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FORENSIC TESTING PROGRAM

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Paint Analysis
Test No. 20-5452 Summary Report

Each participant received a sample set consisting of two known paint samples (Items 1 and 2) and one questioned paint sample (Item 3). Participants were requested to analyze and compare these and report their findings. Data were returned from 67 participants and are compiled into the following tables:

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. Item 1 was a known paint sample representative of the damaged area of suspect vehicle #1. Item 2 was a known paint sample representative of the damaged area of suspect vehicle #2. Item 3 was questioned paint chips recovered from the victim's motorcycle. Participants were requested to examine the questioned paint chips and determine if it could have originated from the damaged area of either suspect vehicle #1 or #2.

The paint samples in Items 1 and 3 were prepared from the same automotive paint panel. The test panel was described by the supplier as a gray coil coated aluminum substrate panel. The panel used for Item 2 was made with the same basecoat and primer, but contained a different clear coat.

SAMPLE PREPARATION-
The panels used for this test were inspected for defects, and the areas containing defects were not used.

ITEMS 1 AND 3 (ASSOCIATION): For the known Item 1, the paint panel was cut into approximately ½" x ½" wide pieces and one piece was packaged into a glassine bag and a pre-labeled Item 1 coin envelope. For the associated Item 3 samples, paint chips were cut into approximately ¼" x ¼" wide pieces. Two of these pieces were packaged into a glassine bag and then a pre-labeled Item 3 coin envelope. This process was repeated until all of the Items were created. Items 1 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.

ITEM 2 (ELIMINATION): For the known Item 2, the appropriate paint panel was cut into approximately ½" x ½" wide pieces and one piece was packaged into a glassine bag and a pre-labeled Item 2 coin envelope. Item 2 was 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 results were confirmed by predistribution laboratories who used the following combined list of techniques: ALS/fluorescence, comparison microscope, FTIR, polarized light, Raman, SEM/EDX, and stereomicroscope.

Summary Comments

This test was designed to allow participants to assess their proficiency in the examination, comparision, and interpretation of multi-layered automobile paint samples. Each sample set consisted of three items with layered paint and primer; two known samples (Items 1 and 2) and one questioned sample (Item 3) were cut from aluminum substrate panels. Items 1 and 3 came from the same automotive paint panel with the same basecoat, primer, and clear coat. Item 2 was prepared with the same basecoat and primer, but contained a different clear coat (Refer to Manufacturer's Information for preparation details).

Of the 67 participants that reported results, 65 reported expected results and 2 reported outliers. One participant reported that Item 3 could have originated from Item 2 known paint sample. The remaining participant reported Item 3 did not originate from Item 1 known paint sample.

The most common methods utilized include, FTIR (100%), Stereomicroscope (96%), and SEM/EDX (60%).

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 3 Item 1	Item 3 Item 2	WebCode	Item 3 Item 1	Item 3 Item 2
2HKBYD	Yes	No	F2B6R3	Yes	No
2XGPY8	Yes	No	FK3DNX	Yes	No
3AA9DC	Yes	No	GKE9WV	Yes	No
3MVNGC	Yes	No	H9M72W	Yes	No
3XRRL7	Yes	No	J9ELQX	Yes	No
689HX9	Yes	No	JNQZ9V	Yes	No
6CQFQ6	Yes	No	JRUVRY	Yes	No
7AEZW4	Yes	No	KNPLZT	No	No
7ZTYE9	Yes	No	KWJRTU	Yes	No
89DPD7	Yes	No	L29QKV	Yes	No
8XYR93	Yes	No	LKJFXT	Yes	No
9CTG3D	Yes	No	LWXD3W	Yes	No
9UQW36	Yes	No	M4E9JQ	Yes	No
AD298Z	Yes	No	MQ6TCL	Yes	No
AHUET3	Yes	No	NB8Z6P	Yes	No
APE939	Yes	No	NKT6CP	Yes	No
B8PK84	Yes	No	P84RDK	Yes	No
CQ2TLA	Yes	No	QLFPVQ	Yes	No
CTRVQW	Yes	No	QN7NAN	Yes	No
DEMUJY	Yes	No	QYP73V	Yes	No
DRQGJV	Yes	No	R99YTH	Yes	No
DUZ6G9	Yes	No	RC8BPH	Yes	No
EAL8C4	Yes	No	TVEYFK	Yes	No
EDLGCW	Yes	No	U8M3EN	Yes	No
EZKMCW	Yes	Yes	U9X4ZM	Yes	No

TABLE 1

WebCode	Item 3 Item 1	Item 3 Item 2	WebCode	Item 3 Item 1	Item 3 Item 2
ULL7HE	Yes	No			
UM4XUK	Yes	No			
UQ3E7E	Yes	No			
UU3LDH	Yes	No			
VBK3RQ	Yes	No			
W38FKF	Yes	No			
WGRVLL	Yes	No			
X684AG	Yes	No			
X8GT3E	Yes	No			
XX7QGD	Yes	No			
Y97E7G	Yes	No			
YJ4HAB	Yes	No			
ZDEKW8	Yes	No			
ZHQ77E	Yes	No			
ZKU2PG	Yes	No			
ZM2JMD	Yes	No			
ZYBW6D	Yes	No			

Examination Response Summary **Participants: 67**

Responses	Item 3 Item 1	Item 3 Item 2
Yes	**66** *(98.5%)*	**1** *(1.5%)*
No	**1** *(1.5%)*	**66** *(98.5%)*
Inc	**0** *(0%)*	**0** *(0%)*

Examination Methods

TABLE 2

WebCode	Stereomicroscope	Polarized Light	Fluorescence	Pyrolysis GC	FTIR	Solubility / Chemical	Microspectrophotometry	XRS / XRF	SEM / EDX	Other
2HKBYD	✓				✓				✓	Raman spectroscopy
2XGPY8	✓		✓		✓	✓			✓	
3AA9DC	✓			✓	✓					
3MVNGC	✓				✓	✓				
3XRRL7	✓				✓					
689HX9	✓				✓	✓				uv light
6CQFQ6	✓				✓		✓		✓	Pyrolysis GC/MS
7AEZW4	✓	✓	✓		✓		✓			
7ZTYE9	✓	✓		✓	✓	✓			✓	
89DPD7	✓	✓		✓	✓				✓	
8XYR93	✓		✓		✓	✓			✓	
9CTG3D	✓	✓	✓		✓					
9UQW36	✓	✓		✓	✓	✓			✓	
AD298Z	✓	✓			✓	✓			✓	
AHUET3	✓	✓	✓		✓				✓	
APE939	✓			✓	✓				✓	Raman, Backscatter imaging
B8PK84	✓				✓				✓	
CQ2TLA	✓	✓			✓				✓	
CTRVQW	✓	✓			✓		✓			
DEMUJY	✓	✓		✓	✓				✓	
DRQGJV	✓				✓					
DUZ6G9	✓	✓	✓		✓					microscopyRaman
EAL8C4	✓				✓				✓	
EDLGCW	✓				✓				✓	Raman
EZKMCW	✓	✓			✓		✓		✓	
F2B6R3					✓					

TABLE 2

WebCode	Stereomicroscope	Polarized Light	Fluorescence	Pyrolysis GC	FTIR	Solubility / Chemical	Microspectrophotometry	XRS / XRF	SEM / EDX	Other
FK3DNX	✓			✓	✓				✓	
GKE9WV	✓			✓	✓				✓	
H9M72W					✓	✓				
J9ELQX	✓				✓				✓	
JNQZ9V	✓				✓					ALS/fluorescence - stereomicroscope
JRUVRY	✓				✓		✓			
KNPLZT					✓					
KWJRTU	✓				✓				✓	
L29QKV	✓		✓		✓					
LKJFXT	✓				✓				✓	
LWXD3W	✓				✓			✓		
M4E9JQ	✓				✓					
MQ6TCL	✓	✓		✓	✓					
NB8Z6P	✓	✓	✓		✓				✓	
NKT6CP	✓	✓			✓	✓			✓	Pyrolysis GC/MS
P84RDK	✓				✓		✓		✓	
QLFPVQ	✓				✓				✓	
QN7NAN	✓		✓		✓					
QYP73V	✓	✓			✓		✓		✓	Comparison Microscope
R99YTH	✓	✓			✓				✓	
RC8BPH	✓				✓			✓		
TVEYFK	✓	✓	✓		✓		✓		✓	
U8M3EN	✓			✓	✓				✓	colorimetry
U9X4ZM	✓				✓					
ULL7HE	✓	✓	✓		✓	✓	✓		✓	
UM4XUK	✓		✓		✓				✓	
UQ3E7E	✓				✓				✓	

TABLE 2

WebCode	Stereomicroscope	Polarized Light	Fluorescence	Pyrolysis GC	FTIR	Solubility / Chemical	Microspectrophotometry	XRS / XRF	SEM / EDX	Other
UU3LDH	✓	✓			✓				✓	Pyrolysis GC/MS
VBK3RQ	✓		✓		✓					
W38FKF	✓	✓	✓	✓	✓			✓	✓	
WGRVLL	✓				✓				✓	
X684AG	✓				✓		✓		✓	
X8GT3E	✓		✓		✓			✓		
XX7QGD	✓				✓		✓		✓	
Y97E7G	✓				✓	✓				
YJ4HAB	✓	✓			✓	✓			✓	
ZDEKW8	✓				✓					
ZHQ77E	✓			✓	✓				✓	
ZKU2PG	✓	✓	✓	✓	✓		✓	✓		
ZM2JMD	✓	✓	✓		✓				✓	Raman Spectroscopy
ZYBW6D	✓				✓	✓				UV Light

Response Summary **Total Participants: 67**

	Stereomicroscope	Polarized Light	Fluorescence	Pyrolysis GC	FTIR	Solubility/ Chemical	Microspectrophotometry	XRF/XRS	SEM/EDX
Participants	64	24	17	13	67	13	12	5	40
Percent	*96%*	*36%*	*25%*	*19%*	*100%*	*19%*	*18%*	*7%*	*60%*

Conclusions

TABLE 3

WebCode	Conclusions
2HKBYD	The questioned paint chips (Item 3) could have originated from the damage area of suspected vehicle represented by Item 1. The questioned paint chips (Item 3) could not have originated from the damage area of suspected vehicle represented by Item 2.
2XGPY8	METHODS: Items 1, 2, and 3 were examined visually and using stereomicroscopy. Samples from Items 1, 2, and 3 were examined using stereomicroscopy, fluorescence microscopy, microchemical tests, and Fourier Transform Infrared Spectrophotometry (FTIR). Samples from Items 1 and 3 were examined using Scanning Electron Microscopy-Energy Dispersive X-Ray Spectrometry (SEM-EDS). RESULTS AND INTERPRETATIONS: The multilayered blue paint particles with decorative flake in Items 1 and 3 were consistent in colors, textures, types, layer sequence, and chemical compositions. Based on the particles examined, it was concluded that the paints in Items 1 and 3 originated from either the same source or difference sources painted in the same manner (Level III – Association with Discriminating Characteristics). This type of conclusion was reached because other vehicles produced at the same manufacturing plant and painted with the same type of paint system would also be indistinguishable. It should be noted that the techniques used in this comparative analysis can typically distinguish paint systems from different assembly plants. Based on the particles examined, the multilayered blue paint particles with decorative flake in Items 2 and 3 could not be associated due to differences in chemical composition (Exclusion/Elimination).
3AA9DC	The questioned paint chips recovered from the victim's motorcycle (item-3) and paint sample representative of the damaged area of suspect vehicle #1 (item-1) were consistent on color, layering and chemical composition and could have originated from the same source. The questioned paint chips recovered from the victim's motorcycle (item-3) and paint sample representative of the damaged area of suspect vehicle #2 (item-2) were inconsistent on chemical composition. The item-3 could not have originated from the same source as represented by the item-2.
3MVNGC	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 victim´s motorcycle (item 3) consist of a three layers paint system with the following layer structure: Item 1: 1. Colorless acrylic-melamine enamel clear coat, 2. Blue acrylic-melamine enamel base coat with decorative flakes, and 3. Gray isophthalic-polyester-melamine enamel primer. Item 2: 1. Colorless styrene modified acrylic-melamine enamel clear coat, 2. Blue acrylic-melamine enamel base coat with decorative flakes, and 3. Gray isophthalic-polyester-melamine enamel primer. Item 3: 1. Colorless acrylic-melamine enamel clear coat, 2. Blue acrylic-melamine enamel base coat with decorative flakes, and 3. Gray isophthalic-polyester-melamine enamel primer. 2) The three layered paint chips in item 1 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. 3) The three layered paint chips in item 2 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.
3XRRL7	The chemistry of the top (clear coat) layer of Item #2 differs with Item #1 and Item #3. The

TABLE 3

WebCode	Conclusions
	submitted paint chips originated from different sources, as represented by the items submitted. The number, colors, and chemistries of the layers of Item #1 and Item #3 are consistent with each other and cannot be excluded from originating from the same source, as represented by the items submitted.
689HX9	The paint in item 3 is similar in color, layer structure, solubility, fluorescence, and infrared absorbance spectra to the paint in item 1. Therefore, the paint in items 3 and 1 could have originated from the same source. The paint in item 3 is similar in color and layer structure to the paint in item 2; however, it is dissimilar in infrared absorbance spectra. Therefore, the paint in items 3 and 2 could not have originated from the same source.
6CQFQ6	Items 1, 2, and 3 were examined by stereomicroscopy, microspectrophotometry, and infrared spectroscopy. Items 1 and 3 were additionally examined by scanning electron microscopy/energy-dispersive x-ray spectroscopy and pyrolysis gas chromatography/mass spectrometry. The blue metallic paint in Item 3 was indistinguishable from the blue metallic paint standard in Item 1 in color, polymer type, texture, layer structure, and elemental composition (Type 3 Association). This means the paint recovered from the victim's motorcycle could have come from the damaged area of Suspect Vehicle #1. The blue metallic paint in Item 3 was different from the blue metallic paint standard in Item 2 (Elimination). This means the paint recovered from the victim's motorcycle did not come from the damaged area of Suspect Vehicle #2.
7AEZW4	Lab item #3: The item contained two blue paint chips which were visually similar to each other. One of the chips was examined. The analyzed paint chip had the following paint layer system: clear coat, blue base coat with effect pigment, and two gray primer layers. The color, physical, and chemical characteristics of the analyzed blue paint chip of Item #3 were consistent with the color, physical, and chemical characteristics of the blue paint chip of Item #1. This is a Type IV Association. Differences were found in the chemical characteristics of the analyzed blue paint chip of Item #3 and the blue paint chip of Item #2. This is an Elimination. The item can be compared to additional known standards in the future, upon request.
7ZTYE9	Items 1 and 2, paints from two known source vehicles, were submitted for comparison with Item 3, paint transfer recovered from the victim's motorcycle. Items 1, 2 and 3 were examined microscopically and analyzed by Fourier transform infrared spectroscopy, scanning electron microscopy with energy dispersive spectrometer, and pyrolysis gas chromatography/mass spectrometry. Examination of Item 3 questioned paint with Item 1, paint from suspect vehicle 1, revealed that they are consistent with respect to their observed and measured physical and chemical properties (e.g., layer structure and chemical composition of corresponding layers) when analyzed using the above listed techniques. It is therefore concluded that the Item 3 questioned paint recovered from the victim's motorcycle corresponds to the Item 1 paint and therefore originated from that vehicle or from another source of automotive paint having the same distinct characteristics. This type of conclusion was reached because other vehicles produced at the same manufacturing plant and painted with the same type of paint would also be indistinguishable. Examination and comparison of the Item 3 questioned paint with Item 2 revealed that they are different with respect to the chemical composition of the clearcoat layers. It is therefore concluded the questioned paint recovered from the victim's motorcycle did not originate from the damaged area paint sample represented by Item 2.
89DPD7	Item 1: Findings: Paint with layer sequence of clear/blue reflective/ grey/grey observed. Used for comparison. Item 2: Findings: Paint with layer sequence of clear/blue reflective/ grey/grey observed. Used for comparison. Item 3: Findings: Paint with layer sequence of clear/blue reflective/ grey/grey observed. Conclusions: Indistinguishable in physical characteristics and

TABLE 3

WebCode	Conclusions
	chemical composition to the paint in Item 1; therefore, the paint in Item 3 could have originated from the same source as Item 1. Comparison to Item 2 revealed differences with the clear coat layer; therefore, this paint could not have originated from the same source as Item 2.
8XYR93	The following methodologies were used in the examination of this case: visual examination, microscopy, solubility and chemical tests, fluorescence, FTIR, and SEM-EDX. KNOWN STANDARD: Examination of the paint sample from the damaged area of suspect vehicle 1 (Item 1) revealed a piece of metal painted blue reflective with the following layer structure: Clear, Blue reflective, Blue-grey, and Grey. Examination of the paint sample from the damaged area of suspect vehicle 2 (Item 2) revealed a piece of metal painted blue reflective with the following layer structure: Clear, Blue reflective, Blue-grey, and Grey. QUESTIONED SAMPLES: Examination of the paint chips from the victim's motorcycle revealed two pieces of metal painted blue reflective with the following layer structure: Clear, Blue reflective, Blue-grey, and Grey. The blue reflective paint chips from the victim's motorcycle (Item 3) were visually and chemically consistent with the blue reflective paint sample from the damaged area of suspect vehicle 1 (Item 1). Therefore, the blue reflective paint from the victim's motorcycle (Item 3) could have originated from the same source as the paint from the damaged area of suspect vehicle 1 (Item 1). The blue reflective paint chips from the victim's motorcycle (Item 3) was not consistent with the blue reflective paint sample from the damaged area of suspect vehicle 2 (Item 2). Therefore, the blue reflective paint from the victim's motorcycle (Item 3) did not originate from the same source as the paint from the damaged area of suspect vehicle 2 (Item 2).
9CTG3D	The clear top coat, color coat, and primer layers of the selected paint chip from item 3 are similar in color, microscopical characteristics, and IR spectra to the clear top coat, color coat, and primer layers of item 1. Therefore, the paint chip could have originated from the damaged area of suspect vehicle 1 or any other paint source with similar class characteristics. The clear top coat of the selected paint chip from item 3 has a different IR spectrum than the IR spectrum of the clear top coat of item 2; therefore, the paint chip could not have originated from the damaged area of suspect vehicle 2.
9UQW36	The paint in Item #3 is similar in color, layer sequence and chemical composition to the paint in Item #1 and could have originated from the same source as the paint in Item #1. The paint in Item #3 is dissimilar in chemical composition to the paint in Item #2 and did not originate from the same source as the paint in Item #2.
AD298Z	The following methodologies were used in the examination of this case: visual examination, microscopy, solubility/chemical tests, FTIR, and SEM-EDX. Examination of Lab Items #1, 2, & 3 revealed the presence of blue reflective paint chips with the following layer structure: clear, blue with reflective flake, gray, and dark gray on a metal substrate. The blue reflective paint chips collected from the victim's motorcycle (Lab Item #3) were found to be physically and chemically consistent with the blue reflective paint chip collected from the damaged area of suspect vehicle #1 (Lab Item #1). Therefore, the blue reflective paint chips from Lab Item #3 could have originated from the same source as the blue reflective paint chip from Lab Item #1. The blue reflective paint chips collected from the victim's motorcycle (Lab Item #3) were not chemically consistent with the blue reflective paint chip collected from the damaged area of suspect vehicle #2 (Lab Item #2). Therefore, the blue reflective paint chips from Lab Item #3 did not originate from the same source as the blue reflective paint chip from Lab Item #2.
AHUET3	The results of the examination support that the paint chips Item 3 originates from the suspect vehicle #1 (Item 1) (Level +2). The results of the examination extremely strongly support that the paint chips Item 3 does not originate from the damaged area of the suspect vehicle #2 (Item 2)(Level -4).

TABLE 3

WebCode	Conclusions
APE939	RESULTS OF EXAMINATIONS: The Item 3 questioned paint chips recovered from the motorcycle were examined and compared to the Item 1 known paint from vehicle 1 and the Item 2 known paint from vehicle 2. Based on the examinations conducted, the four layers of paint comprising Item 1 could not be distinguished in sequence, color, texture, and chemical composition to the corresponding layers of paint in Item 3. Accordingly, Item 1 and Item 3 originated from the same vehicle or from different vehicles painted in the same manner (Type III Association – see Interpretation section). This type of association was reached because other vehicles produced at the same manufacturing plant as the source of Item 1, which were painted with the same color code and paint formulations, would also be indistinguishable. Item 2 and Item 3 differed in chemical composition. Therefore, Item 2 and Item 3 do not share a common source (Elimination). INTERPRETATION: The following categories and their descriptions are meant to provide context to the conclusions reached in this report. Every category may not be applicable in every case nor for every material. Type I Association: Physical/Fracture Match – The 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 evidence with class characteristics can have varying degrees of significance. In general, the smaller the size of the group relative to the relevant population, the more significant the association. A class association cannot definitively establish that the items came from the same source. Type II: Association with Highly Discriminating Characteristics – An association in which items could not be differentiated. Therefore, the possibility that the items came from the same source cannot be eliminated. Additionally, the items share unusual characteristics that would not be expected to be encountered in the relevant population. Type III: Association with Discriminating Characteristics – An association in which items could not be differentiated. 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 with Limitations – An association in which items could not be differentiated. 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. For example, the items are more commonly encountered in the relevant population, a complete analysis was not performed due to limited characteristics or a limited analytical scheme, or minor variations were observed in the data. Inconclusive – No conclusion could be reached. Elimination – The items exhibit exclusionary differences that demonstrate they did not originate from the same source.
B8PK84	[No Conclusions Reported.]
CQ2TLA	The Questioned Paint (Clear/Metallic Blue/Grey) analyzed in Item 3 is consistent with the Known Paint (Clear/Metallic Blue/Grey) analyzed in Item 1 on the basis of color, layer structure, organic composition, and elemental composition. The Questioned Paint analyzed in Item 3 is not consistent with the Known Paint (Clear/Metallic Blue/Grey) analyzed in Item 2 on the basis of organic composition.
CTRVQW	The examined portions of the blue paint chips from the trace item, Questioned paint chips recovered from the victim's motorcycle, Item 1-3, were found to be consistent in microscopic appearance and instrumental properties with the examined portions of the blue paint chip from the trace item, Known paint sample representative of the damaged area of suspect vehicle #1, Item 1-1. Accordingly, the examined portions of the blue paint chips in Item 1-3 could have originated from the examined portions of the blue paint chip in Item 1-1 or another source with similar characteristics. The examined portions of the blue paint chips from the trace item, Questioned paint chips recovered from the victim's motorcycle, Item 1-3, were found to be

TABLE 3

WebCode	Conclusions
	consistent in microscopic appearance but different in instrumental properties with the examined portions of the blue paint chip from the trace item, Known paint sample representative of the damaged area of suspect vehicle #2, Item 1-2. Accordingly, the examined portions of the blue paint chips in Item 1-3 could not have originated from the examined portions of the blue paint chip in Item 1-2.
DEMUJY	The questioned paint recovered from the victim's motorcycle (item 3) is the same distinct type of paint as the known paint on the damaged area of suspect vehicle #1 (item 1) and originated either from that source or another source of automotive paint having the same distinct characteristics. The questioned paint recovered from the victim's motorcycle (item 3) did not originate from the damaged area of suspect vehicle #2 represented by item 2.
DRQGJV	The findings provide moderately strong support for the view that the questioned paint chips recovered from the victim's motorcycle came from the same source as the known paint sample from the damaged area of suspect vehicle #1, rather than the view that they came from a different source. The questioned paint chips recovered from the victim's motorcycle did not come from the same source as the known paint sample from the damaged area of suspect vehicle #2.
DUZ6G9	Questioned paint chips recovered from the victim's motorcycle (Item 3) matched in colour, layer structure and chemical composition with Item 1, known paint sample representative of the damaged area of suspect vehicle #1. Thus, the questioned paint chips in Item 3 could have originated from the known paint sample, Item 1. Questioned paint chips (Item 3) were inconsistent with the other known paint sample, Item 2, representative of the damaged area of suspect vehicle #2.
EAL8C4	The comparative Microscopic observation and chemical analysis of the paint samples collected from the damaged area of two suspected vehicles item 1 and item 2 and the questioned paint chips recovered from the victim's motorcycle item 3, reveal that: The paints of Item 1 and Item 3 show similarities in color, paint type and chemical composition. The paints of Item 2 and Item 3 show slight differences in chemical composition principally in infra red spectra and SEM/EDX.
EDLGCW	Based on FTIR examinations, the questioned paint chips recovered from the victim's motorcycle (Item 3) could be differentiated from the known paint sample representative of the damaged area of suspect vehicle #2 (Item 2). Therefore, the questioned sample (Item 3) could not have come from the damaged area of the suspect vehicle #2 (Item 2). Based on microscopy, FTIR, Raman and SEM/EDS examinations, the questioned paint chips recovered from the victim's motorcycle (Item 3) could not be differentiated from the known paint sample representative of the damaged area of suspect vehicle #1 (Item 1). Therefore, the questioned sample (Item 3) could have come from the damaged area of suspect vehicle #1 (Item 1). In my opinion, the evidence supports the proposition that the suspect vehicle #1 has come in to contact with the victim's motorcycle.
EZKMCW	Paint comparisons were performed on the following items: Item 1.1 Item 1: Known paint sample representative of the damaged area of suspect vehicle #1, Item 1.2 Item 2: Known paint sample representative of the damaged area of suspect vehicle #2, Item 1.3 Item 3: Questioned paint chips recovered from the victim's motorcycle. The paint blue paint sample of item 1.3 consists of a three layer structure of clear, blue, and gray. The paint sample of Item 1.3 is similar in color, layer structure, elemental composition and chemical composition to the blue paint standard of Item 1.1. Accordingly, the item 1.1 and 1.3 paints may have originated from the same vehicle or from different vehicles painted in the same manner (Type III association). This level of association was reached because vehicles produced at the same manufacturing plant, with the same color code and same paint formulation, would also be

TABLE 3

WebCode	Conclusions
	indistinguishable from each other. The paint sample of Item 1.3 is similar in color, layer structure, elemental composition and chemical composition to the blue paint standard of Item 1.2. Accordingly, the item 1.2 and 1.3 paints may have originated from the same vehicle or from different vehicles painted in the same manner (Type III association). This level of association was reached because vehicles produced at the same manufacturing plant, with the same color code and same paint formulation, would also be indistinguishable from each other. Paint comparisons were performed using Fourier transform infrared spectroscopy, scanning electron microscopy with energy dispersive x-ray spectroscopy, and microspectroscopy. Association Scale: Type I Association: A physical match; items fit back to one another demonstrating that the items are from the same source. Type II Association: An association in which items are consistent in all measured physical properties and/or chemical composition and share atypical characteristics (e.g., factory repaint layers) that would not be expected to be readily available in the relevant population. Type III Association: An association in which items are consistent in all measured physical properties and/or chemical composition and, therefore, could have originated from the same source, but not exclusively, because other manufactured items in this class would be indistinguishable from the submitted evidence. Type IV Association: An association in which items are consistent in all measured physical properties and/or chemical composition and, therefore, could have originated from the same source. As compared to a Type III association, items categorized as a Type IV share characteristics that are more common amongst these kinds of manufactured products. Alternatively, an association between items would be categorized as a Type IV if a limited analysis was performed due to characteristics or size of the specimen(s). Type V Association: An association in which items are consistent in some, but not all, measured physical properties and/or chemical composition. Some minor variation(s) exist between the known and questioned items and could be due to factors such as sample heterogeneity, weathering, contamination of the sample(s), or having a sample of insufficient size to adequately assess homogeneity of the entity from which it was derived. Inconclusive: No conclusion could be reached regarding an association/elimination between the items. Elimination: The items were dissimilar in physical properties and/or chemical composition, indicating that they did not originate from the same source.
F2B6R3	Grey paint would be found in bottom layer is same 1# and 3# items. Grey paint would be found in bottom layer is different 2# and 3# items.
FK3DNX	Item# 1-3 is similar in color, layer sequence, and chemical composition to the paint standard in Item# 1-1, therefore the paint in Item# 1-3 could have originated from the same source as the paint in Item# 1-1. Item# 1-3 is similar in color and layer sequence, but dissimilar in chemical composition to the paint standard in Item# 1-2, therefore the paint in Item# 1-3 may not have originated from the same area of the source of Item# 1-2.
GKE9WV	Suspect Vehicle #1, as represented by item 1, could not be eliminated as a possible source of the paint chips recovered from the victim’s motorcycle, item 3. As such, the paint chips recovered from the victim’s motorcycle, item 3, either came from Suspect Vehicle #1, as represented by item 1, or from another source of damaged four-layer blue metallic pearlescent paint that is indistinguishable from item 1 with respect to the properties listed in the results. Suspect Vehicle #2, as represented by item 2, was eliminated as a possible source of the paint chips recovered from the victim’s motorcycle, item 3.
H9M72W	On analysis , I found that the questioned paint chips recovered from the victim's motorcycle 'Item 3' was similar with known paint sample representative from the damaged area of the suspect vehicle #1 'Item 1'. I also found that questioned paint chips recovered from the victim's motorcycle 'Item 3' was not similar with known paint sample representative from the damaged area of the suspect vehicle #2 'Item 2'.

TABLE 3

WebCode	Conclusions
J9ELQX	It was found that Item 3 could have oriqinated from Item 1; Item 3 could not have oriqinated from Item 2.
JNQZ9V	The questioned sample (item #3) could have originated from the known sample (item #1) or from another source exhibiting all of the same analyzed characteristics. Item #3 could not have originated from the source represented by item #2.
JRUVRY	Examination of Item 3 revealed a paint chip with the following layer structure: Clearcoat/Basecoat/Primer/Electrocoat Primer. The paint recovered from Item 3 was found to be physically and chemically consistent with paint from Item 1. Therefore, the paint from Item 3 could have originated from Item 1. The paint recovered from Item 3 was found to be physically and chemically not consistent with paint from Item 2. Therefore, the paint from Item 3 could not have originated from Item 2. Based on the above findings, in my professional opinion; i. Item 3 could have originated from the damaged area of suspect vehicle #1, represented by Item 1. ii. Item 3 could not have originated from damaged area of suspect vehicle #2, represented by Item 2.
KNPLZT	Neither item #1 nor item #2 match item #3. The primer layer of item #3 contains more silicate than items #1 or #2. The clear topcoat of item #2 was slightly different than item #3.
KWJRTU	The questioned blue paint chips marked "Item 3", recovered from the victim's motorcycle, could have originated from the same source as the blue paint sample marked "Item 1", collected from the damaged area of the front bumper of suspect vehicle #1, or another source of paint with similar characteristics. The questioned blue paint chips marked "Item 3", recovered from the victim's motorcycle, did not originate from the same source as the blue paint sample marked "Item 2", collected from the damaged area of the front bumper of suspect vehicle #2.
L29QKV	In my opinion, the clear lacquer layer in recovered item 3 is different by FTIR analysis, from the clear lacquer layer in Item 2 and as such the recovered paint in item 3 could not have originated from suspect vehicle #2 as represented by the paint in item 2. In my opinion, all three layers of paint in recovered item 3 are indistinguishable, by the properties tested, from the respective three layers of paint in Item 1 from suspect vehicle #1. In my opinion, these findings provide strong support for the view that the paint in item 3 has originated from suspect vehicle #1.
LKJFXT	3) Microscopic analysis conducted on the three items revealed that they are similar in their layer structure and layer colors. Each item consists of paint with four layers: a colorless layer, an effect blue layer, a dark grey layer and a grey layer. The organic analysis (FTIR) made upon the four layers and the elemental analysis (SEM_EDX) made upon the three colored layers of the items 1 and 3, showed no differences between them. The organic analysis (FTIR) made upon colorless layer of items 2 and 3 produced different spectra. According to the microscopic and analytical results, questioned paint chips recovered from the victim’s motorcycle (item 3) can’t come from the damaged area of the suspect vehicle #2 (item 2). Nevertheless, questioned paint chips recovered from the victim’s motorcycle (item 3) were undistinguishable in color, inorganic and organic composition from samples recovered on from the damaged area of the suspect vehicle #1 (item 1). Therefore, it can’t be excluded than samples recovered from the victim’s motorcycle (item 3) come from the suspect vehicle #1 (item 1).
LWXD3W	Physical and chemical examinations indicate that: Item 1 and 3 are indistinguishable from one another. Therefore, item 3 (questioned paint chips recovered from the victm's motocycle) could have originated from item 1(known paint sample representative of the damaged area of suspect vehicle 1). Item 2 differed in chemical composition from item 3. Therefore, item 2 (known paint sample representative of the damaged area of suspect vehicle 2) did not

TABLE 3

WebCode	Conclusions
	originated from item 3 (questioned paint chips recovered from the victm's motocycle).
M4E9JQ	Items 1, 2, and 3 each consisted of at least three layers of paint starting from the metal surface: (a) a dull gray primer, (b) blue semi-translucent with opaque reflective flakes, and (c) a colorless clear top coat. The thickness of each layer slightly varied across each sample; however, no significant difference was observed between the layer thicknesses from each of the three items. When analyzed by FTIR, the gray primer layer from all three items appeared to be a polyester melamine. No significant difference was observed in the spectra from all three items. The blue semi-translucent layer material from all three items was consistent with an acrylic melamine enamel. No significant difference was observed in the spectra from all three items. The spectra from the top clear coat of Item 1 and Item 3 were consistent with an acrylic melamine enamel. No significant difference between the spectra from Item 1 and Item 3 were observed. The spectra from the clear top coat of Item 2 was a styrene-modified acrylic melamine enamel. The three layers of paint examined in Item 1 appeared similar to the three layers of paint examined from Item 3, and therefore Item 1 cannot be excluded as a possible origin of the paint in Item 3. The top clear coat of Item 2 was not consistent with the top clear coat from Item 3 and therefore, Item 2 could not be the origin of the questioned paint chips in Item 3.
MQ6TCL	Item 1 (01-01-AA): This item was used for comparison purposes. Item 2 (01-02-AA): This item was used for comparison purposes. Item 3 (01-03-AA): This item contains two blue, with effect, paint chips that are visually similar to the submitted known paint samples from the damaged area of suspect vehicle #1 (01-01-AA) and damaged area of suspect vehicle #2 (01-02-AA). One of the questioned paint chips was used for further analysis. The questioned paint chip is visually similar in color, layer sequence, but different in paint type to the submitted known paint from the damaged area of suspect vehicle #2 (01-02-AA). It is my opinion the questioned paint from the victim's motorcycle did not originate from the damaged area of suspect vehicle #2 (Category 5). This same questioned paint chip is visually similar in color, layer sequence, paint type, and paint composition to the submitted known paint from the damaged are of suspect vehicle #1 (01-01-AA). It is my opinion the questioned paint from the victim's motorcycle could have originated from suspect vehicle #1 or any other vehicle with similar paint characteristics (Category 2B). No analysis was done on the remaining paint chip.
NB8Z6P	The results strongly support the proposition that the paint in item 3 is of the same material as the paint in item 1. See "Additional Comments". The paint in item 3 is not of the same as the paint in item 2.
NKT6CP	The paint in Item 1-3 is similar in color, layer sequence, and chemical composition to the paint in Item 1-1; therefore, the paint in 1-3 could have originated from the same source as the paint in Item 1-1. The paint in Item 1-3 is similar in color and layer sequence but dissimilar in chemical composition to the paint in Item 1-2; therefore, the paint in 1-3 did not originate from the same source as the paint in Item 1-2.
P84RDK	Results of Laboratory Examination: The questioned paint from Item 3 were compared to the known paint in Item 1 and Item 2. Item 3 was examined microscopically (PLM) and corresponded in color and layer structure (clear-blue-grey primer-grey primer), chemical composition (FTIR), visible spectra (MSP), and elemental composition (SEM/EDS) to the known paint in Item 1. Therefore, the Item 3 paint could have come from the same source as Item 1 or another source with the same characteristics (Type III Association). It should be noted that the analytical techniques used allow for a high degree of discrimination between different paints, however, other items (cars/tools/etc.) may have paint systems manufactured to the same specifications that would be indistinguishable from the submitted evidence. Item 3, though visibly similar in color and layer structure (clear-blue-grey primer-grey primer), elemental

TABLE 3

WebCode	Conclusions
	composition (SEM/EDS), and visible spectra (MSP), is different in chemical composition (FTIR) from the known paint in Item 2. Therefore, the paint in Item 3 did not come from the same source as the Item 2 known paint (Exclusion). Different panels on the same vehicle may have different paint systems. Further comparisons can be performed if additional known samples are submitted. Instrument and Equipment Acronyms: FTIR - Fourier Transform Infrared Spectroscopy, MSP - Microspectrophotometry, SEM/EDS - Scanning Electron Microscopy/Energy Dispersive Spectroscopy. Interpretation: The following descriptions are meant to provide context to the opinions reached in this report. Not every type of conclusion may be applicable in every case or for every material type. Type I Association, Identification Source, identification is reached when the discernible class and individual characteristics have corresponding detail and the examiner would not expect to see the same arrangement of details repeated in another source. This includes when two Items fit or realign together in a manner that is not expected to be replicated. Type II Association, Association with distinct characteristics, Items correspond in all measured physical properties, chemical composition and/or microscopic characteristics and share distinctive characteristic(s). Although the examiner would not expect to see these distinctive characteristic(s) repeated in another source, it lacked sufficient characteristics for a source identification. Type III Association, Association with conventional characteristics, Items correspond in all measured physical properties, chemical composition and/or microscopic characteristics. However, it is possible for another sample to be indistinguishable from the submitted evidence; therefore, an individual source cannot be determined. Type IV Association, Association with limitations, An association of decreased evidential value in which items correspond in all measured physical properties, chemical composition and/or microscopic characteristics, but there is a limitation to the exam. Limitations could include items commonly encountered in the relevant population, the inability to perform a complete analysis, or limited information. Inconclusive: No conclusion could be reached regarding an association or an exclusion between the items. Exclusion with Limitations: The item exhibits differences to the comparison sample that suggests that it did not originate from the same source. However, there are limiting factors, such as possible natural or manufactured source variations. Exclusion: The items exhibit differences in physical properties and/or chemical composition to the comparison sample that demonstrate they did not originate from the same source.
QLFPVQ	All three samples are composed of three layers above the base metal. No significant variations, both in terms of morphology and elemental composition, could be found between the three items in any of the layers by SEM and EDS analysis. On that basis it could be concluded that item 3 (victim's motorcycle) could have originated from either of items 1 (suspect vehicle #1) or 2 (suspect vehicle #2). However, FTIR analysis was also carried out on the top layer of all three paint samples. This analysis showed the IR spectrum of Item 1 (suspect vehicle #1) showed very similar features to the IR spectrum of Item 3 (victim's motorcycle). The IR spectrum of Item 2 (suspect vehicle #2) shows some features in common with that of Item 3 but also distinct differences. We therefore conclude that Item 3 (victim's motorcycle) could have originated from Item 1 (suspect vehicle #1) but can be excluded as having originated from Item 2 (suspect vehicle #2).
QN7NAN	The items n° 1, n° 2, and n° 3 have been analyzed for this police investigation. The item n° 1 is a known sample representative of the damaged area of the suspected vehicle labelled #1. The item n° 2 is a know sample representative of the damaged area of the supected vehicle labelled #2. The item n° 3 is the questionned paint chips recovered from the victim's motorcycle. The results of our observations and analyzes show that the Item n° 3 is different from the Item n° 2 : the Item n° 3 paint chips don't originate from the suspected vehicle labelled #2. Within the limit of our analytical techniques, the Item n° 3 paint chips are indistiguishable from the Item n° 1

TABLE 3

WebCode	Conclusions
	paint sample. Consequently, the Item n° 3 paint chips could originate from the vehicle labelled #1.
QYP73V	The paint on Item 3 could have originated from Item 1, as represented by the known submitted exemplar, or from another source exhibiting all of the same analyzed characteristics. The paint on Item 3 could not have originated from the source represented by Item 2.
R99YTH	Item 1 (known paint sample from suspect vehicle #1) was consistent to item 3 (questioned paint chips) with respect to characteristics including color/appearance under LED and UV light sources, presence/approximate thicknesses of three layers, and chemical composition of three layers. This indicates that item 3 could have originated from item 1 (suspect vehicle #1), or additional sources that exhibit similar characteristics. No statistical or numerical probabilities can be applied to the conclusions of this report. Item 2 (known sample from suspect vehicle #2) was not consistent to item 3 (questioned paint chips).
RC8BPH	The submitted paint chips in Exhibits 1, 2, and 3 were observed visually and with the aid of a stereomicroscope and each found to have a three-layered paint structure: clear / blue metallic / gray primer adhering to a metal substrate. The chemical compositions, analyzed via Fourier Transform Infrared Spectroscopy (FTIR), of each layer of Exhibit 3 were compared to the corresponding colored-layer of each paint standard (Exhibits 1 and 2). All three layers of Exhibit 1 were chemically consistent with the paint found on Exhibit 3. The blue metallic and gray primer layers of Exhibit 2 were chemically consistent with Exhibit 3; however the clear layers are different. The elemental composition of the blue metallic and gray primer layers from Exhibits 1, 2, and 3 were each analyzed with X-ray Fluorescence Spectroscopy (XRF). The elemental compositions of the blue metallic and gray primer layers of Exhibit 3 could not be differentiated from either respective colored-layers of Exhibits 1 or 2. The three layers of Exhibit 1 are chemically and elemental consistent with the paint recovered from the victim's motorcycle (Exhibit 3). Exhibit 1 (suspect vehicle #1), or another vehicle with the same chemical and elemental composition, could be the source of the paint recovered from Exhibit 3 (the victim's motorcycle). While there are some chemical and elemental similarities between Exhibits 2 and 3, based on the standard provided, Exhibit 2 (suspect vehicle #2) is not the source of paint from Exhibit 3.
TVEYFK	The paint layers from a representative paint chip in Item 3 and the paint layers in Item 1 were examined and compared visually, microscopically and instrumentally and were found to be consistent in all measured microscopic, chemical and elemental compositions and color characteristics. They could have come from the same source or any other source with the same compositions. The paint layers from a representative paint chip in Item 3 and the paint layers in Item 2 were examined and compared visually, microscopically and instrumentally and the paint chips were found to be inconsistent in chemical composition. They could not have come from the same source.
U8M3EN	Physical and chemical examinations indicate that Items 1 and 3 are indistinguishable from one another. Therefore, Item 3 originated from the vehicle represented by Item 1 or from another vehicle painted in the same manner (Type III Association). This conclusion was reached because other vehicles produced at the same manufacturing plant, with the same specifications would have paint applied in the same manner, and would therefore also be indistinguishable. Item 3 differed in chemical composition from Item 2 in one (or more) layers. Therefore, Item 3 did not originate from the vehicle represented by Item 2 (Elimination). The following categories and their descriptions are meant to provide context to the conclusions reached in this report. Every category may not be applicable in every case nor for every material. Type I Association: Physical/Fracture Match – The items exhibit physical features that demonstrate they were once

TABLE 3

WebCode	Conclusions
	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 evidence with class characteristics can have varying degrees of significance. In general, the smaller the size of the group relative to the relevant population, the more significant the association. A class association cannot definitively establish that the items came from the same source. Type II: Association with Highly Discriminating Characteristics – An association in which items could not be differentiated. Therefore, the possibility that the items came from the same source cannot be eliminated. Additionally, the items share unusual characteristics that would not be expected to be encountered in the relevant population. Type III: Association with Discriminating Characteristics – An association in which items could not be differentiated. 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 with Limitations – An association in which items could not be differentiated. 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. For example, the items are more commonly encountered in the relevant population, a complete analysis was not performed due to limited characteristics or a limited analytical scheme, or minor variations were observed in the data. Inconclusive – No conclusion could be reached. Elimination – The items exhibit exclusionary differences that demonstrate they did not originate from the same source.
U9X4ZM	Results/Conclusions: 1. Items 1 and 2 each consisted of a paint chip having the paint layer sequence: clear / blue metallic / blue-grey / grey. The clear paint layer of Item 2 was physically and chemically different from the clear paint layer of Item 1. The blue metallic paint layer of Item 2 was physically indistinguishable from, and chemically similar to, the blue metallic paint layer of Item 1. The blue-grey and grey paint layers of Item 2 were physically and chemically indistinguishable from the blue-grey and grey paint layers of Item 1. 2. Item 3 consisted of two (2) paint chips having the paint layer sequence: clear / blue metallic / blue-grey / grey. The clear, blue metallic, blue-grey, and grey paint layers of Item 3 were physically and chemically indistinguishable from the corresponding paint layers of Item 1. Item 3 originated either from the source of Item 1 or from another source bearing paint physically and chemically indistinguishable from the paint of Item 1. (See Result 4). 3. The clear paint layer of Item 3 was physically and chemically different from the clear paint layer of Item 2. The blue metallic paint layer of Item 3 was physically indistinguishable from, and chemically similar to, the blue metallic paint layer of Item 2. The blue-grey and grey paint layers of Item 3 were physically and chemically indistinguishable from the blue-grey and grey paint layers of Item 2. Item 3 did not originate from the source of Item 2. 4. In a laboratory database of 1101 automotive paint samples encountered in casework, 23 samples (approximately 1 in 47) have the paint layer sequence: clear / blue metallic / grey / grey. The database does not distinguish among different shades of colour or chemical composition.
ULL7HE	The questioned paint sample (Item 3; Exhibit 3) and the known paint sample (Item 2; Exhibit 2) reveal significant differences in the physical, microscopic and chemical properties, therefore the questioned sample (Item 3; Exhibit 3) did not originate from the source represented by the known sample (Item 2; Exhibit 2). The questioned paint sample (Item 3; Exhibit 3) and the known paint sample (Item 1; Exhibit 1) reveal no significant differences in the physical, microscopic, and chemical properties, therefore the questioned sample (Item 3; Exhibit 3) could have originated from the same source represented by the known sample (Item 1; Exhibit 1) or of a paint sample exhibiting the same physical, microscopic and chemical properties.
UM4XUK	The recovered sample (item 3) was compared to the control sample (item 1) when it was found

TABLE 3

WebCode	Conclusions
	to be similar in colour, layer structure, chemical properties, composition and elemental composition such that, in our opinion these paint samples could have had a common origin. This supports the proposed scenario that the motorcycle (item 3) and motor vehicle (item 1)have had contact. Item 3 was found to be different from item 2 such that these paint samples did not originate from a single source.
UQ3E7E	Item 1: Four layer metallic blue paint standard was analyzed for comparison to item 3. Item 2: Four layer metallic blue paint standard was analyzed for comparison to item 3. Item 3: Two, four layer metallic paint chips were found. In the sample analyzed, the unknown paint and the standard paint (item 1) are the same in physical and chemical characteristics. The unknown paint either originated from the standard or another source of paint possessing the same distinct physical and chemical characteristics. In the sample analyzed, the unknown paint and the standard paint (item #2) are not the same in chemical characteristics. The unknown paint could not have originated from the standard.
UU3LDH	The paint chips recovered from the motorcycle were compared to the known paint samples taken from the damaged areas of the two subject vehicles to determine if they could have originated from either vehicle. Item 1 consists of one paint sample having the following layers of paint on an apparent metal substrate: 1. Clear colorless acrylic-melamine topcoat, 2. Dark blue metallic-pearlescent acrylic-melamine-styrene basecoat, 3. Medium grey melamine-polyester primer, 4. Dark grey melamine-polyester primer. Item 2 consists of one paint sample having the following layers of paint on an apparent metal substrate: 1. Clear colorless acrylic-melamine-styrene topcoat, 2. Dark blue metallic-pearlescent acrylic-melamine-styrene basecoat, 3. Medium grey primer, 4. Dark grey primer. Samples of paint taken from these two items exhibit characteristics consistent with original automotive paint layer systems; they were used as standards for comparison to the questioned paint recovered from the motorcycle. Item 3 consists of two “chips” of paint having the following layers on an apparent metal substrate: 1. Clear colorless acrylic-melamine topcoat, 2. Dark blue metallic-pearlescent acrylic-melamine-styrene basecoat, 3. Medium grey melamine-polyester primer, 4. Dark grey melamine-polyester primer. Samples of paint taken from these chips also exhibit characteristics consistent with original automotive paint layer systems. Microscopic and instrumental examinations and comparisons revealed that the paint in Item 3 and the paint standard in Item 1 are like one another with respect to their layer sequence, layer colors and layer textures, the decorative flake content of their dark blue basecoats, and the pigment characteristics and detailed binder characteristics of their respective layers. It is therefore concluded that the paint recovered from the victim’s motorcycle in Item 3 originated either from the damaged area of subject vehicle #1 or from another damaged source of dark blue metallic-pearlescent automotive paint having the same characteristics. The paint in Item 3 is like the paint standard in Item 2 with respect to their layer colors, layer textures, their decorative flake content and their Layer 2 binder types. However, an instrumental examination revealed significant differences in the binder characteristics of their clear topcoats. It is therefore concluded that the paint recovered from the victim’s motorcycle in Item 3 could not have originated from the damaged area of subject vehicle #2, as it is represented by the paint standard in Item 2.
VBK3RQ	Paint from two suspect vehicles (items #1 and #2) was compared to the traces recovered from the victim’s motorcycle (item #3). Microscopy of these paints showed that all paint systems consist of four layers, namely two greyish ground layers, a clear blue effect colour layer and a transparent clearcoat. The paint layers in each sample were isolated manually and analyzed individually using FTIR. The results indicate that item #1 and item #3 cannot be discriminated. Item #2 has similar ground layers, but the top layers, both the coloured effect layer and the

TABLE 3

WebCode	Conclusions
	clearcoat, have a different chemical composition. It is concluded that suspect vehicle item #2 is not the source of the paint samples recovered from the victim's motorcycle. The results strongly support the hypothesis that vehicle #1 is the source of the paint samples recovered from the victim's motorcycle.
W38FKF	Exhibits 1 (known paint sample representative of the damaged area of suspect vehicle #1), 2 (known paint sample representative of the damaged area of suspect vehicle #2), and 3 (questioned paint chips recovered from the victim's motorcycle) contained multilayered paint chips with the following layer sequence: clear top layer, blue metallic layer, light grey primer layer, and dark grey primer layer. Comparative examinations of Exhibit 3 (questioned paint chips recovered from the victim's motorcycle) with the paint from Exhibit 2 (known paint sample representative of the damaged area of suspect vehicle #2) disclosed them to be inconsistent in their organic compositions of their top clear layers. Therefore, Exhibit 3 could not have originated from Exhibit 2. Comparative examinations of Exhibit 3 (questioned paint chips recovered from the victim's motorcycle) with the paint from Exhibit 1 (known paint sample representative of the damaged area of suspect vehicle #1) disclosed them to be consistent in their physical characteristics, organic compositions, and elemental compositions. Therefore, Exhibit 3 could have originated from Exhibit 1. It should be noted that a paint association is not a means of positive identification and the number of possible sources for a specific paint is unknown.
WGRVLL	Item 3 could have originated from item 1.
X684AG	The known paint reference from suspect vehicle #1 (Item #1) has the following layer structure: 1 – Clear Coat, 2 – Blue Metallic Base Coat, 3 – Blue/Grey Primer, 4 – Charcoal Grey Primer. The known paint reference from suspect vehicle #2 (Item #2) has the following layer structure: 1 – Clear Coat, 2 – Blue Metallic Base Coat, 3 – Blue/Grey Primer, 4 – Charcoal Grey Primer. The unknown paint chips from the victim's motorcycle (Item #3) have the following layer structure: 1 – Clear Coat, 2 – Blue Metallic Base Coat, 3 – Blue/Grey Primer, 4 – Charcoal Grey Primer. One of the paint chips from the victim's motorcycle (Item #3) was analyzed and compared to the known reference sample from suspect vehicle #1 (Item #1). Based on the examinations conducted, the layers comprising the analyzed paint chip from Item #3 are comparable in color, texture, relative thickness, and chemical composition to the corresponding layers of Item #1. Accordingly, the analyzed paint chip from Item #3 and Item #1 originated from the same vehicle or from different vehicles painted in the same manner (Type III Association). This level of association was reached because vehicles produced at the same manufacturing plant as the source of Item #1, which were painted with the same color code and same paint formulations, would also be indistinguishable from the source of the analyzed paint chip from Item #3. The paint from the victim's motorcycle (Item #3) does not compare to the known reference paint sample from suspect vehicle #2 (Item #2). No further analysis at this time.
X8GT3E	In my opinion, the findings provide very strong support for the proposition that Item 3 (Questioned sample recovered the victim's motorcycle) originated from Item 1 (Known sample from the damaged area of suspect vehicle #1). Item 3 could not have originated from Item 2 (Known sample from the damaged area of suspect vehicle #2) based on different chemical compositions of the clear layers.
XX7QGD	Examination of the known paint sample representative of the damaged area of suspect vehicle #1 (Item 1); Item 1 comprised a paint sample with layer sequence: clearcoat/blue metallic/light grey/dark grey. The clearcoat was identified as an acrylic/melamine type paint. The inorganic elemental composition of the clearcoat principally comprised silicon. The blue

TABLE 3

WebCode	Conclusions
	metallic layer was identified as an acrylic/melamine type paint. The inorganic elemental composition of the blue metallic layer principally comprised aluminium, silicon, titanium and potassium. The light grey layer was identified as an isophthalic alkyd/melamine type paint. The inorganic elemental composition of the light grey layer principally comprised barium, sulfur, titanium, aluminium and silicon. The dark grey layer was identified as an isophthalic alkyd/melamine type paint. The inorganic elemental composition of the dark grey layer principally comprised titanium, iron, aluminium and silicon. Examination of the known paint sample representative of the damaged area of suspect vehicle #2 (Item 2); Item 2 comprised a paint sample with layer sequence: clearcoat/blue metallic/light grey/dark grey. The clearcoat was identified as an acrylic/melamine/styrene type paint. The inorganic elemental composition of the clearcoat principally comprised silicon. The blue metallic layer was identified as an acrylic/melamine type paint. The inorganic elemental composition of the blue metallic layer principally comprised aluminium, silicon, titanium and potassium. The light grey layer was identified as an isophthalic alkyd/melamine type paint. The inorganic elemental composition of the light grey layer principally comprised barium, sulfur, titanium, aluminium and silicon. The dark grey layer was identified as an isophthalic alkyd/melamine type paint. The inorganic elemental composition of the dark grey layer principally comprised titanium, iron, aluminium and silicon. Examination of the questioned paint chips recovered from the victim's motorcycle (Item 3); Item 3 comprised a paint sample with layer sequence: clearcoat/blue metallic/light grey/dark grey. The clearcoat was identified as an acrylic/melamine type paint. The inorganic elemental composition of the clearcoat principally comprised silicon. The blue metallic layer was identified as an acrylic/melamine type paint. The inorganic elemental composition of the blue metallic layer principally comprised aluminium, silicon, titanium and potassium. The light grey layer was identified as an isophthalic alkyd/melamine type paint. The inorganic elemental composition of the light grey layer principally comprised barium, sulfur, titanium, aluminium and silicon. The dark grey layer was identified as an isophthalic alkyd/melamine type paint. The inorganic elemental composition of the dark grey layer principally comprised titanium, iron, aluminium and silicon. The layer colour, layer sequence and composition of Item 3 corresponded with that of Item 1. Therefore, the results support the proposition that the paint recovered from the victim's motorcycle (Item 3) originated from the damaged area of suspect vehicle #1 (Item 1). The composition of the clearcoat from Item 3 did not correspond with that of Item 2. Therefore, the results do not support the proposition that the paint recovered from the victim's motorcycle (Item 3) originated from the damaged area of suspect vehicle #2 (Item 2).
Y97E7G	On analysis, I found: i. The known paint sample representative of the damaged area of suspect vehicle #1 (Item 1) to be similar to the questioned paint chips recovered from the victim's motorcycle (Item 3). ii.The known paint sample representative of the damaged area of suspect vehicle #2 (Item 2) to be dissimilar to the questioned paint chips recovered from the victim's motorcycle (Item 3). Based on the findings, I am of the opinion that: i. The known paint sample representative of the damaged area of suspect vehicle #1 (Item 1) and the questioned paint chips recovered from the victim's motorcycle (Item 3) could have come from the same source. ii.The known paint sample representative of the damaged area of suspect vehicle #2 (Item 2) and the questioned paint chips recovered from the victim's motorcycle (Item 3) did not come from the same source.
YJ4HAB	Items 1, 2, and 3 are blue metallic automotive paint on a metal substrate. There are three layers of paint on the metal substrate from Items 1, 2, and 3: a clear coat, a blue metallic color coat, and a gray primer. The blue metallic paint chips from Item 3 are similar in color, layer sequence, and chemistry in comparison to the blue metallic paint from the standard, Item 1. The paint from Item 3 could have come from Item 1, or any other blue metallic automotive

TABLE 3

WebCode	Conclusions
	paint source that is similar in color, layer sequence, and chemistry. The blue metallic paint chips from Item 3 are similar in color and layer sequence but different in chemistry in comparison to the blue metallic paint from the standard, Item 2. The paint from Item 3 could not have come from the standard, Item 2. Items 1, 2, and 3 were examined visually and using stereomicroscopy, polarized light microscopy (PLM), Fourier Transform Infrared Spectroscopy (FTIR), and Scanning Electron Microscopy/Energy Dispersive X-Ray Spectroscopy (SEM/EDS), solubility analysis, and fluorescence. Samples collected and analyzed during examination and analysis of the items in this case were returned to and retained with the original item unless otherwise noted.
ZDEKW8	There are no optically discernible features of the three submitted paint systems. The source of the paint system representative of Item #2 is excluded from those representative of Items #1 and #3 owing to differences in the chemistries of the clear coat (topcoat). The paint systems representative of Items #1 and #3 consist of four layers: a clear coat, a blue finish coat with decorative flake and two primers. The number, colors, and chemistries of the layers of the paint chips submitted for comparison from Item #1 and Item #3 are consistent with each other and cannot be excluded from originating from the same source, as represented by the items submitted.
ZHQ77E	The paint in item 3 was found to be similar to item 1 in microscopic appearance, layer structure, and chemical composition. Therefore, item 3 could have originated from the same source as item 1 or another similary painted source. Item 3 was found to be different from item 2 in chemical composition.
ZKU2PG	The questioned paint chips recovered from victim's motorcycle (item 3) could have originated from the damaged area of the suspect vehicle #1 (item 1), because of the similarities of their physical properties and chemical compositions. The questioned paint chips recovered from victim's motorcycle (item 3) could NOT have originated from the damaged area of the suspect vehicle #2 (item 2), because of the differences of their physical properties and chemical compositions.
ZM2JMD	The paint chips recovered from the victim's motorcycle (Item 3) could have originated from the damaged area of suspect vehicle #1 represented by Item 1. The paint chips recovered from the victim's motorcycle (Item 3) couldn't have originated from the damaged area of suspect vehicle #2 represented by Item 2.
ZYBW6D	The paint in item 3 is similar in color, layer structure, solubility, fluorescence and infrared absorbance spectra to the paint in item 1. Therefore, the paint in items 3 and 1 could have originated from the same source. The paint in item 3 is similar in color, layer structure, solubility and fluorescence to the paint in item 2; however it is dissimilar in infrared absorbance spectra. Therefore, the paint in items 3 and 2 could not have originated from the same source.

Additional Comments

TABLE 4

WebCode	Additional Comments
2HKBYD	Item 1 and Item 3 were consistent with all analysed features while Item 2 and 3 differ at least in general view (bottom of paints), as well as chemical composition of clear-coat. Within SEM/EDX only SEM part was used which allow for comparison of view of cross section of compared paints. Elemental analysis was not performed due to equipment failure.
3MVNGC	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 very small fragment size and is usual to work with refinish cars with more than 10 layers.
6CQFQ6	Type 3 Association: Association with Conventional characteristics—Items are consistent in all measured and observed physical properties, chemical composition and/or microscopic characteristics, and therefore could have originated from the same source. Because other items have been manufactured or are naturally occurring that would also be indistinguishable from the submitted evidence, an individual source cannot be determined. Elimination—Items exhibit differences in one or more of the following: physical properties, chemical composition, or microscopic characteristics and therefore did not originate from the same source.
CQ2TLA	The Questioned Paint analyzed in Item 3 could share a common source with the Known Paint in Item 1. It should be noted that in the absence of a fracture match between paint flakes, paint does not possess enough individual chemical and microscopic characteristics to be positively identified as originating from a particular source to the exclusion of all other sources. The conclusions in this report only pertain to the paint that was analyzed from each Submission and makes no assumptions about the entire contents of each Submission.
DEMUJY	Depending on case scenario, since item 2 was different based only on layer 1 CC it might be reported that the possibility of the questioned paint originating from a different area/panel of that vehicle could not be eliminated and additional standards requested.
GKE9WV	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 the 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 paint: Scanning Electron Microscopy - Energy Dispersive X-ray Spectroscopy (SEM-EDX), Fourier Transform Infrared Spectroscopy (FTIR), Pyrolysis Gas Chromatograph - Mass Spectroscopy (PGC-MS).
L29QKV	If possible I would normally address if the vehicles could have been in forceful contact with each other however the interpretation is limited due to the nature of the samples provided.
NB8Z6P	The findings give a strong support to the hypothesis that the paint in item 3 originates from the same source as the paint in item 1, when compared to the alternative hypothesis that they do not originate from the same source.
UM4XUK	The paint samples had the appearance of an original finish ie lacquer, metallic coloured layer and primer. This reduces the strength of our conclusion.
VBK3RQ	Vehicles (item #1 and #2) have clearly distinguishable top layers. However, the ground layers cannot be discriminated with the used methodology. This might form an indication that both samples were taken from similar cars, e.g. cars from the same brand. This relation is currently not further investigated. We did no additional investigation into e.g. the elemental composition of the paints as the chance that such additional analyses alter the evidential value are very low.

TABLE 4

WebCode	Additional Comments
X684AG	The following descriptions are meant to provide context to the levels of opinions reached in this report. Every type of conclusion may not be applicable in every case nor for every material type. Type I Association: A physical match; items physically fit back to one another, indicating that the items were once from the same source. Type II Association: An association in which items are consistent in all measured physical properties and/or chemical composition and share atypical characteristic(s) (e.g., repaint layers) that would not be expected to be readily available in the relevant population. Type III Association: An association in which items are consistent in all measured physical properties and/or chemical composition and, therefore, could have originated from the same source. Because other items have been manufactured that would also be indistinguishable from the submitted evidence, an individual source cannot be determined. Type IV Association: An association in which items are consistent in all measured physical properties and/or chemical composition and, therefore, could have originated from the same source. As compared to a Type III association, items categorized as Type IV share characteristics that are more common amongst these kinds of manufactured products. Alternatively, an association between items would be categorized as a Type IV if a limited analysis was performed due to characteristics or size of the specimen(s). Type V Association: An association in which items are consistent in some, but not all physical properties and/or chemical composition. Some minor variation(s) exist(s) between the known and questioned items and could be due to factors such as sample heterogeneity, contamination of the sample(s), or having a sample of insufficient size to adequately assess homogeneity of the entity from which it was derived.
X8GT3E	The Pyrolysis-GCMS technique could not be used as it was not fit for casework.

-End of Report-
(Appendix may follow)

Collaborative Testing Services ~ Forensic Testing Program

Test No. 20-5452: Paint Analysis

DATA MUST BE SUBMITTED BY **Nov. 23, 2020, 11:59 p.m.** TO BE INCLUDED IN THE REPORT

Participant Code: U1234J WebCode: 8WL2B6

The Accreditation Release section can be accessed by using the "Continue to Final Submission" button above. This information can be entered at any time prior to submitting to CTS.

Scenario:
Police are investigating a fatal hit-and-run incident involving a motorcyclist. A witness described a blue truck sideswiping the victim's motorcycle and driving away. Two suspect vehicles have been located which match witness descriptions, both of which appear to have sustained damage to the front bumper. A known paint sample has been collected 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 suspect vehicle.

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 supplemental 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 victim's motorcycle.

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?

Item 1

	Yes	No	Inconclusive
Item 3:	○	○	○

Item 2

	Yes	No	Inconclusive
Item 3:	○	○	○

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

Please check all that apply.

Microscopic Exams:	☐ Stereomicroscope	☐ Polarized Light
	☐ Fluorescence	
☐ Pyrolysis GC	☐ FTIR	☐ Solubility/Chemical
☐ XRS/XRF	☐ SEM/EDX	☐ Microspectrophotometry

Other (specify):

Please note: *Any additional formatting applied in the free form space below will not transfer to the Summary Report and may cause your information to be illegible. This includes additional spacing and returns that present your responses in lists and tabular formats.*

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

4.) Additional Comments

RELEASE OF DATA TO ACCREDITATION BODIES

The Accreditation Release is accessed by pressing the "Continue to Final Submission" button online and can be completed at any time prior to submission to CTS.

CTS submits external proficiency test data directly to ASCLD/LAB, ANAB, and/or 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 below must be completed.)
○ This participant's data is **not** intended for submission to ASCLD/LAB, ANAB, and/or A2LA.

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

ANAB Certificate No.
(Include ASCLD/LAB Certificate here)

A2LA Certificate No.

Step 2: Complete the Laboratory Identifying Information in its entirety

Authorized Contact Person and Title

Laboratory Name

Location (City/State)