



forensic
FOUNDATIONS™
ISO 9001 & ISO/IEC 17043

Final Report **(March 2020)**

Proficiencytesting@forensicfoundations

Automotive Paint Examination and Analysis 2019-6

Authorised by Ben Davey, Manager, Proficiency Tests, Forensic Foundations,
20/03/2020.

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Introduction

Design

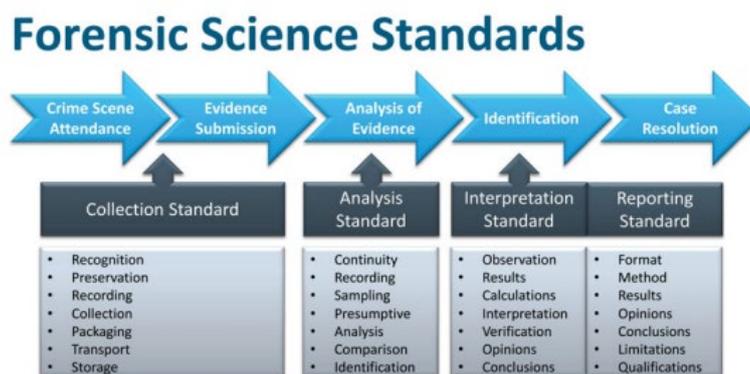
Forensic Foundations' Proficiency Tests are designed to address the following points:

- Relevance to forensic science laboratories;
- Limitation of any potential context information;
- Knowledge of the 'ground truth' of samples;
- Importance of consistency between tests; and
- Cost affordability for the laboratories.

In addition to this exercise being a test of your laboratory procedures using controlled items, we also anticipated that it would enable participants to evaluate the quality of their analytical results against those from other laboratories and observe how other laboratories express their opinions or advice to clients. To enable this, we requested that participants submit the following:

- An outline of the methodology used; and
- Their opinion in the format that they would provide to court.

Forensic Foundations' Proficiency Tests are designed to test the end-to-end forensic examination process. The AS5388 and the ISO21043 series of Standards describe the forensic examination process from collection to reporting. This figure¹ illustrates the inter-relatedness of all steps in this process and was used as the basis of the Australian Standards' development. The figure is also used as the basis of the development of Forensic Foundations' Proficiency Tests.



Thus, all Forensic Foundations' Proficiency Tests commence with item collection and/or receipt and all the subsequent examination/analysis steps, culminating in the reporting, therefore reflecting actual forensic casework.

Individual laboratory results remain confidential.

The Final Reports of this 2019 round of Proficiency Tests will be publicly available via Forensic Foundations web site. Participating laboratories may use the report as outlined in their respective laboratory policies.

¹James Robertson, Karl Kent & Linzi Wilson-Wilde (2013) The Development of a Core Forensic Standards Framework for Australia, Forensic Science Policy & Management: An International Journal, 4:3-4, 59-67

Automotive Paint Interpretation 2019-6

This test was distributed to two laboratories, only one laboratory returned results for this round of Proficiency testing. As this is a specific report for that one laboratory, Forensic Foundations is unable to formulate statistical analysis on the performance of the participant.

The manufacture, distribution, assessment and reporting of this proficiency test has provided, and will provide, the basis for continuous improvement for both Forensic Foundations and the participating laboratory.

In addition to interpreting the results from examining known and unknown paint samples, testing generic issues such as receipt, triage and continuity of items for examination also formed part of the overall process.

In order to remove other sources of uncertainty and variability, the participants were not required to carry out the initial steps of a forensic examination (searching, identification of suitable samples) and were provided with samples from known sources. In order to remove any contextual bias in the interpretation, the participants were told only that the samples were collected from the scene of a hit and run.

Laboratory Response

Continuity, receipt and description of items

Laboratory 96150-A provided information that the item receipt has been recorded in their LIMS, and that they received a "Single package containing 4 paint samples".

The description provided by Laboratory 96150-A concurs with the packaging of the samples as distributed.

Examination / Analysis

Laboratory 96150-A:

PPMS number	Exhibit number	Exhibit description	Examination
nil	1905365/1.01	Paint K1	Four layer paint consisting of clear (1), metallic silver (2), grey (3) and grey (4)
nil	1905365/1.02	Paint K2	Four layer paint consisting of clear (1), metallic silver (2), grey (3) and grey (4)
nil	1905365/1.03	Paint K3	Four layer paint consisting of clear (1), metallic silver (2), grey (3) and grey (4)
nil	1905365/1.04	Paint Q1	Four layer paint consisting of clear (1), metallic silver (2), grey (3) and grey (4)

All 4 paint samples visually appeared the same and were subjected to further testing. (Micrographs were taken of the paint top surface and cross-section)

The following methods were used for analysis:

- Optical Microscopy
- Infrared Spectroscopy
- UV-Visible Spectrophotometry
- Scanning Electron Microscopy with Energy Dispersive X-Ray Microanalysis

Results

Note: as per denotes indistinguishable by the analyses performed.

K1-K3 as per Q1 by SEM/ EDX – all layers analysed

K1-K3 as per Q1 by UV-Vis of clear coat only.

K2 different to Q1 by FTIR of the top clear coat (1)

K1 and K3 as per Q1 by FTIR of the clear coat (1), metallic (2) and grey (3)

K1 and K3 as per Q1 by UV-Vis, SEM/EDX and FTIR

Instructions indicated to ignore primer and electro coat

Case Analysis, Interpretation and Conclusions

In my opinion the results provide a level 3 association with respect to a comparison between Q1 and the paint from the suspect's vehicles K1 and K3.

A level 3 association is an association in which exhibits are consistent in observed and measured physical properties and/or chemical composition and, therefore, could have originated from the same source. Because other exhibits have been manufactured that would also be indistinguishable from the submitted evidence, an individual source cannot be determined.

Therefore the paint located on the bicycle could have originated from suspect 1 or suspects 3 vehicle.

Conclusion and Summary of the Test

The submitted results concur with the pretesting and test set up.

The aim of this test was to examine the end-to-end forensic examination and analysis process. To minimise extraneous elements influencing the interpretation, limited contextual information was provided to the participating laboratories.

Pre-test analytical results (undertaken by Flinders University.)

See appendix D

End of Report.

Proficiencytesting@forensicfoundations

PROGRAM PLAN

Program	Automotive Paint	
Round	2019-6	
Advisory Group		
Program Coordinator /Technical Manager	Mrs Anna Davey Director Forensic Foundations PO Box 2279 North Ringwood, 3134	
Discipline specific expert(s)	Prof K. Paul Kirkbride Professor of Forensic Science School of Chemical and Physical Sciences Flinders University GPO Box 2100 Adelaide, SA 5001	
Provider(s)	Initial sample collection & test production. Results interpretation.	Paint Panel production
	Forensic Foundations PO Box 2279 North Ringwood, Victoria 3134	PPG Australia 14 McNaughton Rd Clayton South Vic 3169
	Sample distribution to government facilities within Australia & NZ by ANZPAA-NIFS 637 Flinders St Docklands	
Aims/Objectives	The aim of the program is to assess the laboratories' ability to competently analyze, compare and interpret samples of automotive paints.	
Purpose	To assist the laboratories by ensuring their methods/procedures are performing adequately.	
Program Design		
Number of Rounds	1	
Number and type of samples	4, Samples are either: <ul style="list-style-type: none"> excised from electrocoated steel panels to which primer, paint and clear coat had been applied; or lakes of dried paint from the above panel produced by bending the panels 	
Hazards involved	There are no known hazards associated with setting up or completing this test, normal safe handling precautions should be taken in case of sharp edges etc.	
Scenario	A fatal hit and run occurred. Automotive paint flakes were recovered from the scene. Participants will be provided with the paint flakes and samples collected from a number of suspect vehicles	
Sample size/ volume	The thickness of each layer will be industry standard. Only one sample will be provided per item and paint chips will be of a	

	size slightly larger than that typically encountered in casework in order to ensure that sample preparation is not the most challenging aspect of the trial.
Range of values/assigned values for reporting	The expected answers are binary – match or no match. It is not feasible for participants to arrive at chemical composition more detailed than the broad classification of the paint (e.g., melamine acrylic) and pigment (e.g., organic). The match/non-match of items was set by the paint application process carried out by the manufacturer and verified at duplicate positions on panels using infrared microspectrometry at Flinders University.
Traceability/origin of assigned values	See above
Design and Methods	Machine and hand application of layer, followed by baking. Samples to be prepared as described above. Match/non-match was determined using infrared microspectrometry. Primer, paint and clear coat to be selected from existing PPG products
Selection Criteria	Products to be selected include those which are chemically distinguishable but look very similar to the naked eye.
Potential Major Sources of Error	Failure to distinguish between non-matching samples.
Participants	Chemical Criminalistic laboratories
Reporting Criteria, Accuracy	NA
Analysis	Correctly identify chemical composition of layers in all samples and interpret similarities/differences. .

Pre-testing	
Homogeneity Testing and criteria	Uniform spraying of initial panels as far as is possible. Duplicate samples from panels were pretested, additional samples retained, for subsequent homogeneity/repeatability checking if required.
Stability Testing and criteria	NA – Automotive paint is designed to be stable
Technical Review (internal)	
Participant Instructions	Provide copy of Instructions and evidence of Technical Review
Results Sheet	Provide copy of Results Sheet and evidence of Technical Review
Report	Include copy of Report and evidence of Technical Review

Sample Preparation	
Special conditions	Nil
Storage requirements	Room Temperature
Distribution requirements	Distributed via Forensic Foundations
Sample checks	NA
Program Dates	
Invitation letter	August 2018

Sample distribution	First week September 2019
Results due	29 th November 2019
Manufacturing Information to be sent	13 th December 2019
Final report due date	First week February 2020
Statistical Analysis	
Homogeneity Testing	NA
Stability Testing	NA
Data Entry	Include evidence of data entry checks in file
	NA
Review by Statistician	NA
Reporting	
Report No:	2019-6
Master copy	Reports folder
Availability	Website

Program Coordinator signature: KAD

Date: 7/2018

Appendix B



2019-6
Test ID: xxx

Proficiencytesting@forensicfoundations Automotive Paint Examination 2019-6

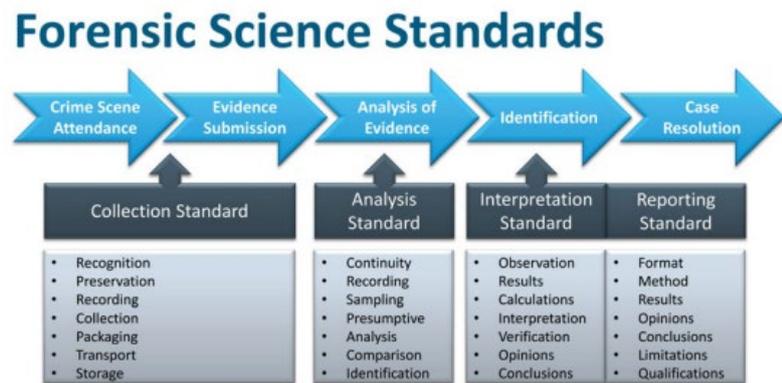
Thank you for participating in this Proficiency Test. We hope that you find this test useful and welcome any feedback which can be used in the design of further tests.

In addition to this exercise being a test of your laboratory procedures using controlled items, we also anticipate that it will enable participants to evaluate the quality of their analytical results against those from other laboratories and observe how other laboratories express their opinions or advice to clients. To enable this, we request that participants submit the following:

- An outline of the methodology used; and
- Their opinion in the format that they would provide to court.

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Thus, all Forensic Foundations' Proficiency Tests commence with item collection and/or receipt and all the subsequent examination / analysis steps, culminating in the reporting and therefore reflecting actual forensic casework.



Attached you will find the case 'Examination Request and Item Submission' form and the test commences with the receipt of the items followed by your routine processes- item description, examination, analysis and interpretation. The information submitted to the laboratory on the examination request form will direct what testing needs to be undertaken. Please use the attached results sheets. Additional pages may be added if required. An electronic copy of the results sheet can be downloaded from <https://www.forensicfoundations.com.au/download/> The results sheets should be returned to Forensic Foundations by Friday 25th October 2019. Hardcopy can be returned to PO Box 2279, Ringwood, Victoria, 3134, Australia or a soft copy can be uploaded to <https://www.forensicfoundations.com.au/upload/>

Qualitative feedback will be provided to participants. Feedback will be both participant-specific (i.e., whether a particular laboratory "got the right answer") and group specific (e.g., which techniques seemed to perform better than others).

Following the conclusion of the testing participants will be advised of the expected results and details regarding the production of the test.

²James Robertson, Karl Kent & Linzi Wilson-Wilde (2013) The Development of a Core Forensic Standards Framework for Australia, Forensic Science Policy & Management: An International Journal, 4:3-4, 59-67

Appendix C

EXAMINATION REQUEST AND ITEM SUBMISSION	EASTERN AUSTRALIAN POLICE SERVICE
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OFFENCE:	Hit and run
DATE OF OFFENCE	Saturday 31 st August 2019
BRIEF STATEMENT OF FACTS	
A fatal hit and run occurred. Automotive paint flakes were recovered from the scene. Participants will be provided with the paint flakes and samples collected from a number of suspect vehicles	
ITEM SUBMITTED FOR EXAMINATION	
Q1 – foreign paint chips recovered from the victim's bicycle. K1 – samples of paint taken from suspect 1's vehicle K2 – samples of paint taken from suspect 2's vehicle K3 – samples of paint taken from suspect 3's vehicle	
EXAMINATION REQUESTED	
Police request an examination to establish whether there is any association between the paint chips and metal samples taken from the panel beaters. An expert's report for investigational purposes is requested We suggest you ignore the composition of the primer and any electrocoat you may find.	

Appendix D

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PROFICIENCY TESTING@FORENSIC FOUNDATIONS AUTOMOTIVE PAINT 2019-6

MANUFACTURER'S INFORMATION Issued 3rd March 2020

Paint Panel Preparation

450x300mm sheets of electrocoated steel from the same source were used in the preparation of all painted panels.

Panel 2 construction:

Two electrocoated steel sheets were machine-applied with a standard PPG Australia formulation FORD Primer (30-40 μ m build) and baked at 140°C for 30min.

A standard PPG FORD **solvent-based** silver basecoat (Lightning Strike) was then machine-applied (15-25 μ m build), force air-dried for 10min at 80°C, then coated with PPG standard Ford Australia 2K clear coat (30-50 μ m) and finally baked at 80°C for 30min. In effect, the clear coat was applied wet-on-wet, despite the air-dry at 80°C.

The primer was a polyurethane-modified polyester with butylated melamine cross-linker.

The silver basecoat was a cellulose acetate butyrate-polyester resin with butylated melamine cross-linker.

The clear coat was a hydroxy-functionalized acrylic resin using isocyanate cross-linker. Additional details are not available for this formulation.

Panel 3 construction:

Two electrocoated steel sheets were machine-applied with a standard PPG Australia formulation FORD Primer (30-40 μ m build) and baked at 140°C for 30min.

A standard PPG FORD **solvent-based** silver basecoat (Lightning Strike) was then machine-applied (15-25 μ m build) then coated with PPG standard Ford Australia solvent-based clear coat (30-50 μ m) and finally baked at 140°C for 30min. The clear coat was applied wet-on-wet.

The primer was a polyurethane-modified polyester with butylated melamine cross-linker.

The silver basecoat was a cellulose acetate butyrate-polyester resin with butylated melamine cross-linker.

The clear coat is a HEMA and butylated melamine cross-linked acrylic with hindered amine light stabilizer and benzotriazole UV absorber.

Sample construction

Item Q1 – foreign paint chips recovered from the victim’s bicycle. This Item was prepared by bending a piece of Panel 2 until the entire coating flaked off. Two pieces of coating were provided to participants.

Item K1 – samples of paint taken from suspect 1’s vehicle. This Item was prepared by bending a piece of Panel 2 until the entire coating flaked off. One large piece was provided to participants.

Item K2 – samples of paint taken from suspect 2’s vehicle. This Item was prepared by bending a piece of Panel 3 until the entire coating flaked off. One large piece was provided to participants.

Item K3 – samples of paint taken from suspect 3’s vehicle. This Item was prepared by bending a piece of Panel 2 until the entire coating flaked off. One large piece was provided to participants.

Pretesting

Infrared spectrometry.

Two samples of Panel 2 and two of Panel 3 were selected. Each panel was bent, causing the painted finish to detach, thus allowing two pairs of intact paint layers to be collected. The top and bottom layers of each Panel sample (i.e., the clearcoat and electrocoat) were analysed using a diamond macro-ATR accessory (5 replicates of each layer were analyzed).

Spectrometry confirmed that Panel 2 and Panel 3 had the same electrocoat composition. Spectrometry confirmed that Panel 2 had a polyurethane clearcoat whereas Panel 3 had a melamine cross-linked acrylic clearcoat.

Therefore the clearcoats from Panel 2 and 3 were different, therefore, as expected, Item Q1 could be discriminated from Item K2 on the basis of the clearcoat composition.

One sample of each Panel was then selected and dissected with a scalpel in order to remove the clearcoat (thus exposing the metalflake basecoat) and then dissected further to expose the grey primer layer. The exposed layers were then analysed using ATR microspectrometry (5 replicate analyses per sample). Spectrometry showed clear differences between the silver basecoats for Panel 2 and Panel 3, despite the formulations for the basecoats being identical. It is surmised that differences arose from permeation of the polyurethane clearcoat into the basecoat. Furthermore, spectrometry showed clear differences between the primer layers for Panel 2 and Panel 3, despite the formulations for the primers being identical. As for the basecoat, it was surmised that the differences arose from permeation of the polyurethane clearcoat into the primer.

However, the permeation of the polyurethane into the primer appeared to decrease with distance from the interface. Therefore, although basecoat and primer analysis indicates that these layers differ between Panel 2 and Panel 3, the differences are due to ‘bleed’ or migration of polyurethane compounds from the clearcoat in Panel 2 into the layers beneath.

Scanning electron microscopy – energy dispersive X-ray microanalysis.

One sample of Panel 2 and one of Panel 3 were bent to provide intact paint layer samples. Subsamples of each, approximately 3mm x 2 mm, were removed, mounted in resin and their cross-sectional surfaces polished (0.25 µm diamond paste as the final treatment). The samples were then carbon coated and analyzed using energy dispersive X-ray microanalysis at a beam energy of 25 KeV and spot size of 5. Microanalysis showed that the pairs of electrocoats, primers and basecoats each had the same elemental compositions.

As paint layers are heterogeneous (except for clearcoat) no attempt was made to evaluate the homogeneity of test items.

Expected results

Following examination and analysis participants should be able to report the following results:

- K1 and K3 are indistinguishable from one another.
- Q1 is indistinguishable from K1 and K3.
- K2 is from a different source.

Automotive Paint 2019-6 Feedback

Forensic Foundations prides itself in providing flexible fit-for-purpose forensic programs. The manufacture, distribution and assessment and reporting of this test has provided and will provide the basis for continuous improvement for both Forensic Foundations and the forensic laboratories. To this end we would appreciate your comments to assist us to improve the tests.

Please tick the appropriate box and make any relevant comments.

	Strongly Agree	Agree	Disagree	Strongly Disagree	NA
1. The test was relevant to our facility	<input type="checkbox"/>				
.....					
.....					
.....					
2. The samples supplied reflect our normal work	<input type="checkbox"/>				
.....					
.....					
.....					
3. The results required were not outlined sufficiently in the instructions	<input type="checkbox"/>				
.....					
.....					
.....					
4. The final report provided suitable detail	<input type="checkbox"/>				
.....					
.....					
.....					
5. The tests involved were sufficiently challenging	<input type="checkbox"/>				
.....					
.....					
.....					

Please comment briefly on the following:

6. Are there additional aspects which could be included in the test?

.....
.....
.....
.....

7. Any additional comments

.....
.....
.....
.....

8. Facility (optional)

.....
.....
.....
.....

Forensic Foundations' Proficiency Tests are required to be fit-for purpose. To assist us to provide the relevant tests, please use the following form to suggest further tests for development.

Recommendation for Proficiency Test development

Contact	Name	
	Email	
	Phone	
Discipline/ subdiscipline		
Specific issues(s) to be addressed*. Note: The tests can be designed to be multidisciplinary.		
Suggested technical advisor (if known)		
Suggested manufacturer (if known)		

* All Proficiency Tests will include the end to end process (receipt & continuity, triage, description, examination, analysis, data generation, interpretation, reporting) but one aspect may be of particular interest/focus.

This form can be emailed to quality@forensicfoundations.com.au or you can discuss your suggestions on either 03 9018 8919 or 0429 966 012.