A. PURPOSE: To define a method by which paint and polymer evidences will be collected and / or examined and / or compared.

B. **RESPONSIBILITY:**

Forensic Science Examiner who has successfully completed paint training is accordance with the Trace Section Training Manual.

A Paint Examiner from another ASCLAD accredited laboratory may act as the co-signor or technical reviewer for paint examinations.

The Director or Supervisor may act as the co-signor of a report, which includes paint comparisons.

C. SAFETY:

The appropriate measures for the proper handling of biohazard materials, sharps instruments and chemicals will be used according to the Connecticut State Forensic Science Laboratory Safety Manual.

D. PROCEDURE: Set up

1. The examiner will use his / her discretion to assess the probative value of the evidence; as well as, determine the types and extent of the examinations conducted. The examiner will use their knowledge, training and experience to determine which tests will be performed and the order in which the tests will be performed.
2. The examiner may deem it necessary to vary from the set paint and polymer protocol based on the evidence submitted. If a variation in the paint and polymer procedure is necessary, the submitting agency will be notified.
3. If at any time during the comparison of a known and an unknown paint the examiner determines a significant difference, no further examinations will be conducted and the paint will be deemed "dissimilar".

E. PROCEDURE: Documentation

1. Evidence will be documented. (SOP-TR-05) Evidence Documentation.
2. Evidence and paint samples examined in the Trace Section will be documented on the appropriate Quality Record Worksheet. These worksheet will remain in the case jacket.

3. The examiner may photo document paint-type evidence.
4. The examiner will document the paint samples (questioned and known) with regard to color, layer structure, texture, presence of effect or other pertinent distinguishing characteristics. The examiner will use their training and experience to determine the characteristics which will be documented.
5. Paint layer structure may be photo documented and the images may be included in the case jacket.

F. PROCEDURE: Collection

1. Questioned and known paint / polymer samples may be submitted to the laboratory as chips, scrapings, flakes or as intact item by which the examiner will remove paint at the laboratory. Parts of vehicles, building material or other various forms of evidence may be submitted to the laboratory for examination from a submitting agency.

2. Paint /polymer evidence may be transferred from other sections of the Laboratory to the Trace Section for further examination.

3. Paint / polymers may be removed from evidence during examination within the Trace Section.

4. Removal of a known paint sample from an item should be done with the goal of the removal of all the layers paint or primer down to the substrate. These methods may include but are not limited to: scraping, cutting or removing loose chips which are raised from the substrate.

5. Paint removal from vehicles should include all to the layers down to the substrate of the vehicle. Substrate materials will vary and may include, but are not limited to, plastic-type material or metal. A known sample should be taken as close to an area of damage without including the area of damage.

6. The examiner will determine the best method to remove paint sample from a item of evidence.

7. Known paint samples taken from different areas of a vehicle should be packaged separately.
8. The examiner will document the method of collection in the case file.

G. PROCEDRUE: Analysis and Comparison

1. Topical debris which is adhered to paint-type evidence may be removed prior to analysis. This may be conducted by using water moistened Kimwipe or by brushing it off with a soft brush.

2. Paint-type evidence will be prepared for examination based on the condition in which it is received. The examiner will use their training, knowledge and experience related to paint-type evidence to prepare samples for examination (macroscopic and microscopic) and instrumental analysis. The examiner may choose to use blades or another "sharp" instrument to separate layers of paint prior to analysis. The examiner may choose to flatten a sample(s) to obtain optimum instrumental results. This may be done by manually rolling the sample flat with a micro-roller or using a similar method such as flattening the sample with a diamond compression cell. The is examiner will decide, based on their training, knowledge and experience the best method to prepare the sample.
3. Upon comparing a questioned and a known paint / polymer sample the examiner may first attempt to determine if a physical match of the paints may be made. The examiner will determine if two samples may be physically matched together. If two samples are physically matched together the examiner may photograph the "matched" area and may include this photograph in the report.
4. If an examiner determines that two samples are a physical match, thus the two items were once one continuous piece, no further examinations may be necessary.
5. When comparing an unknown and a known paint sample the following scheme will generally be followed, based on the examiner's discretion – all or some of the following may be used:
   a. Stereoscopic comparison
   b. Compound microscope (comparison compound microscope)
   c. Fluorescence
   d. Polarized light microscope (comparison polarized light microscope)
   e. FT-IR
   f. Microspectrophotometery

   *The paint sample used for visual-type examinations will then be used for instrumental analysis.

   **During the preparation of a paint sample for instrumental analysis – similar thicknesses of the Q and K sample should be analyzed.

   ***The sample should be prepared so that only one layer of the paint sample will be analyzed instrumentally at one time.

6. Supplemental examinations may be utilized at the discretion of the examiner for the determination of location, recovery, collection, identification or comparison of paints. These examinations may include UV light, alternate light source (Crime Lights-brand), florescence

microscopy, solubility or SEM EDAX. If one or more of these supplemental forms of examination are utilized, their use will be documented in the case jacket.

** If a paint-type sample will be examined via SEM EDAX, an examiner from the Chemistry Section of the Forensic Science Laboratory may perform the analytical analysis needed and provide the data/ results/ images to the Trace Evidence Examiner. The data / results / images provided will be included in the case jacket for the case examined.

H. PROCEDURE: Storage

1. Paint samples may be packaged / stored in paper folds, between glass microscope slides or a similar method. The examiner 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 / polymer evidence from a case will be placed in a sealed envelope with the examiner's initials across the seal and stored in the appropriate long-term storage area.

I. PROCEDURE: Report Writing

1. The examiner will assess the macroscopic / microscopic optical results and comparisons and analytical data (instrumental analysis) along with utilizing their training and experience to determine if two paints are similar or dissimilar.
2. Polymers other than paints, which are presented in a thin film such as plastics, rubbers, waxes, oils or greases, may be encountered in casework. They may be analyzed utilizing the same procedure as paints.
3. Upon the completion of a paint comparison, the examiner may utilize wording similar to those listed below. The examiner will use their training and experience to draft a report, which reflects the results obtained on a case-by-case basis.

   Typical statements used when writing a report may include:

   *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."

   *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".

*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".

*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".

*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".

*Submission #1 consisted of red paint. Instrumental analysis of item #1 determined it to be a alkyd-type paint.

The examiner will consult with the co-signer to draft a report, which best reflects the results obtained.

Statements regarding the end-use of paint should be similar to the following:

A. Possible uses of this paint include, but are not limited to, automotive repaint.
B. This paint is not consistent with automotive-type paint.

J. Paint Data Query (PDQ)

Paint Data Query (PDQ) is a database that may be utilized to provide a list of possible vehicle makes and/ or models to a submitting agency. A search of this database is based upon the chemistry and layer structure of original automotive paint. The examiner will assess the case and the evidence submitted to determine if PDQ may be used in a case.

It is recommended that a paint examiner take the PDQ Class if it is available. Contact the PDQ Maintenance Team to find out more information about PDQ classes.

Software installation

PDQ software is sent to the Forensic Laboratory from the PDQ Maintenance Team on an annual basis. The current version of the PDQ database will be installed when received from the Royal Canadian Mounted Police (RCMP). When a new version of PDQ is received, please refer to the installation guide as provided by the PDQ Maintenance Team. After installation is complete, perform the Quality Control test layer system query to ensure the software is functioning properly and follow the directions for informing the PDQ Maintenance Team of the successful installation as provided.

Paint sample analysis

The examiner will determine the number of layers present in a paint sample and run each layer on the FTIR. FTIR spectra of each of the layers of the questioned paint must be obtained prior to beginning a layer system query search. The examiner must assess the FTIR data for the paint sample and code the peaks present as defined in the PDQ Users Manual.

PDQ Queries

A USER MANUAL will be provided with each updated version of PDQ. This manual will be stored next to the computer in the Trace Section on which the software is uploaded. The examiner will follow the guidelines in the Manual for performing a PDQ Search.

- The examiner will include a copy of the "Layer System Query Report" in the case jacket. The examiner will write on this sheet the version of PDQ used for the search.
- The examiner 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.
- If the initial PDQ "hit list" exceeds 500 hits , the examiner will consult with the section supervisor to determine if the list should be narrowed by using spectral searching.
- The examiner 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

- The examiner may include the information from a "PDQ Hit List" in their report. The examiner and the technical reviewer will decide on the appropriate wording of the report based on the PDQ Hit list.

- 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" was 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 only intended as a guide for investigative purposes.

- If the examiner includes information in the 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 types and year ranges of manufacture based on the sample(s) provided. This information may be used to located a vehicle. The results of this database search are limited to the data in the most current version of the database at the time of search.

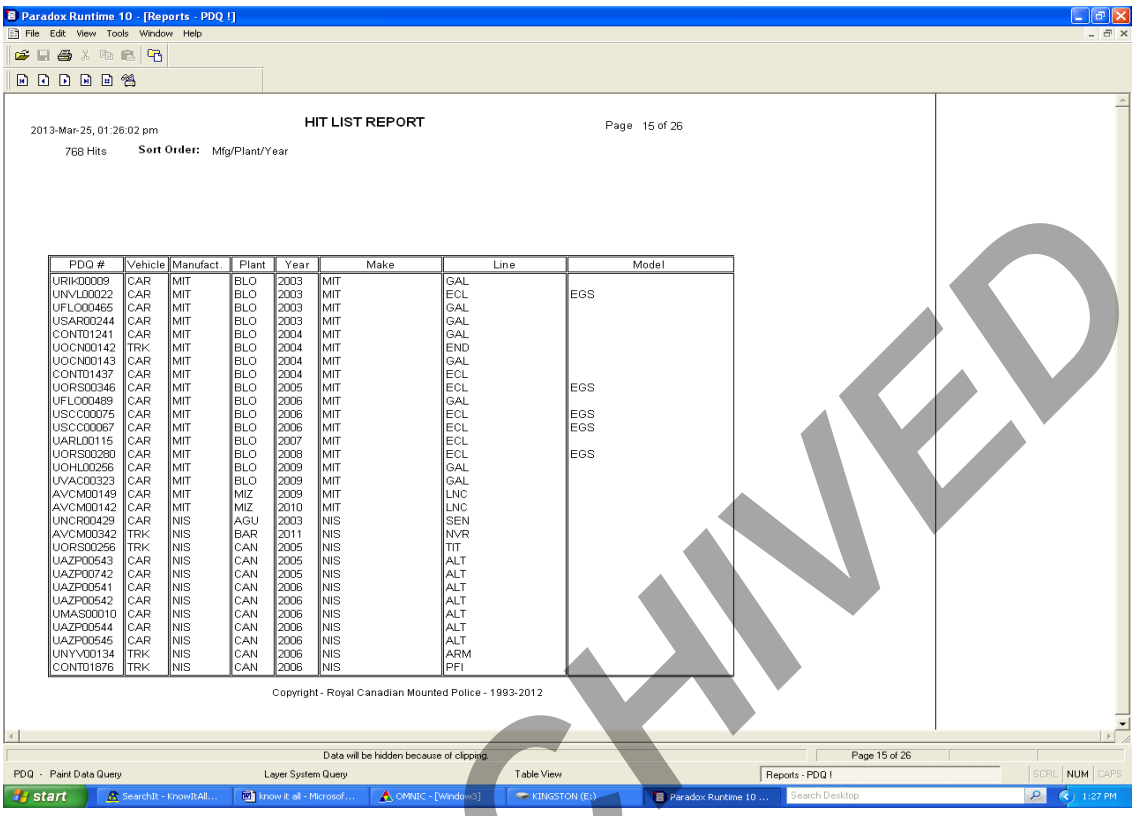
K. Spectral searching using KnowitALL ™ software

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 to the PDQ. The examiner will assess the evidence submitted to determine if the KnowitALL ™ software can be used in a case.

How to perform a KnowitALL ™ Sadtler Search

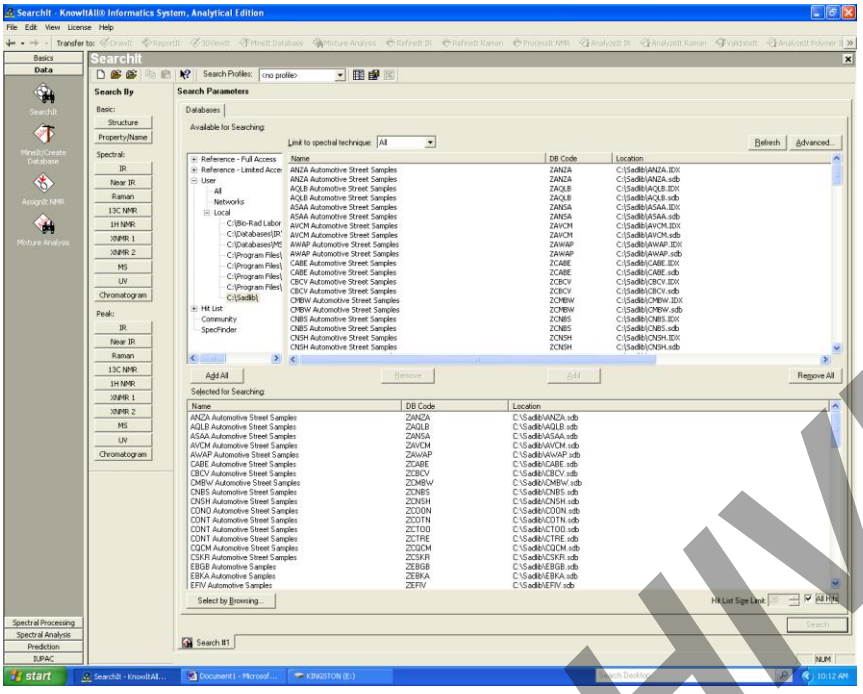
- Open KnowitALL ™ software

- 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.

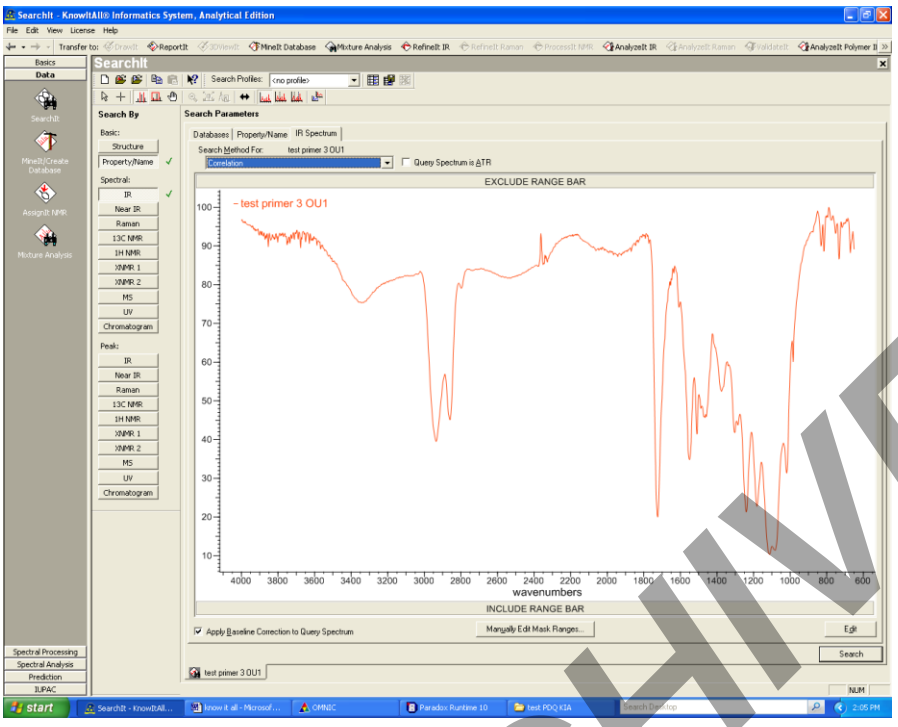


PDQ #	Vehicle	Manufact.	Plant	Year	Make	Line	Model
URIK00009	CAR	MIT	BLO	2003	MIT	GAL	
UNVL00022	CAR	MIT	BLO	2003	MIT	ECL	EGS
UFLO00465	CAR	MIT	BLO	2003	MIT	GAL	
USAR00244	CAR	MIT	BLO	2003	MIT	GAL	
CONT01241	CAR	MIT	BLO	2004	MIT	GAL	
UOCN00142	TRK	MIT	BLO	2004	MIT	END	
UOCN00143	CAR	MIT	BLO	2004	MIT	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	

- Before you begin your search you must ensure the appropriate search libraries are chosen. Under the “Basics” heading, click on the “Data” tab, then choose the “SearchIt” icon. Add all of the PDQ libraries (under C:\Sadlib). Choose “add all” (or highlight libraries of interest and choose “add”) - check “All Hits” on the bottom right.

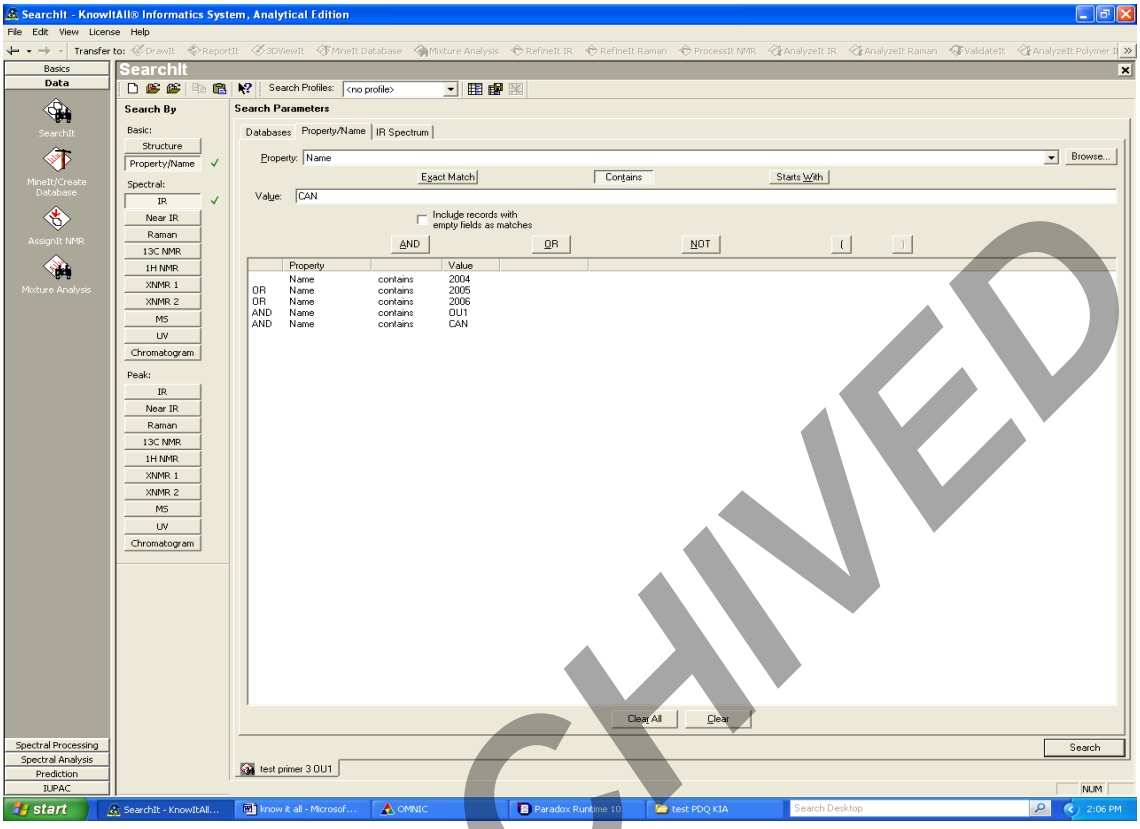


- Then enter search parameters:
  Under "Spectral" heading, click the "IR"tab then, starting with the most unique layer, open the appropriate file for the layer that you are searching (for example test primer 3 OU1)

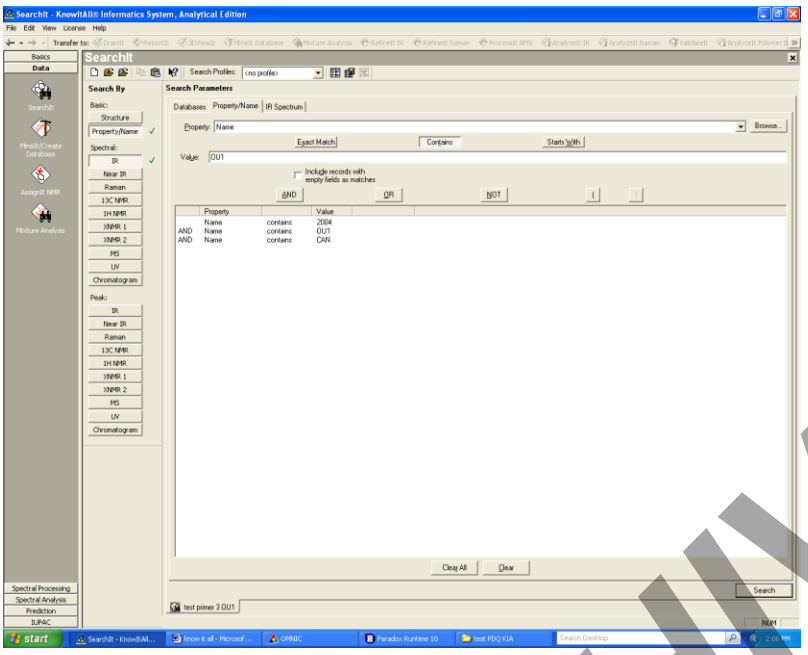


- Then enter year/manufacturer/ layer information from PDQ layer system query search. Under the "Basics" heading click "property/name" and in the "Property/Name" field, and choose "Name" in the drop down menu. In "value" field, first enter the year(s) you are evaluating, click on "AND" then enter the 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"



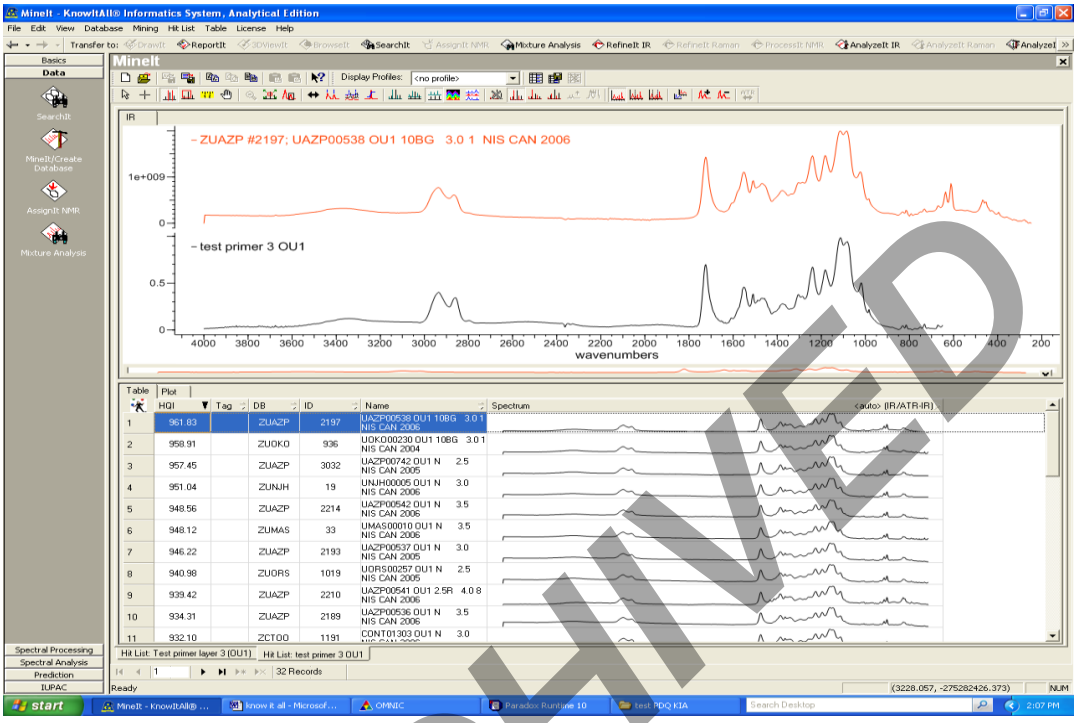
- When searching between years, the "OR" drop down must be used. The "AND" drop down field must be utilized in between plant codes and layer information. You will see a green check mark next to your selected fields of search ("IR" and "Property/name").

- Click the "Search " tab located in the bottom right.

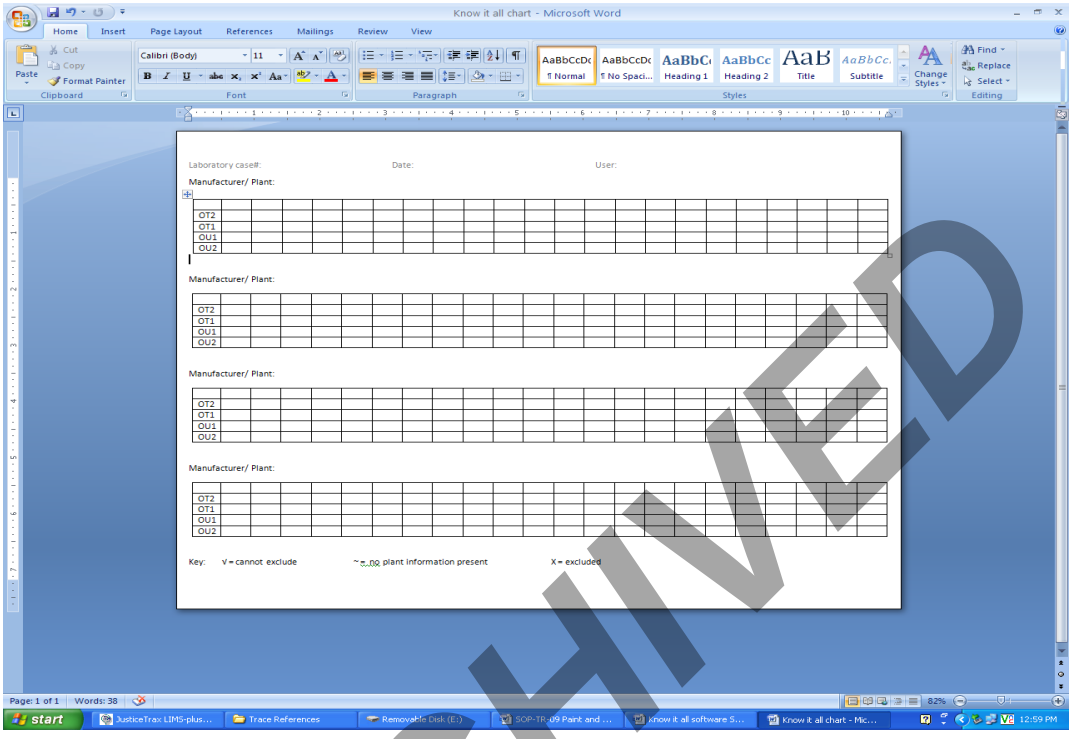
- The search will then be found under the "Mine it" field.

- 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 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 analyst discretion should be used here. 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 case notes



Evaluating spectral searching data

When you are unable to exclude a plant based on significant spectral differences, then you must include it. Significant differences in spectras 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 as it is unknown exactly when a manufacturer starts and stops production on a particular model during a specific year. Example, if using the software 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:"
(Example)
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 as such:
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/ year ranges of vehicles with similar paint system chemistry, however notable spectral differences were observed in all of the vehicles listed and failed to disclose significant results. The PDQ list is available upon request.

Required statement
An examiner must indicate that there may have been more models manufactured at this plant during this time period, but the results are limited to the samples that were available in the PDQ. Or not all vehicles/ makes/ models are represented and information provided is used for an investigative guide.

L. References:
PDQ 2012 Users Manual
Boston Police Department Crime Laboratory: Trace Evidence Section Procedure