similar in color to the paint in item 1, however, it is dissimilar in infra-red absorbance spectra. Therefore the paint in items 1 and 3 could not have originated from the same source.
PGFUWB	The paint from both vehicles (Items 1 and 2) consisted of a four layer sequence, lacquer/green effect/white/grey on a metal substrate. While they were indistinguishable from each other with regards to microscopic appearance and layer sequence, they differed from each other with regards to chemical composition of the lacquer layers. The questioned paint chips from the guard rail (Item 3) consisted of a four layer sequence, lacquer/green effect/white/grey on a metal substrate which matched the paint from vehicle #2 with regards to microscopic appearance and layer sequence and in chemical composition of the corresponding lacquer, white and grey layers. The questioned paint chips from the guard rail (Item 3) did not match the sample from vehicle #3 with regard to chemical composition of the corresponding lacquer layers.
PNECD9	In the limit of our analytical techniques, the item N°2 is indistinguishable from the item N°3. The item chip N°1 present some significantly differences with the item N°3. To conclude, item N°3 could be originated from the car on which item N°2 has been sampled.
Q3VYBR	It was found that Item 2 could have originated from Item 3, Item 1 could not have originated from Item 3.
QPPHAA	The Item 3 unknown paint corresponded to the known paint in Item 2 with respect to color and layer structure (clear, metallic green, lighter grey, darker grey), visible spectra of green layer (MSP) and chemical composition (FTIR). Therefore, Item 3 and Item 2 cannot be eliminated as coming from a common source (Type IV Association). The laboratory has other techniques available but not operational (PGCMS and SEM) which may provide additional discrimination. Without these additional examinations, this paint comparison is limited in its conclusion. The Item 1 paint differed in chemical composition (FTIR) to the Item 3 unknown paint and can be eliminated as being a possible source (Elimination). KEY for instrument acronyms: FTIR – Fourier Transform Infrared Spectroscopy, PGC/MS – Pyrolysis Gas Chromatography Mass Spectrometry, MSP – Microspectrophotometry, SEM/EDS – Scanning Electron Microscopy/Energy Dispersive Spectroscopy
RTYJYT	[No Conclusions Reported.]
TD7BGL	The questioned paint chip (item 3) could have originated from suspect vehicle 2 (item 2). Item 3 could not have originated from item 1.
TT3QWZ	The green metallic paint recovered from ITEM 3 consisted of four layers of paint which were consistent in color, texture, layer sequence, chemical composition, and elemental composition to the known paint sample from ITEM 2. The paint from ITEM 3 could have come from the known paint sample ITEM 2 or any other source with similar characteristics. The green metallic paint recovered from ITEM 3 was dissimilar to the known paint sample from ITEM 1 in chemical composition. Samples were examined by stereomicroscopy, comparison polarized light microscopy, Fourier transform infrared spectroscopy, microspectrophotometry, microchemical tests, and scanning electron microscopy with energy dispersive X-ray spectroscopy.
TWEDFQ	Items 3 and 1 are distinguishable in chemical composition. It was concluded that the questioned paint chips (Item 3) could not have come from the damaged area of suspect vehicle #1. Items 3 and 2 are indistinguishable in color and chemical composition. It was

TABLE 3

WebCode	Conclusions
	concluded that the questioned paint chips(Item 3) could have come from the damaged area of suspect vehicle #2.
U4AU6M	In my opinion the paint recovered from the guard rail did not originate from suspect vehicle 1 as represented by the paint sample in item 1. In my opinion the findings provide strong support for the view that the paint from the guard rail originated from the suspect vehicle 2 as represented by the paint sample in item 2.
VKCEBU	Vehicle #1, as represented by item 1, can be eliminated as a possible source of the paint on the guard rail, item 3. Vehicle #2, as represented by item 2, cannot be eliminated as a possible source of the paint on the guard rail, item 3. The paint on the guard rail, item 3, either came from vehicle #2, as represented by item 2, or another source of damaged paint indistinguishable in colour, layer sequence, microscopic appearance and chemical composition. Other vehicles with paint indistinguishable from vehicle #2 would include other green pearlescent vehicles manufactured at the same assembly plant during the time these formulations were in use.
W7B3FV	The results of the examination support that the paint chips Item 3 originate from the suspect vehicle#2 (Item 2) (Level +2). The results of the examination extremely strongly support that the paint chips Item 3 doesn't originate from the damaged area of the suspect vehicle#1 (Item 1) (Level -4).
WRBDD4	The questioned paint chips recovered from the guard rail (Item 3) could have originated from the damaged area of suspect vehicle #2 or from another source of the same paint and layer structure.
X6ERD2	The Item 3 questioned paint from the guard rail was examined and found to consist of two paint chips containing four automotive paint layers. It was compared to the Item 1 and Item 2 known paint samples representative of vehicle 1 and vehicle 2, respectively. As a result of these examinations, Item 1 differs in chemical composition from Item 3, and therefore, the vehicle part represented by Item 1 is not the source of Item 3 (Elimination). However, the corresponding paint layers in Items 2 and 3 are indistinguishable in sequence, color, texture, relative thickness, and chemical composition. Accordingly, Item 3 originated from the vehicle represented by Item 2 or from another vehicle painted in the same manner (Type III Association – see Interpretation scale). This type of conclusion was reached because other vehicles coated with the same paint formulations in the same layer sequence would also be indistinguishable. It is important to note that the analytical techniques used in the analysis of these items allow for a high degree of discrimination among automotive paint systems from different vehicles and/or manufacturing plants. The following analytical techniques were used in the examination of these items of evidence: visual and stereomicroscopical examinations, Fourier transform infrared spectroscopy, pyrolysis-gas chromatography/mass spectrometry, and scanning electron microscopy with backscattered electron imaging and energy dispersive X-ray spectroscopy. Interpretation: The following descriptions are meant to provide context to the conclusions reached in this report. Every type of conclusion may not be applicable in every case nor for every material. Type I Association: Physical/Fracture Match – The compared items exhibit physical features that demonstrate they were once part of the same object. Associations of Evidence with Class Characteristics: Class characteristics are physical and/or chemical properties that place an item within a particular group of items. Associations of class evidence can have varying degrees of significance. As the size of the class decreases, the significance of the association between items in that class increases. A class association does not definitively establish that the items came from the same source. Type II Association: Association with atypical characteristics – An association in which items could not be differentiated based on observed and/or measured properties and/or chemical composition. Therefore, the possibility

TABLE 3

WebCode	Conclusions
	that the items came from the same source cannot be eliminated. Further, the items share unusual characteristics that would not be expected to be encountered in the relevant population. Type III Association: Association with typical characteristics – An association in which items could not be differentiated based on observed and/or measured properties and/or chemical composition. Therefore, the possibility that the items came from the same source cannot be eliminated. Other items have been manufactured that would also be indistinguishable from the submitted items and could be encountered in the relevant population. Type IV Association: Association with limited characteristics/examinations – An association in which items could not be differentiated based on observed and/or measured properties and/or chemical composition. Therefore, the possibility that the items came from the same source cannot be eliminated. As compared to the categories above, this type of association has decreased evidential value as a result of items that are more commonly encountered in the relevant population, the inability to perform a complete analysis, or minor variations observed in the data. Inconclusive – No conclusion could be reached regarding an association or an elimination between the items. Elimination/Exclusion – The compared items exhibit differences in observed and/or measured properties and/or chemical composition that demonstrate they did not originate from the same source.
X9E3A2	On analysis, I found the questioned paint chips (item 3) to be similar to the known paint sample (item 2) but dissimilar to the known paint sample (item 1). Therefore, I am of the opinion that: i. the questioned paint chips (item 3) could have originated from the damaged area of vehicle 2 (item 2). ii. the questioned paint chips (item 3) did not originate from the damaged area of vehicle 1 (item 1).
XJGVRM	The recovered sample (Item 3) was examined when it was found to be different from Suspect Vehicle 1, such that in our opinion, this sample (Item 3) did not come from Vehicle 1. The recovered sample (Item 3) was examined when it was found to be similar in colour, cross-sectional layer structure, chemical properties and elemental composition to the control sample from Suspect Vehicle 2, such that at one time, in our opinion, they could have had a common origin.
XV4U33	Questioned paint chips recovered from the guard rail (Item #3) were four layer paint chips, which matched in colour, layer structure and chemical composition with Item #2, the known paint sample representative of the damaged area of suspect vehicle #2. Thus the questioned paint chips in Item #3 could share a common origin with the known paint sample, Item #2. Item #3 was inconsistent with the other known paint sample, Item #1.
YAZXZL	The questioned paint chips (Item 3) recovered from the guard rail could come from the damage area of suspect vehicle #2, not suspect vehicle #1.
YEEWMT	Examinations and comparisons were performed to determine if the paint chips recovered from the guardrail could have originated from either of the damaged areas of the suspect vehicles. Examination of Item 1, which was collected from suspect vehicle #1, revealed the presence of one (1) paint chip with the following layer structure: 1. Clear colorless acrylic-melamine-polyester-styrene-urethane enamel topcoat, 2. Dark green pearlescent acrylic-melamine-polyester-styrene-urethane enamel finishcoat, 3. Light grey melamine-polyester enamel primer, 4. Dark grey epoxy-melamine-polyester enamel primer, Metal substrate. This paint chip exhibits characteristics consistent with an original automotive paint layer system, and it was used as a standard sample for comparison purposes. Examination of Item 2, which was collected from suspect vehicle #2, revealed the presence of one (1) paint chip with the following layer structure: 1. Clear colorless acrylic-melamine-styrene-urethane enamel topcoat, 2. Dark green pearlescent acrylic-melamine-polyester-styrene-urethane enamel finishcoat, 3. Light grey

TABLE 3

WebCode	Conclusions
	<p>melamine-polyester enamel primer, 4. Dark grey epoxy-melamine-polyester enamel primer, Metal substrate. This paint chip exhibits characteristics consistent with an original automotive paint layer system, and it was used as a standard sample for comparison purposes. Item 3 consists of two (2) paint chips with the following layer structure: 1. Clear colorless acrylic-melamine-styrene-urethane enamel topcoat, 2. Dark green pearlescent acrylic-melamine-polyester-styrene-urethane enamel finishcoat, 3. Light grey melamine-polyester enamel primer, 4. Dark grey epoxy-melamine-polyester enamel primer, Metal substrate. These paint chips exhibit characteristics consistent with an original automotive paint layer system. Microscopical, microchemical and instrumental examinations and comparisons between the paint chips recovered from the guardrail and the standard paint sample from Item 2 revealed that they are like one another with respect to layer colors, layer textures, layer sequence, decorative flake content of Layer 2, as well as microchemical reactivities, detailed binder characteristics and elemental composition of the respective layers. It is therefore concluded that the Item 3 paint chips recovered from the guardrail originated either from the damaged area of suspect vehicle #2 or another source of original automotive paint having the same characteristics. Microscopical and microchemical examinations and comparisons between the paint chips recovered from the guardrail and the standard paint sample from Item 1 revealed that they are like one another with respect to layer colors, layer textures, layer sequence, decorative flake content of Layer 2, as well as microchemical reactivities. However, further instrumental examinations revealed significant differences with respect to the binder type of Layer 1. It is therefore concluded that the Item 3 paint chips recovered from the guardrail did not originate from the damaged area of suspect vehicle #1 as represented by the Item 1 standard paint sample.</p>
YMTRG2	<p>The following items were analyzed utilizing the Fourier Transform Infrared Microscope (FTIR), Scanning Electron Microscope with Energy Dispersive Spectrometer (SEM-EDS), and Microspectrophotometer (MSP). Items 1 and 3 both consisted of green metallic paint; however, these items could not have originated from the same source of paint due to chemical composition of the clear layer. Items 2 and 3 both consisted of green metallic paint and were consistent in color, layer sequence, physical and chemical properties. Item 3 could have originated from item 2 or from paint with similar color, layer sequence, physical and chemical properties.</p>
Z7YHDW	<p>The paint chips of all 3 samples consist of four layers: clear coat, black coloured coat, white primer surfacer and grey first primer. The paint chips of the suspect vehicle 2 and from the guard rail show similar IR-spectra in all 4 layers. All four layers of sample 2 and 3 contain the same inorganic elements. It is highly probable that the questioned paint chips from the guard rail originated from the damaged area of the suspect vehicle 2.</p>
Z8VTFQ	<p>Examination of the known paint chip recovered from the damaged area of the vehicle #1 (Item 1) - Item 1 comprised a paint sample with layer sequence: clearcoat/green metallic/light grey/dark grey. The clearcoat was identified as an acrylic:urethane/melamine/ styrene type paint. The green metallic topcoat was identified as an acrylic/melamine/ styrene type paint. The light grey layer was identified as isophthalic alkyd type paint. The dark grey layer was identified as isophthalic alkyd type paint. The clear layer was identified as an acrylic:urethane/melamine/ styrene type paint, which does not correspond with the clear layer of the paint chip recovered from the guard rail (Item 3). Therefore, the paint chip recovered from the guard rail (Item 3) did not originate from the damaged area of the vehicle #1 (Item #1). Examination of the known paint chip recovered from the damaged area of the vehicle #2 (Item 2) - Item 2 comprised a paint sample with layer sequence: clearcoat/green metallic/light grey/dark grey. The clearcoat was identified as a acrylic:urethane/melamine/ styrene type paint. The inorganic elemental composition of the clearcoat principally comprised</p>

TABLE 3

WebCode	Conclusions
	<p>silicon. The green metallic topcoat was identified as an acrylic/melamine/ styrene type paint. The inorganic elemental composition of the green metallic topcoat principally comprised titanium, sulfur, barium, aluminium and silicon. The light grey layer was identified as isophthalic alkyd type paint. The inorganic elemental composition of the light grey layer principally comprised titanium, barium, sulfur, silicon, aluminium and iron. The dark grey layer was identified as an isophthalic alkyd type paint. The inorganic elemental composition of the dark grey layer principally comprised titanium, silicon, aluminium and iron. Examination of the questioned paint chips recovered from the guard rail (Item 3) - Item 3 comprised a paint sample with layer sequence: clearcoat/green metallic/light grey/dark grey. The clearcoat was identified as a acrylic:urethane/melamine/ styrene type paint. The inorganic elemental composition of the clearcoat principally comprised silicon. The green metallic topcoat was identified as an acrylic/melamine/ styrene type paint. The inorganic elemental composition of the green metallic topcoat principally comprised titanium, sulfur, barium, aluminium and silicon. The light grey layer was identified as an isophthalic alkyd type paint. The inorganic elemental composition of the light grey layer principally comprised titanium, barium, sulfur, silicon, aluminium and iron. The dark grey layer was identified as an isophthalic alkyd type paint. The inorganic elemental composition of the dark grey layer principally comprised titanium, silicon, aluminium and iron. The layer colour, layer sequence and composition of Item 2 correspond with Item 3. Therefore the results support the proposition that the paint recovered from the guard rail (Item 3) originated from the damaged area of vehicle #2 (Item 2).</p>
ZDYAVL	<p>Top layer of item 2 is similar with item 3 by FT-IR spectroscopy. But, top layer of item 1 is different from item 3.</p>
ZKF6CF	<p>The 3 Items were analysed with the procedures checked above [Table 2 -Examination Methods] and the results showed as follows. The IR spectrum of the clear layer of Item 1 seems to be acrylmelamine and different from that of Item 3 and the ratio of S to Ti of the top layer of Item 1 is different from that of Item 3. However both IR spectrum and the ratio of S to Ba of Item 2 are similar to those of Item 3. Thus we concluded the paint specimen of Item 3 was originated from the paint of Item 2.</p>
ZQM972	<p>Item 2 is similar in all examined characteristics to item 3. Item 3 could have come from Vehicle 2, as represented by item 2, or from another similarly painted vehicle. Vehicle 1, as represented by item 1, could not be the source of the paint in item 3.</p>

Additional Comments

TABLE 4

WebCode	Additional Comments
4RCEJW	The laboratory's SEM/EDS instrument was out of service so no elemental analysis was conducted.
8Z7HQA	1. The difference in the chemical composition of the layers 1 and 2 of the item #1 with respect to layers 1 and 2 of the Item #3, is that even though the same type of resin used, the paint formulation based on these different generating a different infrared spectrum between said layers of paint of both items. 2.The difficulty associated with certainty the item # 2 and # 3 was because it is only possible to compare four layers of paint with no individualizing common characteristics.
9YTHER	Our PyGC has not been working within timeline of this test or I would have run that.
BNLHXP	Methods of Analysis Paint was analyzed using a combination of stereomicroscopy, high power and polarized light microscopy, microchemical test, Fourier transform infrared spectroscopy (FTIR), and pyrolysis gas chromatography-mass spectrometry (PGC-MS).
D934J4	In our laboratory the majority of casework received consists of automobile paint transfer, it is common to receive different exhibits from a real case scenario to compare with a suspect car. The typical problems are fragment size and usual refinish cars with more than 10 layers. According to our experience, this test is unusual scenario. The new for us is work only with OEM finish.
KG9GFY	The two upper layers (ie the clearcoat and metallic green layers) of the extraneous paint fragment (item 3) were distinguishable from the respective layers from vehicle 1, in the result of the tests carried out (although the lower two layers were indistinguishable between the two samples.
NMTHCU	the chemical composition of the questioned paint chips (item 3) is similar to that of suspect vehicle paint chips (item 2)
PGFUWB	In normal casework we would generally attempt to evaluate results at activity level, however in order to do this we would require additional information e.g. vehicle make and model.
QPPHAA	<p>Interpretation: The following descriptions are meant to provide context to the opinions reached in this report. Every type of conclusion may not be applicable in every case or for every material type.</p> <p>Type I Association: Identification - An association in which items share individual characteristics and/or physically fit together that demonstrate the items were once from the same source.</p> <p>Type II Association: Association with distinct characteristics - An association in which items correspond in all measured physical properties, chemical composition and/or microscopic characteristics and share distinctive characteristic(s) that would not be expected to be found in the population of this evidence type. The distinctive characteristics were not sufficient for a Type I Association.</p> <p>Type III Association: Association with conventional characteristics - An association in which items correspond in all measured physical properties, chemical composition and/or microscopic characteristics and could have originated from the same source. Because it is possible for another sample to be indistinguishable from the submitted evidence, an individual source cannot be determined.</p> <p>Type IV Association: Association with limitations - An association in which items could not be differentiated based on observed and/or measured properties and/or chemical composition. As compared to the categories above, this type of association has decreased evidential value as a result of items that are more commonly encountered in the relevant population, the inability to perform a complete analysis, limited information, or minor variations observed in the data.</p> <p>Inconclusive: No conclusion could be reached regarding an association or an elimination between the items.</p> <p>Dissimilar: The items were dissimilar in physical properties</p>

TABLE 4

WebCode	Additional Comments
	and/or chemical composition, indicating that the items may not have originated from the same source. However, these dissimilarities were insufficient for a definitive Elimination. Elimination: Items exhibit dissimilarities in one or more of the following: physical properties, chemical composition or microscopic characteristics and, therefore, conclusively did not originate from the same source.
U4AU6M	In my view the correspondence observed between the layers of the paint from the guard rail and the layers of the paint from suspect vehicle 2 is significant. I would expect to be able to rule out very many other sources of paint, including the paint of many other vehicles.
VKCEBU	Technical assistance has been provided in the examination and analysis of the items discussed in this report, in accordance with the policies and procedures of this laboratory. This report contains interpretations and opinions based on scientific data. To obtain information about sample availability for retesting or additional testing, clarification, or a copy of the documentation underlying this report, please contact the writer of this report. The following instrumental analytical techniques were used to analyze the items: Pyrolysis Gas Chromatography - Mass Spectrometry (PGC-MS; items 2 and 3), Scanning Electron Microscopy - Energy Dispersive X-ray Spectroscopy (SEM-EDX; items 2 and 3), Fourier Transform Infrared Spectroscopy (FTIR; items 1, 2 and 3)
X6ERD2	It is a disservice to the forensic science community that interpretation scales are not reproduced in the final CTS report.

Appendix: Data Sheet

Collaborative Testing Services ~ Forensic Testing Program

Test No. 16-546: Paint Analysis

DATA MUST BE RECEIVED BY November 21, 2016 TO BE INCLUDED IN THE REPORT

Participant Code:

WebCode:

Accreditation Release Statement

CTS submits external proficiency test data directly to ASCLD/LAB, ANAB, and A2LA. Please select one of the following statements to ensure your data is handled appropriately.

This participant's data is intended for submission to ASCLD/LAB, ANAB, and/or A2LA. (Accreditation Release section on the last page must be completed and submitted.)

This participant's data is NOT intended for submission to ASCLD/LAB, ANAB or A2LA.

Scenario:

Police are investigating a homicide. Witnesses described a dark green car driving erratically away from the scene around the time of the murder. When driving away, the vehicle struck a guard rail, sustaining damage to the passenger side. Police were able to recover paint chips from the guard rail. Several days later, the police acquired two suspect vehicles that matched the witness' description and had damage to the passenger side. A known paint sample was taken from the damaged area of each vehicle. Police are requesting that you examine the recovered paint chips and determine if they could have originated from the damaged area of either of the suspect vehicles.

Please Note:

- Samples contained within each individual item are representative of a single source.
- The purpose of this test is the examination of the paint; please ignore the metal substrate.

CTS will not reproduce Interpretation Scales, Scale of Conclusions or Terminology Keys in the final report, please do not submit with the participant's data sheet.

Items Submitted (Sample Pack P2):

- Item 1: Known paint sample representative of the damaged area of suspect vehicle #1
- Item 2: Known paint sample representative of the damaged area of suspect vehicle #2
- Item 3: Questioned paint chips recovered from the guard rail

1.) Could the questioned paint chips (Item 3) have originated from the damaged area of either suspect vehicle #1 or #2 as represented by Items 1 and 2, respectively?

<p>Suspect Vehicle 1 (Item 1)</p> <hr style="width: 80%; margin: 0 auto;"/> <p>Item 3 Yes <input type="checkbox"/> No <input type="checkbox"/> Inc <input type="checkbox"/></p>	<p>Suspect Vehicle 2 (Item 2)</p> <hr style="width: 80%; margin: 0 auto;"/> <p>Item 3 Yes <input type="checkbox"/> No <input type="checkbox"/> Inc <input type="checkbox"/></p>
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Please return all pages of this data sheet.

Participant Code:

WebCode:

2.) Indicate the procedure(s) used to examine the submitted items:

Microscopic Examinations:

Stereomicroscope

Polarized Light

Fluorescence

Pyrolysis GC

FTIR

Solubility/Chemical

XRS/XRF

SEM/EDX

Microspectrophotometry

Other (specify): _____

3.) What would be the wording of the Conclusions in your report?

4.) Additional Comments

<p>Return Instructions: Data must be received via online data entry, fax (please include a cover sheet), or mail by November 21, 2016 to be included in the report. Emailed data sheets are not accepted.</p> <p>QUESTIONS? TEL: +1-571-434-1925 (8 am - 4:30 pm EST) EMAIL: forensics@cts-interlab.com www.ctsforensics.com</p>	Participant Code:
	<p>ONLINE DATA ENTRY: www.cts-portal.com</p> <p>FAX: +1-571-434-1937</p> <p>MAIL: Collaborative Testing Services, Inc. P.O. Box 650820 Sterling, VA 20165-0820 USA</p>

Please return all pages of this data sheet.

Collaborative Testing Services - Forensic Testing Program

RELEASE OF DATA TO ACCREDITATION BODIES

The following Accreditation Releases will apply only to:

Participant Code:

WebCode:

for Test No. **16-546: Paint Analysis**

This release page must be completed and received by **November 21, 2016** to have this participant's submitted data included in the reports forwarded to the respective Accreditation Bodies.

Have the laboratory's designated individual complete the following steps **only if your laboratory is accredited in this testing/calibration discipline** by one or more of the following Accreditation Bodies.

Step 1: Provide the applicable Accreditation Certificate Number(s) for your laboratory

ASCLD/LAB Certificate No. _____

ANAB Certificate No. _____

A2LA Certificate No. _____

Step 2: Complete the Laboratory Identifying Information in its entirety

Signature and Title _____

Laboratory Name _____

Location (City/State) _____

Return Instructions**Accreditation Release**

Please submit the completed Accreditation Release at the same time as your full data sheet. See Data Sheet Return Instructions on the previous page.

*Questions? Contact us 8 am-4:30 pm EST
Telephone: +1-571-434-1925
email: forensics@cts-interlab.com*

Please return all pages of this data sheet.

Page 3 of 3