The State of Data in Explosives and Ignitable Liquids

Michael Sigman and Mary Williams
National Center for Forensic Science
University of Central Florida

Acknowledgements

The NCFS Databases have been partially supported by:

1. *The National Center for Forensic Science, A State of Florida Type II Research Center.*
2. *Award Numbers 2005-MU-MU-K044, 2008-IJ-CX-K401, 2011-DN-BX-K539,* 2015-DN-BX-K051 *awarded by the National Institute of Justice, Office of Justice Programs, U.S. Department of Justice. The opinions, findings, and conclusions or recommendations expressed in this presentation are those of the authors and do not necessarily reflect those of the Department of Justice.*
3. *The Prevention of and Fight against Crime Programme of the European Union. This project has been funded with support from the European Commission. This publication reflects the views only of the author, and the European Commission cannot be held responsible for any use which may be made of the information contained therein.*

Presentation Outline

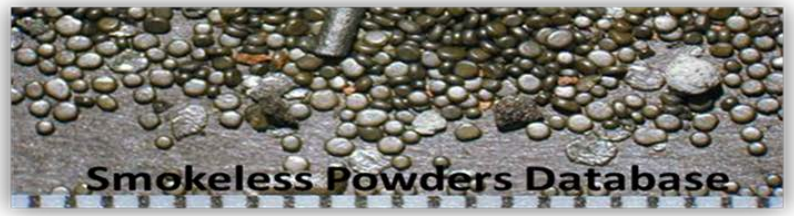
- Overview of NCFS databases and partnerships
- Detailed Descriptions
  - Ignitable Liquids Reference Collection Database
  - International Database of Ignitable Liquids
  - Substrates Database
  - Smokeless Powders Database
- Future needs and directions
- Summary

NCFS Database Time Line

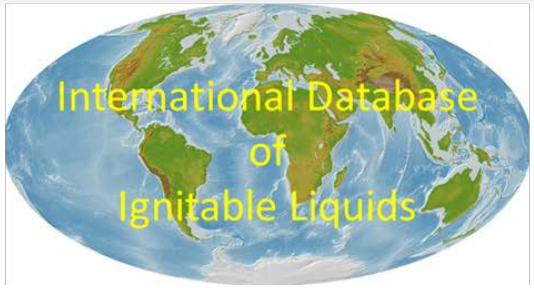
2000 ➡

2010 ➡

2011 ➡



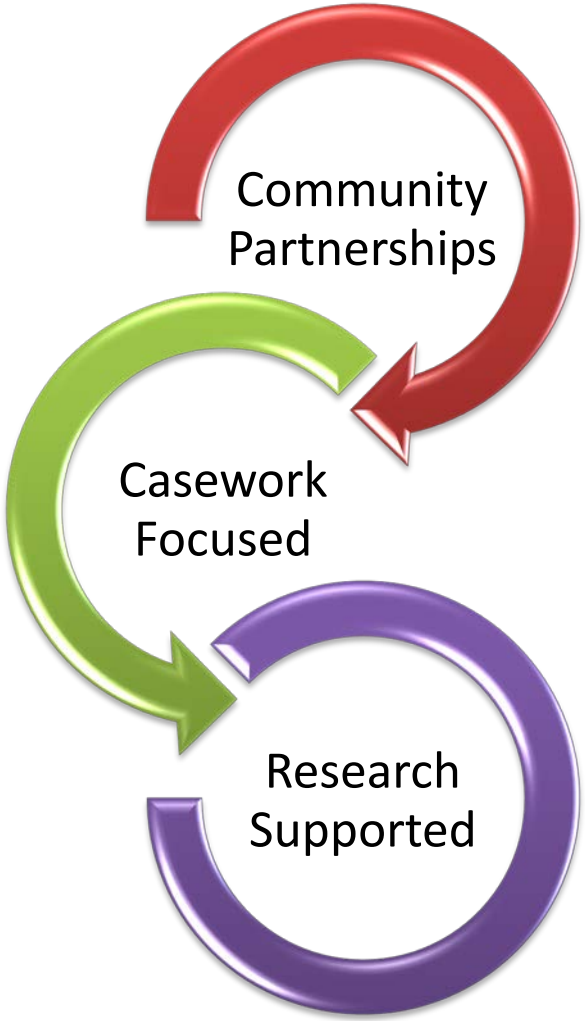
2016 ➡



T/SWGFEX Partnership

ENFSI (+) Partnership

NCFS Database Development



Database projects are driven by needs of the forensic science community and conducted as partnerships with the community.

Databases are designed to meet the daily needs of analysts performing casework. Database growth to answer new questions and meet new casework needs is anticipated.

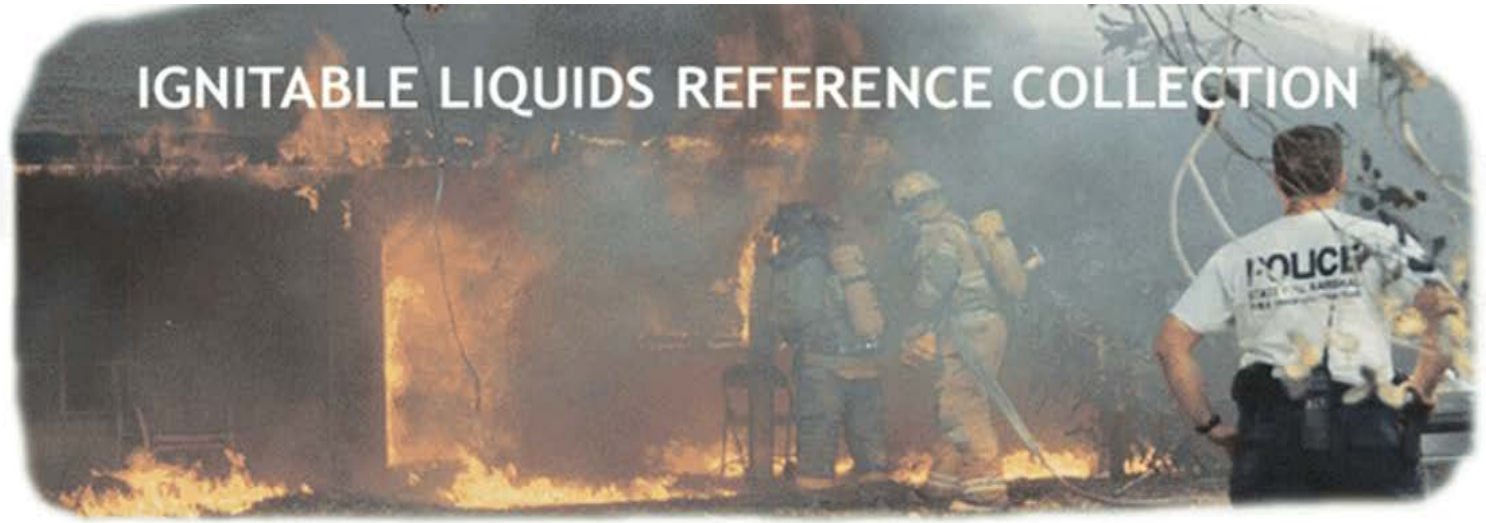
Combining Community Partnerships and Casework Focus with literature and community driven research support is a strong basis for obtaining competitive funding.

Ignitable Liquids Database

Substrate Database

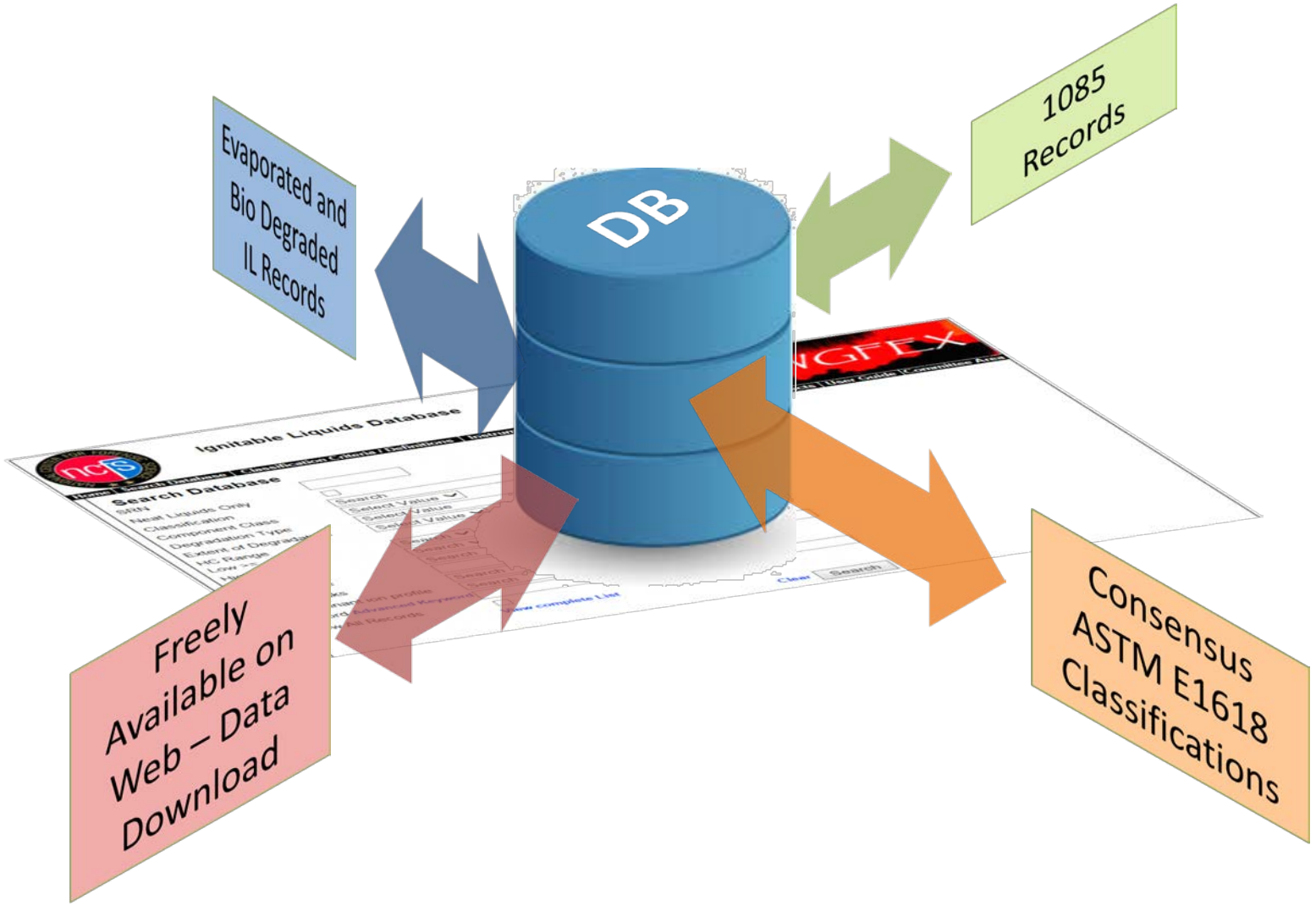
TWGFEX

Home | Search Database | Classification Criteria / Definitions | Instrument Parameters | Download All | Contacts | Help | Committee Area



http://ilrc.ucf.edu/

Ignitable Liquids Reference Collection Database



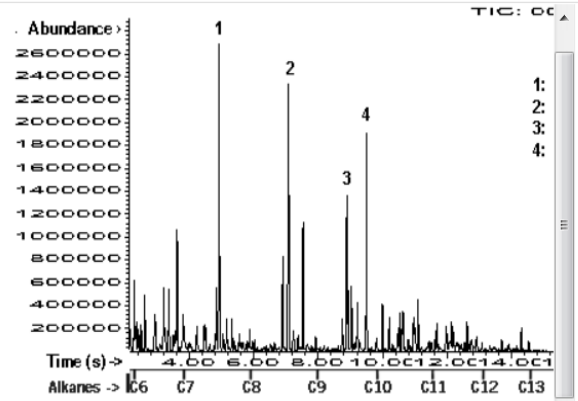
ILRC Database: Search Page

ILRC Database: Search Results

Ignitable Liquids Reference Collection

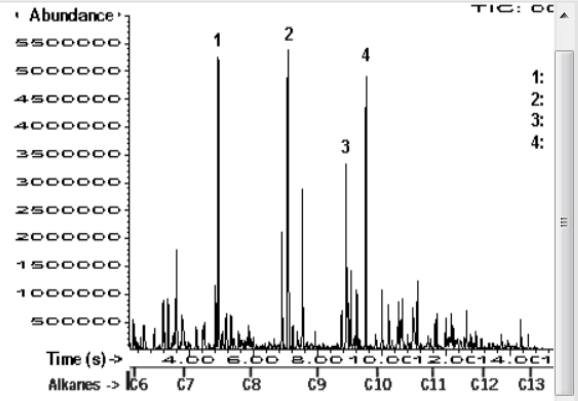
Total Records: 34
Certain browsers scale the image. Please click on the image to zoom in/out

SRN	Brand Name	HC Range	Predominant ion profile	Classification	Major Peaks



SRN	0096
Brand Name	BP Regular Unleaded Gasoline
HC Range	C 6-C 14
Predominant ion profile	Aromatics
Classification	Gasoline
Major Peaks	1,2,4-trimethylbenzene m,p-ethyltoluene m,p-xylene toluene

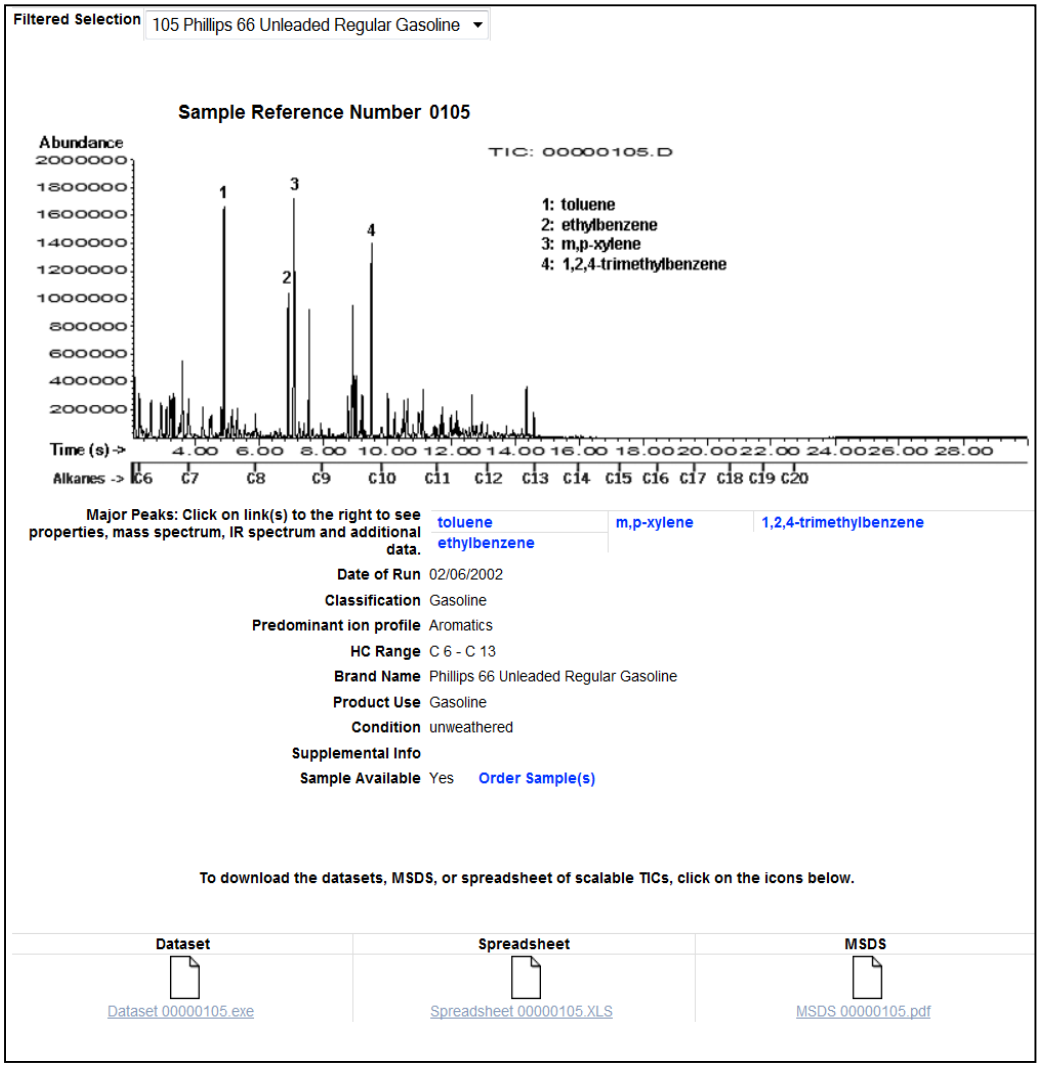
Sample detail & download section



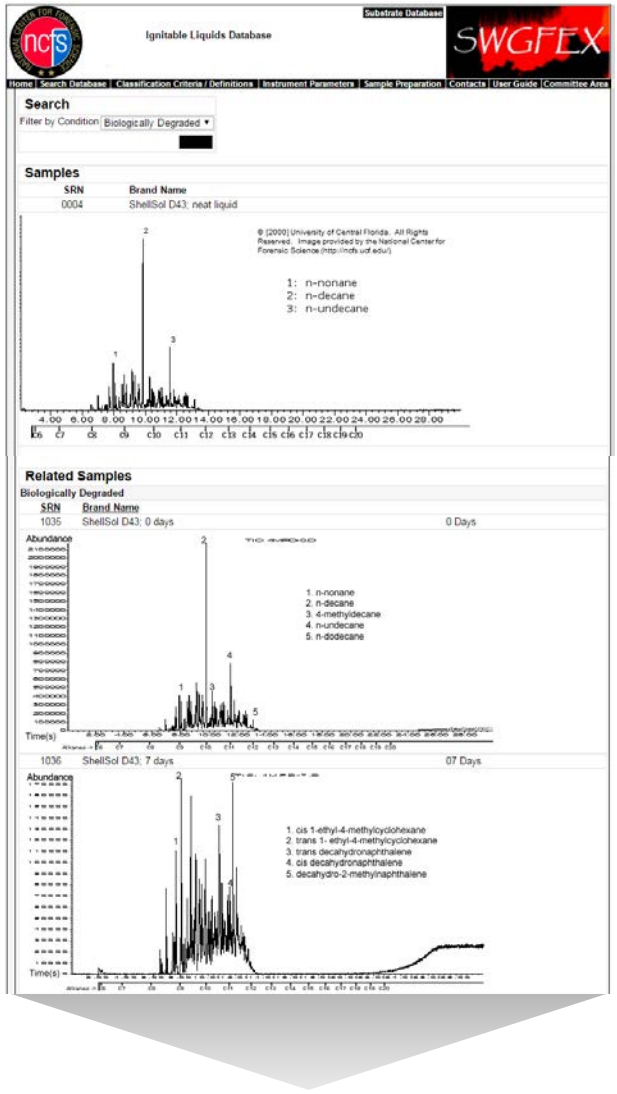
SRN	0097
Brand Name	BP Regular Unleaded Gasoline
HC Range	C 6-C 14
Predominant ion profile	Aromatics
Classification	Gasoline
Major Peaks	1,2,4-trimethylbenzene m,p-ethyltoluene m,p-xylene toluene

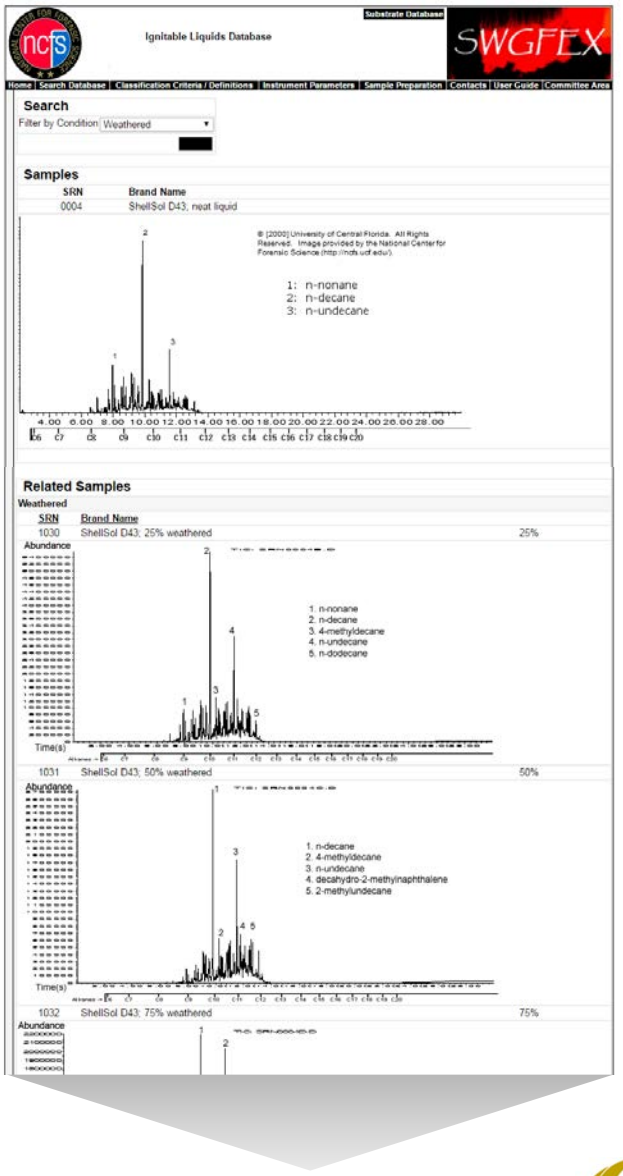
Sample detail & download section

ILRC Database: Sample Detail & Download



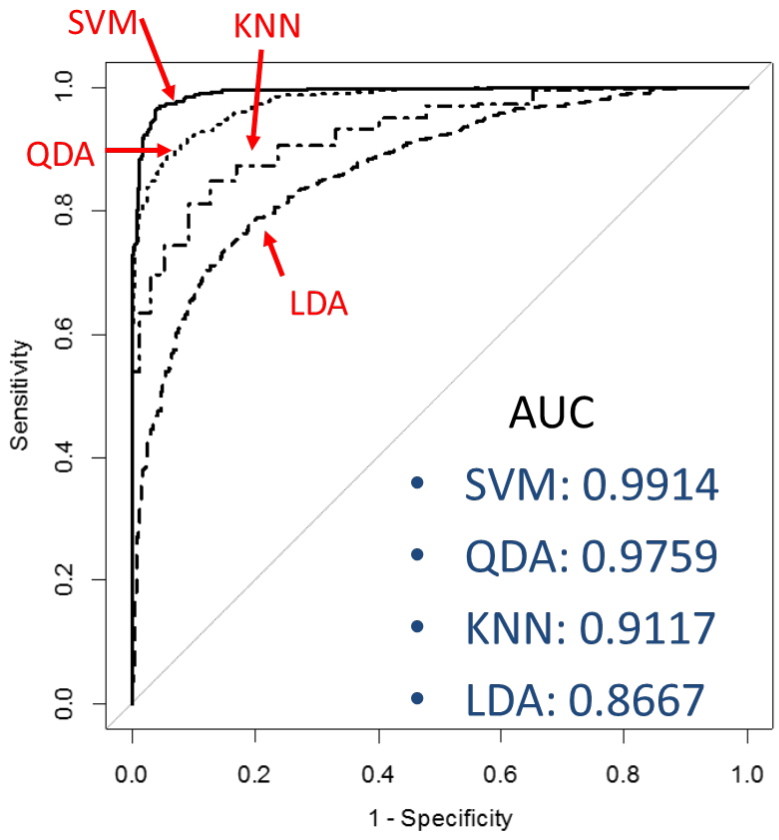
ILRC Database: Related Samples

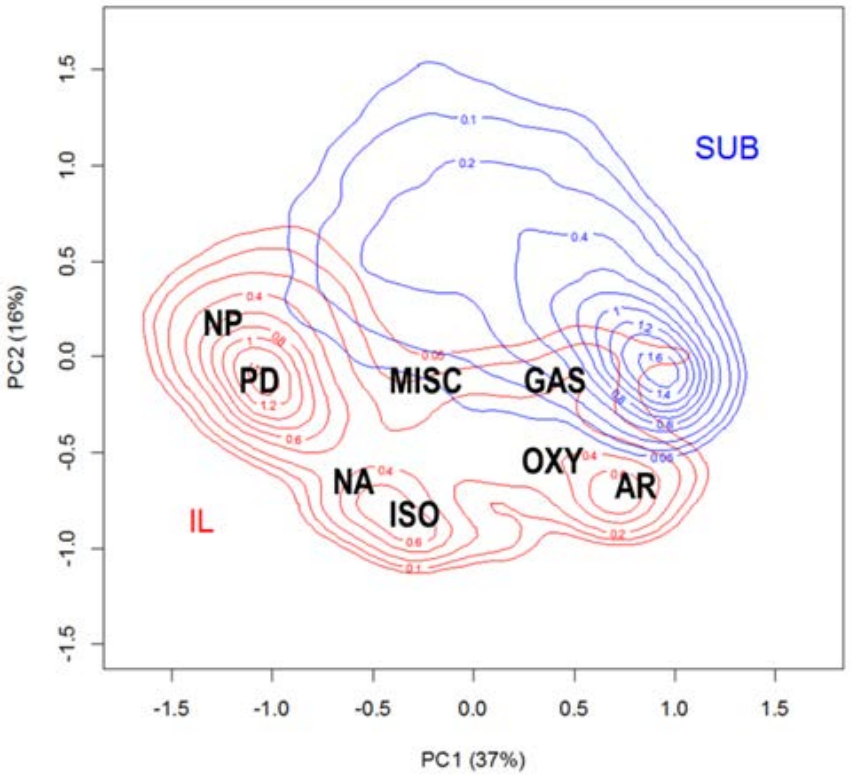




Modeling Fire Debris: Classification Models

Fire Debris 0 – 100% SUB, Validation Data

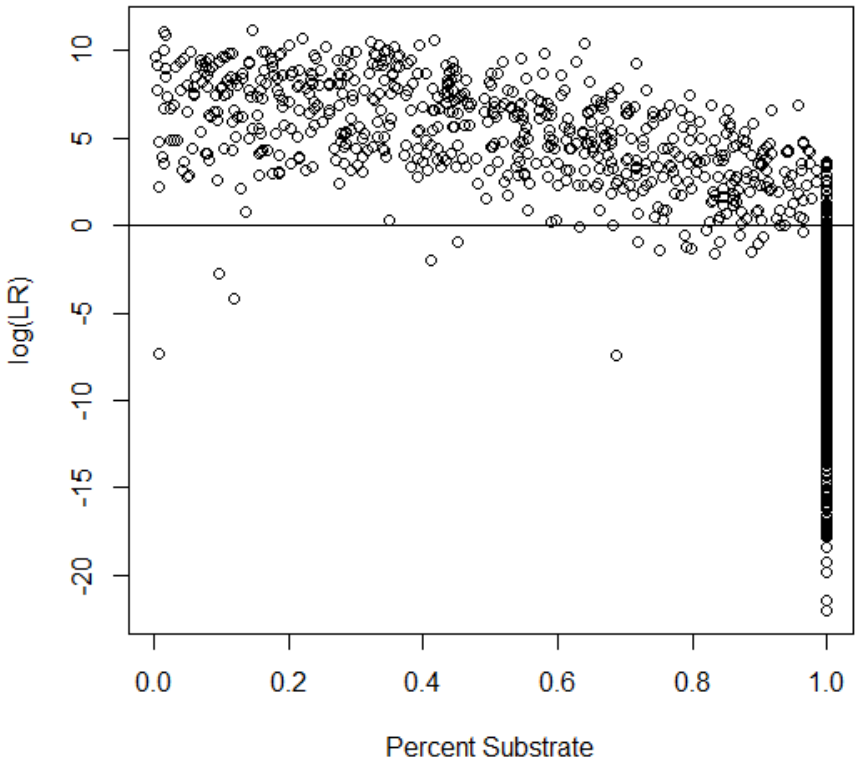


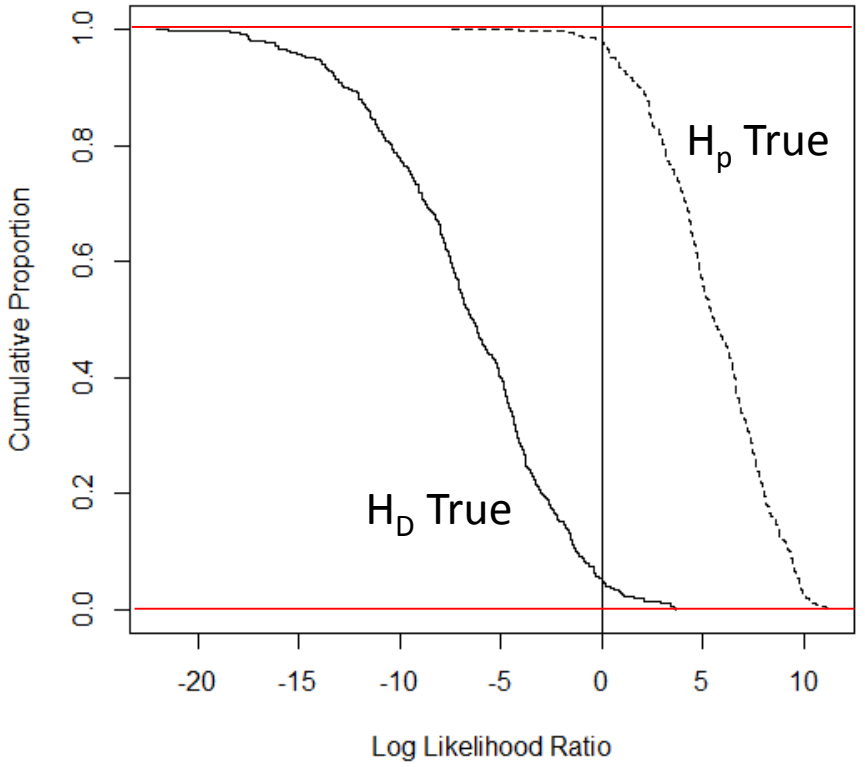


Sigman, M. E.; Williams, M. R., "Assessing Evidentiary Value in Fire Debris Analysis by Chemometric Approaches", Forensic Sci. International, (**2016**) 264, 113 – 121.

Tippett Plot

Fire Debris 0 – 100% SUB, Validation Data





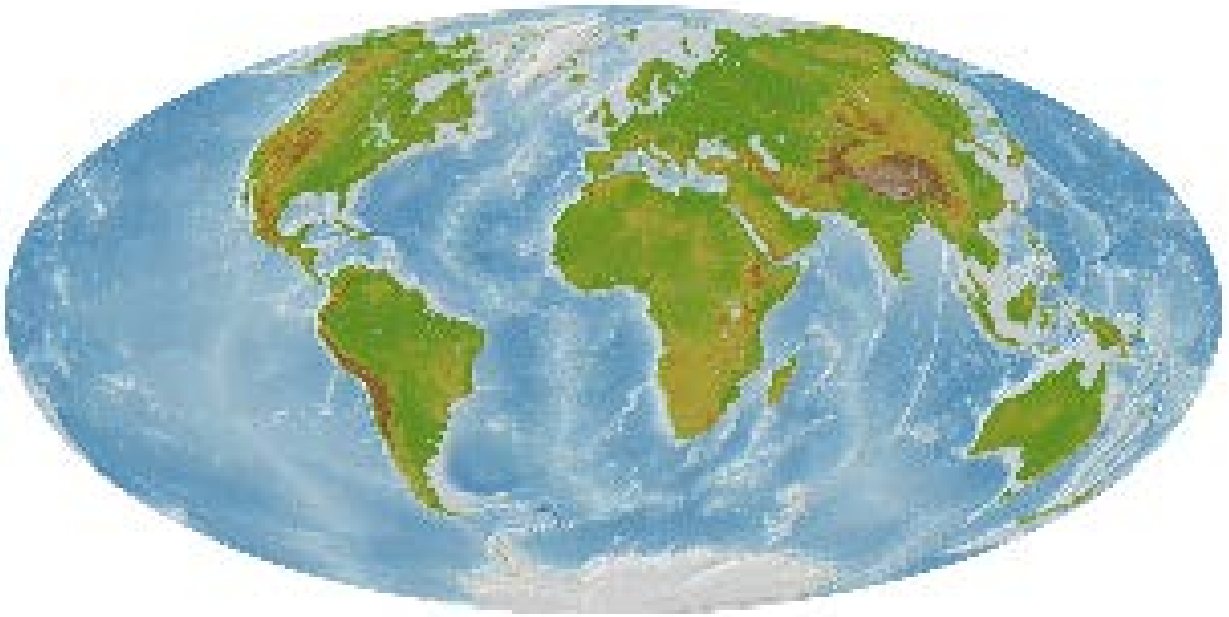
H_P: The sample is positive for ILR
H_D: The sample is not positive for ILR

International Database of Ignitable Liquids

Home | Search Database | Contacts | User Guide | Download | Administration

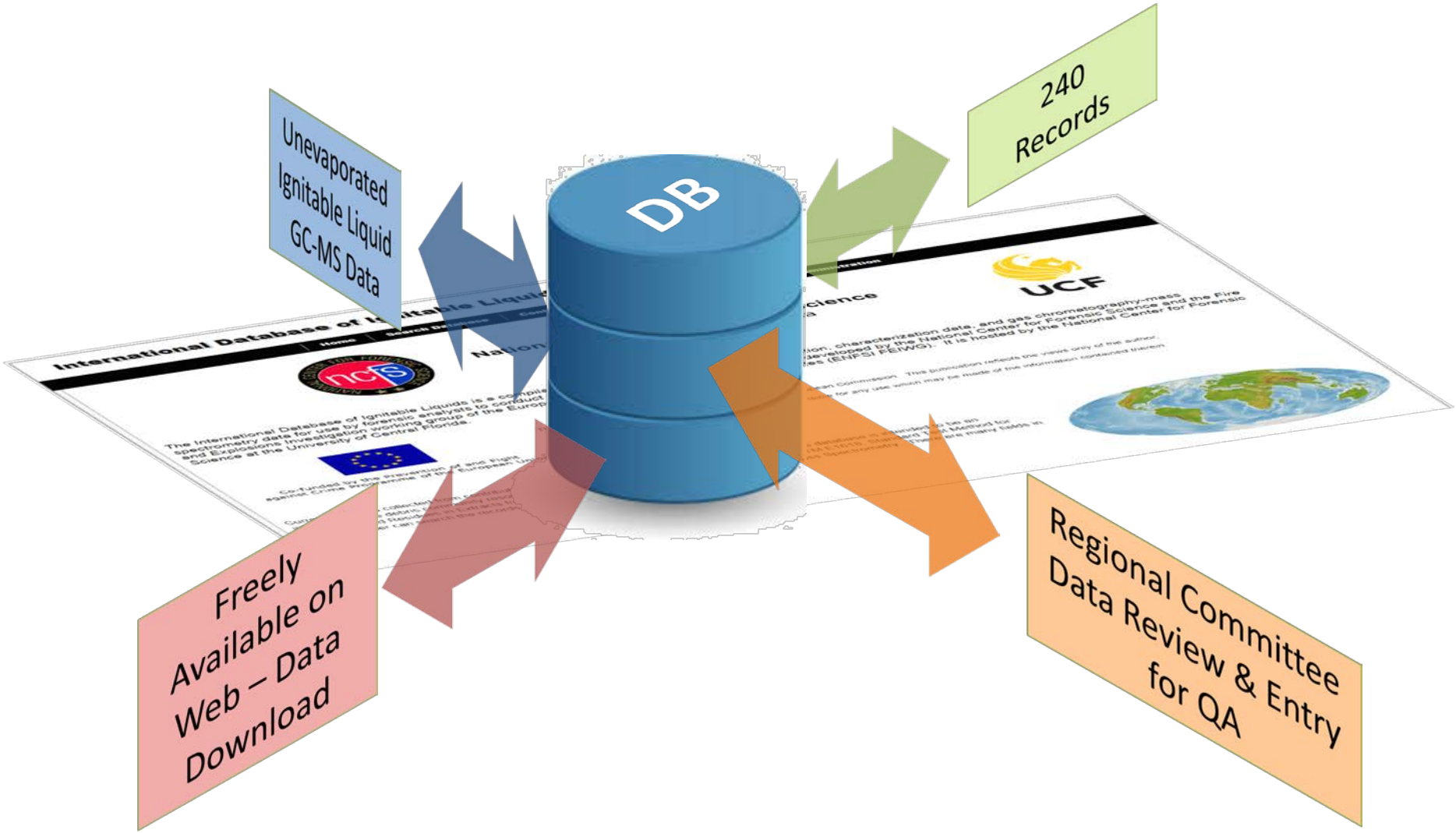
National Center for Forensic Science
University of Central Florida

Co-funded by the Prevention of and Fight against Crime Programme of the European Union

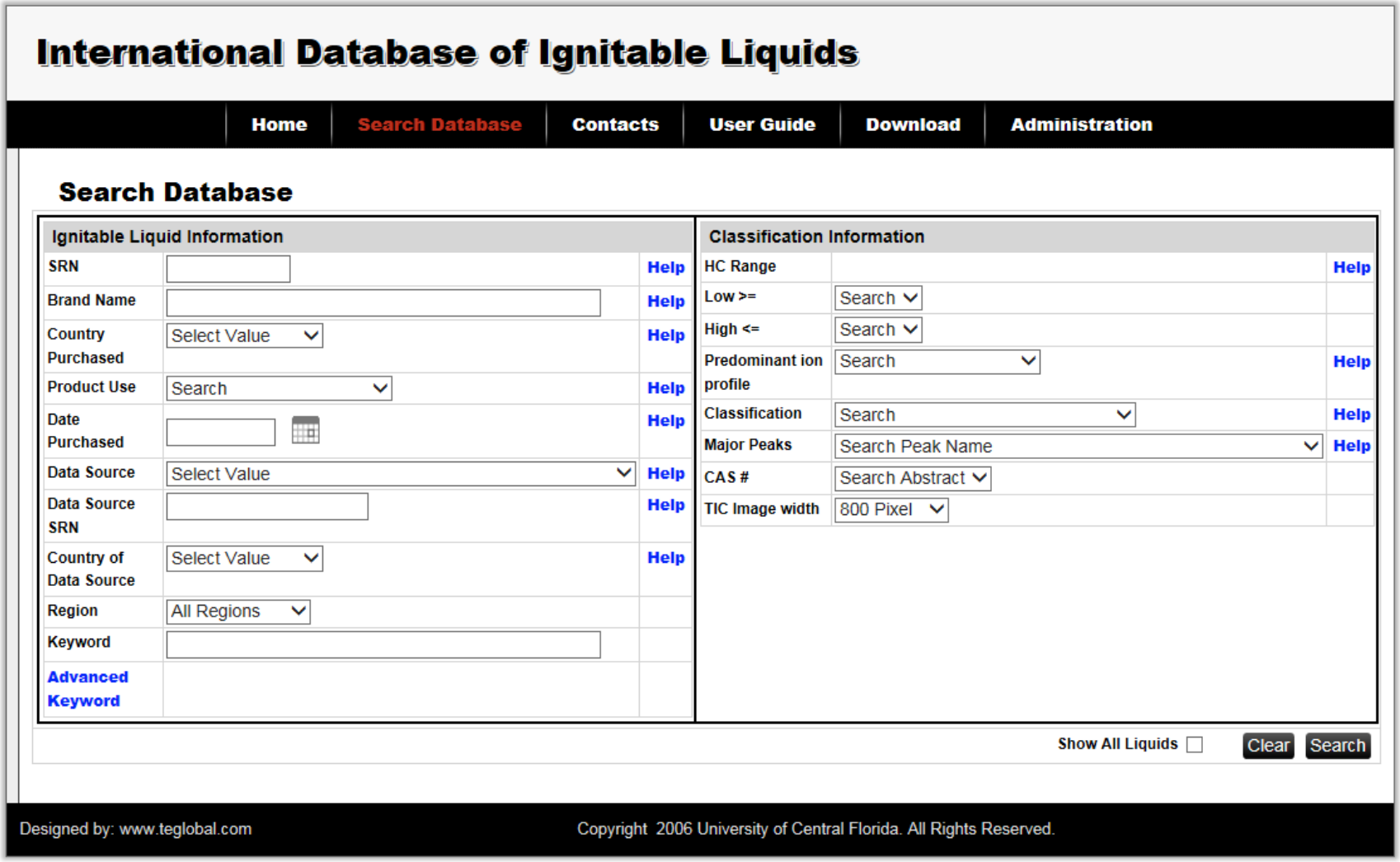


http://ncfs.ucf.edu/internationaldb/

International Database of IL



International Database of IL: Search Page



International Database of IL: Search Results

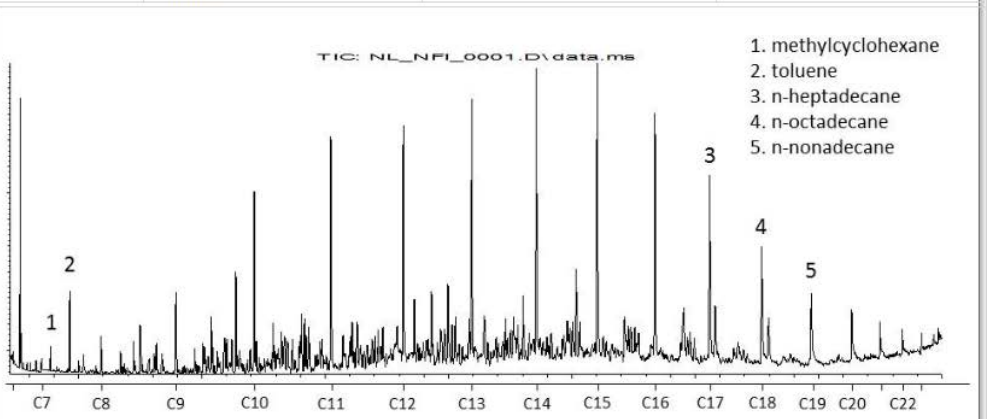
Released Samples

Total Records: 7

SRN	Brand Name	HC Range	Predominant ion profile	Classification	Major Peaks

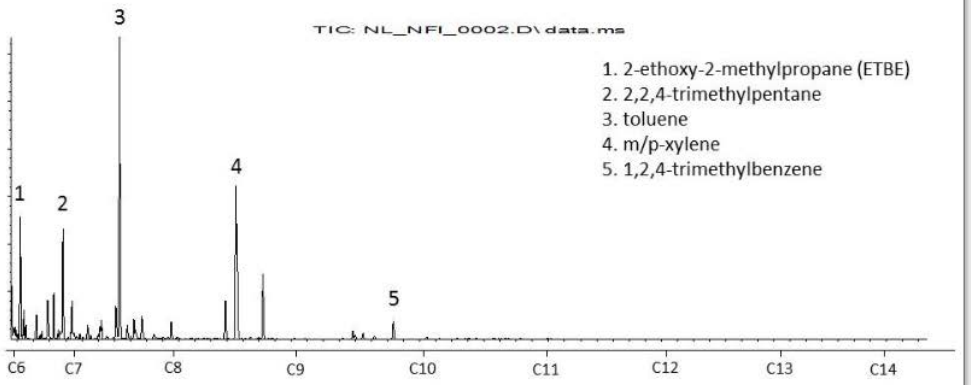
SRN	0032
Country Purchased	Netherlands
Brand Name	Diesel, Shell
HC Range	C 6-C 23
Predominant ion profile	Alkanes
Classification	Heavy petroleum distillate (HPD)
Major Peaks	methylcyclohexane | 0000108-87-2 n-heptadecane | 0000629-78-7 n-hexadecane | 0000544-76-3 n-nonadecane | 0000629-92-5 toluene | 0000108-88-3

Sample detail & download section

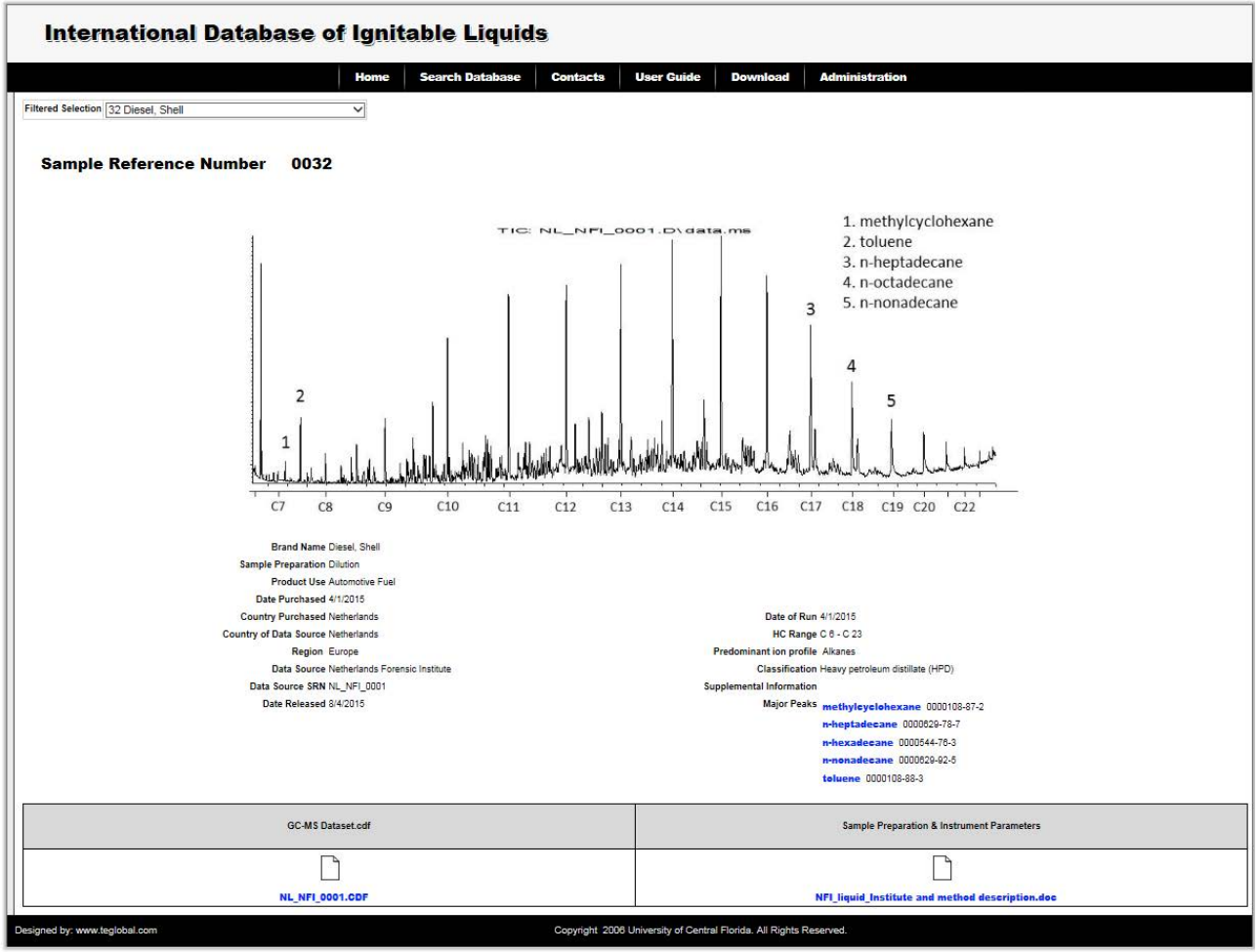


SRN	0037
Country Purchased	Netherlands
Brand Name	Gasoline, BP Ultimate
HC Range	C 6-C 12
Predominant ion profile	Aromatics
Classification	Gasoline
Major Peaks	1,2,4-trimethylbenzene | 0000095-63-6 2,2,4-trimethylpentane | 0000540-84-1 2-ethoxy-2-methylpropane (ETBE) | 0000637-92-3 m,p-xylene | 0000108-38-3 toluene | 0000108-88-3

Sample detail & download section

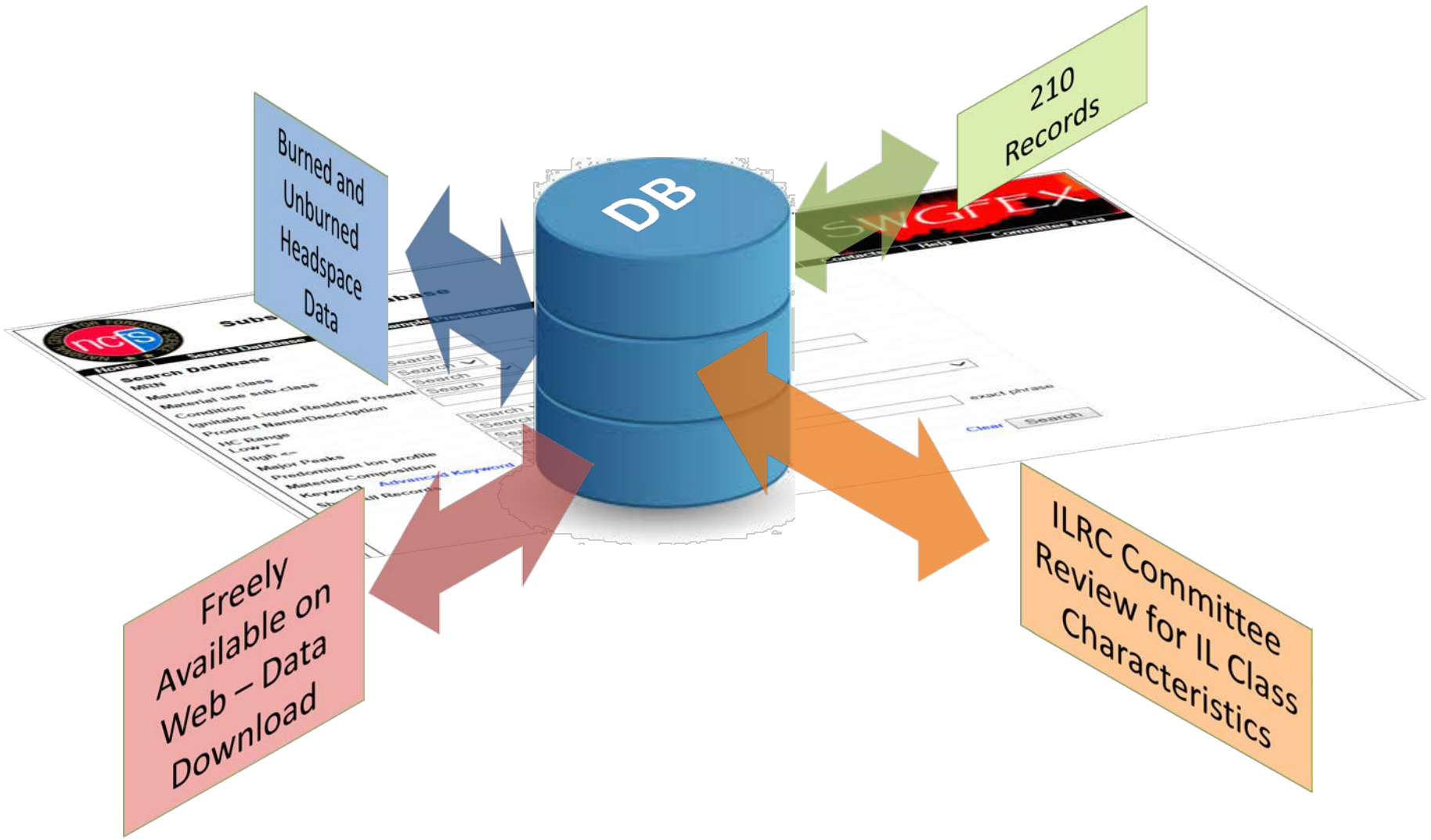


International Database of IL: Sample Detail & Download

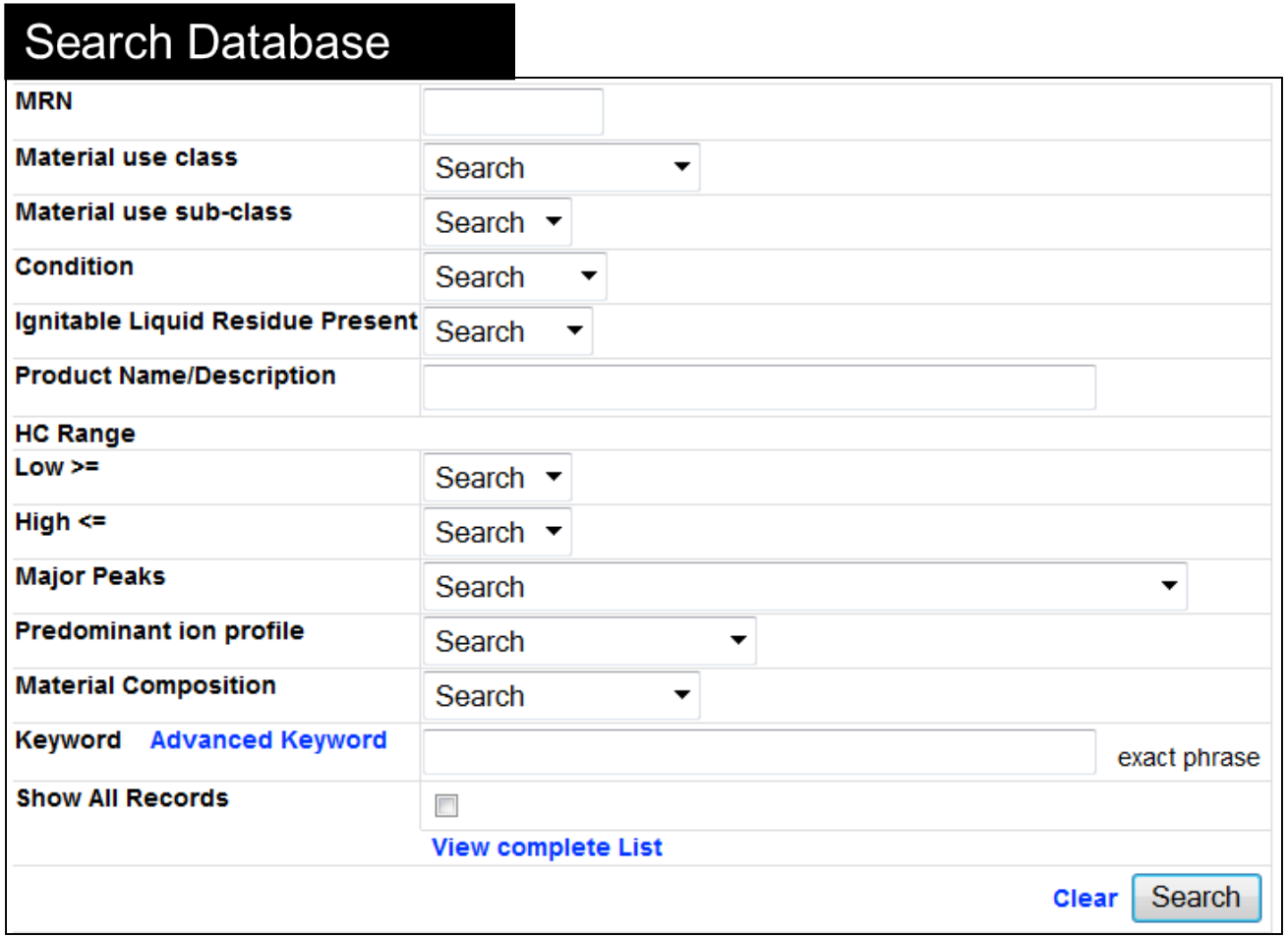


http://ilrc.ucf.edu/substrate/

Substrate Database



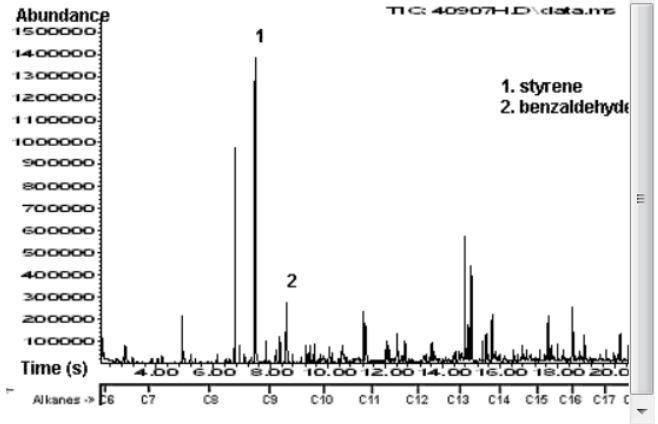
Substrate Database: Search Page



Substrate Database: Search Results

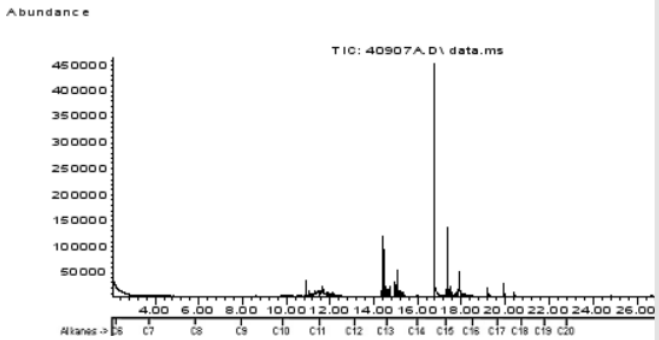
Total Records: 14
Certain browsers scale the image. Please click on the image to zoom in/out

MRN	Product Name/Description	HC Range	Condition	Material use class	Major Peaks



MRN	0007
HC Range	C 7-C 19
Material use class	Flooring
Material use sub-class	Carpet
Product Name/Description	Olefin Carpet
Ignitable Liquid Residue Present	None
Condition	Burned
Major Peaks	benzaldehyde styrene
Predominat Profile	Cycloalkanes/alkenes
Material Composition	polypropylene

Sample detail & download section



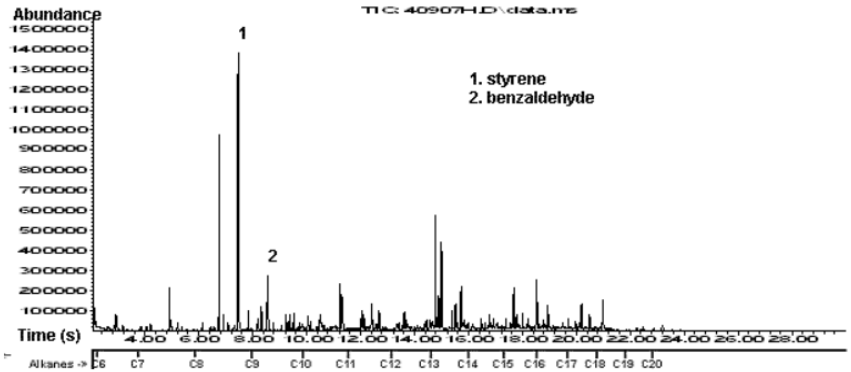
MRN	0008
HC Range	C 10-C 18
Material use class	Flooring
Material use sub-class	Carpet
Product Name/Description	Olefin Carpet
Ignitable Liquid Residue Present	None
Condition	Unburned
Major Peaks	Peaks not identified
Predominat Profile	Cycloalkanes/alkenes
Material Composition	polypropylene

Sample detail & download section

Substrate Database: Sample Detail & Download

Filtered Selection 7 Olefin Carpet

Material Reference Number 0007



Major Peaks: Click on link(s) to the right to see properties, mass spectrum, IR spectrum and additional data. benzaldehyde | styrene

Date of Run	04/09/2007
Ignitable Liquid Residue Present	None
Material use class	Flooring
Material use sub-class	Carpet
HC Range	C 7 - C 19
Product Name/Description	Olefin Carpet
Sample information	100% Olefin Manufacturer: Shaw Color: Viking-Stingray
Condition	Burned
Predominant ion profile	Cycloalkanes/alkenes
Material Composition	polypropylene

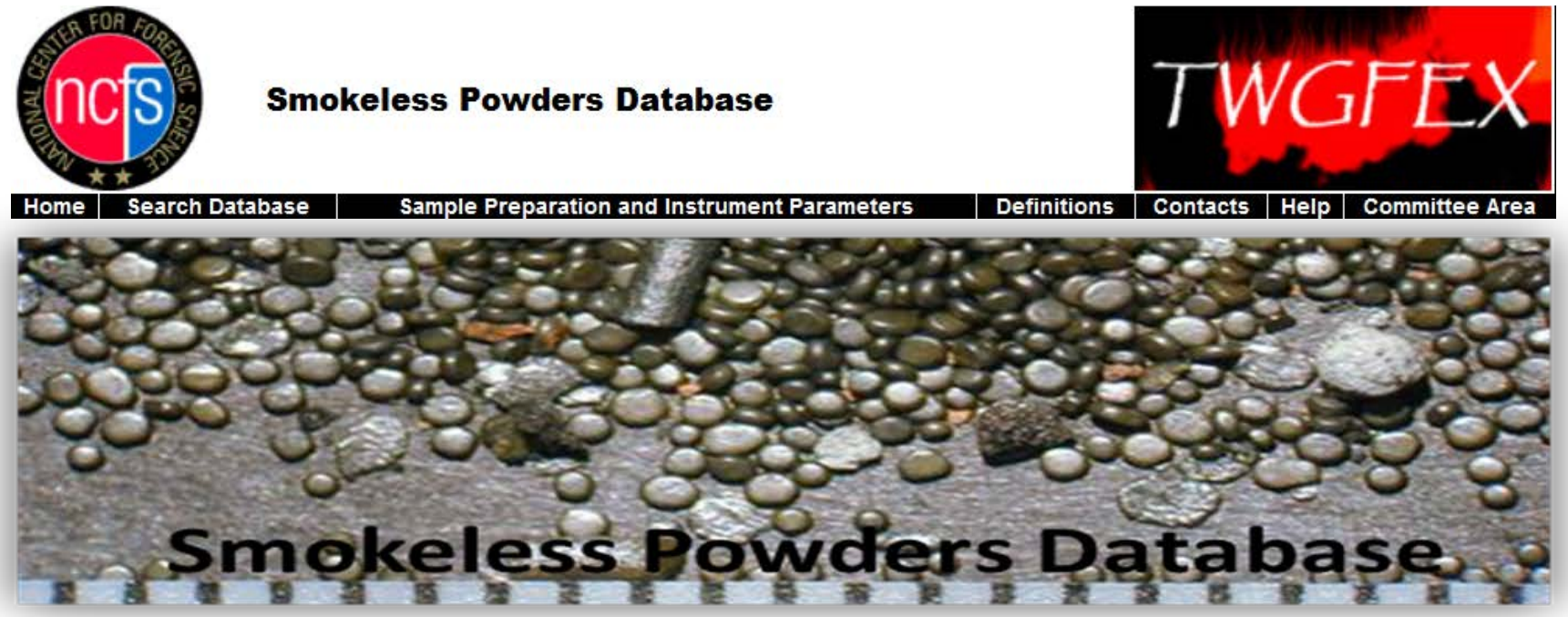
To download the datasets, spreadsheet or additional sample information of scalable TICs, click on the icons below.

Dataset	Spreadsheet	Additional Sample Information
Dataset M0000007.exe	Spreadsheet M0000007.xls	Sample Information M007.pdf

Substrate Database: Current Expansion Work

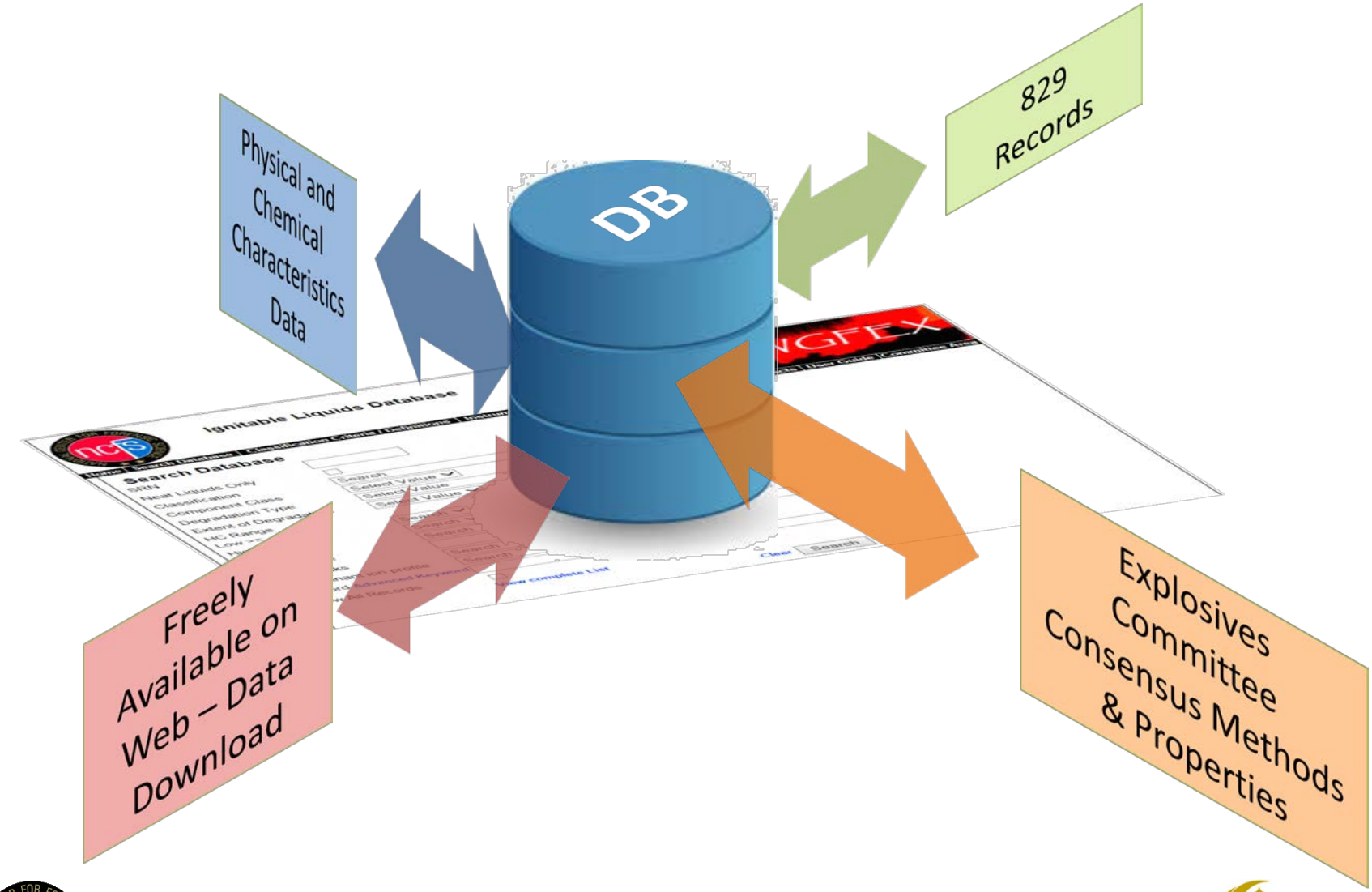
- Addition of 1350 new records
- Multiple burn methods
- Tabulation of frequency of occurrence of 255 major compounds in each ILRC and Substrates Database record
- Investigation of improved modeling of fire debris using new substrate pyrolysis data

2015-DN-BX-K051 *awarded by the National Institute of Justice, Office of Justice Programs, U.S. Department of Justice*

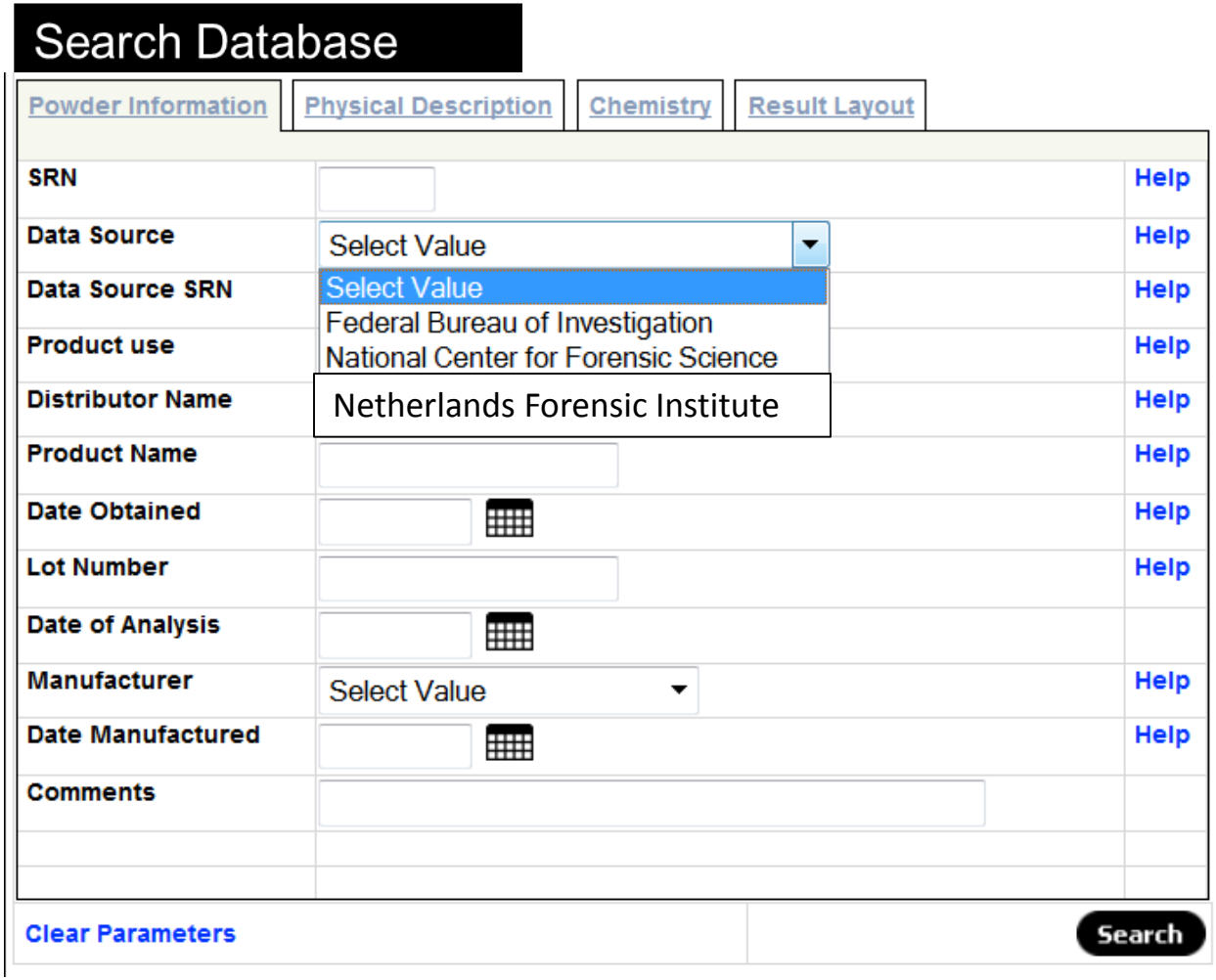


http://www.ilrc.ucf.edu/powders/

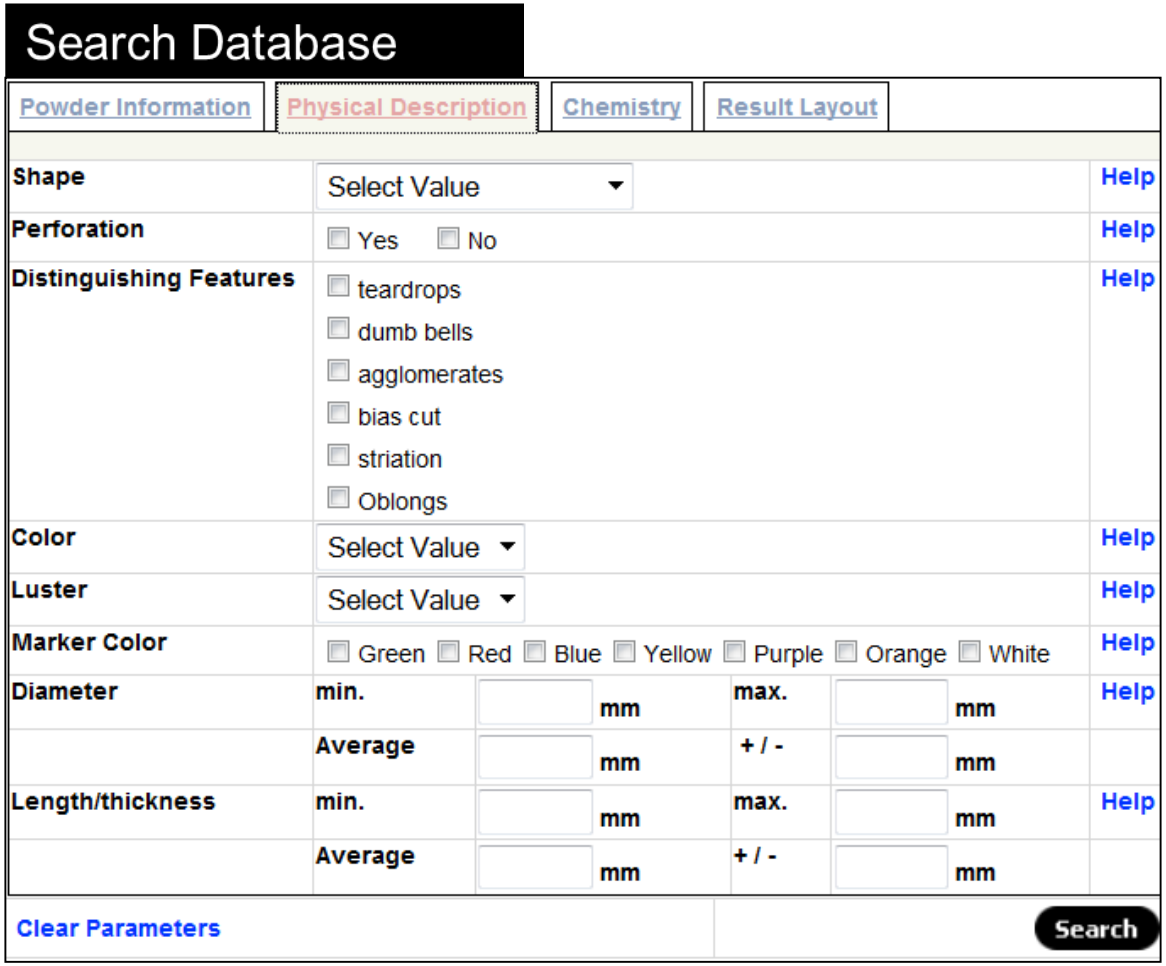
Smokeless Powders Database



Smokeless Powders Database: Search Page



Smokeless Powders Database: Search Page



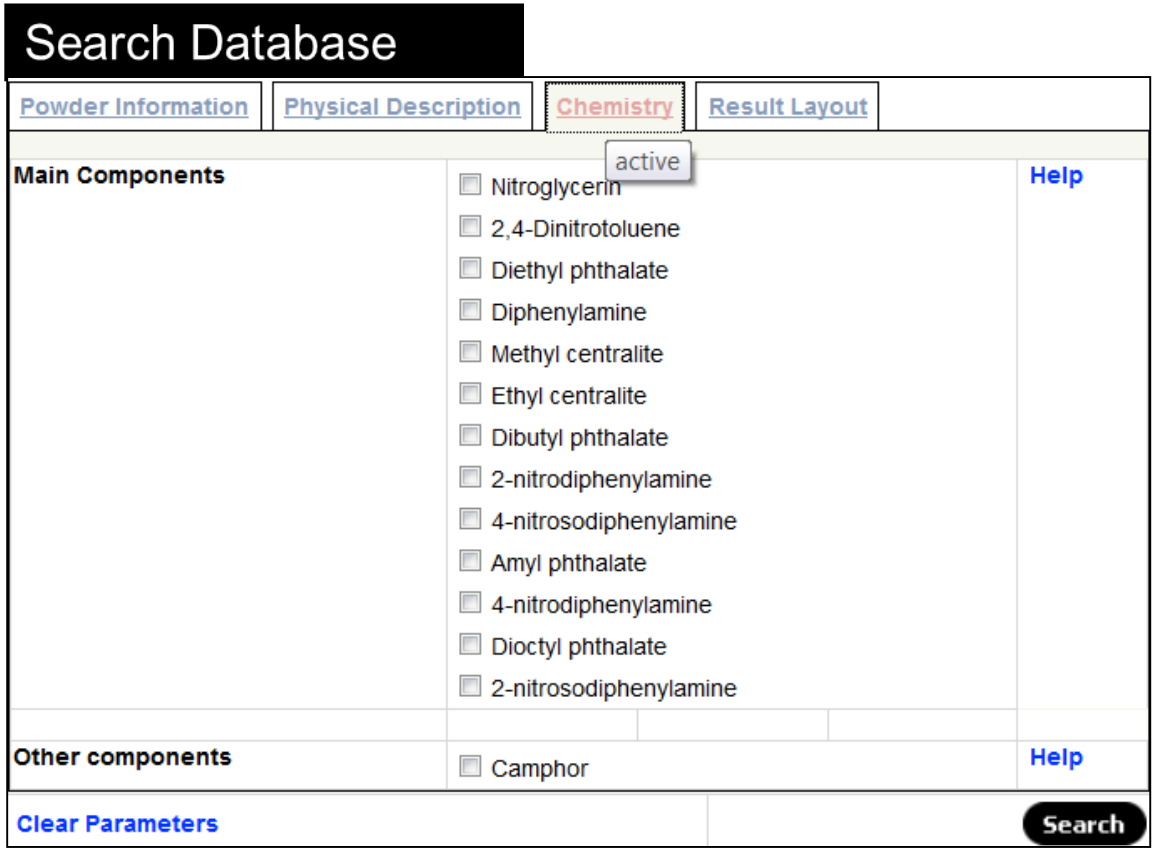
Search Database

Powder Information | Physical Description | Chemistry | Result Layout

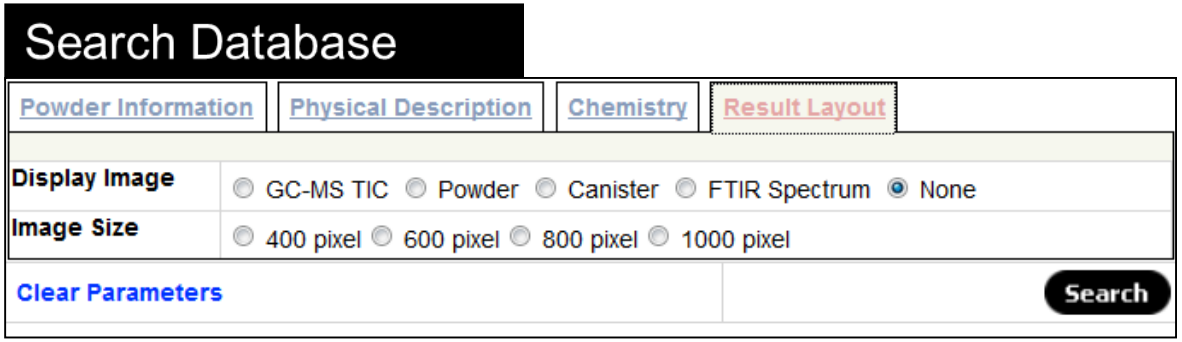
Shape	Select Value					Help
Perforation	☐ Yes ☐ No					Help
Distinguishing Features	☐ teardrops ☐ dumb bells ☐ agglomerates ☐ bias cut ☐ striation ☐ Oblongs					Help
Color	Select Value					Help
Luster	Select Value					Help
Marker Color	☐ Green ☐ Red ☐ Blue ☐ Yellow ☐ Purple ☐ Orange ☐ White					Help
Diameter	**min.**		**mm**	**max.**	**mm**	Help
	Average		**mm**	**+ / -**	**mm**	
Length/thickness	**min.**		**mm**	**max.**	**mm**	Help
	Average		**mm**	**+ / -**	**mm**	

Clear Parameters | Search

Smokeless Powders Database: Search Page



Smokeless Powders Database: Results Layout

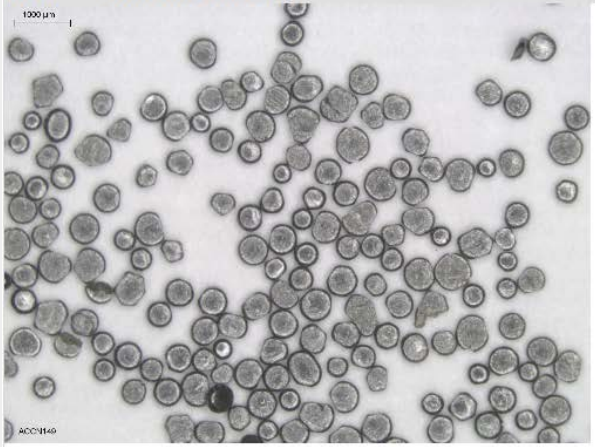


Smokeless Powders Database: Search Results

Total Records: 14

SRN	Distributor	Product Name

0101 Winchester 296



SRN	0101
Distributor	Winchester
Product Name	296
Shape	flattened ball
avg. Diameter	0.50 mm
avg. Length/thickness	
List of components	Nitroglycerin Diethyl phthalate Diphenylamine Ethyl centralite Dibutyl phthalate 2-nitrodiphenylamine 4-nitrodiphenylamine

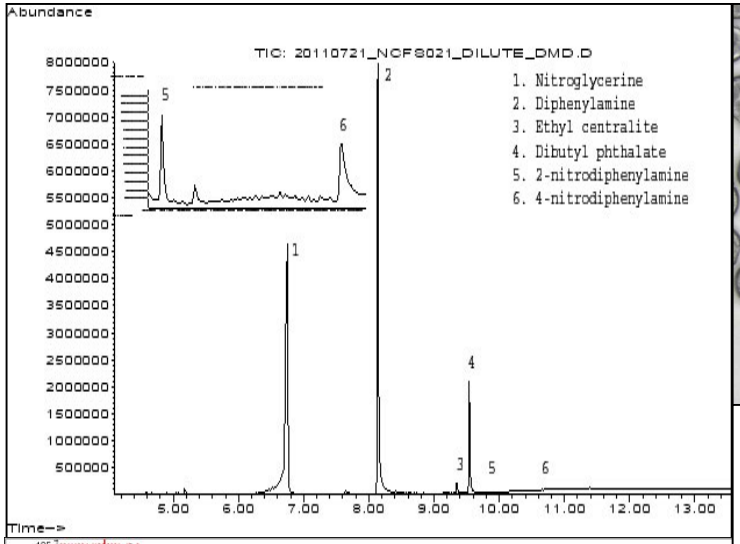
Sample detail & download section

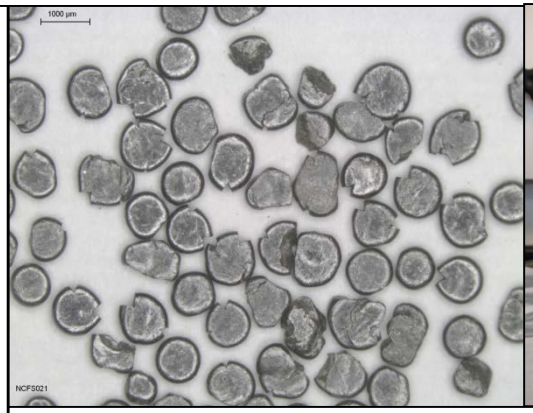
0139 Hodgdon HS-6

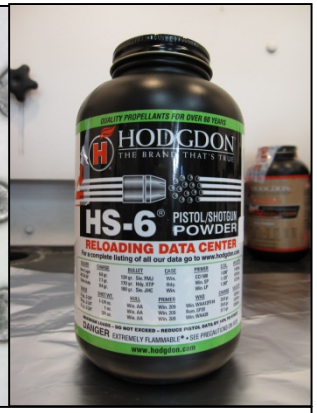
SRN	0139
Distributor	Hodgdon
Product Name	HS-6
Shape	flattened ball
avg. Diameter	0.90 mm
avg. Length/thickness	
List of components	Nitroglycerin Diphenylamine Ethyl centralite Dibutyl phthalate 2-nitrodiphenylamine 4-nitrodiphenylamine

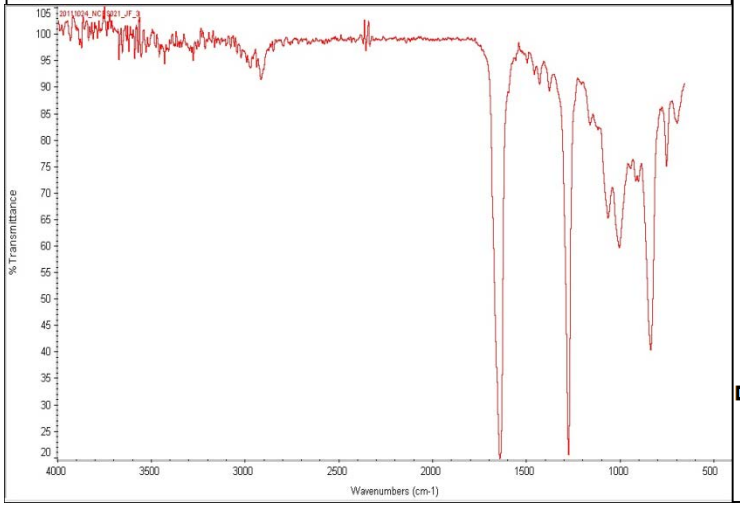
Sample detail & download section

Smokeless Powders Database: Sample Detail & Download









Powder Info

SRN	0139
Distributor	Hodgdon
Product Name	HS-6
Data Source	National Center for Forensic Science
Source SRN	NCFS21
Product use	Reload
Date obtained	7/18/11
Lot Number	041211 2218
Manufacturer	USA
Date Manufactured	
Date of Analysis	7/22/11
Comments	

Physical Description

Shape	flattened ball
Color	Black
Perforation	No
Distinguishing Features	
Luster	Dull
Marker Color	
Diameter	
avg.	0.9 mm
std. dev.	0.1
min.	0.06 mm
max.	1.1 mm
Length/thickness	
avg.	
std. dev.	
min.	
max.	

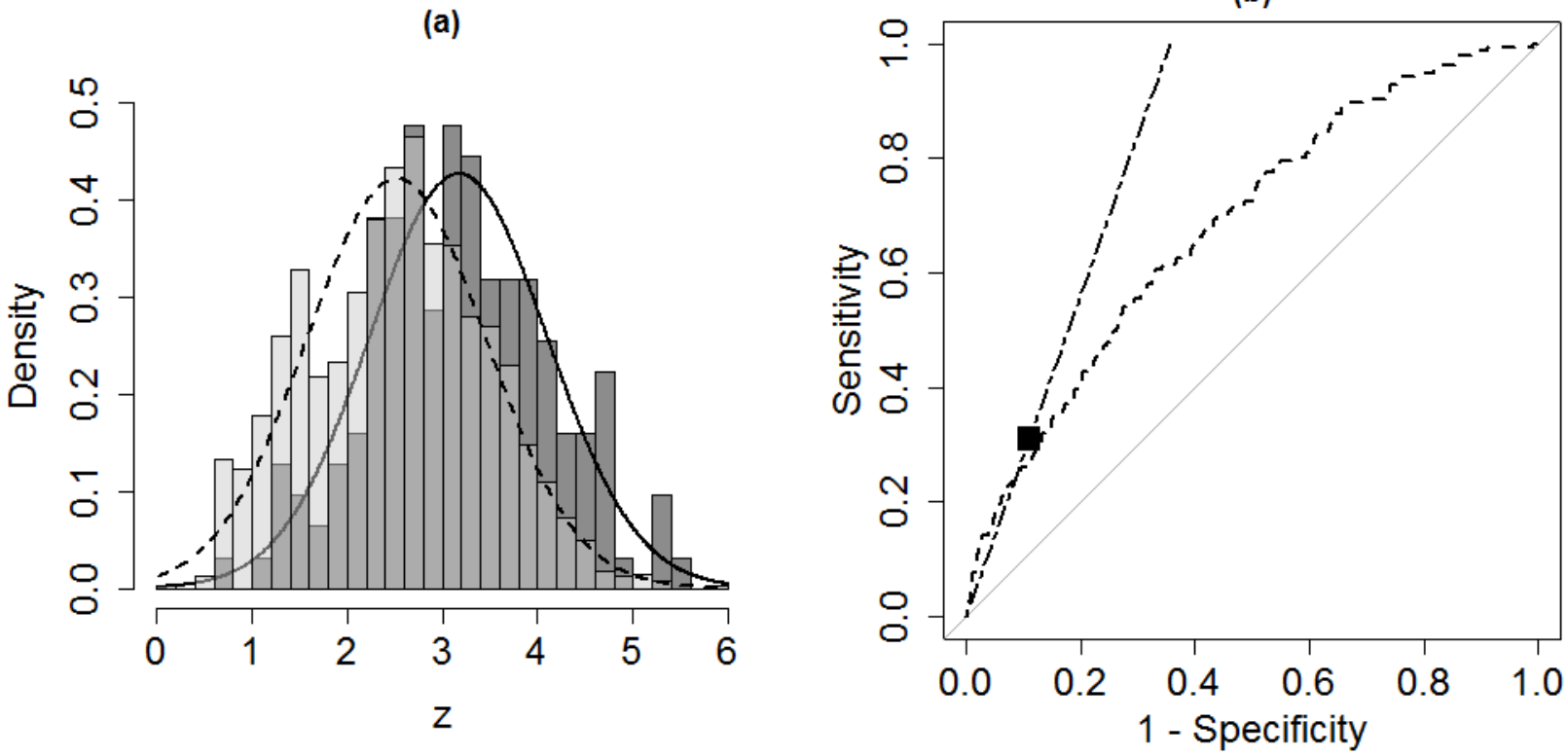
Chemistry

List of components	Nitroglycerin
	Diphenylamine
	Ethyl centralite
	Dibutyl phthalate
	2-nitrodiphenylamine
	4-nitrodiphenylamine
Other components	

Download

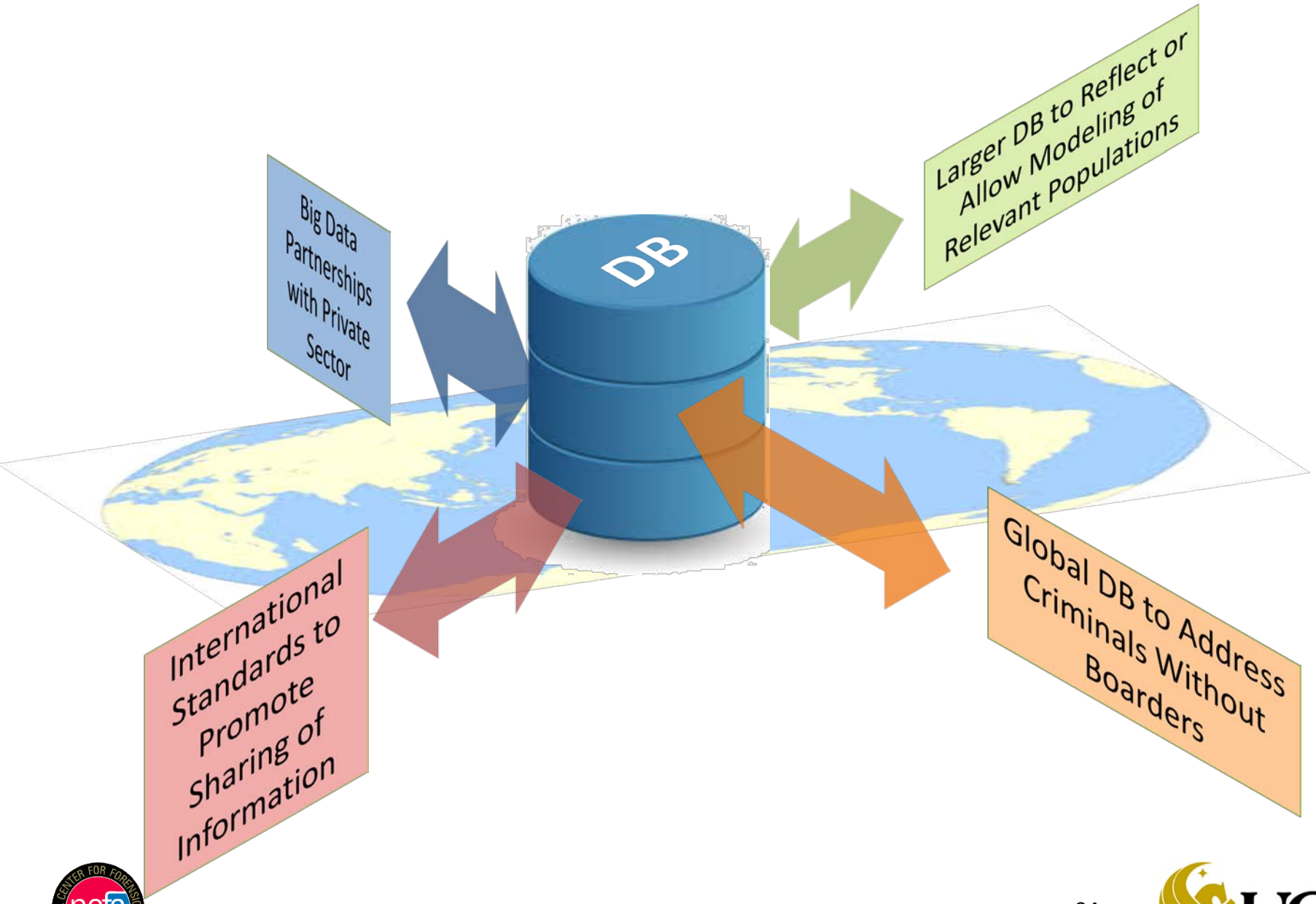
GC-MS dataset	FTIR dataset	MSDS	Physical Measurements
GC-MS_0000139.exe	ATR-FTIR_0000139.CSV	MSDS_Hodgdon_HS6.pdf	Measurments_0000139.xlsx

Evidentiary/Investigative Value of DB Match



Dana-Marie K. Dennis, Mary R. Williams, Michael E. Sigman "Assessing the evidentiary value of smokeless powder comparisons", Forensic Sci. International (**2016**) Vol. 259, p179–187.

Forensic Databases: Future Needs and Directions



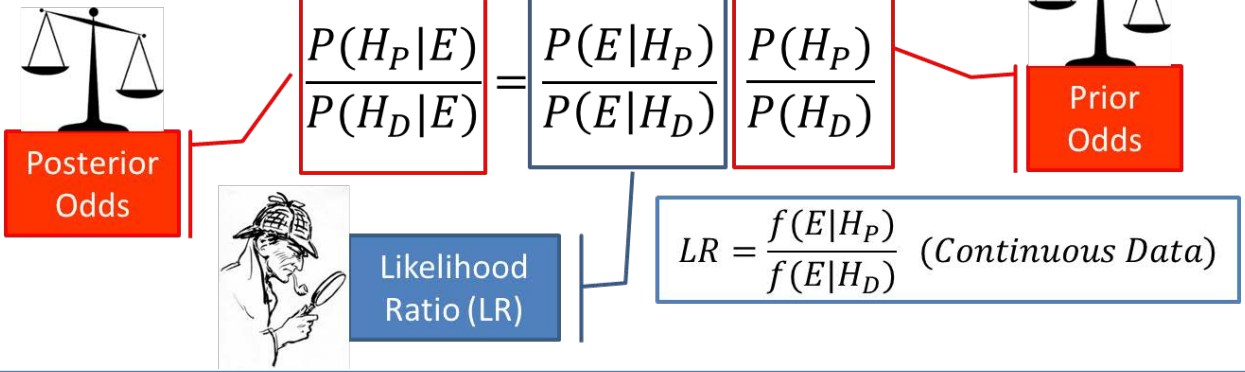
Trace Problems: Comparison & Classification

- Comparison Problem: Association between two or more items

C Champod, IW Evett, G Jackson " Establishing the most appropriate databases for addressing source level propositions", Science & Justice, **2004**, 44, 153 – 164.

- Classification Problem: Assign an object into one of several classes

Rarity, Variance, Feature correlation



Zadora et al. "Statistical Analysis in Forensic Science: Evidential Value of Multivariate Physicochemical Data", Wiley, UK, 2014.

Database vs Relevant Population

FL 1992-2013 (n=70,521)

- AR 331 (0.47%)
- GAS 23,243 (32.96%)
- ISO 219 (0.31%)
- MISC 4,104 (5.82%)
- NA 127 (0.18%)
- NP 233 (0.33%)
- OXY 860 (1.22%)
- PD 4,386 (6.22%)
- SUB 37,016 (52.49%)

ILRC + Substrate (n=1,305)

- AR 74 (5.67%)
- GAS 111 (8.51%)
- ISO 88 (6.74%)
- MISC 203 (15.56%)
- NA 58 (4.44%)
- NP 55 (4.21%)
- OXY 169 (12.95%)
- PD 337 (25.82%)
- SUB 210 (16.09%)

Carl E. Chasteen, B.S., CPM, F-ABC, Chief of Forensic Services, Bureau of Forensic Fire and Explosives Analysis, Division of State Fire Marshal, Department of Financial Services, State of Florida

Summary

- Databases:
  - 2 Ignitable Liquid, 1 Substrate, 1 Smokeless Powders
  - Designed for casework and training as partnerships with forensic community
  - Research applications have been secondary to casework
- Expansion and Future Databases
  - Should consider representation of relevant population
  - Should account for: rarity, variance, feature correlation
  - International databases
  - ANSI/ISO data standards to promote sharing of data
    - i.e., netCDF data files
  - Additional funding/Private sector partnerships

Thank you.

NCFS Ignitable Liquids and Explosives Research Group 2016.