Title: Paint Analysis (TR SOP-09)

A. PURPOSE:

To define a method by which paint evidence will be collected and/or examined.

B. RESPONSIBILITY:

An analyst who is qualified in the Paint category of testing.
A paint analyst from another ASCLD/LAB-accredited laboratory may act as the co-signor or technical reviewer for paint examinations.

C. SAFETY:

The appropriate measures for the proper handling of biohazard materials, sharps instruments, and chemicals will be used according to the Laboratory Safety Manual.
Lab coat and gloves will be worn when examining evidence. A mask will be worn when examining biological evidence.
Eye protection may be worn when working with glass, plastics, or related materials.

D. PROCEDURE:

Setup

1. Analysts will follow general laboratory procedures for case assignment and evidence transfers.
2. Applicable incoming paperwork will be read to determine the types of examinations that are requested. Analysts will be aware whether items of evidence should be examined by other sections of the laboratory either before or after paint examinations. The submitted agency may be contacted if questions arise during the examination.
3. In the event there are multiple examination requests on submitted items of evidence, the proper sequence as to the analysis will be taken.
4. The analyst may use their discretion to assess the probative value of the evidence, as well as determine the types and extent of the examinations that will be conducted. If a variation in the procedure is necessary, the section supervisor will be notified and a deviation will be issued.

Documentation

1. Examination of evidence will be documented appropriately. Any worksheets used will be considered examination documents and will be placed within Analytical Case Folders.
2. Case notes should reflect the packaging, seals, and contents of submissions (e.g., color, size, style, damage, condition). Photographs and/or sketches may be used to supplement descriptions.
3. Physical characteristics of [question or known] paint samples (e.g., color, layer structure, texture, presence of effect or other pertinent distinguishing characteristics) will be documented.

4. A note or photo can be included within examination documentation if evidence is repackaged different than the way it was received.
5. Observations, examination practices (e.g., collection methods, analysis methods, instrumental analyses), and other relevant information will be documented appropriately (e.g., case notes, worksheets).

Evidence Processing

1. Different lab coats can be used when examining items from a victim and items from a suspect in the same case.
2. Gloves must be changed in between the examination of different items of evidence.
3. Examination areas will be cleaned appropriately (e.g., solvent or cleaner) in between different items of evidence.
4. Evidence submitted from the victim and the suspect should be examined in different areas. Examinations may take place on different days, if necessary.
5. When possible, the submitting agency's evidence seal should remain intact when opening packaging.
6. Appropriate information should be placed on evidence packaging material (e.g., analyst's initials, laboratory number, item number).
7. Each item of evidence should be marked with the analyst's initials. If placing initials on an item of evidence would be detrimental to future analyses, no initials will be placed on the evidence. It can be noted on the worksheet that the item was not initialed. In the event the item of evidence is too small to add initials, a note can be made on the worksheet that the no initials were placed on the item.
8. A hangtag may be used in place of initials.
9. If the packaging contains more than one item then it may be sub-divided (e.g., 1-1, 1-2, 1-3) in accordance with laboratory policy.
10. Trace material may be removed and collected using forceps, a scraping method, tape lifts (e.g., tape roller), gel lifts, or vacuuming. One or more methods of trace material collection may be used. Documentation of sample collection will be captured within examination case notes.
11. Alternate light sources (e.g., Crime-Lite) may be used to facilitate the collection of trace material.
12. When appropriate, other sections will be notified if an item would require additional examinations (e.g., swabbing for touch/DNA).
13. Evidence removed from larger pieces of evidence will be itemized appropriately (e.g., given sub-item numbers), according to policy (e.g., 1-Z1, 2-Z4), and be entered into the JusticeTrax system.
14. Evidence may be placed on glass microscope slides, in paper folds, or other appropriate storage containers. These storage containers will be marked with the Laboratory number, the item/sub-item number, and analyst's initials.

15. Upon completion of examination, each item can be returned to its original packaging (when available) and properly sealed. The analyst's initials should be written across, and partially off, the seal. Additional packaging material may be used to secure evidence.

Collection

1. Removal of paint from an item should include all of the paint layers or primer down to the substrate.
2. Analysts will determine the best method to remove paint from evidence.
3. Known paint samples taken from different areas of a vehicle should be packaged separately.

Analysis and Comparison

1. Topical debris which is adhered to paint-type evidence may be removed prior to analysis (e.g., using water moistened Kim-wipe, brushing it off with a soft brush).
2. Paint evidence will be prepared for examination using appropriate methods (e.g., microscopy, spectroscopy, high-resolution imaging, elemental analysis).
3. Samples will be examined to determine if a physical match is present.
4. If physical matches are not identified, further examination of the evidence will be done.
5. When comparing an unknown and a known paint sample, one or more of the following examination techniques may be used based on the analyst's discretion:
   a. Microscopic examination techniques
      -Stereoscopic comparison
      -Polarized light microscope (PLM ; comparison PLM)
      -Compound microscope (comparison compound microscopy)
   b. Instrumental examination techniques
      -Fourier-transform infrared spectroscopy (FTIR microscopy)
      -Scanning electron microscopy/energy dispersion X-ray spectroscopy (SEM/EDS)
      -Microspectrophotometry (MSP)
   c. Chemical testing (e.g., solubility testing)
6. Layers of paint within multi-layer paint samples should be examined separately and individually.
7. The number of layers within paint will be noted.

Evaluation

1. Visual and instrumental examinations will be evaluated.
2. During a comparison examination, if evidence is determined to be different, dissimilar, and not consistent with having come from a common source, then examinations from that comparison can stop.
3. Evaluate observations and analytical data to determine if evidence are similar, dissimilar, or inconclusive.

4. Evidence determined to be similar and possibly coming from the same source must have data to support that conclusion. Visual and spectroscopic data should compare favorably and elemental data must support conclusions.
5. Evidence determined to be dissimilar and not coming from the same source must have data to support that conclusion.
6. Inconclusive results must state a reason why conclusions cannot be made.
7. Supplemental examinations may be utilized, at the discretion of the analyst, for information to be reported relating to location, recovery, collection, identification, or comparison of paints. These examinations may include UV light, alternate light source (Crime Lights-brand), florescence microscopy, or solubility.
8. If evidence will be examined by SEM/EDS, a separate analyst who has been qualified to operate the instrument may perform the analytical analysis in collaboration with the paint Examiner if that Examiner is not able to operate the instrument.

Evaluating questioned automotive paints – OEM and refinish type paints

If a known paint has not been submitted and if the instrumental and/or microscopic examination of a questioned sample indicates that it may be paint from an original automotive paint finish (OEM) with three (3) or more layers, appropriate information for each layer will be entered into the currently available reference collection of known automotive paints—the Paint Data Query (PDQ) database. A search will be conducted to determine a possible vehicle make or model. (see PDQ section of document).

a. If no OEM or partial OEM sequence is present, report layer sequence, topcoat or clearcoat coat, and note the presence of metallic-type flakes.
b. For determination of paint chemistry, the analyst will use a combination of training, experience, and reference materials.

Storage

1. The analyst will determine the best method to secure paint-type evidence for examination and/or storage. A variation of the previously listed methods may be used.
2. Retained paint evidence from a case will be placed in a sealed envelope with the analyst's initials across the seal and stored in an appropriate storage area.

Report Writing

Comparisons

1. Upon the completion of a paint comparison, wording similar to those listed below may be used. Analysts will use their training and experience to write a report which reflects the results obtained based on observations and data.
2. Typical statements used when writing a report may include:

a. A three-layered (metallic red/brown/black) paint chip was located on Item #1 (green pry bar "from the suspect"). This paint exhibited microscopic and instrumental characteristics similar to the three-layered (metallic red/brown/black) known paint sample "from the vehicle."
b. A red effect paint smear was located on Item #1 (green pry bar "from the suspect"). This paint exhibited microscopic and instrumental characteristics similar to the top layer of the three layered (metallic red/brown/black) known paint sample "from the vehicle."
c. A red effect paint smear was located on Item #1 (green pry bar "from the suspect"). This paint exhibited microscopic characteristics similar to the top layer of the three-layered (metallic red/brown/black) known paint sample " from the vehicle."
d. A red effect paint smear was located on item #1 (green pry bar "from the suspect"). This paint exhibited characteristics dissimilar to the three-layered (metallic red/brown/black) known paint sample "from the vehicle."
e. Item #1 consisted of red paint. Examination of Item #1 determined it to be an alkyd-type paint.

Paint Evaluation – Reporting Questioned Paints

When evaluating paint evidence, conclusions may include information regarding the type of paint and a possible end use (original finish, refinish, architectural).

Typical statements used when writing a report may include:

a. It Submission #1 consisted of a red "metallic" paint. Instrumental analysis of item #1 indicated the presence of an acrylic-melamine type paint which is encountered in the automotive industry as original finish (OEM) type paints.
b. Submission #1 is not consistent with automotive type paint.

Paint Data Query (PDQ)

Paint Data Query (PDQ) is a database that may be utilized to provide information (e.g., list of vehicle makes / models). A search of this database is based upon the chemistry and layer structure of original automotive (OEM) paint. Analysts will assess the evidence to determine if PDQ may be useful.

Paint sample analysis – PDQ

1. The number of layers present in a paint sample will have been noted.
2. Each layer will have been analyzed by FTIR microscopy.
3. Spectra from each of the layers of the questioned paint will have been obtained and coded prior to beginning a layer system query search.

PDQ Queries

1. The "Layer System Query Report" will be considered Examination Documents and the version of PDQ used for the search will be included in the case file.
2. The analyst and the technical reviewer will determine, on a case by case basis, the related "hit list" PDQ printout(s) which will be included in the case jacket.

3. If the initial PDQ "hit list" exceeds 500 hits, the analyst should consult with another appropriately qualified analyst to determine if the list should be narrowed by using spectral searching.
4. The analyst may consult the PDQ Maintenance Team with inquiries about PDQ related to a particular case (see the PDQ Manual for Contact information).

Report Writing for PDQ Hits

1. Information from a "PDQ Hit List" may be included in final reports.
2. The analyst may consult another appropriately qualified analyst to decide on verbiage for the report based on the PDQ Hit List.
3. Possible report wording includes:
   FTIR analysis of the questioned paint indicates the presence of an original finish. Therefore the instrumental data for "XX" "layers 1 through 4" were entered into the Paint Data Query (PDQ) to search for a possible vehicle make and/or model. A search of the PDQ generated a list of XX possible vehicle makes and/or models. The search is intended as a guide and for investigative purposes only.
4. If information is included in a report from a PDQ hit list, the following statement will be included in the report:

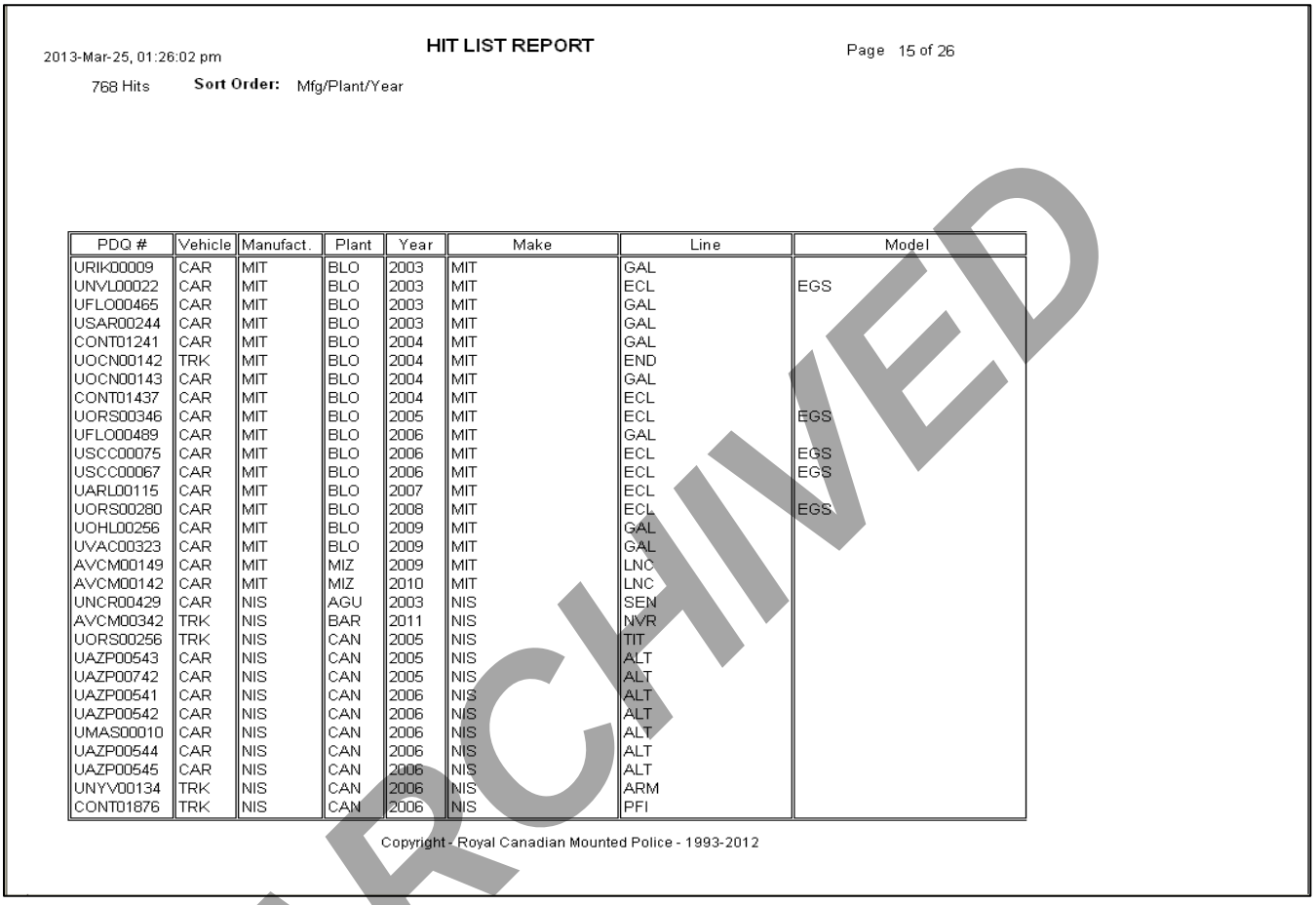
   > It is to be noted that the use of Paint Data Query (PDQ) is to provide an investigating agency with possible vehicle manufacturer type and year ranges based on the sample(s) provided. The results of this database search are limited to the data in the most current version of the database at the time of the search.

Spectral searching using KnowItAll® software

The purpose of the KnowItAll® software is to provide a guide to investigators by narrowing down a PDQ system layer query search (or PDQ Hit List). Each layer of a questioned paint sample is spectrally compared to spectra from specific manufacturers, plants, and year ranges, based upon the PDQ layer system query "hit list." Using the KnowItAll® software, each layer of a questioned paint particle can be evaluated by each of the paint database libraries that are available within the PDQ database. Evidence is assessed to determine if the KnowItAll® software can be used in a case.

How to perform a KnowItAll® Sadtler Search

- Open KnowItAll® software
- To perform a search, you must utilize information from the PDQ hit list (plant and year) along with the FTIR spectra of each of the layers of the paint sample in question.



HIT LIST REPORT

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768 Hits **Sort Order:** Mfg/Plant/Year

PDQ #	Vehicle	Manufact.	Plant	Year	Make	Line	Model
URIK00009	CAR	MIT	BLO	2003	MIT	GAL	
UNVL00022	CAR	MIT	BLO	2003	MIT	ECL	EGS
UFLO00465	CAR	MIT	BLO	2003	MIT	GAL	
USAR00244	CAR	MIT	BLO	2003	MIT	GAL	
CONT01241	CAR	MIT	BLO	2004	MIT	GAL	
UOCN00142	TRK	MIT	BLO	2004	MIT	END	
UOCN00143	CAR	MIT	BLO	2004	MIT	GAL	
CONT01437	CAR	MIT	BLO	2004	MIT	ECL	
UORS00346	CAR	MIT	BLO	2005	MIT	ECL	EGS
UFLO00489	CAR	MIT	BLO	2006	MIT	GAL	
USCC00075	CAR	MIT	BLO	2006	MIT	ECL	EGS
USCC00067	CAR	MIT	BLO	2006	MIT	ECL	EGS
UARL00115	CAR	MIT	BLO	2007	MIT	ECL	
UORS00280	CAR	MIT	BLO	2008	MIT	ECL	EGS
UOHL00256	CAR	MIT	BLO	2009	MIT	GAL	
UVAC00323	CAR	MIT	BLO	2009	MIT	GAL	
AVCM00149	CAR	MIT	MIZ	2009	MIT	LNC	
AVCM00142	CAR	MIT	MIZ	2010	MIT	LNC	
UNCR00429	CAR	NIS	AGU	2003	NIS	SEN	
AVCM00342	TRK	NIS	BAR	2011	NIS	NVR	
UORS00256	TRK	NIS	CAN	2005	NIS	TIT	
UAZP00543	CAR	NIS	CAN	2005	NIS	ALT	
UAZP00742	CAR	NIS	CAN	2005	NIS	ALT	
UAZP00541	CAR	NIS	CAN	2006	NIS	ALT	
UAZP00542	CAR	NIS	CAN	2006	NIS	ALT	
UMAS00010	CAR	NIS	CAN	2006	NIS	ALT	
UAZP00544	CAR	NIS	CAN	2006	NIS	ALT	
UAZP00545	CAR	NIS	CAN	2006	NIS	ALT	
UNYV00134	TRK	NIS	CAN	2006	NIS	ARM	
CONT01876	TRK	NIS	CAN	2006	NIS	PFI	

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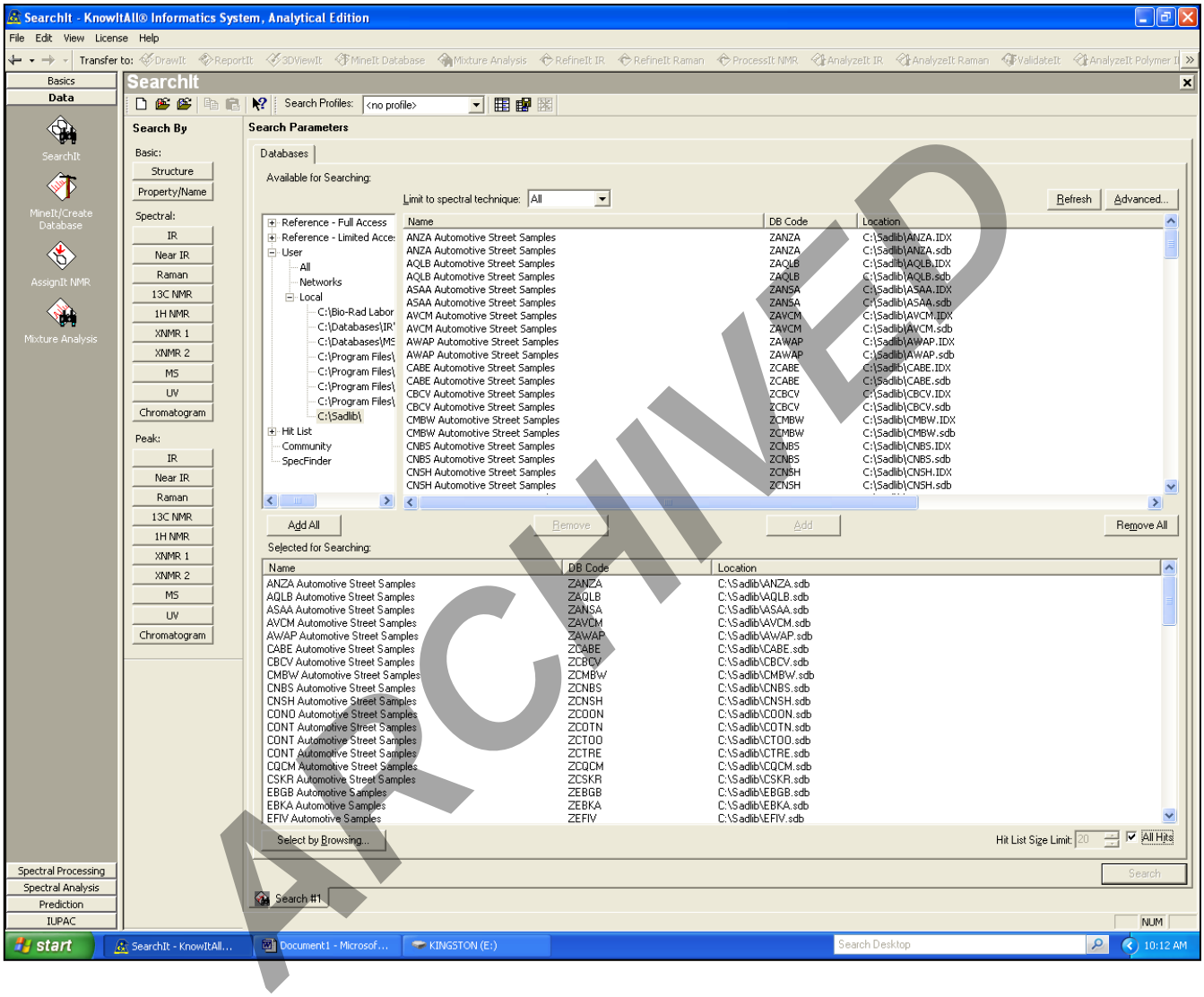
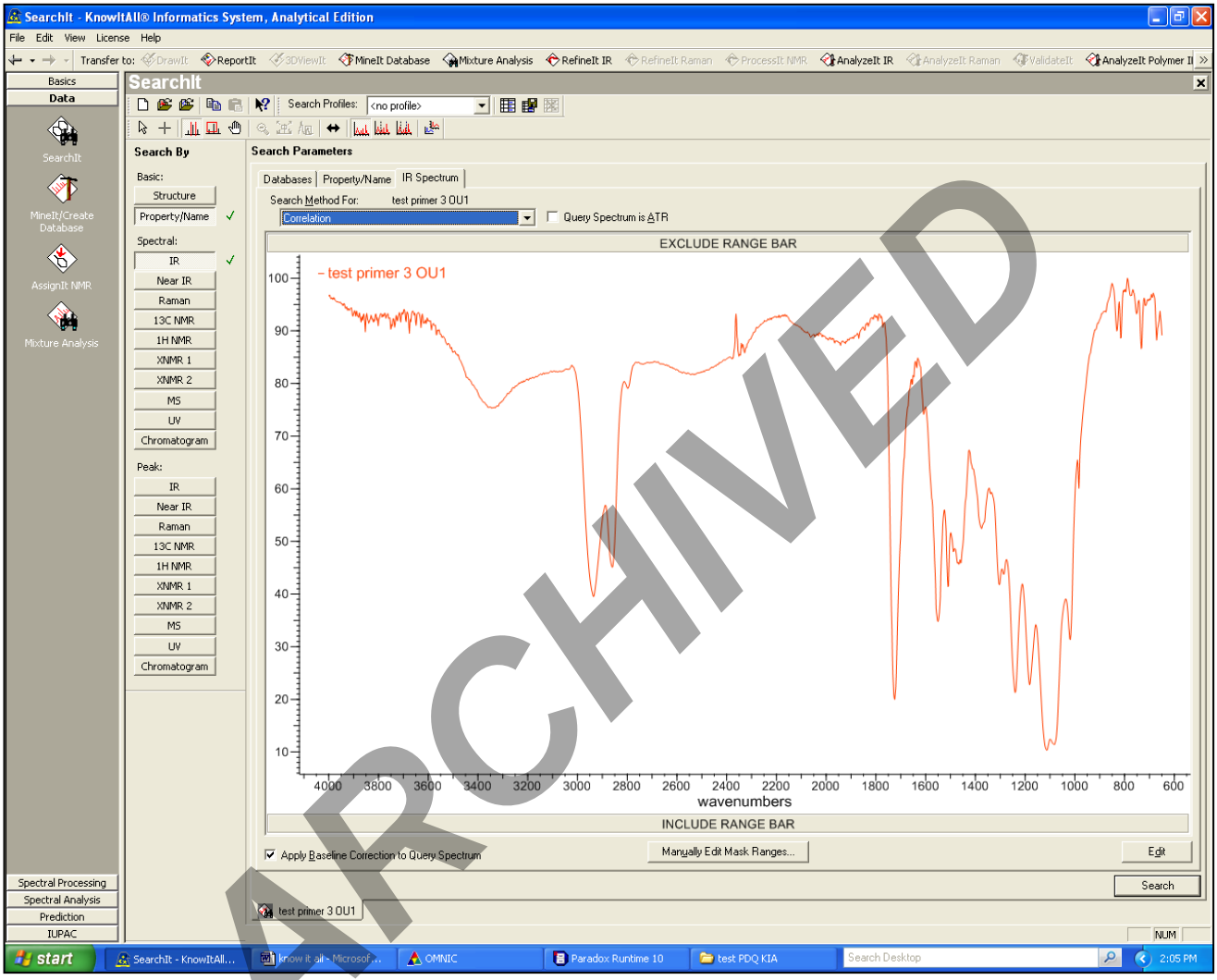
- Before beginning a search, the appropriate search libraries must be chosen. Under the "Basics" heading, click on the "Data" tab, then choose the "SearchIt" icon. Make sure the most current version of the PDQ spectral library is chosen, then check "All Hits" on the bottom right.

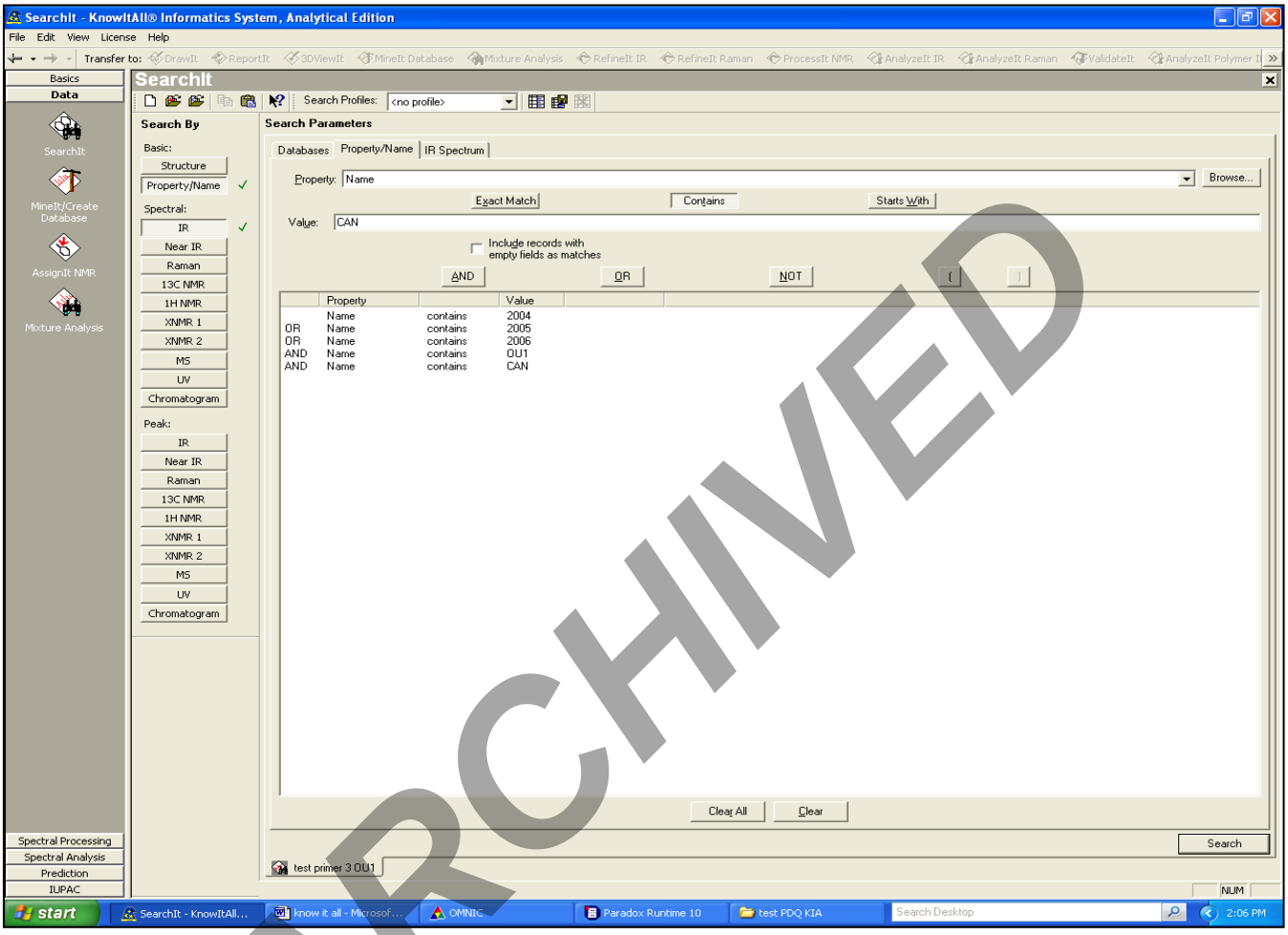


- Enter search parameters:

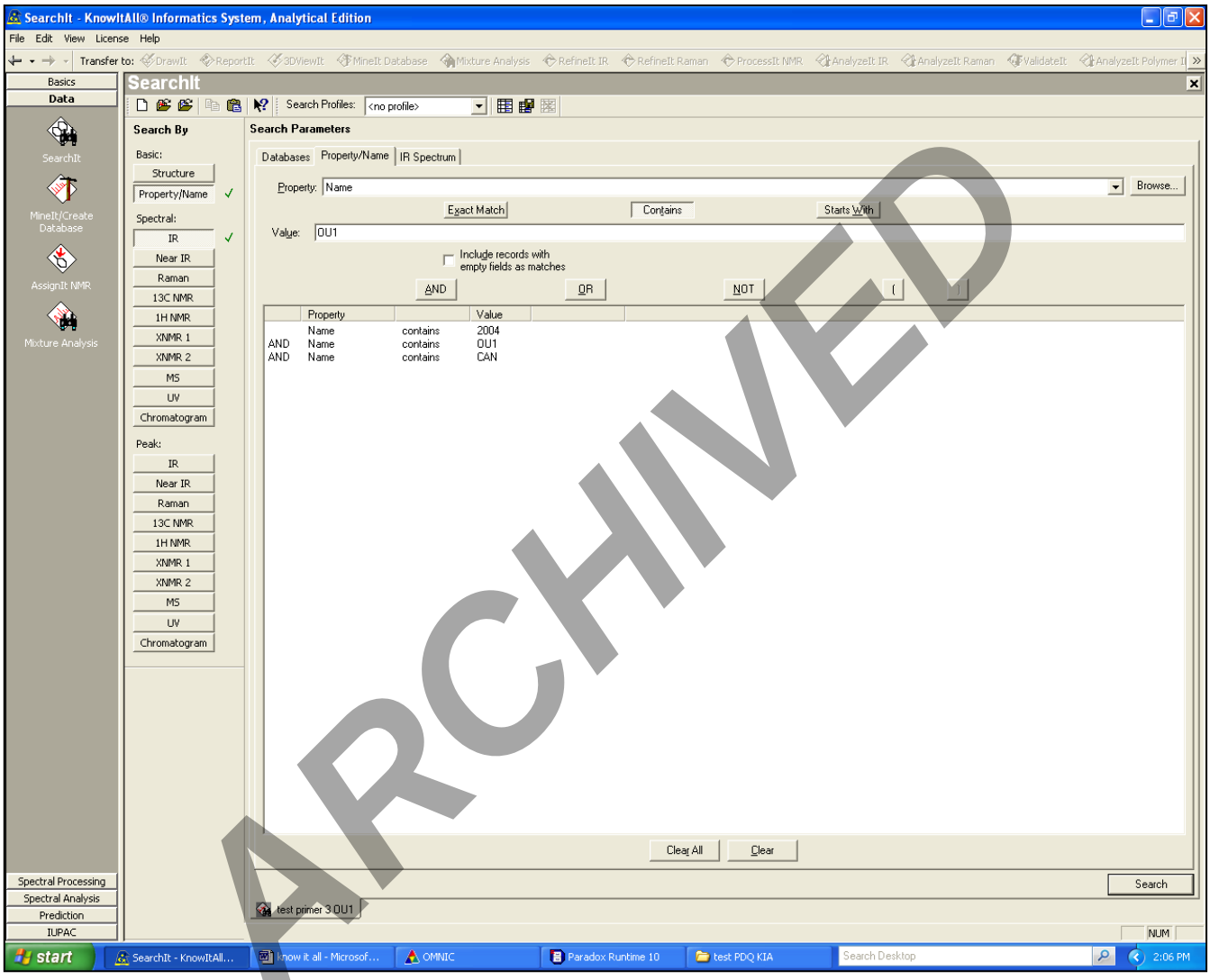
  Under "Spectral" heading, click the "IR"tab then, starting with the most unique layer, open the appropriate file for the layer that you are searching (for example test primer 3 OU1). Choose "search method" as "1st Derivative Euclidean Distance"



- Enter year/manufacturer/ layer information from PDQ layer system query search.
- Under the "Basics" heading click "property/name" and in the "Property/Name" field, and choose "Name" in the drop down menu. In "value" field, first enter the year(s) you are evaluating, click on "AND" then enter the plant abbreviation along with the layer for which you are searching.
- For example, if evaluating multiple years in one search:
  Highlight "name" enter "2004" OR highlight "name" enter "2005" OR highlight "name" enter "2006" AND "name" enter plant code "CAN" AND "name" enter layer that you are evaluating "OU1"



- If evaluating only one year highlight “name” enter year “2001” AND “name” enter plant code “CHR” AND “name” enter layer that you are evaluating “OU1”


SearchIt - KnowItAll® Informatics System, Analytical Edition
File Edit View License Help
Transfer to: DrawIt ReportIt 3DViewIt MineIt Database Mixture Analysis RefineIt IR RefineIt Raman ProcessIt NMR AnalyzeIt IR AnalyzeIt Raman ValidateIt AnalyzeIt Polymer I
Basics
Data
SearchIt
MineIt/Create Database
AssignIt NMR
Mixture Analysis
Spectral Processing
Spectral Analysis
Prediction
IUPAC
SearchIt
Search Profiles: <no profile>
Search By
Basic:
Structure
Property/Name
Spectral:
IR
Near IR
Raman
13C NMR
1H NMR
XNMR 1
XNMR 2
MS
UV
Chromatogram
Peak:
IR
Near IR
Raman
13C NMR
1H NMR
XNMR 1
XNMR 2
MS
UV
Chromatogram
Search Parameters
Databases
Property/Name
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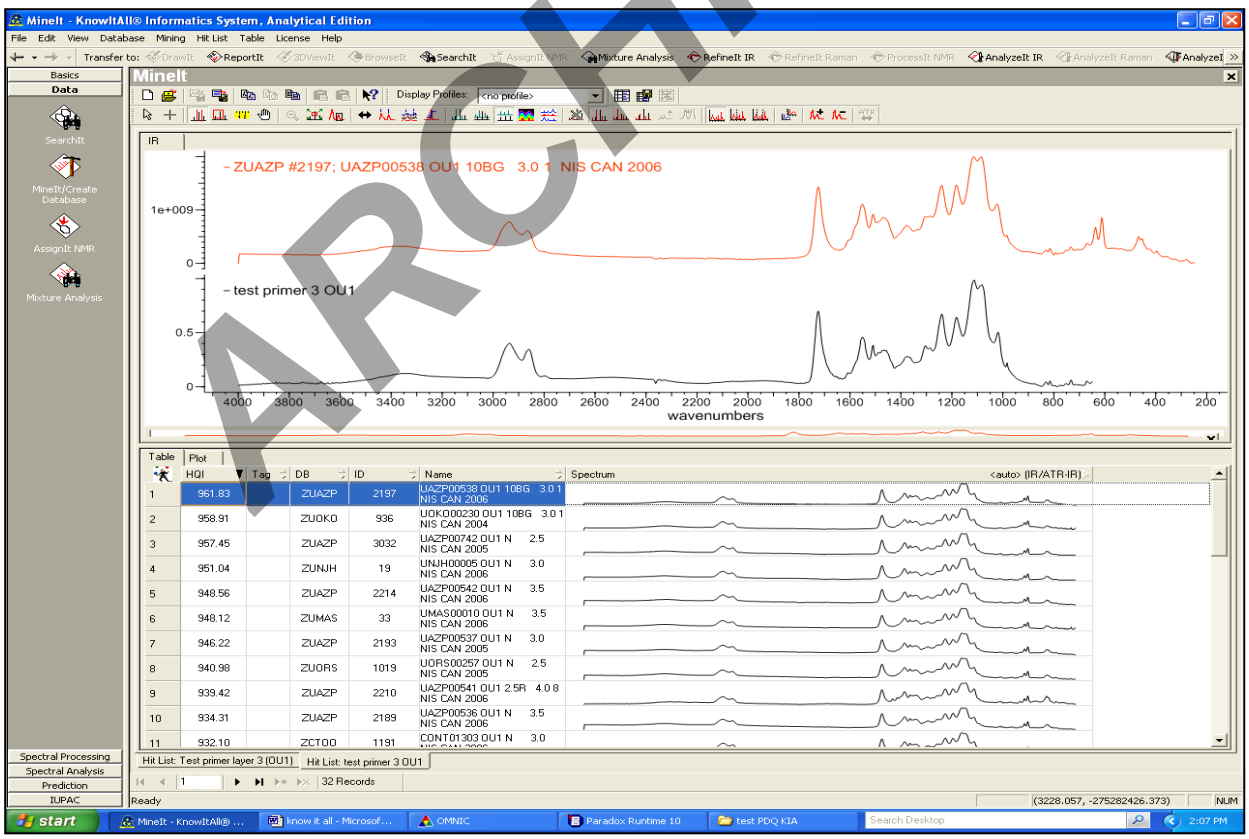
Property: Name
Browse...
Exact Match
Contains
Starts With
Value: OU1
Include records with empty fields as matches
AND
OR
NOT
( )
Property Value
Name contains 2004
AND Name contains OU1
AND Name contains CAN
Clear All
Clear
Search
test primer 3 OU1
NUM
start
SearchIt - KnowItAll...
know it all - Microsof...
OMNIC
Paradox Runtime 10
test PDQ KIA
Search Desktop
2:06 PM

- When searching between years, the "OR" drop down must be used. The "AND" drop down field must be utilized in between plant codes and layer information. You will see a green check mark next to your selected fields of search ("IR" and "Property/name")
- Click the "Search " tab located in the bottom right.
- The search will then be found under the "Mine it" field.
- The results of the search are listed with the spectra with the highest HQI first. The result also lists the database where the specific spectra can be located, along with the model, plant, and year corresponding to the spectra and layer/ plant information from the questioned paint.
- Scroll through the results list and compare your spectra from the specific questioned paint layer to each spectra of the search results. Exclude any plants/ years based on significant spectral differences, in one or more years. If the plant cannot be excluded based on significant spectral differences, then repeat the search with a different layer and any remaining layers. The color coat spectra can also be searched, but with discretion. Not all color coats are present in the database for a particular year/model/plant. Determining an inclusion or exclusion should be more heavily weighted based on spectra of the clear coat and primer layers.



- If a "hit" is included after searching the first layer, the following chart can be utilized. The chart allows simplification for determining a year range for a specific plant and must be included with the Examination Documents.

Laboratory case#: Date: User:

Manufacturer/ Plant:

OT2																						
OT1																						
OU1																						
OU2																						

Manufacturer/ Plant:

OT2																						
OT1																						
OU1																						
OU2																						

Manufacturer/ Plant:

OT2																						
OT1																						
OU1																						
OU2																						

Manufacturer/ Plant:

OT2																						
OT1																						
OU1																						
OU2																						

Key: √ = cannot exclude ~ = no plant information present X = excluded

Evaluating spectral searching data

When unable to exclude a plant based on significant spectral differences, then it must be included. Significant differences in spectra may include differing peak heights, peak positions, and, in some cases, peak intensities.

When reporting a year range of vehicles based on spectral similarities, you must include +/- one year. It is unknown exactly when a manufacturer starts and stops production on a particular model during a specific year. Example, if similarities are found in 2003-2008, you must report the years 2002-2009.

Report wording for KnowItAll® software searches
The FTIR spectra from the questioned paint layers were compared with the spectra from each result from the PDQ layer system query or "hit list". The following makes, models, manufacturing plants, and year ranges "could not be excluded" or "were found to be most comparable" to the questioned paint with respect to chemical type:"
Make: Nissan
Models: Altima, Quest, QX56, Armada and Pathfinder
Year ranges: 2004-2011
Manufacturing plant: Canton, MS (USA)

Specific North American vehicle production information from *Automotive News* can be found in an appendix of the most current PDQ software.

If a spectral search of results from the PDQ resulted in spectral differences and all vehicles on the PDQ list can be excluded, wording should be:
The results of the PDQ layer system query and the spectral library searches were combined to come up with a list of possible makes, models, and year ranges of vehicles with similar paint system chemistry. However, notable spectral differences were observed in all of the vehicles that were listed and the search failed to disclose significant results. The PDQ list is available upon request.

Required statement
An analyst must indicate that there may have been more models manufactured at a particular plant during a particular time period, but the results are limited to the samples that were available in the PDQ. Or not all vehicles, makes, and models are represented. Information provided should be used for investigative guidance.

E. References:

a) PDQ User Manual (most recent version)

b) Boston Police Department Crime Laboratory: Trace Evidence Section Procedure

c) ASTM E1610-95 Standard Guide for Forensic Paint Analysis and Comparison

d) The Infrared Spectroscopy: Its Use In The Coatings Industry book pgs. 1-48, Federation of Societies for Paint Technology, 1969

e) PDQ database version: PDQi 1.0.0.60 (or later)

f) Coding/ interpretation references: Forensic examination of Glass and Paint, 2001, Brian Caddy pp 223-224

g) Practical guide to Infrared Microspectroscopy, 1995, Edited by Howard Humecki, Scott Ryland - Infrared Microspectroscopy of Forensic Paint Evidence, pp. 163-243

Revision #	Revision History
2	Title was changed. General format and re-wording changes throughout document. Replaced 'section' with 'unit' throughout document. Replaced 'Trace Examiner' with 'analyst' or 'Examiner' throughout document. Re-worded criteria for SEM/EDS operator. Removed polymer exams from document. Removed PDQ Software Installation instructions. Removed PDQ manual references. Clarified and combined examination techniques to be listed under Microscopic techniques, instrumental techniques and chemical testing. Removed 'polymer' from the procedure. Title change.
3	Updated responsibility section and references section.